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Development of New Products by DEMATEL

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Abstract

In this study, the consumer of the glass coffee stir bar design was used as the research object, and DEMATEL (Decision-Making Trial and Evaluation Laboratory) was used to explore the causality and importance of the evaluation factors for the purchase decision. The study found that the three most important key assessment factors before the purchase decision of glass coffee stir bars were 'beautiful', 'operability', and 'durability'; 'beauty' was the main influencing factor; 'operability' – this is the main factor affected. In addition, glass coffee stir bars are the three most important key assessment factors before the general consumer purchase decision. Therefore, it is recommended to use this method to verify the case study of glass coffee stirrer bar designs, and to study the possible development directions for evaluation. This model process can not only quantitatively evaluate the simple factors of complex interaction factors, but the results can also be used as a design to determine the direction of future development.

Keywords: modular design, product family, interpretive structural model, product design

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1. Introduction

Tazki and Amagsa (Tazki,1997) pointed out that when people learn complicated and divergent problems or behavioral problem analysis and needs assessment, they usually let them use their intuition and experience judgments. Therefore, an ideal planning more effective method should be used, such as the Decision Making Trial and Evaluation Laboratory (DEMATEL) and the kJ Method. DEMATEL is based on graph theory and is particularly effective because all elements can be processed with the ISM. In order to manage a complete evaluation model that influences customer relationships and build internal and external customer satisfaction, and to understand the main aspects of the impact of different evaluation indicators, the study uses DEMATEL to examine the relationship between the standards and the relative weights of the criteria used for ANP calculations. The analysis also includes internal and external

customer satisfaction to provide a comprehensive reference. In the past, many scholars believed that consumers' willingness to buy was determined by the consumer's perceived value of the product. Many scholars also proposed cognitive prices, cognitive quality, and cognitive value models to explain the formation of consumer buying intentions, and conducted relevant empirical studies. Research (Rao,1989;Zeithaml,1988). In addition, according to related studies, it is found that consumers are often affected by aesthetic awareness when purchasing products. For buyers, aesthetics is the easiest way to identify products, and aesthetic perceptions affect consumers' buying habits are unquestionable facts in trading behavior. Wooside & Clolcety(Woodside,1975) has established a general model of brand loyalty and proposed that the factors affecting brand loyalty include product characteristic variables, marketing strategy variables, and market structure variables; Snyder & Fromkin(1977) The uniqueness theory is that "when the uniqueness of the self-concept is threatened, the individual's and others' different needs will be challenged by certain motives."

Therefore, this study takes into account the priority factors that influence the key factors for consumers to purchase glass coffee stir bars, and provides relevant companies with effective research and development plans for the research findings. Based on the general consumer purchase behavior, it is derived from the evaluation factors that professional consumers face when making glass coffee stir bars. Therefore, the main purpose of this study is to construct the key decision-making evaluation factors and causality assessment models for consumers to purchase glass coffee stir bars. Based on the findings, relevant industry-effective product marketing strategies and market development planning recommendations are proposed.

2. Outline of the Development Process for the Research Model

This study uses DEMATEL to analyze the data, because DEMATEL can analyze the problems related to each other to find out the main and minor issues, and construct the causal relationship between consumers' decision-making assessment factors for purchasing sports shoes and leisure shoes. In addition, this study also obtained personal interviews and questionnaires to obtain the views of respondents on the relevant topics of this study to help collect more in-depth and detailed information.

Research Framework Based on the foregoing literature review and summarization of factors that influence consumer decision-making behavior, this study summarizes three main aspects: professional consumers, consumer purchasing decision-making

processes, and evaluation criteria for sports and casual shoes. The "professional con-sumer" facets are divided into three factors: "unique demand", "conspicuous con-sumption", and "materialism." The "consumer purchasing decision-making process" facets are divided into "pre-purchase behavior" and "purchase". The "post-action" two-factor; "The evaluation criteria for the purchase decision of sports and casual shoes" was divided into three factors: "pop", "product", and "brand".

3. DEMATEL

The method of DEMATEL is to inspect whether there are interactions between factors, and it is a type of self-feedback and can be utilized to construct network relations between measurement criteria. tzeng et al. (2007) pointed out that DEMATEL can provide the identification of viable schemes aiming at special problems via hierarchical frameworks(Lin,2013). For the past few years, articles related to the method of DEMA-TEL have been broadly proposed since this method can assist in the effective under-standing of complicated causal relationships. Through the inspection on the degree of influence between factors, the causal relationships and the degrees of influence between all of the factors can be calculated. the structural models of network relations can be further established, and the complex relations of influence between factors can be investigated by graphical methods. The method of DEMATEL is divided into five steps as follows.

Step 1: Obtain the average influence matrix

by applying a pairwise judgment by specified criteria, each subject's perception of the degree of influence between indices can be assessed. the subjects have been asked to mark the degree of relation of direct influence of index i on index j with an influence scale of 0, 1, 2, 3 to 4, which respectively represents "without any influence (0)", "minor influence (1)", "moderate influence (2)", "major influence (3)", and "great influence (4)" for assessments. An $n \times n$ direct influence matrix $A = [a_{ij}]_{n \times n}$ can be acquired from the answers of subjects.

Step 2

Transformation into normalized direct influence matrix The direct influence matrix A can be further normalized by Eq. (2) and Eq. (3), and the direct influence matrix after normalization is $D = [d_{ij}]_{n \times n}$, which is a matrix with zero diagonal.

$$D = kA \tag{1}$$

$$k = \min \left\{ 1/\max_i \sum_{j=1}^{n} a_{ij}, 1/\max_j \sum_{i=1}^{n} a_{ij} \right\}, \quad i, j \in \{1, 2, ..., n\} \tag{2}$$

Step 3: Calculate total influence-relation matrix

After acquiring the normalized direct influence matrix, Eq. (4) can be used to construct the overall influence matrix T of network relation chart, where I is an identity matrix.

$$T = D + D^2 + D^3 + ... + D^k = D(I + D + D^2 + ... + D^{k-1})[(I - D)(I - D)^{-1}] = D(I - D^k)(I - D)^{-1} \tag{3}$$

$$T = D(I - D)^{-1},$$

when

$$k \to \infty, \quad D^k = [o]_{n \times n}$$

when $D = [d_{ij}]_{n \times n}$, $0 \le d_{ij} < 1$, $0 < \sum_{j=1}^{n} d_{ij} \le 1$, $0 < \sum_{i=1}^{n} d_{ij} \le 1$

Step 4: Result analysis

The summation along columns ($\sum_{j=1}^{n} t_{ij} = t_i$) and the summation along rows ($\sum_{i=1}^{n} t_{ij} = t_j$) of the above-mentioned matrix are utilized to establish influence index vectors $r = (r_1, ..., r_i, ..., r_n)'$ and $c = (c_1, ..., c_j, ..., c_n)'$ which are defined by Eq. (5) and Eq. (6), where r represents affecting other indices, c represents being affected by other indices. The horizontal axis vector ($r+c$) could be obtained by adding **r** and **c.** This value indicates the degree of relation between indices, and is called prominence. Similarly, the vertical axis vector ($r-c$) is obtained by subtracting **c** from **r**. This value represents the intensities of affecting or being affected by indices, and it is also called relation. Generally speaking, when ($r - c$) is positive, this indicates that the index is in the reason group. Contrarily, if ($r - c$) is negative, then this indicates that the index is in the effect group.

$$T = [t_{ij}]_{n \times n}, i, j = 1, 2, ..., n$$

$$r = \left[\sum_{j=1}^{n} t_{ij} \right]_{n \times 1} = [t_{i \cdot}]_{n \times 1} = (r_1, ..., r_i, ..., r_n)' \qquad (4)$$

$$c = \left[\sum_{i=1}^{n} t_{ij} \right]_{1 \times n}' = [t_{\cdot j}]_{n \times 1} = (c_1, ..., c_j, ..., c_n)' \qquad (5)$$

where vector r and vector c represent the summation of rows or columns of the overall influence matrix $T = [t_{ij}]_{n \times n}$ respectively.

Step 5: Establish DEMATEL network relation chart

with (r + c) as the axis of abscissa and (r - c) as the axis of ordinate, the criteria coordinate value (r + c, r - c) can be labeled on the coordinate axes. if there is an influence relation between indices, arrows will be drawn to indicate the links, and then the causal relation chart, which provides decision-makers with the construction method of effective network relation charts, can be obtained.

the prominence (r + c), which is also called the degree of relation, indicates the degree of affecting or being affected by an index. this value reveals the relation strength of the index among the problem group. this value can also indicate the core extent of the index among all problems. when the value is larger, this indicates that the correlation degree of the index in the problem group is higher.

the relation (r - c), which is also called the influence extent, indicates the difference in the intensity for the index affecting or being affected by others. this value reveals the casual extent which belongs to a problem among all of the problems. when its value is positive, this indicates that the index approaches the reason group; when its value is negative, this indicates that the index approaches the result group.

4. Establishment of Evaluation Criteria

the a in this study for the analysis of each task. the methods that are going to be used in this study are explained respectively as follows.

in this study, the product glass coffee stir bar was used as an example at this stage(Figure 1 glass coffee stir bar). in order to be able to understand the possibility of the glass coffee stir bar, the glass coffee stir bar has a total of 12 products in order to verify the feasibility of DEMATEL. examples of glass coffee stir bars, sample collection to cross-validate the conventional part.
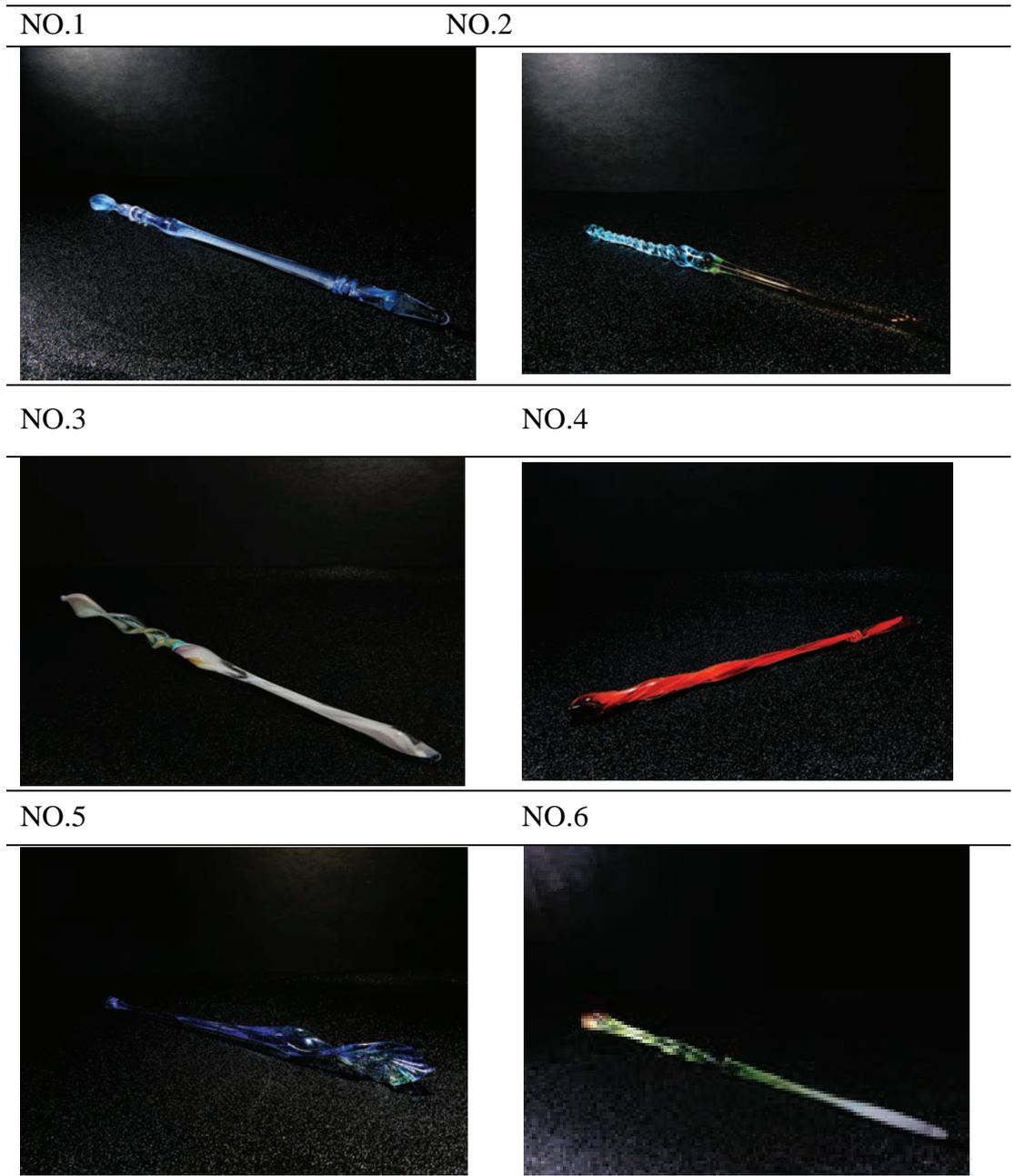
NO.1	NO.2

NO.3	NO.4

NO.5	NO.6

Figure 1: Glass coffee stir bar.

In this study, DEMATEL was used for data analysis, because DEMATEL can analyze problems related to each other to find out, secondary issues, and construct a causal relationship among decision-making evaluation factors for consumers to buy glass coffee stir bars. In addition, this study also obtained personal in-depth interviews and questionnaires to obtain the views of respondents on the relevant topics of this study to help collect more in-depth and detailed information. The questionnaire data is processed at this stage. The questionnaire was given to 58 of the 58 respondents, 45 of whom passed the conformance test, of which 13 were considered invalid. all

interviewees for the design department of college students, including 13 graduate students and 45 undergraduate DEMATEL calculated input values, obtained the criteria of the total impact degree matrix, put DEMATEL's total impact on relationship conditions applied to evaluate important indicators from Table 1 can be found There are mutual influence relations among the five items of the facets. Comparing with other facets, operability is the most influential factor in all facets. The relationship between the degree of influence shown can be found, compared with other facets, aesthetics is the most influential factor; and delivery is the smallest cause of all facets.

the values in the total impact relation matrix (T) are deleted from table 1 through the setting of the threshold value to show more significant causality. the threshold value is the arithmetic average of the values in the total impact relation matrix (T).

finally, the value greater than or equal to the threshold value is plotted on the coordinate graph according to the comparison of the seven criteria, such as table 2 average. in order to make it easier to see the causality between the criteria, it is assumed that only the number within the total impact relationship matrix (T) greater than the threshold value is retained, simplifying the total impact of the applied decision-making laboratory analysis method to evaluate the analysis, Fig. 2 ranks and (D+ R) and rank difference (DR) numerical data, respectively (D + R) for the horizontal axis and (DR) for the 縱 axis of the intersection, the seven selection criteria in accordance with the coordinate values plotted on the coordinate graph, In addition, Showing more significant causality, from the perspective of guidelines, all the criteria have an influential relationship, and innocuity is a direct or indirect effect. comparing with other criteria, conformity with production and aesthetics is the consideration and the highest degree of impact; otherwise, productivity and delivery are the criteria that have the least influence and influence in all criteria. therefore, aesthetics and practicability represent the most likely influence of this criterion on the influence of other criteria in the group and the indicators.

4.1. Acquisition of element weights

This result can serve as a reference for developing multiple products in the design process. The highest weight value proposed according to this study is 0.971. It is suggested that the design meets the needs of different styling markets and provides the best advantages. The conditions have been studied and the results from the required weight values in Table 3.

TABLE 1: Overall influence relation matrix of criteria.

T=	Operability	Practicability	Aesthetics	Safety	Productivity	Functionality	Deliverability		
Operability	0.798807823	0.827297735	0.823701508	0.995512253	0.503686836	0.616107854	0.383878615	4.948992623	7
Deliverability	0.980597977	0.75132215	0.909637786	0.983911197	0.547485638	0.620570677	0.399809664	5.19333509	6
Aesthetics	1.212817905	1.115583123	0.927409615	1.239851818	0.644034023	0.804007552	0.505993576	6.449697613	1
Safety	1.113140857	0.976880028	0.962350449	0.934348319	0.579757336	0.694811303	0.444625262	5.705913554	3
Productivity	0.98086913	0.895479423	0.859387514	0.983727403	0.447820377	0.630920946	0.411773307	5.209978101	5
Practicability	1.1566673	1.022207137	1.070136568	1.204796769	0.612090242	0.649560423	0.503770073	6.219228511	2
Functionality	1.006451394	0.938844404	0.958588907	1.044297793	0.544581702	0.70586591	0.372086979	5.570717089	4
	7.249352386	6.527614	6.511212347	7.386445554	3.879456155	4.721844664	3.021937476	0.801997196	
	2	3	4	1	6	5	7		

Table 2: DEMATEL Averages.

Deliverability	Operability	Practicability	Aesthetics	Safety	Productivity	Functionality	Deliverability
Operability	0	0.827297735	0.823701508	0.995512253	0	0	0
Deliverability	0.980597977	0	0.909637786	0.983911197	0	0	0
Aesthetics	1.212817905	1.115583123	0.927409615	1.239851818	0	0.804007552	0
Safety	1.1131408 57	0.976880028	0.962350449	0.934348319	0	0	0
Productivity	0.98086913	0.895479423	0.859387514	0.983727403	0	0	0
Practicability	1.1566673	1.022207137	1.070136568	1.204796769	0	0	0
Functionality	1.006451394	0.938844404	0.958588907	1.044297793	0	0	0

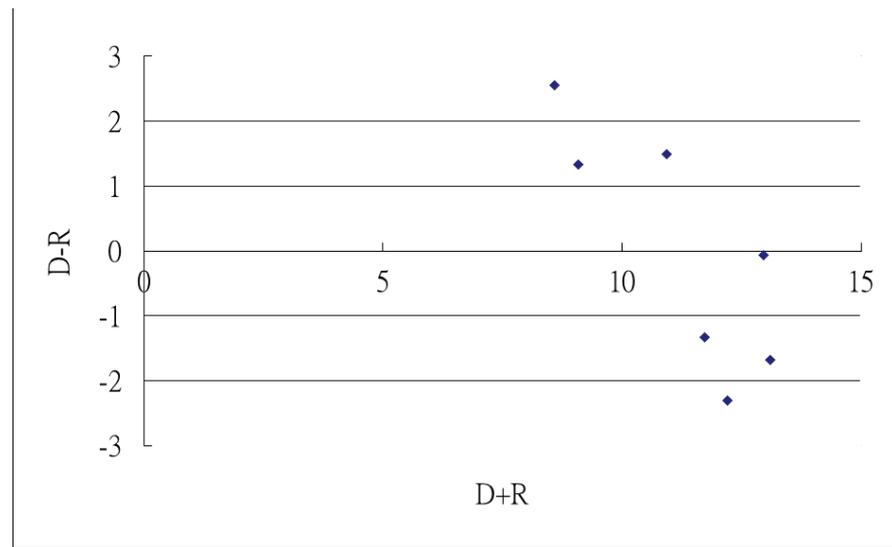|	Operability	Practicability	Aesthetics	Safety	Productivity	Functionality	Deliverability
D+R	12.19834501	11.72094909	12.96090996	13.09235911	9.089434256	10.94107318	8.592654565
D-R	-2.300359763	-1.33427891	-0.061514734	-1.680531999	1.330521947	1.497383847	2.548779612

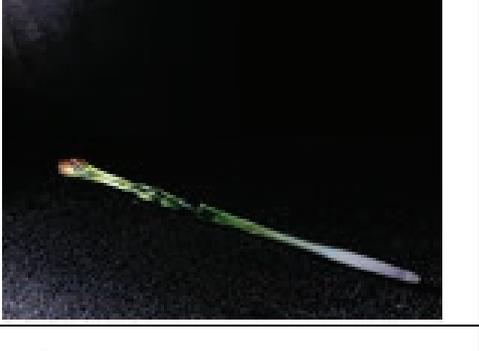**Figure** 2: DEMATELD+R_D–R element distribution values.

5. Conclusions and Suggestions

These results prove that the required products can be designed objectively and feasibility studies in this method. however, on the other hand, it called for gathering conclusions. In this study, the DEMATEL system integrated the mix of the glass coffee stir bar, and then proposed a system for predicting consumer effectiveness. and post-test experiments were used to verify this system. these results illustrate the choice of products by consumers and designers. Therefore, it is helpful for designers to predict the correct product mix and sell to target groups using this method. With this prediction system, designers can get matching consumer needs. based on market demand forecasting system can get the best benefits, this method can also be used to design other products.

6. Conclusion

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TABLE 3: Consumer weight.
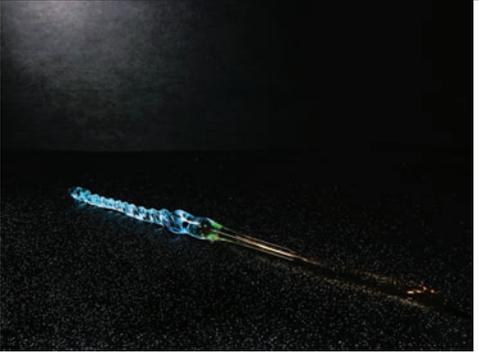
image		
Weights :	0.801	0.782
image		
Weights :	0.971	0.725
image		
Weights :	0.672	0.872

demand forecasting system can get the best benefits, this method can also be used to design other products.

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