

Analyzing Consumers' Decisions to Select Micro-Invasive Aesthetic Service Providers using a Hybrid Method

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Abstract: Micro-invasive aesthetic services are becoming more popular, and thus the industry is becoming more competitive. It is thus critical for companies to better understand the criteria that consumers use when choosing a micro-invasive aesthetic service provider. In order to investigate this issue, three focus group interviews were carried out in this study and the related literature was reviewed in order to find the relevant criteria. The Decision Making Trial and Evaluation Laboratory (DEMATEL) was then employed to find casual relationships among the criteria, while the Analytic Network Process (ANP) was further applied to evaluate the importance of each criterion. After examining four criteria and 15 sub-criteria, the most important items were found to be consultant services, reputation of medical clinics, after-sales services, process and efficiency, and previous customer outcomes. If service providers can better understand the factors underlying consumer decisions with regard to micro-invasive aesthetic procedures, then they can better allocate their resources to enhancing their competitiveness.

Keywords: Micro-invasive aesthetic, Decision Making Trial and Evaluation Laboratory (DEMATEL), Analytic Network Process (ANP)

1 Introduction

According to statistics from the American Society of Plastic Surgeons (ASPS), about 12.5 million people received aesthetic services in 2009 in the US, around 69% more than it in 2000[1]. In addition, the value of the aesthetic services market in Europe achieved 2 billion US dollars in 2007, rising at a rate of 20% a year. The implementation of the Hospital Global Budget Payment System in Taiwan in 2001 lead to a fall in the profits of many clinics, which thus turned to offer self-pay medical services to make up for this, with aesthetic services being especially popular. According to a report by the International Society of Aesthetic Plastic Surgery (ISAPS), Taiwan was ranked the sixteenth in the world in spending on cosmetic services in 2009[2], revealing the importance of this market. Micro-invasive aesthetic services are considered safer than other forms of cosmetic surgery, and also require much shorter recovery periods. Consumers who are worried about the risks of cosmetic surgery are thus more willing to accept micro-invasive aesthetic services. According to statistics from the ASPS,

demand for micro-invasive aesthetic services in 2009 was 99% higher than in 2000, while demand for cosmetic surgery fell 20% over the same period[1]. For clinics, micro-invasive aesthetic services are relatively simple and low risk procedures. ISAPS also reported that in 2009 cosmetic surgeons around the world performed more non-surgical cosmetic procedures than surgical ones[2]. In response to this, an increasing number of medical providers have invested in entering the micro-invasive aesthetic market, based on both market trends and new technologies[3]. Since there are still some risks associate with micro-invasive aesthetic services, consumer satisfaction with the outcomes is very important[4]. In addition, potential consumers also face the issue of information asymmetry with regard to such services[5][6], and thus the criteria used to select a service provider may be both numerous and complex. Past research on selecting medical service providers focused more on patient decisions in relation to selecting different kinds of operations, whether to be hospitalized or not, and what nursing institute to enter[5][6][7][8]. Nevertheless, micro-invasive aesthetic services are very

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different from other medical services, as they are not emergency of even essential procedures, and thus consumers have enough time to collect the information they need about service providers, and then to carefully evaluate it before making a choice. Service providers should thus work to understand the key decision-making criteria in this context, so that they can formulate improved strategies to flourish in this increasingly competitive market. In summary, people use many criteria when selecting a micro-invasive aesthetic service provider, and thus this study aims to establish a decision model for such consumers. To this end the current work applies Decision Making Trial and Evaluation Laboratory (DEMATEL) to quantitatively present the criteria and produce the related structural model, which can then be used to analyze the causes and effects among the various criteria. However, DEMATEL cannot determine the weights of individual criteria, and thus the Analytic Network Process (ANP) is used to achieve this. The rest of this study is organized as follows: Section 2 reviews the literature related to the micro-invasive aesthetic industry and the methodologies used in this work. Section 3 then presents the decision analysis model work, while the results of the analysis are discussed in Section 4. Finally, the conclusions of this study and suggestions for researchers and managers are presented in Section 5.

2 Literature review

2.1 Micro-invasive aesthetic services

Micro-invasive aesthetic services apply minimally invasive medical treatments to improve a person's appearance, often by using injections, lasers, and light or heat. Compared to more traditional forms of cosmetic surgery, these services have the advantages of a short treatment period, no scarring, immediate effects, and less pain[3][4]. Since such services are growing in popularity, it is of obvious interest to find out what criteria customers use when looking for a service provider, as this can help firms to attract and retain more business.

2.2 Decision making criteria

The use of cosmetic surgery and related treatments is becoming more popular, as they are now seen as less dangerous, more affordable, and more socially acceptable. However, since the risks and costs remain relative high, micro-invasive aesthetic services are regarded as high-involvement purchases. The decision to purchase such services is a form of Extensive Problem Solving (EPS), in which consumers would actively collect information about various services, and then compare and evaluate the details before making a purchase[11]. Moreover, different consumers make consumption-related

decisions based on different criteria, because of individual and environmental differences[11], and this has also been found when selecting a physician or medical service[12]. In short, decision criteria are the key factors that affect a person's decision-making, and there are a broad range of these in relation to purchasing micro-invasive aesthetic services. In the existing literature related to medical behaviors and decision criteria for micro-invasive aesthetic services, Tzung, Tzung, Yang, Yang and Kao[13] identified 17 criteria in relation to the selection of laser and intense pulsed light services. D'Amico et al.[3] investigated consumer demands and preference for aesthetic services, and concluded that the key factors are trust in physicians, expenses, physician recommendations, recommendations of friends and relatives, and electronic word-of-mouth. Rothman, Park, Hays, Edwards and Dudley [14] found that they key the criteria that affect the perceived quality of hospitals are communication with physicians, communication with nursing personnel, hospital environment, nursing services, pain control, drug information, discharge information, ability to negotiate services, hospital ranking, and the recommendations of others. In a study of consumers undergoing breast enlargement operations and the related interactions with physicians, Hede'n, Adams Jr, Maxwell, Nava, Scheffan and Stan[15] reported that consumers would focus on whether the physicians would respect their patients and listen to their demands, as well as the doctors' communication skills, the provision of detailed information, as well as proof of the previous successful customer experiences. Merle, Germain, Tavolacci, Brocard, Chefson, Cyvoct, Edouard, Guet, Martin and Czernichow[16] explored consumer perceptions of the infection control quality of hospitals, and found that the key factors were good medical equipment, physician's reputation, and recommendations from other physicians. Fasolo, Reutskaja, Dixon and Boyce[17] studied the factors which affect patients' perceptions of hospital quality, and found that these include physician quality, specialty competence, and distance to hospital, waiting time, and service quality. Based on the classification systems in Tzung et al.[13] and Lee, Shih and Chung[18], the evaluation criteria related to this work are classified into six categories, as shown in Table 1, in which "V" represents that a criterion was mentioned in a study.

2.3 Decision Making Trial and Evaluation Laboratory (DEMATEL)

In complex environments many factors affect consumer decisions with regard to purchasing services or products, and the Decision Making Trial and Evaluation Laboratory (DEMATEL) is a method that has been widely applied to examine many complicated issues[27][28]. DEMATEL can help decision makers to better understand the

Table 1: Decision criteria

Dimension/ Criteria	Sub-criteria	3	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Total
Professionalism of Physicians	Work experiences	√			√		√		√			√	√				6
	Communication skill		√	√	√							√				√	5
	Reputation of physicians		√		√	√		√									4
	Professional certificates	√							√								2
	Character of physicians		√						√								2
Medical Personnel	Attitudes		√	√	√		√	√	√		√		√	√			9
	Communication skills			√												√	3
	Personality								√			√					2
	Specialty										√					√	2
Characteristics of Medical Clinics	Equipment		√			√	√	√					√				6
	Environment		√	√	√		√							√		√	6
	Reputation			√				√					√		√		4
	Process and efficiency			√			√	√				√					4
	Climate				√							√					3
	Decoration and design		√										√				2
Service costs	Location convenience		√		√	√	√	√	√				√	√	√		9
	Prices	√	√		√			√		√	√						6
	Waiting time						√	√				√			√		4
	Recommendation of friends and relatives	√	√		√	√		√			√		√	√	√		9
Relative Recommendation	Physicians' Recommendation	√	√			√					√		√		√		6
	Media reports				√	√					√		√	√			5
	Electronic word-of-mouth	√								√					√		3
	Advertisement									√	√						2
Service Integrity	Business integrity	√		√					√								3
	Drug consultation			√												√	3
	After-sales services			√	√											√	3
	Consultant services												√				2
	Requirements for responses															√	2
	Provision of relevant information											√			√		2
	Pain management			√								√					2

problems they face, as well as the mutual relations among clusters of related factors, so that complex problems can be analyzed using a hierarchical structure[29]. With this method graphs are used to plot the casual relations among the factors of interest, and the direct relations that are thus revealed can then be used to derive better solutions to problems[30]. More specifically, DEMATEL can be used to produce a structure model in which the evaluation criteria are divided into cause and effect groups, in order to reveal the correlations among them. According to such results, the decisions could therefore be formulated[27][31]. As consumers can not directly judge the results of micro-invasive aesthetic services before they have made a purchase, they must consider the related costs and risks before making a decision, based on the information that is available to them. Since past research has shown that DEMATEL can be used to examine complex consumer purchase behaviors[30], and it has also been applied in the medical industry[32], this study thus adopts this approach to find out the key evaluation criteria when consumers are considering purchasing a micro-invasive aesthetic service.

2.4 Analytic Network Process (ANP)

When making decisions people tend to consider a variety of criteria and alternatives. Saaty proposed the Analytic Hierarchy Process (AHP) in 1971 to solve decision-making problems with a number of evaluation

criteria under uncertain situations, by systematically dividing the focal problem into several criteria, defining the importance and hierarchy of these, finding out the relative importance with pairwise comparisons, and ordering the priority of evaluation criteria in order selecting the optimal alternative[33][34]. Although AHP has been widely utilized for solving multi-criteria decision-making problems, since it is assumed that the criteria in each hierarchy are independent, its range of application has been relatively limited[35]. As a result, Saaty extended this earlier approach with the Analytic Network Process (ANP) in 1996, which is able to deal with decision-making problems without assuming the independence of criteria in different hierarchies, and thus considering possible dependence and feedback among criteria and alternatives[34]. ANP has thus been applied to multi-criteria decision-making problems which cannot be presented with a hierarchical structure in order to help decision-makers consider the possibly interacting effects among criteria, rather than simply using a linear top-to-bottom or bottom-to-top approach, as with AHP, and so it has been applied in wide range of fields[34][35]. For example, Karsak, Sozer and Alptekin[36] utilized ANP to evaluate the key factors that affect the quality and function design of products. Mohanty, Agarwal, Choudhury and Tiwari[37] considered the uncertainties and fuzziness of a firm's environment, as well as the viewpoints of various beneficiaries in the organization resulting in the complex and, and applied ANP in order to evaluate various R&D projects based on the related risks,

uncertainties, investments, and benefits. Bayazit and Karpak[38] investigated 250 large-scale manufacturers, identified 32 evaluation criteria for quality, and utilized ANP to find the key factors for promoting overall quality management. Wu, Lin and Chen[39] examined the selection of hospital locations using ANP and Porer's Diamon Model. As the evaluation criteria that consumers consider when selecting micro-invasive aesthetic services are diverse and complex, ANP is applied in this study to analyze the priority of the criteria and the relations among them.

3 Model Construction

3.1 Focus Group Interview Results

Focus group interviews are a quantitative method that is often used for collecting data[40], and this study thus interviewed a group of consumers in order to find the criteria it then examined[41]. Such interviews are also useful for providing new knowledge or concepts, as well as indicating the priority among various criteria and consumer demands[42]. After acquiring the focal criteria from the interviews, DEMATEL is used to calculate the direct and indirect relations among these in order to find out the casual relationships, and thus establish the related structural model. As DEMATEL does not consider the importance of criteria, ANP is further utilized to obtain the relative weights among these. By combining the results of DEMATEL and ANP it is possible to identify the critical decision-making criteria with regard to the section of micro-invasive aesthetic service providers. At the end of this work the conclusions are presented, along with suggestions for both academics and practitioners

3.2 DEMATEL Analysis

When applying DEMATEL the following six steps and processes are followed[33][43]. (1) Establishing a pairwise comparison scale The major decision criteria and the sub-criteria are used to design the pairwise DEMATEL questionnaire. Based on the mutual effects among criteria, the marking scales are divided into four levels of 0-No influence, 1-Low influence, 2-Midium influence, and 3-High influence, with plus and minus symbols indicating the direction of effects. To ensure the reliability of the analyses, the questionnaire was only distributed to subjects who were familiar with micro-invasive aesthetic service providers. Consumers with experience of such procedures, as well as related medical workers, were thus selected as the research subjects, as the former could present details of their own experiences and demands in this context, while the latter could contribute based on their extensive medical knowledge.

(2) Establishing a direct-relation matrix After the questionnaires had been completed, the arithmetic means were calculated in order to integrate the experts' opinions and determine the mutual effects among criteria, and the direct-relation matrix was then established. Assuming that there are n evaluation criteria, the $n \times n$ direct-relation matrix A would be acquired, where a_{ij} stands for the degree to which criteria i has an effect on criteria j , as in equation (1).

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

(3) Calculating normalized direct-relation matrix The direct-relation matrix is normalized by multiplying the matrix A with s for the normalized matrix X , as in equation (2), where s is shown in equation (3).

$$X = s \times A \quad (2)$$

$$s = \frac{1}{\max_{1 \leq i \leq n} \sum_j^n a_{ij}} \quad (3)$$

(4) Attaining the total-relationship matrix With the normalized direct-relation matrix X , the total-relationship matrix T can be acquired by equation (4), where I is the unit matrix.

$$T = X(I - X)^{-1} \quad (4)$$

(5) Calculating the prominence and relation t_{ij} is the element in the total-relationship matrix T . The elements in rows of the total-relationship matrix are summed as L_i , and the elements in columns are summed as R_j , as in equations (5) and (6), respectively.

$$L_i = \sum_{j=1}^n t_{ij} \quad \text{for } i = 1, 2, \dots, n \quad (5)$$

$$R_j = \sum_{i=1}^n t_{ij} \quad \text{for } j = 1, 2, \dots, n \quad (6)$$

where L_i stands for the sum of other elements, with i being the cause, including direct and indirect effects, and R_j the sum of other elements, with j being the result. When $i = j$, the sum of rows and columns ($L_i + R_j$) represents the total relationship of i , i.e. the importance of i in the problem, called prominence. On the other hand, the difference between rows and columns ($L_i - R_j$) is used for dividing criteria into cause and effect groups. When the ($L_i - R_j$) of an element is positive, the element is in the cause group, while if it is negative then it is in the effect group.

(6) Establishing a causal diagram Having $L + R$ as the horizontal axis and $L - R$ as the vertical one, the ($L_i + R_j$) and ($L_i - R_j$) thus obtained are used for marking the coordinates. To present a more significant causal relationship, the value in the total-relationship matrix (T),

with the arithmetic mean, is regarded as the threshold value. Elements that have values below this threshold have less correlation, and are thus removed from the analysis, while those that have values greater than this are included in the causal diagram. The causal diagram can simplify otherwise complex causal relationships, and thus help decision makers in selecting an appropriate alternative.

3.3 ANP framework

ANP obtains the relative priority of criteria based on individual judgments or actual measurements, and these represent the relative effects among the various criteria (Saaty, 2004b). The following steps are used when applying the ANP (Jharkharia and Shankar, 2007; Saaty, 2004a, 2004b).

Step 1 Developing the model

An evaluation model needs to be established before using ANP to examine the various evaluation criteria. In this study, the ANP model is developed based on the causal diagram from DEMATEL analyses.

Step 2 Determining the pairwise comparison matrix

Having established the model, the experts then use the questionnaires to make pairwise comparisons among the criteria, with the comparison scales being divided into nine levels, as shown in Table 2. The pairwise comparison matrix A is established according to the results of equation (7). The pairwise comparisons are also divided into internal and external relationships, with the latter being used to assess the relative importance of the in-group elements with regard to achieving the set objectives, while the former are used to judge the relative importance of an element with regard to how it is affected by other elements in the same group.

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & 1 \end{bmatrix} \quad (7)$$

Step 3 Corresponding to expert preference

As the respondents in this study include both patients and medical staff, it is likely that their responses would differ, as would the results of the pairwise comparisons. Saaty suggested integrating such results using the geometric mean. The integrated pairwise comparison matrix is further calculated to obtain the maximal eigenvalue λ_{max} and the corresponding maximal eigenvector W using equation (8).

$$AW = \lambda_{max}W \quad (8)$$

Furthermore, consistency among the tests is considered essential by Saaty, and so the calculated λ_{max}

is further used to calculate using Consistency Ratio (CR), as shown in equation (10), as well as the Consistency Index (CI), using equation (9), and the Random Index (RI), as shown in Table 3, so as to assess the consistency of the results. When $CR \leq 0.1$, the result is in an acceptable range, i.e. it appears to be consistent. In contrast, when $CR > 0.1$ the questions need to be re-examined and the pairwise comparisons need to be revised.

$$CI = \frac{\lambda_{max} - n}{n - 1}, \quad n : \text{no. of criteria} \quad (9)$$

$$CR = \frac{CI}{RI} \quad (10)$$

Step 4 Calculating the supermatrices

A supermatrix is composed of several sub-matrices, where each sub-matrix contains a mutually pairwise comparison relationship between the elements in one group and those in other groups. The value of each sub-matrix is the eigenvector and weight calculated by the pairwise comparisons, which is integrated into a supermatrix. The supermatrix is presented as W , as in equation (11), where W_{ij} stands for the comparison of eigenvector between the i^{th} element and the j^{th} group. When $W_{ij} = 0$, there is no dependence. The calculation of ANP requires an unweighted supermatrix, weighted supermatrix, and limit supermatrix. The unweighted supermatrix integrates the eigenvector of the original pairwise comparisons into a large matrix, by multiplying the unweighted supermatrix by the eigenvector acquired from the pairwise comparison matrix of the evaluation criteria, and thus producing the weighted supermatrix. When dependence exists among evaluation criteria, a fixed convergent extreme, called the limit supermatrix, is acquired after several self-multiplications.

$$W = \begin{bmatrix} W_{11} & W_{12} & \cdots & W_{1m} \\ W_{21} & W_{22} & \cdots & W_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ W_{m1} & W_{m2} & \cdots & W_{mm} \end{bmatrix} \quad (11)$$

Step 5 Determine weights of each criterion

After computing the supermatrix, the weight of each criteria can be used as the basis of the priority sequence of evaluation criteria.

4 Analysis and Discussion of the Results

4.1 Selecting the evaluation service criteria

Krueger and Casey[40] stated that sufficient information about an issue can be acquired after three or four focus group interviews. Online recruitment and snowball sampling were first to screen the respondents. A total of

Table 2: ANP comparison scale[29]

Scale	Definition	Explanation
1	Equal Importance	Two evaluation criteria present equal importance on contributing to the objective.
3	Moderate Importance	There is a preference for one of the criteria.
5	Strong Importance	The experience and judgment appear stronger preference than the other index.
7	Very Strong or Demonstrated Importance	Reveal much stronger preference than the other index, and indeed present significant strength.
9	Extreme Importance	More evidence to show the more affirmative preference than the other index.
2, 4, 6, 8	Intermediate Value	Two neighboring criteria are preferred to the same extent.
Opposite	Moderate unimportance, Strong unimportance, Very strong unimportance, Extreme unimportance	In comparison to the other index, it tends to unimportance with distinct levels.

Table 3: Random indices[29]

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

twenty-three females and 15 males were included in three focus group interviews, seven of whom had experience of receiving micro-aesthetic services, while the rest were all medical professionals. The respondents were asked to discuss the various motivations, considerations, and decisions that are related to selecting such services, and to share other relevant knowledge and experiences. The participants in this study all had at least a bachelor's degree, and were familiar with micro-aesthetic services. In order to obtain more varied opinions, some degree of heterogeneity among the respondents was acceptable. The various criteria that were mentioned in the interviews are ranked in Table 4.

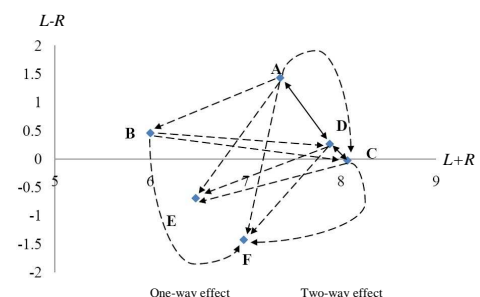
After the focus group interviews, it was found that risks and promotional events were the most important factors that consumers considered. In addition, the criteria of communication skills of physicians, communication skills of medical personnel, process and efficiency, physician recommendations, and famous people recommendations, and mentioned in the literature, were also important. However, since the appearance of the medical personnel was not seen as a critical selection criterion, it was excluded from further analysis. The remaining evaluation criteria were then classified into professional competence of physicians, characteristics of medical personnel, characteristics of medical clinics, relevant costs, service integrity, and recommendation from relatives, as shown in Table 5.

4.2 Results of DEMETAL Analysis

The six criteria and 24 sub-criteria, as acquired from the interviews and literature, were used to design the DEMATEL questionnaire for pairwise comparisons. Using the Internet and regular mail to recruit experienced consumers and medical workers, total a total of 22 valid

questionnaires were collected from the former and 234 from the latter. MS Excel was then used to analyze the questionnaires, and the six main criteria underwent correlation analysis. The total-relationship matrix is shown in Table 6, in which $L + R$ is the sum of the relationships among all the elements, which can reveal the prominence of each of the elements in the overall relationship. When $L - R > 0$ this means that the focal element affects the other elements to a greater extent than it is affected by them, while the reverse is true when $L - R < 0$.

The arithmetic mean to calculate the relations among all the elements in the total-relationship matrix, a threshold value of 0.5942 is obtained, and thus decisions with significant effects can be found. The relationships among the six criteria are shown in Table 7. $L + R$ and $L - R$ are further utilized to draw the casual diagram among the six criteria, as shown in Fig. 1.

**Fig. 1:** Causal diagram among primary criteria.

Professional Competence of Physicians ($L - R = 1.4314$) was regarded as the most important

Table 4: Criteria discussed by the focus group members

Ranking	Criteria	No. of times	%
1	Professional Competence of Physicians	19	14.52%
2	Expenses	22	12.50%
3	Recommendation	12	8.27%
4	Risks	11	7.54%
5	Educational and work experience of physicians	7	7.17%
6	Reputation of physicians	8	5.88%
7	Service attitudes	8	3.86%
8	Previous customer outcomes	5	3.68%
9	Equipment	8	3.31%
10	Consultant services	6	3.31%
11	Time needed for overall treatment	8	3.31%
12	After-sales services	5	2.94%
13	Certificates of physicians	4	2.76%
14	Promotional events	6	2.76%
15	Transportation	7	2.39%
16	Recommendation of friends and relatives	4	2.21%
17	Electronic word-of-mouth	3	2.02%
18	Time needed for post-operation nursing	4	1.65%
19	Decoration and environment of clinics	7	1.65%
20	Reputation of clinics	3	1.65%
21	Overall cost of services	4	1.47%
22	Quality of services	2	1.29%
23	Implementation items	2	1.10%
24	Characteristics of clinics	3	1.10%
25	Specialty of medical personnel	3	0.92%
26	Time needed for the operation	1	0.37%
27	Media recommendations	1	0.37%
28	Appearance of medical personnel	1	0.18%

cause, and influenced all the other criteria, with high prominence ($L + R = 7.3642$). The related businesses could therefore train physicians to improve overall service performance. Service Integrity ($L - R = 0.2630$) also affect all the other elements and presented high correlations with the other factors ($L + R = 7.8848$), and thus consumer evaluations of the business would be enhanced by reinforcing the integrity of medical clinics, which cannot have a personality of the services offered, such as increasing the number and range of services, providing complete consultant services and after-sales services, and holding promotional events. Characteristics of Medical Personnel ($L - R = 0.4562$) was in cause group, but with the lowest prominence ($L + R = 6.0018$). Finally, relevant costs and recommendations from relatives did not appear to have any significant effects on the other criteria, and thus cannot be used to directly improve business performance, and so were not discussed in the ANP. The relations among the 24 sub-criteria were further examined using the same DEMATEL steps. The results are shown in Table 8, while the row/column results are shown in Table 9.

The results showed that the educational and work experiences of physicians and professional certificates ($L - R = 2.1441$) and communication skills of physicians

($L - R = 0.5865$) in Professional Competence of Physicians were the major causes ($L - R > 0$), and thus that businesses should work to improve these. Reputation of physicians ($L + R = 10.3015$) and Previous customer outcomes ($L + R = 10.1236$) both had strong correlations with the other criteria. Specialty of medical personnel ($L - R = 4.9704$) and attitudes of medical personnel ($L - R = 0.5696$) in Characteristics of Medical Personnel were the main causes ($L - R > 0$) that affected the other criteria, and communication skills of medical personnel ($L + R = 131.2844$) is an important factor that businesses could work to improve. Products and equipment was the most important cause ($L - R = 1.7230$), and reputation of medical clinics ($L + R = 16.2378$) had strong correlations. When the quality of products and equipment is high, people will make more positive evaluations of the clinic's reputation, and perceptions of process and efficiency in therapy services will also be improved. Therefore, businesses should invest in purchasing good quality equipment to improve overall performance with regard to Characteristics of Medical Clinics. Promotional events ($L - R = 1.6648$) in Service Integrity was a primary cause, while therapy subjects and scope ($L - R = 0.7058$) was also a cause and an important criteria ($L + R = 17.0426$), and thus businesses should

Table 5: Decision criteria and sub-criteria

Criteria	Sub-criteria
Professional Competence of Physicians	<ul style="list-style-type: none"> ◆ Educational and work experience of physicians, as well as their professional certificates ◆ Communication skills of physicians ◆ Previous customer outcomes ◆ Reputation of physicians
Characters of Medical Personnel	<ul style="list-style-type: none"> ◆ Communication skills of medical personnel ◆ Specialty of medical personnel ◆ Attitudes of medical personnel
Characters of Medical Clinics	<ul style="list-style-type: none"> ◆ Reputation of medical clinics ◆ Process and efficiency ◆ Products and equipment ◆ Environment and climate
Service Integrity	<ul style="list-style-type: none"> ◆ Focus and scope of treatment ◆ Consultant services ◆ After-sales services ◆ Promotional events
Relevant Costs	<ul style="list-style-type: none"> ◆ Expenses ◆ Time ◆ Risks ◆ Transportation
Recommendation from relatives	<ul style="list-style-type: none"> ◆ Electronic word-of-mouth ◆ Physician recommendation ◆ Famous people recommendation ◆ Recommendation of friends and relatives ◆ Media recommendation

Table 6: Row/column computation of the total-relationship matrix of the six criteria

Criteria	L	R	L+R	L-R
A. Professional Competence of Physicians	4.3978	2.9664	7.3642	1.4314
B. Characteristics of Medical Personnel	3.2290	2.7728	6.0018	0.4562
C. Characteristics of Medical Clinics	4.0211	4.0490	8.0702	-0.0279
D. Service Integrity	4.0739	3.8109	7.8848	0.2630
E. Relevant Costs	2.8919	3.5861	6.4779	-0.6942
F. Recommendation from Relatives	2.7768	4.2051	6.9819	-1.4284

Table 7: Effect relations of primary criteria

Source of effect	Relations affecting other elements
A. Professional Competence of Physicians	A → B ; A → C ; A → D ; A → E ; A → F
B. Characteristics of Medical Personnel	B → C ; B → D ; B → F
C. Characteristics of Medical Clinics	C → D ; C → E ; C → F
D. Service Integrity	D → A ; D → C ; D → E ; D → F
E. Relevant Costs	-
F. Recommendation from Relatives	-

work to improve both of these. With regard to Relevant Costs, risks ($L - R = 0.5472$) could significantly affect the other criteria. For example, if consumers see a low level of risk, then they are willing to spend more time and money on the services. Businesses should thus work to reduce risk by keeping their equipment clean and carrying out thorough medical evaluations before agreeing to do operations. Expenses ($L + R = 17.0680$) showed higher

prominence, while Transportation had relatively low prominence ($L + R = 11.5414$). Physician recommendation ($L - R = 1.8328$) was the most important cause in Recommendations from Relatives, which could affect other recommendation channels. Recommendations from physicians were regarded credible, as these individuals have specialist medical knowledge. Businesses could therefore form alliances

Table 8: Causal relations among the 24 sub-criteria

Criteria	Source of effect	Relations affecting other elements
A. Professional Competence of Physicians	A1: Educational and Work experiences of physicians and the professional certificates A2: Communication skills of physicians A3: Previous customer outcomes A4: Reputation of physicians	A1 → A2 ; A1 → A3 ; A1 → A4 A2 → A3 ; A2 → A4 A3 → A4 A4 → A3
B. Characteristics of Medical Personnel	B1: Communication skills of medical personnel B2: Specialty of medical personnel B3: Attitudes of medical personnel	B1 → B3 B2 → B1 B3 → B1
C. Characteristics of Medical Clinics	C1: Reputation of medical clinics C2: Process and efficiency C3: Products and equipment C4: Environment and atmosphere	C1 → C2 C2 → C1 C3 → C1 ; C3 → C2 C4 → C1
D. Service Integrity	D1: Therapy subjects and scope D2: Consultant services D3: After-sales services D4: Promotional events	D1 → D2 ; D1 → D3 ; D1 → D4 D2 → D1 ; D2 → D3 D3 → D2 D4 → D1 ; D4 → D2 ; D4 → D3
E. Relevant Costs	E1 Expenses E2 Time E3 Risks E4 Transportation	E1 → E2 ; E1 → E3 ; E1 → E3 E2 → E1 ; E2 → E3 E3 → E1 ; E3 → E2 -
F. Recommendation from Relatives	F1: Electronic word-of-mouth F2: Physician recommendation F3: Famous people recommendation F4: Recommendation of friends and relatives F5: Media reports	F1 → F3 ; F1 → F4 ; F1 → F5 F2 → F1 ; F2 → F3 ; F2 → F4 ; F2 → F5 F3 → F1 ; F3 → F4 ; F3 → F5 - F5 → F1 ; F5 → F4

with physicians from other departments to increase the options for consumers. With regard to prominence, electronic word-of-mouth ($L + R = 7.9747$) had the highest correlations with the other criteria. Finally, Relevant Costs and Recommendations from Relatives did not appear to have any significant effects on the other criteria, and thus were not included in the ANP model.

4.3 Results of ANP

Based on the results of the DEMATEL analyses, factors which did not affect other criteria were deleted, and the remaining ones were put into the ANP model. In addition to simplifying the ANP, this means that it is easier to understand the actual decisions of consumers, so that service providers can invest the appropriate resources to improve performance related to the most important criteria. (1) Developing the network model Based on the DEMATEL analyses, four primary criteria and 15 sub-criteria were utilized to produce the ANP framework, as shown in Fig. 2. The framework and correlations among criteria were then input into the Super Decisions software for further analyses.

The questionnaire was designed based on the dependence among the criteria, and then emails were used to recruit experienced consumers and related medical staff. A total of 22 valid questionnaires were received

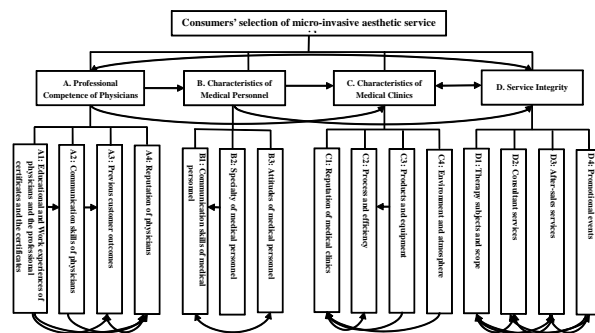


Fig. 2: ANP hierarchy

from experienced consumers, and 31 from medical workers. In order to confirm the differences between consumers and medical workers, ANP was carried out, and no significant difference appeared between the two groups, indicating that the medical workers had a good understanding of consumer preferences.

(2) Integrating expert preferences and testing the consistency The 53 valid questionnaires were then subjected to the pairwise comparison matrix with geometric mean, as well as a consistency test. When $CI < 0.1$ and $CR < 0.1$, the pairwise comparison matrix

Table 9: Causal relations among the 24 sub-criteria

Criteria	Sub-criteria	L	R	L+R	L-R
A. Professional Competence of Physicians	A1: Educational and Work experiences of physicians and the professional certificates	5.522	3.378	8.900	2.144
	A2: Communication skills of physicians	4.840	4.253	9.094	0.586
	A3: Previous customer outcomes	4.757	5.366	10.123	-0.609
	A4: Reputation of physicians	4.090	6.211	10.301	-2.120
B. Characteristics of Medical Personnel	B1: Communication skills of medical personnel	62.872	68.412	131.284	-5.540
	B2: Specialty of medical personnel	62.789	57.818	120.608	4.970
	B3: Attitudes of medical personnel	63.835	63.266	127.101	0.569
C. Characteristics of Medical Clinics	C1: Reputation of medical clinics	7.459	8.777	16.237	-1.318
	C2: Process and efficiency	7.644	7.798	15.443	-0.153
	C3: Products and equipment	8.292	6.569	14.862	1.723
	C4: Environment and atmosphere	6.378	6.629	13.008	-0.251
D. Service Integrity	D1: Therapy subjects and scope	8.874	8.168	17.042	0.706
	D2: Consultant services	7.731	8.911	16.642	-1.179
	D3: After-sales services	7.068	8.259	15.327	-1.190
	D4: Promotional events	8.650	6.985	15.636	1.664
E. Relevant Costs	E1: Expenses	8.662	8.405	17.068	0.256
	E2: Time	7.780	8.630	16.410	-0.849
	E3: Risks	8.584	8.037	16.622	0.547
	E4: Transportation	5.793	5.747	11.541	0.045
F. Recommendation from Relatives	F1: Electronic word-of-mouth	4.153	3.821	7.974	0.331
	F2: Physician recommendation	4.585	2.752	7.337	1.832
	F3: Famous people recommendation	3.826	3.598	7.425	0.227
	F4: Recommendation of friends and relatives	2.690	4.587	7.278	-1.896
	F5: Media reports	3.677	4.173	7.850	-0.495

was consistent. The CI of the pairwise comparison matrix was in the range of 0.0000 – 0.0243 and CR in the range of 0.0000 – 0.0467, both less than 0.1, and thus the consistency test was passed. ANP was used to examine the effects of the criteria, and the results of the pairwise comparisons indicated mutual dependence among the criteria. The limit of supermatrix in ANP was used to acquire the weights of the decision criteria, as shown in Table 10. The ANP results show that Service Integrity (0.4166) was the most important criterion in consumer decisions to select micro-invasive aesthetic service providers. Characteristics of Medical Clinics (0.3304) was the second most important factor, revealing that consumers pay attention to the reputation, service procedure and efficiency, and software, hardware and other equipment and facilities held by micro-invasive aesthetic service providers. The top five factors that consumers considered when making the decision to purchase such services were consultant services, reputation of medical clinics, after-sales services, process and efficiency, and previous customer outcomes.

4.4 Discussion

Operating in a competitive market and with limit resources, the results of this study indicate that micro-invasive aesthetic service providers should invest more resources in trying to attract consumers. This work

shows that by combining DEMATEL and ANP managers can better understand the correlations and importance among various decision-related criteria, and apply the results to enhance the services their companies offer, and thus increase competitiveness. Service integrity is the critical decision criterion for consumers selecting service providers, and is a cause of all the other criteria. Businesses should therefore promote services that better meet consumer demands, such as complete allergy tests and providing simulated images of how a consumer would look after surgery. Consultant services and after-sales services are also important factors for consumers, where the former determines whether consumers would decide to accept the treatment, while the latter relates to repurchase intentions. In terms of consultant services, businesses could provide detailed more information to customers during consultations in order to better understand their demands, as well as explain what services can be provided, as this would enhance overall service standards and perceived integrity. With regard to after-sales services, better customer relationship management, like offering post-treatment consultations and services, would also please consumers, and further enhance repurchase intention. Characteristics of Medical Clinics is the second most important decision criterion that businesses should focus on, such as introducing the latest equipment and products to consumers, and establishing standard operation processes to enhance services and reduce the amount of time

Table 10: Criteria discussed by the focus group members

Criteria	Weight	Ranking	Sub-criteria	Weight	Ranking	Overall ranking
A. Professional Competence of physicians	0.1892	3	A1: Educational and Work experiences of physicians and the professional certificates	0.0138	4	14
			A2: Communication skills of physicians	0.0266	3	11
			A3: Previous customer outcomes	0.0768	1	5
			A4: Reputation of physicians	0.0719	2	7
B. Characteristics of Medical Personnel	0.0638	4	B1: Communication skills of medical personnel	0.0289	1	10
			B2: Specialty of medical personnel	0.0100	3	15
			B3: Attitudes of medical personnel	0.0249	2	12
C. Characteristics of Medical Clinics	0.3304	2	C1: Reputation of medical clinics	0.1442	1	2
			C2: Process and efficiency	0.1401	2	4
			C3: Products and equipment	0.0294	3	9
			C4: Environment and atmosphere	0.0166	4	13
D. Service Integrity	0.4166	1	D1: Therapy subjects and scope	0.0752	3	6
			D2: Consultant services	0.1617	1	1
			D3: After-sales services	0.1425	2	3
			D4: Promotional events	0.0372	4	8

needed. Regarding the reputation of medical clinics and process and efficiency, more resources should be invested in establishing a brand image. In addition, clinical performance is affected by the capabilities of personnel, and thus high quality personnel should be hired or trained. Moreover, products and equipment, as part of the characteristics of medical clinics, also has primary effects on the other criteria, and thus businesses should provide good products and use high quality equipment, along with giving details of the source of origin and related test certificates, and, if they have sufficient capital, buy the latest equipment in order to attract more consumers. Although the weight of professional competence of physicians was not the highest, it is regarded as an important cause. As this can effectively improve the other criteria, so businesses should provide specialist training got their physicians, by encouraging them to learn new technology, undertake training in the use of new equipment, and acquire certificates related to aesthetic services. When physicians' specialties are enhanced, other areas of performance are also promoted and especially previous customer outcomes, which is very important when consumers make decisions. The previous achievements of physicians can be used to present details of successful cases in consultant services, as this would raise the confidence of consumers in the expected outcome. The characteristics of medical personnel are relatively unimportant in decision-making, and thus, while it is still one of the causes, businesses should not focus their limited resources on this area. However, once the four criteria related to these characteristics are improved, relevant costs and recommendations from relative's performance would be indirectly enhanced.

5 Conclusion

Micro-invasive aesthetic services are paid for by consumers themselves, with the aim of changing their appearance. In this very competitive market, many different and complex factors affect consumer decisions when selecting a micro-invasive aesthetic service provider. Based on a literature review and focus group interviews, the related decision criteria were classified into six primary criteria of Professional Competence of Physicians, Characteristics of Medical Personnel, Characteristics of Medical Clinics, Service Integrity, Relevant Costs, and Recommendations from Relatives and 24 sub-criteria. DEMATEL was used to examine the causal relationships among the decision criteria, and the results showed that Professional Competence of Physicians, Characteristics of Medical Personnel, and Service Integrity are in causes group, which have direct effects on the other criteria, while Relevant Costs and Recommendations from Relatives do not have any significant effects on the other criteria, and the remaining criteria are in effects group, which cannot be directly improved. Therefore, Relevant Costs and Recommendations from Relatives are deleted, and the remaining correlations among four criteria and 15 sub-criteria are used to create a causal model of consumer decision-making when selecting micro-invasive aesthetic service providers. Based on the results of ANP, Service Integrity is regarded as the key decision criterion, while Characteristics of Medical Personnel is the least important. Overall, consultant services, reputation of medical clinics, after-sales services, process and efficiency, and previous customer achievement are the top five decision factors. Past research on medical service providers focused more on essential medical services. Turning to micro-invasive aesthetic services, this study

combined DEMATEL and ANP to establish a decision model based on the relative importance of the related criteria. Using this hierarchical approach, six criteria and 24 sub-criteria are first discovered, and then the causal relationships among these are found, and the criteria are reduced down to four primary ones and 15 sub-criteria, which are then included in a decision model. Finally, the weights of the relative importance among criteria are calculated. The decision model presented in this work can be used by businesses to better understand the causal relationships among the criteria, and thus achieve greater effectiveness by improving the most important ones. The weights found in this work show that the top five criteria being consultant services, reputation of medical clinics, after-sales services, process and efficiency, and previous customer outcomes, which are included in the criteria of Service Integrity, Characteristics of Medical Clinics, and Professional Competence of Physicians. Therefore, businesses should aim to invest their limited resources in these areas to enhance the competitiveness and attract consumers. It should be noted that, although the literature review was thorough and three focus group interviews were held, some criteria may have been excluded from the model. As a consequence, it is suggested that future research include different criteria and use other methods, such as the Delphi Method or in-depth expert interviews. While research subjects in this study were experienced consumers and medical staff, as individuals they may have had very limited experience of in micro-invasive aesthetic services and the related professional knowledge. It is therefore suggested that future works distribute questionnaires to consumers with more experiences of such services, as this would obtain better results. This study examined consumer decisions when selecting micro-invasive aesthetic service providers, using DEMATEL and ANP, as well as pairwise comparisons. The DEMATEL questionnaire contained six primary criteria and 24 sub-criteria, while only four primary criteria and 15 criteria were included in the ANP, so that responses were not too complicated or too long for the participants. Since different research methods could result in different outcomes, it is suggested that fewer criteria and simpler presentation methods be used in future work, and that various research methods are applied.

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