BRANDING STRATEGY DEFINITIONS FOR HIGH TECHNOLOGY SERVICE FIRMS BY HYBRID MCDM METHODS

San-Yan Hsu, Institute of international Business Administration, Chinese Culture University
Chi-Yo Huang, National Taiwan Normal Univ., georgeh168@gmail.com
Wen-Rong Ho, Department of Banking and Finance, Chinese Culture University
Gwo-Hshiung Tzeng, Institute of Project Management, Kainan University

ABSTRACT

The high technology services industry emerged in the past decades, and provides services including manufacture, purchase, design and logistic instead of traditional high technology manufacturing industry's production, sales and marketing. At moment when the high technology service industry emerging, very few scholars tried to uncover the impacts of branding on a high technology service firm. Instead, most previous researches focused on general consumer goods industry. However, the empirical study results or theory constructions based on general consumer goods can't really be applied on high technology industry in general and high technology service industry in special. Thus, this research aims to investigate the factors influencing branding strategies for high technology service firms and derive the most suitable branding strategies. Further, develop a multi criteria decision making (MCDM) framework for branding strategy definitions in high technology service firms. First of this research, use the Decision Making Trial and Evaluation Laboratory (DEMATEL) for configuring the decision problem structure. Then, the Analytical Network Process (ANP) as the tool for calculating weights of each criterion. Finally, the Grey Relational Analysis (GRA) method will be introduced for deriving the relationships between criteria and the branding strategy solution. Thus, the alternatives have been proposed for used the branding strategy of a high technology service firm. The empirical study on IC design service companies will be leveraged for verifying the usefulness of this proposed analytic framework on branding strategies. The result of this research will be standards and suggestions of the business strategy for high technology service industry.

Keywords: Branding Strategy, High Technology Services, Multiple Criteria Decision Making (MCDM), Decision Making Trial and Evaluation Laboratory (DEMATEL), Analytic Network Process (ANP)

1. Introduction

The high-technology service industry has emerged recently. Those high technology service firms provide manufacturing, purchasing, design and logistics services not only to emphasize on production, sales, marketing, etc. The concept of branding in the high-tech marketing management is gaining increasing attention since there is a general consensus that the brand is becoming daily important as high-tech services are becoming accessible to mass consumers [25;27;39]. Therefore, managers must realize that the branding strategy has become daily important for the high technology service firms. Further, most previous research on the branding strategy focuses on general consumer goods industry. There is notably little empirical research concerning high-tech brands. According to Zambuni [42] writes: "an area that is less well understood that fast-moving consumer goods or services branding". The past research results or theory constructions based on consumer goods can't really be applied on high technology industry in general and high technology service industry in special.

However, after IBM more high technology services firms use the technology to manufacturing their goods. Further, the firms will market their products by many branding strategy. By summarizing Kotler's [17] viewpoint, branding strategy for a general (service) firm include line extension strategy, brand extension strategy, multi brands strategy and new brand strategy. The four strategic types correspond to Tauber [33] summarize viewpoint. Although some different literally, the meaning is no different. Such as introduce new brands in the existing product categories. Tauber called flanker brand strategy, and Kotler called multi-brand strategy. Further, the high technology service firms can find the best strategy to market their products. Thus, the purposes of the this research are twofold:(1) defining a multiple criteria decision making (MCDM) theories based high technology service firms branding strategy definition framework to resolve the above mentioned problem; (2) enhancing the competitiveness of high technology service firms in general and IC design service companies by using the branding strategy as the tool.

In this paper, the questionnaire included assessment criteria and branding strategy solution for the high technology services industry. The questionnaires were distributed to the director of Taiwan's IC design service companies. They will examine the criteria weight from the questionnaire.

This research is organized as follows. The related literature regarding to branding, branding strategy, high technology services and branding strategy of high technology firms will be reviewed in Section 2. The multiple criteria decision making (MCDM) method will be introduced in Section 3.The high technology services as a foundation for the empirical study to appear in Section 4. Discussion as well as managerial implications will be presented in Section 5. Finally, the whole article will be concluded in Section 6.

2. Literature Review

This Section demonstrates the basic concepts about branding strategy, high technology services, and the branding strategy of the high technology firms. Through past literature review to investigate the basic concepts of those names or theory.

2.1 Branding

The brand and branding are defined as follows:"A brand as a name, term, sign, symbol or design, or a combination of them intended to identify the goods and services of one seller or groups of sellers and to differentiate them from those of competition" [18;24].

De Chernatony and McDonald [5] describe a brand as, an identifiable product augmented in such a way that the buyer or user perceives relevant unique added values which match their needs most closely. Furthermore, its success results from being able to sustain these added values in the face of competition. "A brand as a product, but one that adds other dimensions that differentiate it in some way from other products designed to satisfy the same need" [16]. "Branding means the use of a name, term, symbol, or design or a combination of these to identify a product"[21].

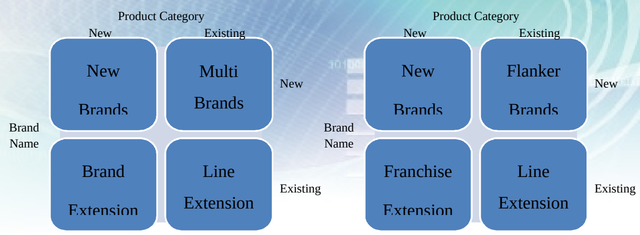
Firms are using branding as a strategy tool in today's business environment with increasing regularity. Organizations develop brands as a way to attract and keep customers by promoting value, image, prestige, or lifestyle [12]. Although brands and branding are not new ideas, firms are applying them to more diverse settings where the role of branding is becoming increasingly important [40]. Business historians agree that branding itself is over 100 years old, with the majority of countries having trademark acts to establish the legality of a protected asset by 1890. It was from 1800 through 1925 that was known as the richest period of name-giving [13].

2.2. Branding Strategy

Deriving a branding strategy involves deciding the nature of new and existing brand identities to be applied to new and existing products [16;18]. We summarizing Kotler's [17] viewpoint, branding strategy for a general (service) firm include (1) line extension strategy, (2) brand extension strategy, (3) multi brands strategy and (4) new brand strategy (For our summary, see Fig.1.). The branding strategies definition as follows:

(1) Line extension strategy occur when a company introduces additional items in a given category under the same brand name, such as new flavours, colours etc. (2) Brand extension strategy means to use a successful brand name to launch or modify products in a new category. (3) Multi brands strategy means a stable of brand names within the same product category. (4) New brands strategy means to introduce new brand names in a new product category.

The four strategic types correspond to Tauber [33] summarize viewpoint. Although some different literally, the meaning is no different. Such as introduce new brands in the existing product categories. Tauber called flanker brand strategy, and Kotler called multi-brand strategy (For our summary, see Fig.1.).



Source: Kotler [17]; Tauber [33]

Fig.1. Brand Strategy Matrix

2.3. High Technology Services

We compile the high technology services article. The literature review as follows. A revolution is at work in the high technology industry: the irresistible growth of business-to-business high tech services [38]. High tech services are the firms that offering a new range of sophisticated services to their corporate customers, quite different from the traditional hardware maintenance and repair services. Their business can be defined as offering value to their customers through services, based on innovative information technology (hardware and software) implemented by personnel who have required expertise and who rely heavily on methodology [38].

Successful innovation is crucial for firm survival in high-technology service industries. Effects of inter firm differences are investigated in the new service development phase of the innovation process [37]. Services involving the use of information and communication technology (ICT), contribute increasingly to the growth of the global economy. Revolutionary technological developments have created many opportunities for service innovation, while these new high-technology services potentially create significant value for providers as well as users [36]. As a consequence of the speed of technological developments and the related globalization of markets, most high-technology service providers currently experience hyper competition and exceptional turbulence in their marketplaces [1].

High technology services have some important distinguishing features [38]: (1) they are intangible; (2) their ownership is not transferred at the time of the purchasing; (3) customers are associated with them; (4) they are location independent but time dependent; (5) they are relatively homogeneous so they can be stored and quality controlled; (6)they cannot be easily demonstrated before purchasing.

Increasingly short product life cycles are the result, implying an urgent need for continuous, fast, and effective innovation [19]. At the same time, the trend in the macro environment of firms has turned high-technology service is necessary.

2.4 Branding Strategy of High Technology Firms

Ingredient branding is a special form of alliance between two brands, based on their cooperation for designing and delivering the product, with particular emphasis on the possibility to recognize and identify the used components in the final product [26]. An ingredient branding strategy pulls demand from end users through the distribution channel back to the original equipment manufacturers (OEMs), who feel pressure to use the branded ingredient in the goods they make. Business-to-business marketers will recognize this strategy as one designed to stimulate derived demand, whereby demand for the component, or ingredient, at the upstream level of the supply chain is derived from the end customers' demand (at the downstream level of the supply chain) for the products in which the components are used.(Fig. 2. will show the supply chain)

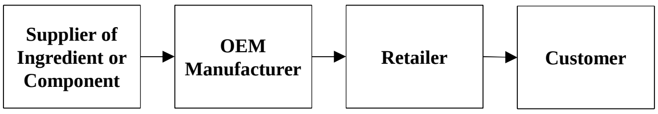


Fig.2. Ingredient Branding Supply Chain

Source: Mohr, et al. [22]

Ingredient branding seems to make the most sense when the supplier's "ingredient" is integrally related to the performance capabilities of the end product in which it embedded. For example, Intel's chip plays a key role in the performance capabilities of computers.

3. Methods

3.1 The DEMATEL Method

The DEMATEL method was developed by the Battelle Geneva Institute (1) to analyze complex 'world problems' dealing mainly with interactive man-model techniques; and (2) to evaluate qualitative and factor-linked aspects of societal problems [11]. The applicability of the method is widespread, ranging from industrial planning and decision-making to urban planning and design, regional environmental assessment, analysis of world problems, and so forth. It has also been successfully applied in many situations, such as marketing strategies, control systems, safety problems, developing the competencies of global managers and group decision-making [4;14]. Furthermore, a hybrid model combining the two methods has been widely used in various fields, for example, e-learning evaluation [34] and innovation policy portfolios for Taiwan's SIP Mall [14]. Therefore, in this paper we use DEMATEL not only to detect complex relationships and build a NRM of the criteria, but also to obtain the influence levels of each element over others; we then adopt these influence level values as the basis of the normalization supermatrix for determining ANP weights to obtain the relative importance. To apply the DEMATEL method smoothly, the authors refined the definitions based on above authors, and produced the essential definitions indicated below. The DEMATEL method is based upon graph theory, enabling us to plan and solve problems visually, so that we may divide multiple criteria into a relationship of cause and effect group, in order to better understand causal relationships. Directed graphs (also called digraphs) are more useful than directionless graphs, because digraphs will demonstrate the directed relationships of sub-systems. A digraph typically represents a communication network, or a domination relationship between individuals, etc. Suppose a system contains a set of elements, $S=\{s_1,s_2,\ldots,s_n\}$, and particular pair-wise relationships are determined for modeling, with respect to a mathematical relationship, MR. Next, portray the relationship MR as a direct-relation matrix that is indexed equally in both dimensions by elements from the set S. Then, extract the case for which the number 0 appears in the cell (i, j), if the entry is a positive integral that has the meaning of: the ordered pair (s_i, s_j) is in the relationship MR; it has the kind of relationship regarding that element such that s_i causes element s_j. The digraph portrays a contextual relationship between the elements of the system, in which a numeral represents the strength of influence. The elements s_1, s_2, s_3 and s_4 represent the factors that have relationships in Fig.3. The number between factors is influence or influenced degree. For example, an arrow from s_1 to s_2 represents the fact that s_1 influences s_2 and its influenced degree is two. The DEMATEL method can convert the relationship between the causes and effects of criteria into an intelligible structural model of the system [4].

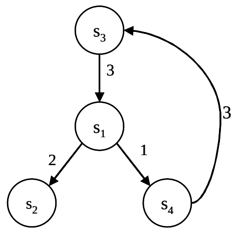


Fig.3. An Example of the Directed Graph

Definition 1: The pair-wise comparison scale may be designated as eleven levels, where the scores 0,1,2,…,10 represent the range from 'no influence' to 'very high influence'.

Definition 2: The initial direct relation/influence matrix $\boldsymbol{A}$ is an $n \times n$ matrix obtained by pair-wise comparisons, in terms of influences and directions between the determinants, in which a_{ij} is denoted as the degree to which the i^{th} determinant affects the j^{th} INC.

$$\boldsymbol{A}=\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

Definition 3: The normalized direct relation/influence matrix $\boldsymbol{N}$ can be obtained through Equations (1) and (2), in which all principal diagonal elements are equal to zero.

$$\boldsymbol{N} = z\boldsymbol{A}$$

$$z=\min\left\{1/\max_i \sum_{j=1}^{n} a_{ij}, 1/\max_j \sum_{i=1}^{n} a_{ij}\right\},$$

$$i, j \in \{1, 2, \ldots, n\}$$

In this case, $\boldsymbol{N}$ is called the normalized matrix. Since

$$\lim_{l\to\infty} \boldsymbol{N}^l = [0].$$

Definition 4: Then, the total relationship matrix $\boldsymbol{T}$ can be obtained using Equation (3), where $\boldsymbol{I}$ stands for the

identity matrix. $\boldsymbol{T} = \boldsymbol{N} + \boldsymbol{N}^2 + ... + \boldsymbol{N}^l = \boldsymbol{N}(\boldsymbol{I} - \boldsymbol{N})^{-1}$ (3)
where $l \to \infty$ and $\boldsymbol{T}$ is a total influence-related matrix; $\boldsymbol{N}$ is a direct influence matrix and $\boldsymbol{N} = [x_{ij}]_{n\times n}$; $\lim_{l\to\infty}\left(\boldsymbol{N}^2 + \cdots + \boldsymbol{N}^l\right)$ stands for a indirect influence matrix;

[Explanation]

$$\begin{aligned}
\boldsymbol{T} &= \boldsymbol{N} + \boldsymbol{N}^2 + \boldsymbol{N}^3 + ... + \boldsymbol{N}^l \\
&= \boldsymbol{N}(\boldsymbol{I} + \boldsymbol{N} + \boldsymbol{N}^2 + ... + \boldsymbol{N}^{l-1})(\boldsymbol{I} - \boldsymbol{N})(\boldsymbol{I} - \boldsymbol{N})^{-1} \\
&= \boldsymbol{N}(\boldsymbol{I} - \boldsymbol{N}^l)(\boldsymbol{I} - \boldsymbol{N})^{-1} \\
&= \boldsymbol{N}(\boldsymbol{I} - \boldsymbol{N})^{-1}, \text{when } l \to \infty, \quad \boldsymbol{N}^l = [0]_{n\times n} \qquad (3)
\end{aligned}$$

where $0 \le x_{ij} < 1$, $0 < \sum_{j=1}^{n} x_{ij} \le 1$ and $0 < \sum_{i=1}^{n} x_{ij} \le 1$, at least one row or column of summation is equal to 1, but not all , then $\lim_{l\to\infty} \boldsymbol{N}^l = [0]_{n\times n}$.

The (i, j) element t_{ij} of matrix $\boldsymbol{T}$ denotes the direct and indirect influences of factor i on factor j .

Definition 5: The row and column sums are separately denoted as $\boldsymbol{r}$ and $\boldsymbol{c}$ within the total-relation matrix $\boldsymbol{T}$ through Equations (4), (5), and (6).

$$\boldsymbol{T} = [t_{ij}], \quad i, j \in \{1, 2, ..., n\} \qquad (4)$$

$$\boldsymbol{r} = [r_i]_{n\times 1} = \left(\sum_{j=1}^{n} t_{ij}\right)_{n\times 1} \qquad (5)$$

$$\boldsymbol{c} = [c_j]_{n\times 1} = \left(\sum_{i=1}^{n} t_{ij}\right)'_{1\times n} \qquad (6)$$

where the $\boldsymbol{r}$ and $\boldsymbol{c}$ vectors denote the sums of the rows and columns, respectively.

Definition 6: Suppose r_i denotes the row sum of the i^{th} row of matrix $\boldsymbol{T}$. Then, r_i is the sum of the influences dispatching from factor i to the other factors, both directly and indirectly. Suppose that c_j denotes the column sum of the j^{th} column of matrix $\boldsymbol{T}$. Then, c_j is the sum of the influences that factor i is receiving from the other factors. Furthermore, when $i = j$ (i.e., the sum of the row sum and the column sum $(r_i + c_i)$ represents the index representing the strength of the influence, both dispatching and receiving), $(r_i + c_i)$ is the degree of the central role that factor i plays in the problem. If $(r_i - c_i)$ is positive, then factor i primarily is dispatching influence upon the strength of other factors; and if $(r_i - c_i)$ is negative, then factor i primarily is receiving influence from other factors [14;20;32].

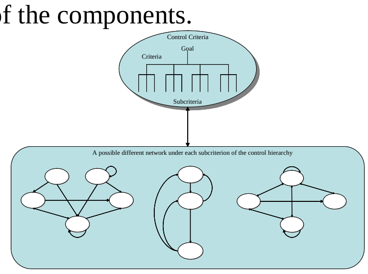
3.2 The Analytic Network Process Method

The ANP method, a multi criteria theory of measurement developed by Saaty [28], provides a general framework to deal with decisions without making assumptions about the independence of higher-level elements from lower level elements and about the independence of the elements within a level as in a hierarchy. Compared with traditional AHP (Analytic Hierarchy Process) [31] based applications which usually assume the independence between criteria, ANP, a new theory that extends AHP to deal with dependence in feedback and utilizes the supermatrix approach [28], is a more reasonable tool for dealing with complex MCDM problems in the real world. In this section, concepts of the ANP are summarized based on Saaty's earlier works [28;29;31].

The ANP is a coupling of two parts. The first consists of a control hierarchy or network of criteria and subcriteria that control the interactions. The second is a network of influences among the elements and clusters. The network varies from criterion to criterion and a different supermatrix of limiting influence is computed for each control criterion. Finally, each of these supermatrices is weighted by the priority of its control criterion and the results are synthesized through addition for all the control criteria [30]. A control hierarchy is a hierarchy of criteria and subcriteria for which priorities are derived in the usual way with respect to the goal of the system being considered.

The criteria are used to compare the components of a system, and the subcriteria are used to compare the elements. The criteria with respect to which influence is presented in individual supermatrices are called control criteria. Because all such influences obtained from the limits of the several supermatrices will be combined in order to obtain a measure of the priority of overall influences, the control criteria should be grouped in a structure to be used to derive priorities for them. These priorities will be used to weight the corresponding individual supermatrix limits and add. Analysis of priorities in a system can be thought of in terms of a control hierarchy with dependence among its bottom-level alternatives arranged as a network as shown in Fig.4. Dependence can occur within the components and between them.

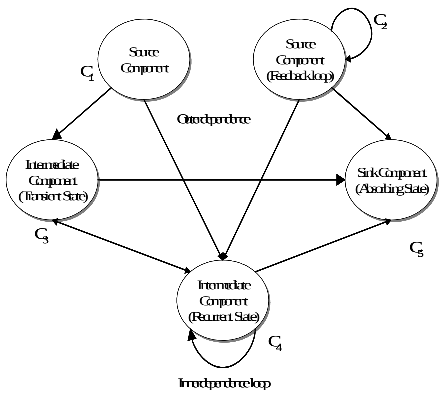
A control hierarchy at the top may be replaced by a control network with dependence among its components, which are collections of elements whose functions derive from the synergy of their interaction and hence has a higher-order function not found in any single element. The criteria in the control hierarchy that are used for comparing the components are usually the major parent criteria whose subcriteria are used to compare the elements need to be more general than those of the elements because of the greater complexity of the components.



Source: Saaty [28]

Fig.4. The Control Hierarchy

A network connects the components of a decision system. According to size, there will be a system that is made up of subsystems, with each subsystem made up of components, and each component made up of elements. The elements in each component interact or have an influence on some or all of the elements of another component with respect to a property governing the interactions of the entire system, such as energy, capital, or political influence. Fig.5 demonstrates a typical network. Those components which no arrow enters are known as source components such as $\mathbf{C}_1$ and $\mathbf{C}_2$. Those from which no arrow leaves are known as sink component such as $\mathbf{C}_5$. Those components which arrows both enter and exit leave are known as transient components such as $\mathbf{C}_3$ and $\mathbf{C}_4$. In addition, $\mathbf{C}_3$ and $\mathbf{C}_4$ form a cycle of two components because they feed back and forth into each other. $\mathbf{C}_2$ and $\mathbf{C}_4$ have loops that connect them to themselves and are inner dependent. All other connections represent dependence between components which are thus known to be outer dependent.



Source: Saaty [28]

Fig.5. Connections in a Network

A component of a decision network which was derived by the DEMATEL method in Section 3.1 will be denoted by $\boldsymbol{C}_h, h=1,\cdots,m,$ and assume that it has n_h elements (determinants), which we denote by $e_{h1},\ e_{h2},\cdots,\ e_{hm}$. The influences of a given set of elements (determinants) in a component on any element in the decision system are represented by a ratio scale priority vector derived from paired comparisons of the comparative importance of one criterion and another criterion with respect to the interests or preferences of the decision makers. This relative importance value can be determined using a scale of 1–9 to represent equal importance to extreme importance [28]. The influence of elements (determinants) in the network on other elements (determinants) in that network can be represented in the following supermatrix $\boldsymbol{W}$.

A typical entry $\boldsymbol{W}_{ij}$ in the supermatrix, is called a block of the supermatrix in the following form where each column of $\boldsymbol{W}_{ij}$ is a principal eigenvector of the influence of the elements (determinants) in the i^{th} component of the network on an element (determinants) in the j^{th} component. Some of its entries may be zero corresponding to those elements (determinants) that have no influence.

$$\boldsymbol{W} = \begin{array}{cc} & \begin{array}{ccccccccccc} & \boldsymbol{C}_1 & & & \boldsymbol{C}_2 & & \cdots & & \boldsymbol{C}_m & \\ e_{11} & \cdots & e_{1n_1} & e_{21} & \cdots & e_{2n_2} & \cdots & e_{m1} & \cdots & e_{mn_m} \end{array} \\ \begin{array}{cc} & e_{11} \\ & e_{12} \\ \boldsymbol{C}_1 & \vdots \\ & e_{1n_1} \\ & e_{21} \\ & e_{22} \\ \boldsymbol{C}_2 & \vdots \\ & e_{2n_2} \\ \vdots & \vdots \\ & e_{m1} \\ & e_{m2} \\ \boldsymbol{C}_2 & \vdots \\ & e_{mn_m} \end{array} & \begin{bmatrix} \boldsymbol{W}_{11} & \boldsymbol{W}_{12} & \cdots & \boldsymbol{W}_{1m} \\ \boldsymbol{W}_{21} & \boldsymbol{W}_{22} & \cdots & \boldsymbol{W}_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ \boldsymbol{W}_{m1} & \boldsymbol{W}_{m2} & \cdots & \boldsymbol{W}_{mm} \end{bmatrix} \end{array}$$

$$\boldsymbol{W}_{ij} = \begin{bmatrix} w_{i_1 j_1} & w_{i_1 j_2} & \cdots & w_{i_1 j_{n_j}} \\ w_{i_2 j_2} & w_{i_2 j_2} & \cdots & w_{i_2 j_{n_j}} \\ \vdots & \vdots & \ddots & \vdots \\ w_{i_{n_i} j_1} & w_{i_{n_i} j_2} & \cdots & w_{i_{n_i} j_{n_j}} \end{bmatrix}$$

After forming the supermatrix, the weighted supermatrix is derived by transforming all columns sum to unity exactly. This step is very much similar to the concept of the Markov chain in terms of ensuring that the sum of these probabilities of all states equals 1. Next, the weighted supermatrix is raised to limiting powers, such as Equation (7) to get the global priority vector or called weights [15].

$$\lim_{\theta\to\infty} \boldsymbol{W}^{\theta} \tag{7}$$

In addition, if the supermatrix has the effect of cyclicity, the limiting supermatrix is not the only one. There are two or more limiting supermatrices in this situation, and the Cesaro sum would need to be calculated to get the priority. The Cesaro sum is formulated as follows.

$$\boldsymbol{w} = \lim_{\psi\to\infty} \left(\frac{1}{\nu}\right) \sum_{j=1}^{\nu} \boldsymbol{W}_j^{\psi}$$

To calculate the average effect of the limiting supermatrix (i.e. the average priority weights can be shown by the vector $\boldsymbol{w}$) where $\boldsymbol{W}_j$ denotes the j^{th} limiting supermatrix. Otherwise, the supermatrix would be raised to large powers to get the priority weights [15]. The weights of the k^{th} determinants derived by using the above ANP processes, namely $\omega_k,\ k\in\{1,2,...,n\}$, will be used as weights for aggregating the performance score versus each alternative.

3.3 Grey Relational Analysis

Since Deng [6] proposed Grey theory, related models have been developed and applied to MCDM problems. Similar to fuzzy set theory, Grey theory is a feasible mathematical means that can be used to deal with systems analysis characterized by inadequate information. Fields covered by the Grey theory include systems analysis, data processing, modeling, prediction, decision-making, and control engineering [7;9;10;35]. In this section, we briefly review some relevant definitions and the calculation process for the Grey Relation Model. This research modified the definitions by Chiou and Tzeng [3] and produced the definitions indicated below. GRA is used to determine the relationship between two sequences of stochastic data in a Grey system. The procedure bears some similarity to pattern recognition technology. One sequence of data is called the 'reference pattern' or 'reference sequence,' and the correlation between the other sequence and the reference sequence is to be identified [8;23;41;35]. The relationship scale also may be designated into eleven levels, where the scores 0,1,2,…,10 represent the range from 'no relationship' to 'very high relationship' between the specified evaluation criteria and the fuel cell technologies. The initial relationship matrix $\boldsymbol{G}$ is a $m \times n$ matrix, where there are m $(k = 1, 2, ..., m)$ fuel cell technologies and n criteria $(j = 1, 2, ..., n)$, obtained by surveying the relationships, where g_{kj} is denoted as the relationship between the j^{th} criterion and the k^{th} technology.

$$\boldsymbol{G} = \begin{bmatrix} g_{11} & \cdots & g_{1j} & \cdots & g_{1n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ g_{k1} & \cdots & g_{kj} & \cdots & g_{kn} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ g_{m1} & \cdots & g_{mj} & \cdots & g_{mn} \end{bmatrix}$$

The normalized relationship matrix $\boldsymbol{G}$ can be obtained through Equations (9) and (10).

$$x_k(j) = \frac{g_{kj}}{aspiration - value\ x_0(j)} \tag{9}$$

$$\boldsymbol{X} = \begin{bmatrix} x_1(1) & \cdots & x_1(j) & \cdots & x_1(n) \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_k(1) & \cdots & x_k(j) & \cdots & x_k(n) \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_m(1) & \cdots & x_m(j) & \cdots & x_m(n) \end{bmatrix} \tag{10}$$

In this case, let $\boldsymbol{x}_0$ be the aspiration-value vector with n criteria: $\boldsymbol{x}_0 = (x_0(1), ..., x_0(j), ..., x_0(n)) = (10, ..., 10, ..., 10)$ and the matrix containing the normalized mapping information of each strategy (fuel cell technology) to the innovation competence (criteria), be one of the m strategic patterns with n criteria to be compared with the aspiration vector $\boldsymbol{x}_0$ where $\boldsymbol{x}_k$ is written as: when $x_{kj} = x_k(j)$, $j = 1, 2, ..., n$ in Eqs (9) and (10), then $\boldsymbol{x}_k = (x_k(1), ..., x_k(j), ..., x_k(n))$, $k = 1, 2, ..., m$. How much grade of strategy $\boldsymbol{x}_k$ close to aspiration level $\boldsymbol{x}_0$ in cell technology. Let $\boldsymbol{X}$ be a normalized strategic performance set of grey relations, $\boldsymbol{x}_0 \in \boldsymbol{X}$ the aspiration level for referential sequence, and $\boldsymbol{x}_k \in \boldsymbol{X}$ the kth strategy for comparative sequence; with $x_0(j)$ and $x_k(j)$ representing the numerals at criterion j for $\boldsymbol{x}_0$ and $\boldsymbol{x}_k$, respectively. If $\gamma(x_0(j), x_k(j))$ and $\gamma(\boldsymbol{x}_0, \boldsymbol{x}_k)$ are real numbers, and satisfy the grey axioms being defined in Deng [8], then call $\gamma(x_0(j), x_k(j))$ the grey relation coefficient, and the grade of the grey relation $\gamma(\boldsymbol{x}_0, \boldsymbol{x}_k)$ is the average value of $\gamma(x_0(j), x_k(j))$. Deng also proposed a mathematical equation for the grey relation coefficient, as follows:

$$\gamma(x_0(j), x_k(j)) =$$

$$\frac{\min_k \min_j \left|(x_0(j) - x_k(j))\right| + \zeta \max_k \max_j \left|(x_0(j) - x_k(j))\right|}{\left|(x_0(j) - x_k(j))\right| + \zeta \max_k \max_j \left|(x_0(j) - x_k(j))\right|} \tag{11}$$

where ζ is the coefficient ($\zeta \in [0,1]$). Generally, ζ =0.5.

Based on Deng [8], if the grey relation coefficient in $x_k(j)$ corresponding to $x_0(j)$ is $\gamma(x_0(j), x_k(j))$, then the grey relation grade in $\boldsymbol{x}_k$ corresponding to $\boldsymbol{x}_0$, $\gamma(\boldsymbol{x}_0, \boldsymbol{x}_k)$, must satisfy the following four axioms.

1. Norm Interval

$0 < \gamma(x_0(j), x_k(j)) \le 1,\ \forall j;\ \gamma(\boldsymbol{x}_0, \boldsymbol{x}_k) = 1\ iff\ \boldsymbol{x}_0 = \boldsymbol{x}_k;$

$\gamma(x_0, x_k) = 0\ iff\ x_0, x_k \in \varnothing;$

where $\varnothing$ is an empty set.

2. Duality Symmetric

$\boldsymbol{x}, \boldsymbol{y} \in \boldsymbol{X} \ \Rightarrow\ \gamma(\boldsymbol{x}, \boldsymbol{y}) = \gamma(\boldsymbol{y}, \boldsymbol{x})\ iff\ \boldsymbol{X} = \{\boldsymbol{x}, \boldsymbol{y}\}.$

3. Wholeness

$\gamma(\boldsymbol{x}_k, \boldsymbol{x}_{k'}) \overset{often}{\neq} \gamma(\boldsymbol{x}_{k'}, \boldsymbol{x}_k)$

$iff\ \ \boldsymbol{X} = \{\boldsymbol{x}_k \mid k = 0, 1, \ldots, m\},\ m > 2.$

4. Approachability

$\gamma(x_0(j), x_k(j))$ decreases when $\left|(x_0(j) - x_k(j))\right|$ increases.

If $\gamma(\boldsymbol{x}_0, \boldsymbol{x}_k)$ satisfies the four grey relation axioms, then γ is called the Grey Relational Map. If Γ is the entirety of the grey relational map, $\gamma \in \Gamma$ satisfies the four axioms of the grey relation, and X is the factor set of the grey relation, then $(\boldsymbol{X}, \Gamma)$ will be called the grey relational space, while γ is the specific map for Γ. Let $(\boldsymbol{X}, \Gamma)$ be the grey relational space, and if $\gamma(\boldsymbol{x}_0, \boldsymbol{x}_k)$, $\gamma(\boldsymbol{x}_0, \boldsymbol{x}_p)$, …, $\gamma(\boldsymbol{x}_0, \boldsymbol{x}_q)$ satisfy $\gamma(\boldsymbol{x}_0, \boldsymbol{x}_k) > \gamma(\boldsymbol{x}_0, \boldsymbol{x}_p) > ... > \gamma(\boldsymbol{x}_0, \boldsymbol{x}_q)$ then we have the grey relational order: $\boldsymbol{x}_k \succ \boldsymbol{x}_p \succ ... \succ \boldsymbol{x}_q$. When the grey relational coefficient is conducted with respect to various fuel cell technologies, we then can derive the grade of the grey relation $\gamma(\boldsymbol{x}_0, \boldsymbol{x}_k)$ between the reference alternative

$$\gamma(\boldsymbol{x}_0, \boldsymbol{x}_k) = \sum_{j=1}^{n} w_j \times \gamma(x_0(j), x_k(j)). \tag{12}$$

where j is the number of criteria (innovation competences), w_j expresses the weight of the j^{th} criterion, by ANP and $\gamma(\boldsymbol{x}_0, \boldsymbol{x}_k)$ represents the grade of grey relation in $\boldsymbol{x}_k$ (shown as k^{th} manufacturing or logistics strategy) correspondence to $\boldsymbol{x}_0$ (aspiration level). In this study, we make the order of the strategies following the grade of grey relation.

4. Analyzing the Factors Influencing Branding Strategies

This Section shows the IC design service industry introduction first. Then, thirteen criteria belong to four aspect, brand equity, cost, industrial structure and environment, are summarized from literature and experts' viewpoint. Finally, an Empirical Study on High Technology Service industries' branding strategies will be introduced. The detailed process for this empirical study will be introduced as following.

4.1 The IC Design Service Industry Introduction

The IC design service industry is a high technology knowledge industry. Throughout the value chain system, the industry stresses the importance of vertical disintegration. The IC design service is a new business model emerging as a vertical disintegration product in the IC industry. We codify the IC design service industry development from the 1970s to the 2000s. In the 1970s, including IC design and an integrated device manufacturer (IDM) fabrication assembly test, the IC industry combines multi-processes into one complete system. Then, IC-designs and IDM separated from one complete set system to develop two subsystems of IC design and IDM fabrication in the 1980s. Further, including IC design and IDM fabrication and assembly continue developed. The IC industry after the 1980s modified processing to include the system, IC design, IDM fabrication, IC foundry, IC assembly and IC test on the subsystem. After 2000, the IC design subsystem expands from one to three parts, including system in package (SIP), design system and IC design. Thus, the IC design service industry has become an important process of the IC design system [2].

Meanwhile, the IC design service industry is multi-dimensional and highly competitive industry. When the company decided to develop branding strategies, the MCDM model can helps to selection the suitably solutions in the IC design service industry.

4.2 Criteria and Alternatives Derivations

Ten experts in IC design service companies were invited to evaluate each of the first four criteria of the function aspect. (For our summary, see Table 1)

Table 1 Aspect and Criteria for Branding Strategies Selection

Aspect	Criteria
Brand Equity (A_1)	(c_1) Brand Loyalty
	(c_2)Brand Awareness
	(c_3)Brand Association
	(c_4)Perceived Quality
Cost (A_2)	(c_5)Price
	(c_6)Human Capital
	(c_7)R&D Expenditure

Aspect	Criteria
Industrial Structure (A_3)	(c_8) Industry Life Cycle
	(c_9) Industrial Division
	(c_{10}) Extent of Competition
Environment (A_4)	(c_{11}) Company Size
	(c_{12}) Company Credibility
	(c_{13}) Time to Market

Source: This Research

4.3 An Empirical Study on High Technology Service industries' branding strategies

First, the structure of branding strategies selection problem was established by using the DEMATEL. Then, using the ANP method derived the weight versus each criterion. Finally, the Grey Relational Analysis (GRA) method will be introduced for deriving the relationships between criteria and the branding strategy solution.

Since the inter-relationship for individual dimensions between criteria which are summarized through the literature review and professional experts based brainstorming process. All of the criteria of the aspects decision problem structure will be deducted by using the DEMATEL method which was introduced in Section 3.1.

At first, the direct relation matrix $\boldsymbol{A}_1$ is individual introduced as shown in Fig.6-1 according to the experts' opinions on pair-wise comparisons in terms of influence and direction between evaluation criteria. After that, the normalized direct relation matrix $\boldsymbol{N}_1$ is shown in Fig.6-2 and the normalized direct relation matrix $\boldsymbol{N}_1$ is normalized based on Equation (1). Finally, the total relationship matrix $\boldsymbol{T}_1$ shown in Fig.6-3 and the total relationship matrix $\boldsymbol{T}_1$ is deducted based on Equation (3). At the same time, in accordance with the above steps on other aspects and criteria by using the DEMATEL method. Following, the detailed process by using the DEMATEL method will be introduced.

$$A_1 = \begin{bmatrix} 0.000 & 3.316 & 3.409 & 4.136 \\ 3.977 & 0.000 & 3.977 & 3.705 \\ 3.614 & 3.568 & 0.000 & 2.932 \\ 4.273 & 3.909 & 4.091 & 0.000 \end{bmatrix}$$

Fig.6-1 The Direct Relation Matrix $\boldsymbol{A}_1$

$$N_1 = \begin{bmatrix} 0.000 & 0.256 & 0.278 & 0.337 \\ 0.324 & 0.000 & 0.324 & 0.302 \\ 0.294 & 0.291 & 0.000 & 0.239 \\ 0.348 & 0.319 & 0.333 & 0.000 \end{bmatrix}$$

Fig.6-2 The Normalized Direct Relation Matrix $\boldsymbol{N}_1$

$$T_1 = \begin{bmatrix} 2.370 & 2.378 & 2.526 & 2.457 \\ 2.768 & 2.315 & 2.703 & 2.579 \\ 2.486 & 2.297 & 2.200 & 2.295 \\ 2.883 & 2.649 & 2.807 & 2.442 \end{bmatrix}$$

Fig.6-3 The Total Relationship Matrix $\boldsymbol{T}_1$

Fig.6. Decision Problem Structuring for Brand Equity

$$A_2 = \begin{bmatrix} 0.000 & 3.705 & 3.886 \\ 4.000 & 0.000 & 3.818 \\ 4.545 & 3.545 & 0.000 \end{bmatrix}$$

Fig.7-1 The Direct Relation Matrix $\boldsymbol{A}_2$

$$N_2 = \begin{bmatrix} 0.000 & 0.434 & 0.455 \\ 0.468 & 0.000 & 0.447 \\ 0.532 & 0.415 & 0.000 \end{bmatrix}$$

Fig.7-2 The Normalized Direct Relation Matrix $\boldsymbol{N}_2$

$$T_2 = \begin{bmatrix} 3.565 & 3.487 & 3.634 \\ 3.955 & 3.248 & 3.697 \\ 4.069 & 3.617 & 3.467 \end{bmatrix}$$

Fig.7-3 The Total Relationship Matrix $\boldsymbol{T}_2$

Fig.7. Decision Problem Structuring for Cost

$$A_3 = \begin{bmatrix} 0.000 & 3.909 & 3.818 \\ 3.273 & 0.000 & 3.545 \\ 4.545 & 3.545 & 0.000 \end{bmatrix}$$

Fig.8-1 The Direct Relation Matrix $\boldsymbol{A}_3$

$$N_3 = \begin{bmatrix} 0.000 & 0.483 & 0.472 \\ 0.404 & 0.000 & 0.438 \\ 0.562 & 0.438 & 0.000 \end{bmatrix}$$

Fig.8-2 The Normalized Direct Relation Matrix $\boldsymbol{N}_3$

$$T_3 = \begin{bmatrix} 4.578 & 4.763 & 4.720 \\ 4.492 & 4.074 & 4.343 \\ 5.102 & 4.899 & 4.555 \end{bmatrix}$$

Fig.8-3 The Total Relationship Matrix $\boldsymbol{T}_3$

Fig.8. Decision Problem Structuring for Industrial Structure

$$A_4 = \begin{bmatrix} 0.000 & 4.455 & 3.364 \\ 3.023 & 0.000 & 2.568 \\ 2.523 & 2.659 & 0.000 \end{bmatrix}$$

Fig.9-1 The Direct Relation Matrix $\boldsymbol{A}_4$

$$N_4 = \begin{bmatrix} 0.000 & 0.570 & 0.430 \\ 0.387 & 0.000 & 0.328 \\ 0.323 & 0.340 & 0.000 \end{bmatrix}$$

Fig.9-2 The Normalized Direct Relation Matrix $\boldsymbol{N}_4$

$$T_4 = \begin{bmatrix} 1.155 & 1.737 & 1.498 \\ 1.195 & 1.089 & 1.200 \\ 1.102 & 1.271 & 0.892 \end{bmatrix}$$

Fig.9-3 The Total Relationship Matrix $\boldsymbol{T}_4$

Fig.9. Decision Problem Structuring for Environment

$$A_5 = \begin{bmatrix} 0.000 & 2.841 & 2.568 & 3.114 \\ 2.955 & 0.000 & 3.727 & 3.182 \\ 2.977 & 3.818 & 0.000 & 3.364 \\ 3.432 & 3.614 & 2.795 & 0.000 \end{bmatrix}$$

Fig.10-1 The Direct Relation Matrix $\boldsymbol{A}_5$

$$N_5 = \begin{bmatrix} 0.000 & 0.277 & 0.250 & 0.303 \\ 0.288 & 0.000 & 0.363 & 0.310 \\ 0.290 & 0.372 & 0.000 & 0.327 \\ 0.334 & 0.352 & 0.272 & 0.000 \end{bmatrix}$$

Fig.10-2 The Normalized Direct Relation Matrix $\boldsymbol{N}_5$

$$T_5 = \begin{bmatrix} 3.031 & 3.467 & 3.173 & 3.335 \\ 3.629 & 3.655 & 3.609 & 3.724 \\ 3.706 & 4.007 & 3.418 & 3.811 \\ 3.632 & 3.886 & 3.532 & 3.461 \end{bmatrix}$$

Fig.10-3The Total Relationship Matrix $\boldsymbol{T}_5$

Fig.10. Decision Problem Structuring between Each Aspects
Source: This Research

Based on the ANP being introduced in Section 3, the weights versus each criterion can be derived. Based on the decision problem structure being derived by the DEMATEL, the ANP method can be applied for calculating the weight versus each criterion. The limit super matrix ***W*** is calculated and shown in all of Figure 11. Then, the performance values of the evaluation criteria being rated against each criterion and aggregated are presented in all of Table 2.

$$W = \begin{bmatrix} 1.000 & 1.022 & 1.070 & 0.958 & 1.045 & 1.460 & 1.252 & 1.211 & 1.296 & 1.108 & 0.958 & 1.057 & 1.559 \\ 0.978 & 1.000 & 1.047 & 0.938 & 1.023 & 1.429 & 1.224 & 1.184 & 1.268 & 1.084 & 0.938 & 1.034 & 1.525 \\ 0.935 & 0.956 & 1.000 & 0.896 & 0.977 & 1.365 & 1.170 & 1.132 & 1.211 & 1.036 & 0.896 & 0.989 & 1.458 \\ 1.043 & 1.067 & 1.116 & 1.000 & 1.091 & 1.524 & 1.306 & 1.263 & 1.352 & 1.157 & 1.000 & 1.103 & 1.627 \\ 0.957 & 0.978 & 1.023 & 0.917 & 1.000 & 1.397 & 1.197 & 1.158 & 1.239 & 0.254 & 0.917 & 1.011 & 1.492 \\ 0.685 & 0.700 & 0.733 & 0.656 & 0.716 & 1.000 & 0.857 & 0.829 & 0.887 & 0.759 & 0.656 & 0.724 & 1.068 \\ 0.799 & 0.817 & 0.855 & 0.766 & 0.835 & 1.167 & 1.000 & 0.967 & 1.035 & 0.886 & 0.766 & 0.845 & 1.246 \\ 0.826 & 0.844 & 0.884 & 0.792 & 0.864 & 1.206 & 1.034 & 1.000 & 1.035 & 0.916 & 0.792 & 0.874 & 1.288 \\ 0.772 & 0.789 & 0.826 & 0.740 & 0.807 & 1.127 & 0.966 & 0.934 & 1.000 & 0.855 & 0.740 & 0.816 & 1.203 \\ 0.902 & 0.922 & 0.965 & 0.865 & 0.943 & 1.317 & 1.129 & 1.092 & 1.169 & 1.000 & 0.865 & 0.954 & 1.407 \\ 1.043 & 1.067 & 1.116 & 1.000 & 1.091 & 1.524 & 1.306 & 1.263 & 1.352 & 1.157 & 1.000 & 1.103 & 1.627 \\ 0.946 & 0.967 & 1.012 & 0.906 & 0.989 & 1.381 & 1.184 & 1.145 & 1.225 & 1.048 & 0.906 & 1.000 & 1.475 \\ 0.641 & 0.656 & 0.686 & 0.615 & 0.670 & 0.937 & 0.803 & 0.776 & 0.831 & 0.711 & 0.615 & 0.678 & 1.000 \end{bmatrix}$$

Fig.11. The Limit Super Matrix ***W*** of Branding Strategies Selection

Table 2 The Weight of the Criteria for Branding Strategies Selection

Criteria	c_1	c_2	c_3	c_4	c_5	c_6	c_7
Weight	0.067	0.068	0.072	0.064	0.07	0.098	0.084

Criteria	c_8	c_9	c_{10}	c_{11}	c_{12}	c_{13}
Weight	0.081	0.087	0.07	0.064	0.071	0.104

Source: This Study

After constructing the structure of the decision problem, weights versus each criterion was derived by using the ANP (refer Table 2). The GRA is applied to derive the relationships between criteria and Branding Strategies then. The initial relationship matrix for deriving branding strategy, G, is a 5×13 matrix, where there are five branding strategies and thirteen determinants for high technology industry, obtained by surveying the relationships, The normalized relationship matrix $\boldsymbol{X}$ can be obtained through Equations (9) and (10). The grey relation coefficients can be calculated by using Equation (11). By setting the distinguished coefficient ζ as 0.5, the Grey relation coefficients were derived. Then the grades of Grey relation $\gamma(x_0, x_i)$ were derived. We established the result that Type 1 f Type4 f Type2 f Type5 f Type 3. Finally, the Grey grades versus each branding strategy were derived and shown in Table 3.

Table 3 The grades of Grey relation with respect to branding strategy ($\zeta = 0.5$)

Type	Branding Strategy	Gray Grade
1	New brands	0.798
2	Multi brands	0.616
3	Brand extension	0.589
4	Line extension	0.700
5	Ingredient brand	0.597

5. Discussion

The new brands strategy is ranked as the best and suitable branding strategy solution while the line extension is ranked as the second better solution in this study.

Based on the result, it is apparent that since the high technology services industry development, the high technology service firms not only need get profit, they should to develop branding strategies to enhance competitive power and extend the enterprise value. In addition, most previous research of the branding strategies only discuss with general consumer goods industry. This research demonstrates how comparisons could be made while selecting the model, which gives a clear direction for high tech managers. It can apply to drawing suggestions of high technology service branding strategies. In comparison with earlier researches on branding strategies, this research proposed a feasible quantitative analytic framework which link branding strategies theories to practical problems.

6. Conclusion

This research develops a scientific framework for the branding strategy of the high technology service industry in MCDM environment. Those methods can be applied to other industry area to define the branding strategies. It also can provide superior insights to help high technology services firms avoid the wrong decision when the firms will development or extend their brand. Due to the high technology service industry is a multi-dimensional and highly competitive industry. This research found that both time to market and human capital are the most important criteria, while industrial division, research & development, industry life cycle also are important in developing or extending the high technology services firms' branding strategies. Thus, the manager should increase abilities to improve these decision problems.

Further, this research suggests that the new brands strategy is the best and suitable branding strategy for high technology services firms. Those high technology services firms can try to use the new brands strategy enhance competitive power and increase the branding value while gain higher profits. Finally, the analytical framework presented in this research can be applied to other industries for branding strategy.

REFERENCES

[1] Bogner, W., & Barr, P. (2000). Making sense in hypercompetitive environments: a cognitive explanation for the persistence of high velocity competition. *Organization Science*, *11*(2), 212-226.

[2] Chen, J. K. C., & Tzeng, G. H. (2009). Perspective strategic alliances and resource allocation in supply chain systems through the De Novo programming approach. *International Journal of Sustainable Strategic Management*, *1*(3), 320-339.

[3] Chiou, H. K., & Tzeng, G. H. (2001). Fuzzy hierarchical evaluation with grey relation model of green engineering for industry. *International Journal of Fuzzy Systems*, *3*(3), 466-475.

[4] Chiu, Y., Chen, H., Tzeng, G., & Shyu, J. (2006). Marketing strategy based on customer behaviour for the LCD-TV. *International Journal of Management and Decision Making*, *7*(2), 143-165.

[5] De Chernatony, L., & McDonald, M. (1992). *Creating Powerful Brands: The strategic route to success in consumer, industrial and service markets*. Boston: Butterworth-Heinemann.

[6] Deng, J. L. (1982). Control problems of grey systems. *SYS. & CONTR. LETT.*, *1*(5), 288-294.

[7] Deng, J. L. (1985). Fundamental Methods of Grey Systems. *Huazhoug University of Science and Technology, Wuhan, China*.

[8] Deng, J. L. (1986). Grey forecasting and decision. *Huazhong University of Science and Technology Press, Wuhan*, 97-134.

[9] Deng, J. L. (1988). Grey System Book. *Science and Technology Information Services, Windsor*.

[10] Deng, J. L. (1989). Introduction of Grey theory. *The Journal of Grey System*, *1*(1), 1-24.

[11] Gabus, A., & Fontela, E. (1972). World problems, an invitation to further thought within the framework of DEMATEL. *Battelle Geneva Research Center, Geneva, Switzerland*.

[12] Ginden, R. (1993). The name game (pp. 59-62): Cheers.

[13] Hambleton, R. (1987). *The branding of America: from Levi Strauss to Chrysler, from Westinghouse to Gillette, the forgotten fathers of America's best-known brand names*: Country Roads Prentice Hall.

[14] Huang, C. Y., Shyu, J. Z., & Tzeng, G. H. (2007). Reconfiguring the innovation policy portfolios for Taiwan's SIP Mall industry. *Technovation*, *27*(12), 744-765.

[15] Huang, J. J., Tzeng, G. H., & Ong, C. S. (2005). Multidimensional data in multidimensional scaling using the analytic network process. *Pattern Recognition Letters*, *26*(6), 755-767.

[16] Keller, K., & Lewi, G. (2008). *Strategic brand management: building, measuring and managing*: New Jersey: Pearson Prentice Hall.

[17] Kotler, P., & Armstrong, G. (2004). *Principles of Marketing: Activebook Version 2.0*. New Jersey: Pearson/Prentice Hall.

[18] Kotler, P., Keller, K., & Burton, S. (2009). *Marketing Management, 13th edn. Upper Saddle*. New Jersey: Prentice-Hall Publishing.

[19] Lehmann, D. (1997). A different game: Setting the stage *Marketing Science Report* (pp. 97-118).

[20] Liou, J., Tzeng, G., & Chang, H. (2007). Airline safety measurement using a hybrid model. *Journal of Air Transport Management*, *13*(4), 243-249.

[21] McCarthy, E. J., Perreault, W.D. (2002). *Basic Marketing, A Global-Managerial Approach*. New York: McGraw-Hill/Irwin.

[22] Mohr, J., Sengupta, S., & Slater, S. (2010). *Marketing of high-technology products and innovations*: Jakki Mohr.

[23] Mon, D., Tzeng, G., & Lu, H. (1995). Grey decision making in weapon system evaluation. *Journal of Chung Chen Institute of Technology*, *26*(1), 73-84.

[24] O'Malley, D. (1991). Brand means business. *Journal of Accountancy*, *107*, 107-108.

[25] Pettis, C. (1995). *Techno Brands*. New York: Amacom.

[26] Pfortsch, W., & Muller, I. (2006). *Die Marke in der Marke*: Springer.

[27] Reddy, A. (1997). *The Emerging Hi-Tech Consumer*. Quorum Books, Westport, CT.

[28] Saaty, T. (1996). *Decision making with dependence and feedback: the analytic network process: the organization and prioritization of complexity*: RWS publications.

[29] Saaty, T. (1999). Fundamentals of the Analytic Network Process *Proceedings of International Symposium on Analytical Hierarchy Process*. Kobe, Japan.

[30] Saaty, T. (2004). Fundamentals of the analytic network process, Dependence and feedback in decision-making

with a single network. *Journal of Systems science and Systems engineering, 13*(2), 129-157.

[31] Saaty, T. (2005). *Theory and applications of the analytic network process: decision making with benefits, opportunities, costs, and risks*: RWS Publications.

[32] Tamura, M., Nagata, H., & Akazawa, K. (2003). *Extraction and systems analysis of factors that prevent safety and security by structural models*.

[33] Tauber, E. (1981). Brand franchise extension: new product benefits from existing brand names. *Business Horizons, 24*(2), 36-41.

[34] Tzeng, G., Chiang, C., & Li, C. (2007). Evaluating intertwined effects in e-learning programs: A novel hybrid MCDM model based on factor analysis and DEMATEL. *Expert Systems with Applications, 32*(4), 1028-1044.

[35] Tzeng, G. H., & Tasur, S. (1994). The multiple criteria evaluation of grey relation model. *The Journal of Grey System, 6*(2), 87-108.

[36] Van den Ende, J., & Wijnberg, N. (2001). The organization of innovation in the presence of networks and bandwagons in the new economy. *International Studies of Management & Organization*, 30-45.

[37] Van Riel, A., Lemmink, J., & Ouwersloot, H. (2004). High Technology Service Innovation Success: A Decision Making Perspective. *Journal of Product Innovation Management, 21*(5), 348-359.

[38] Viardot, E. (2005). Human resources management in large information-based services companies: towards a common framework? *International Journal of Technology Management, 31*(3), 317-333.

[39] Ward, S., Light, L., & Goldstine, J. (1999). What high-tech managers need to know about brands. *Harvard Business Review, 77*, 85-95.

[40] Wentz, L., & Suchard, D. (1993). Euro ad execs pay homage to the brand. *Advertising Age, 64*, 21-39.

[41] Wu, H. S., Deng, J. L., & Wen, K. (1996). Introduction of Grey Analysis. *Gau-Li Publication Inc., Taiwan*.

[42] Zambuni, R. (1997). Hi-tech brands at the crossroad. *Journal of Brand Management, 15*(7), 4-7.