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The Use of a Hybrid MCDM Model for Public Relations Personnel Selection

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Abstract. The purpose of this study is to apply the method of hybrid multiple criteria decision making (MCDM) to select public relations personnel for tourism industry in Taiwan. Fuzzy Delphi method, which can lead to better criteria selection, is used to modify criteria. Considering the interdependence among the selection criteria, analytic network process (ANP) is then used to obtain the weights of them. To avoid calculation and additional pairwise comparisons of ANP, technique for order preference by similarity to ideal solution (TOPSIS) is used to rank the alternatives. The use of a combination of fuzzy Delphi method, ANP and TOPSIS, proposing a MCDM model for public relations personnel selection, and applying these to a real case is the unique features of this study.

Key words: analytic network process, fuzzy Delphi method, personnel selection, public relations, TOPSIS.

1. Introduction

Tourism is one of the leading economic sectors in the world, and represents a major source of employment, income, exports and taxes. Many countries pay attention to the development of tourism to drive their "green" economic growth (Su and Lin, 2014). Liu *et al.* (2012) also point out that the travel and tourism industry is one of the largest industries in the world. Taiwan has not failed to recognize the vital role of tourism. The government has rapidly developed its tourism policies to meet demand and produce related benefit. Besides government policies, tourism industry also tries its best to gain more competitiveness. Public relations are an important component of the marketing mix for the tourism industry in its attempt to inform tourists about what a particular country, region or individual business has to offer (Hanusch, 2012). As a result, selecting optimal public relations personnel to make effective public relations is important to tourism industry. However, there is a lack of published paper in this field.

Personnel selection is the process of choosing, among the candidates applying for a defined job in the organization, the ones who have the qualifications required to perform the job in the best way. Faced the increasing competition in the global market, organizations depend mainly on the contribution of their personnel. It is necessary for organizations to emphasize on personnel selection process (Zhang and Liu, 2011). In order to select most suitable personnel to perform the defined job, develop an effective selection model is very vital. In this paper, a hybrid MCDM model is developed to select public relations personnel for Taiwan tourism industry.

Fuzzy Delphi method which can encompass all the expert opinions in one investigation is used to modify selection criteria. ANP produces more accurate weighting of criteria, since it enables consideration of the dependence among factors in decision-making problems. Unfortunately, ANP requires many pairwise comparisons depending on the number and interdependence of factors and alternatives. This disadvantage of ANP is eliminated via the use of TOPSIS. Thus, the selection process is shortened (Dağdeviren, 2010). By combining fuzzy Delphi method, ANP, and TOPSIS, this study can make better decisions in selecting public relations personnel within a shorter time, which distinguishes this study from others in the literature. The organization of this paper is as follows. We first present a literature review of the personnel selection. Next, the fuzzy Delphi method, ANP and TOPSIS as selection tools are described. The integrated method within the context of selecting the optimal public relations personnel is shown in Section 6. The conclusion is given in Section 7.

2. MCDM methods for personnel selection

In real-world cases, most problems have more than one decision criterion. As the result, MCDM methods have been developed to solve complex problems. The aim in MCDM is to determine overall preferences among alternatives. Based on the objective, MCDM methods can be utilized for ranking alternatives. Several authors have used some MCDM methods to deal with the personnel selection problem. Zavadskas *et al.* (2008) apply complex proportional assessment of alternatives with grey relations (COPRAS-G) to select construction project manager. Liao and Chang (2009a) apply ANP to choose public relations personnel for Taiwanese hospitals. Liao and Chang (2009b) apply ANP to select televised sportscasters for Olympic Games. Dağdeviren (2010) employs ANP and modified TOPSIS to select personnel. Dursun and Karsak (2010) use the principles of fusion of fuzzy information, 2-tuple linguistic representation model, and TOPSIS to select personnel. Kelemenis and Askounis (2010) propose a new approach on the basis of fuzzy TOPSIS to select information technology (IT) professionals. Lin (2010) combines ANP and fuzzy data envelopment analysis (DEA) to select personnel. Boran *et al.* (2011) apply intuitionistic fuzzy TOPSIS to select a sales manager in a manufacturing company. Chen et al. (2011a) propose a linguistic VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) method to deal with personnel selection problem. Keršulienė and Turskis (2011) integrate the principles of fusion of fuzzy information, additive ratio assessment (ARAS) method with fuzzy numbers and step-wise weight assessment ratio analysis (SWARA) technique to select architect. Zhang and Liu (2011) propose an intuitionistic fuzzy multi-criteria decision making method with grey relational analysis (GRA) to select system analysis engineer. Baležentis *et al.* (2012a) modify fuzzy multi-objective optimization by ratio analysis plus the full multiplicative form (MULTIMOORA) for personnel selection. Baležentis *et al.* (2012b) extend fuzzy MULTIMOORA with linguistic reasoning and group decision-making (MULTIMOORA-FG) for personnel selection. Dadelo *et al.* (2012) present a model for personnel selection based on expert evaluation method and ARAS method. El-Santawy and El-Dean (2012) employ VIKOR to rank the candidates. Hashemkhani Zolfani and Antucheviciene (2012) use analytic hierarchy process (AHP) and TOPSIS with grey relations (TOPSIS grey) to select a new drummer for a rock band. Hashemkhani Zolfani *et al.* (2012) use AHP and COPRAS-G method to select quality control manager. Kabak *et al.* (2012) combine fuzzy ANP, fuzzy TOPSIS and fuzzy ELimination Et Choix Traduisant la REalité (ELECTRE) to select sniper. Rouyendegh and Erkan (2012) utilize fuzzy AHP to select most suitable academic staff. Afshari *et al.* (2013) propose a new linguistic extension of fuzzy measure and fuzzy integral for personnel selection. Dadelo *et al.* (2013) apply wisdom-of-crowds principle, TOPSIS, and simple additive weighting (SAW) to select security guard. Hadad *et al.* (2013) propose a decision-making support system module to select project managers. Kabak (2013) applies fuzzy decision-making trial and evaluation laboratory (DEMATEL)-ANP model to select snipers. Rouyendegh and Erkan (2013) use fuzzy ELECTRE to select academic staff. Yu *et al.* (2013) explore aggregation methods for prioritized hesitant fuzzy elements and their application on representative personnel evaluation. Ballı and Korukoğlu (2014) use fuzzy AHP and TOPSIS to select skilful basketball players. Dadelo *et al.* (2014a) propose 2 optimizing algorithms to select security guards. Dadelo *et al.* (2014b) propose an integrated model based on TOPSIS, expert judgment assessment and ranking to select basketball players. Keršulienė and Turskis (2014) integrate the principles of fusion of fuzzy information, ARAS method with fuzzy numbers (ARAS-F), fuzzy weighted-product model and AHP to select a chief accounting officer. Md Saad *et al.* (2014) present a novel approach of handling personnel selection process by using the Hamming distance method.

Extensive MCDM approaches have been proposed in the literature for personnel selection, such as fuzzy AHP, fuzzy TOPSIS and hybrid approaches. It is difficult to figure out the best way to select personnel, so the organizations apply a variety of different methods to deal with it. However, the most crucial issue in the process of personnel selection is to develop a suitable model to select the right personnel. This paper firstly adopts fuzzy Delphi method to modify the selection criteria for public relations personnel. The assumption of independence of criteria is not always correct because in real world the criteria are often dependent with each other (Azimi *et al.*, 2011). After discussing with senior executives, we find that the selection criteria for public relations personnel are interrelated. To address this issue, ANP, which captures the interdependence, is applied to generate the weights of the selection criteria. TOPSIS is used to rank the alternatives. By combining fuzzy Delphi method, ANP and TOPSIS, this study can make better decisions in public relations personnel selection.

3. Fuzzy Delphi Method

The Delphi method is a traditional forecasting approach that does not require large samples. It can be utilized to generate a professional consensus for complex topics (Hartman, 1981). The Delphi method suffers from low convergence expert opinions and more execution cost. Murray *et al.* (1985) integrate Delphi method and fuzzy theory. Membership degree is applied to establish the membership function of each participant. Ishikawa *et al.* (1993) also introduce fuzzy theory into Delphi method. Max–min and fuzzy integration algorithm is developed. Hsu and Yang (2000) apply a triangular fuzzy number to encompass expert opinions and establish a fuzzy Delphi method. The max and min value of expert opinions are taken as the 2 terminal points of triangular fuzzy numbers, and the geometric mean is taken as the membership degree of triangular fuzzy numbers to derive the statistical unbiased effect and avoid the impact of extreme values. Kuo and Chen (2008) point out that the advantage of fuzzy Delphi method for collecting group decision is that every expert opinion can be considered and integrated to achieve the consensus of group decisions. Moreover, it reduces the time of investigation and the consumption of cost and time. Ma *et al.* (2011) describe the advantage of fuzzy Delphi method is its simplicity. All the expert opinions can be encompassed in one investigation. Hence, this method can create more effective criteria selection. Shen *et al.* (2011) use fuzzy Delphi method on the basis of center-of-gravity method to integrate experts' opinions. This paper adopts fuzzy Delphi method to identify the selection criteria for public relations personnel. The geometric mean is used to denote the consensus of the experts' evaluation (Ma *et al.*, 2011).

$$L_G = (L_1 \times L_2 \times \cdots \times L_n)^{1/n} \tag{1}$$

where L_i denotes importance rating of the criteria by i-th expert ($i = 1, 2, \ldots, n$). L_G geometric mean value.

4. ANP

ANP (Saaty, 1996) is a comprehensive decision-making technique that captures the outcome of dependency between criteria. AHP serves as a starting point of ANP. Priorities are established in the same way that they are in AHP using pairwise comparisons. ANP comprises 4 major steps (Saaty, 1996).

Step 1. Construct hierarchy and structure problem

Structure the problem in a hierarchy of different levels constituting goal, perspective, criteria and alternatives. The hierarchy which is comprised of a goal, levels of elements and connections between the elements can be determined by decision makers' opinions via brainstorming or other appropriate methods such as literature reviewing.

Step 2. Determine the perspectives and criteria weights

In this step, the decision-making committee makes a series of pairwise comparisons to establish the relative importance of perspectives and criteria. In these comparisons, a 1–9 scale is applied to compare 2 perspectives or criteria according to the interdependency of perspectives and criteria. The eigenvector of the observable pairwise comparison matrix provide the perspectives and criteria weights at this level, which will be used in the supermatrix.

$$Aw = \lambda_{\max} w \tag{2}$$

where A is defined as the matrix of pairwise comparison values; w is the priority vector, also called principal eigenvector and $\lambda_{\max}$ is the maximum or principal eigenvalue of matrix A.

Saaty (1980) proposes the consistency ratio (C.R.) to verify the consistency of the pairwise comparison matrix. C.I. is the consistency index and R.I. is the random index. n is the number of criteria in the matrix A. If C.R. value $\leqslant 0.1$, the consistency of the pairwise comparison matrix is accepted.

$$\text{C.R.} = \frac{\text{C.I.}}{\text{R.I.}} \quad \text{with C.I.} = \frac{\lambda_{\max} - n}{n - 1}. \tag{3}$$

Step 3. Construct and solve the supermatrix

The supermatrix concept is similar to the Markov chain process. The perspectives and criteria weights derived from Step 2 are used to obtain the column of the supermatrix. The supermatrix represents the influence priority of an element on the left of the matrix on an element at the top of the matrix with respect to a particular control perspective or criterion. Finally, the supermatrix will be stabilized by multiplying the supermatrix by itself until the supermatrix's row values converge to the same value for each column of the matrix. We call the result the limiting matrix.

$$W_{limit} = \lim_{x \to \infty} (W_{weighted})^x \cong (W_{weighted})^{2k+1} \tag{4}$$

where k is an arbitrarily large number.

Step 4. Select the best alternative

According to the limiting matrix and weights of alternatives with respect to criteria, we can aggregate the total weight of each alternative. We rank the alternative according to their priority weights.

ANP has been successfully applied in many fields. Azimi *et al.* (2011) apply strengths, weaknesses, opportunities, and threats (SWOT) analysis to assign feasible strategies. ANP and TOPSIS are used to rank the strategies for Iranian mining sector. Bottero *et al.* (2011) apply AHP and ANP for wastewater treatment (WWT) technology selection. They point out that ANP results more suitable than AHP. ANP enhances the function of AHP to development a complete model that can incorporate interdependent relationships between factors from different levels or within levels, which are assumed to be uncorrelated in AHP. Chen et al. (2011b) use DEMATEL and ANP to solve performance evaluation problems for hot spring hotels. Ho *et al.* (2011) combine DEMATEL, ANP and VIKOR to explore invest portfolio selection based on capital asset pricing model (CAPM). Lee *et al.* (2011) utilize fuzzy ANP and interpretive structural modeling (ISM) to analyze suitable strategic products. Liao *et al.* (2011) use ANP and TOPSIS for assessing the performance of Taiwanese tour guides. Lin *et al.* (2011) apply ANP and TOPSIS to select supplier. Moreover, linear programming (LP) is used to compute the optimal order quantity of each supplier. Shen *et al.* (2011) integrate fuzzy Delphi method, DEMATEL and ANP for the organic light emitting diode technology selection. Vinodh *et al.* (2011) select supplier by fuzzy ANP. Altuntas *et al.* (2012) apply AHP and ANP to measure hospital service quality. Fazli and Jafari (2012) apply DEMATEL, ANP and VIKOR to select the best alternative for investment in stock exchange. Hsu (2012) applies ANP and GRA to select optimal media agency. Hsu *et al.* (2012) propose a process of algorithm that combined the consistent fuzzy preference relations method with ANP to evaluate e-service quality. They also point out that ANP is capable of addressing interdependent relationships among criteria. Hu *et al.* (2012a) utilize ANP to evaluate e-service quality of microblogging. Hu *et al.* (2012b) use ANP to evaluate the performance of Taiwan homestay industry. Kabak *et al.* (2012) combine fuzzy ANP, fuzzy TOPSIS and fuzzy ELECTRE to select sniper. Kang *et al.* (2012) apply fuzzy ANP and ISM to select technologies for new product development (NPD). Lee (2012) uses fuzzy ANP for competitive strategy selection. Lee and Lee (2012) apply ANP to select most suitable competitive strategy for multinational biotech pharmaceutical enterprises. Liu *et al.* (2012) apply DEMATEL, ANP and VIKOR to suggest an optimal improvement plan for Taiwan tourism policy. Tsai and Chang (2012) utilize ANP and GRA to measure the performance of wealth management banks in Taiwan. Chang (2013) combines ANP with TOPSIS to select NPD project for century-old food industry in Taiwan. Hsu *et al.* (2013) use DEMATEL and ANP to select the outsourcing provider. Kabak (2013) applies fuzzy DEMATEL-ANP model to select snipers. Kiriş (2013) uses fuzzy ANP to solve inventory classification problems. Wang *et al.* (2013) construct a project selection model on the basis of fuzzy Delphi method, ISM and ANP. Wu *et al.* (2013a) use fuzzy Delphi method and ANP for assessing the service quality of university library websites. Wu *et al.* (2013b) apply fuzzy Delphi method, ANP, and TOPSIS to select suppliers. Wu *et al.* (2013c) utilize fuzzy Delphi method and ANP to select NPD projects for Taiwanese century-old businesses. ANP, widely applied in decision making, is more accurate and feasible under interdependent situations. However, after discussions with senior executives, we found that the selection criteria for public relations personnel are interrelated. ANP, which captures the interdependence, appears to be one of the more feasible and accurate solutions for generating the weights of the criteria.

5. TOPSIS

TOPSIS, proposed by Hwang and Yoon (1981), enables decision makers to determine the positive ideal solution (A^*) and negative ideal solution (A^-). On the basis of TOPSIS, the chosen alternative should have the shortest distance from the positive ideal solution and farthest from the negative ideal solution. The computation procedure is presented as following.

Step 1. Construct the standardized appraisal matrix

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{5}$$

where i indicates the alternatives, j denotes the selection criteria and x_{ij} means the i alternative under the j criterion to be assessed.

Step 2. Construct the weighted standardized appraisal matrix

Weights of selection criteria, $w = (w_1, w_2, \ldots, w_n)$, multiplied by standardized appraisal matrix can be expressed as

$$v = \begin{bmatrix} v_{11} & v_{12} & \ldots & v_{1n} \\ v_{21} & v_{22} & \ldots & v_{2n} \\ \vdots & \vdots & \ldots & \vdots \\ v_{m1} & v_{m2} & \cdots & v_{nm} \end{bmatrix} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \ldots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \ldots & w_n r_{2n} \\ \vdots & \vdots & \ldots & \vdots \\ w_1 r_{m1} & w_2 r_{m2} & \cdots & w_n r_{mn} \end{bmatrix} \tag{6}$$

Step 3. Identify the positive ideal solution and negative ideal solution

$$A^* = \{v_1^*, v_2^*, \ldots, v_j^*, \ldots, v_n^*\} = \Big\{\Big(\max_i v_{ij} \;\Big|\; j \in J\Big) \Big| \, i = 1, \ldots, m\Big\},$$
$$A^- = \{v_1^-, v_2^-, \ldots, v_j^-, \ldots, v_n^-\} = \Big\{\Big(\min_i v_{ij} \mid j \in J\Big) \Big| \, i = 1, \ldots, m\Big\}. \tag{7}$$

Step 4. Calculate the Euclidean distance between the positive ideal solution (S_i^*) and negative ideal solution (S_i^-) for each alternative

$$S_i^* = \sqrt{\sum_{j=1}^{n} \big(v_{ij} - v_i^*\big)^2}, \quad i = 1, \ldots, m,$$
$$S_i^- = \sqrt{\sum\_j = 1^n \big(v_{ij} - v_i^-\big)^2}, \quad i = 1, \ldots, m. \tag{8}$$

Step 5. Calculate the relative closeness to the positive ideal solution for each alternative

$$C_i^* = \frac{S_i^-}{S_i^* + S_i^-}. \tag{9}$$

An alternative A_i is closer to A^* and farther from A^- as C_i^* approaches to 1.

Step 6. Rank the preference order by C_i^*

According to C_i^*, larger index values indicate better performance of the alternatives.

Many studied have explored TOPSIS. Awasthi *et al.* (2011) use fuzzy TOPSIS to select the best location for implementing an urban distribution center. Azimi *et al.* (2011) apply SWOT analysis to assign feasible strategies. ANP and TOPSIS are used to rank the strategies for Iranian mining sector. Boran *et al.* (2011) apply intuitionistic fuzzy TOPSIS to select a sales manager in a manufacturing company. Liao *et al.* (2011) use ANP and TOPSIS for assessing the performance of Taiwanese tour guides. Lin *et al.* (2011) apply ANP and TOPSIS to select supplier. Zeydan *et al.* (2011) combine fuzzy AHP and fuzzy TOPSIS to rank suppliers. Zhang *et al.* (2011) employ TOPSIS and information entropy to evaluate the tourism destination competitiveness. Büyüközkan and Çifçi (2012) utilize fuzzy AHP and fuzzy TOPSIS to evaluate a set of hospital web site alternatives. Choudhary and Shankar (2012) use fuzzy AHP and TOPSIS to select locations for thermal power plants. Hashemkhani Zolfani and Antucheviciene (2012) use AHP and TOPSIS grey to select a new drummer for a rock band. Kabak *et al.* (2012) combine fuzzy ANP, fuzzy TOPSIS and fuzzy ELECTRE to select sniper. Zouggari and Benyoucef (2012) use fuzzy AHP to select suppliers. Thereafter, fuzzy TOPSIS is utilized to determine the weights for order allocation among selected suppliers. Ishizaka *et al.* (2013) select the location of a casino in the Greater London region using the Weighted Sum Method, TOPSIS, and the preference ranking organization method for enrichment evaluation (PROMETHEE). Khalili-Damghani and Sadi-Nezhad (2013) propose a hybrid MCDM approach on the basis of goal programming (GP) and modified fuzzy TOPSIS to select sustainable project. Kundakci (2013) apply fuzzy axiomatic design (FAD) and fuzzy TOPSIS to select training firm for a textile company. Sadeghi *et al.* (2013) select action plans based on TOPSIS and Grey theory. Wu *et al.* (2013b) apply fuzzy Delphi method, ANP, and TOPSIS to select suppliers. Ballı and Korukoğlu (2014) use fuzzy AHP and TOPSIS to select skilful basketball players. Çelen (2014) applies TOPSIS method to evaluate the financial performances of 13 Turkish deposit banks. Dadelo *et al.* (2014b) propose an integrated model based on TOPSIS, expert judgment assessment and ranking to select basketball players. Although TOPSIS is comprehensible and the computations are uncomplicated, it suffers from the inherent problem of assigning reliable subjective preferences to criteria (Shyur, 2006). Due to the interdependent criteria, ANP is applied in this paper to generate the weights for the selection criteria. TOPSIS is used to rank the alternatives.

6. An empirical application

We employ fuzzy Delphi method, ANP, and TOPSIS in a case study of a real-life firm to select optimal public relations personnel. The decision committee of the travel agency includes 3 managers to make decisions. There are 4 candidates as alternatives. We depict the selecting process as follow.

Step 1. Construct hierarchy and structure problem

Fuzzy Delphi method can create better criteria selection (Ma *et al.*, 2011). Based on fuzzy Delphi method, we revise the hierarchy of Liao and Chang (2009a). Questionnaires based on Likert 9 point scale, with 1 as most unimportant and 9 as most important, are sent to 54 senior public relations personnel of travel agencies to obtain their opinions about the importance of criteria. The statistics for the selection criteria is shown in Table 1. In this paper, the geometric mean of each criterion is used to denote the consensus of the experts' evaluation value of the criteria. According to the geometric mean value of each criterion, we retain top 12 criteria showing in Table 2 to construct the hierarchy for the selecting public relations personnel. The overall goal of the hierarchy is to select most optimal public relations personnel for travel agencies. Level 1 represents the 3 perspectives in selecting most optimal public relations personnel (Work, Efficiency, and Person). Each perspective is decomposed into 4 criteria. Level 3 contains 4 alternatives.

Step 2. Determine the perspectives and criteria weights

In this step, the decision-making committee makes a series of pairwise comparisons to establish the relative importance of perspectives. In these comparisons, a 1–9 scale is ap-

Table 1
Statistics for the selection criteria.

Criteria	Geometric mean values
Interpersonal skill	6.1332
Loyalty	5.3757
Experience	6.2424
Negotiation	6.2904
Language	6.2531
Order	6.5457
Cognitive ability	6.6729
Environment	6.2792
Company	6.1323
Emotion	6.3823
Stress	6.2344
Attitude	6.1874
Response	6.1277

Table 2
Definitions of the criteria.

Perspective	Criteria	Definition
Work	C_1: Interpersonal skill	Interact well with others
	C_2: Experience	Past experience
	C_3: Negotiation	Convince others effectively
	C_4: Language	Familiar with different languages
Efficiency	C_5: Order	The ability to finish orders
	C_6: Cognitive ability	The ability to resolve problem by oneself
	C_7: Environment	Adapt to the external environment
	C_8: Company	Integrate with company
Person	C_9: Emotion	Emotional steadiness
	C_{10}: Stress	The ability to handle stress
	C_{11}: Attitude	Conscientious toward work
	C_{12}: Response	React appropriately to emergency

plied to compare the 2 perspectives. The pairwise comparison matrix and the development of each perspective priority weight are shown in Table 3. According the interdependency of criteria, we apply pairwise comparisons again to establish the criteria relationships within each perspective. The eigenvector of the observable pairwise comparison matrix provide the criteria weights at this level, which will be used in the supermatrix. With respect to Interpersonal skill, for example, a pairwise comparison within the Work perspective can be shown in Table 4. According to this way, we can derive every criterion weight to obtain the supermatrix.

Step 3. Construct and solve the supermatrix

The criteria weights derived from Step 2 are used to get the column of the supermatrix as shown in Table 5. Finally, the system solution is derived by multiplying the supermatrix of model variables by itself, which accounts for variable interaction, until the system's row values converge to the same value for each column of the matrix, as shown in Table 6. According to Tables 3 and 6, we can aggregate the total weight of each criterion as shown in Table 7.

Table 3
The pairwise comparisons of perspectives.

	$\lambda_{max} = 3.0053$, C.R. $= 0.0040$			
	Work	Efficiency	Person	Priority weights
Work	1.0000	1.0627	0.6437	0.2893
Efficiency	0.9410	1.0000	0.7539	0.2929
Person	1.5536	1.3264	1.0000	0.4178

Table 4
The pairwise comparisons within Work perspective with respect to Interpersonal skill.

	$\lambda_{max} = 3.0043$, C.R. $= 0.0032$			
	Experience	Negotiation	Language	Priority weights
Experience	1.0000	0.5848	0.4807	0.2095
Negotiation	1.7100	1.0000	1.0000	0.3824
Language	2.0801	1.0000	1.0000	0.4082

Table 5
The supermatrix before convergence.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
C_1	0.0000	0.2389	0.3390	0.2484								
C_2	0.2095	0.0000	0.2195	0.4611								
C_3	0.3824	0.3395	0.0000	0.2905								
C_4	0.4082	0.4215	0.4416	0.0000								
C_5					0.0000	0.2877	0.1688	0.2936				
C_6					0.1688	0.0000	0.3744	0.3317				
C_7					0.3744	0.2562	0.0000	0.3747				
C_8					0.4568	0.4561	0.4568	0.0000				
C_9									0.0000	0.4009	0.3628	0.4422
C_{10}									0.2820	0.0000	0.4403	0.3167
C_{11}									0.4425	0.1429	0.0000	0.2411
C_{12}									0.2755	0.4562	0.1969	0.0000

Table 6
The supermatrix after convergence (limiting matrix).

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
C_1	0.2153	0.2153	0.2153	0.2153								
C_2	0.2373	0.2373	0.2373	0.2373								
C_3	0.2494	0.2494	0.2494	0.2494								
C_4	0.2980	0.2980	0.2980	0.2980								
C_5					0.2015	0.2015	0.2015	0.2015				
C_6					0.2325	0.2325	0.2325	0.2325				
C_7					0.2525	0.2525	0.2525	0.2525				
C_8					0.3135	0.3135	0.3135	0.3135				
C_9									0.2872	0.2872	0.2872	0.2872
C_{10}									0.2537	0.2537	0.2537	0.2537
C_{11}									0.2208	0.2208	0.2208	0.2208
C_{12}									0.2383	0.2383	0.2383	0.2383

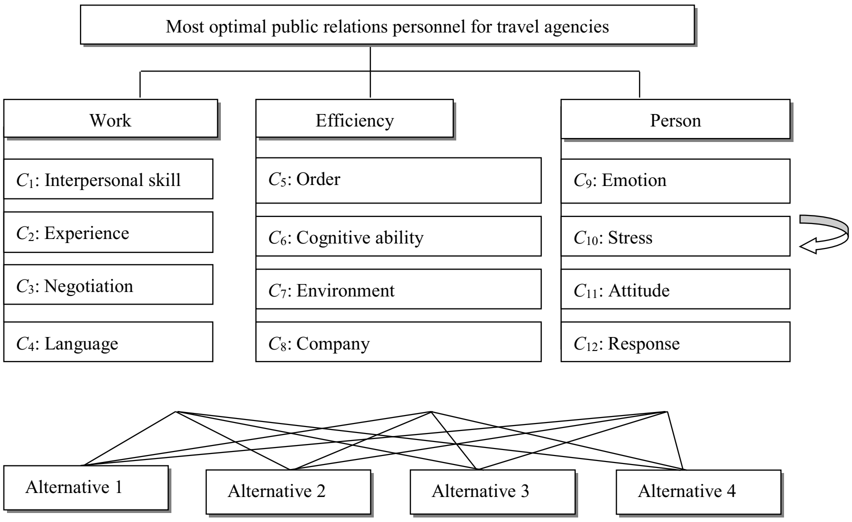


Fig. 1. Hierarchy to select most optimal public relations personnel for travel agencies.

Table 7
The total weight of each criterion.

	Weights from perspectives	Weights from supermatrix after convergence	Total weights
C_1	0.2893	0.2153	0.0623
C_2	0.2893	0.2373	0.0686
C_3	0.2893	0.2494	0.0722
C_4	0.2893	0.2980	0.0862
C_5	0.2929	0.2015	0.0590
C_6	0.2929	0.2325	0.0681
C_7	0.2929	0.2525	0.0739
C_8	0.2929	0.3135	0.0918
C_9	0.4178	0.2872	0.1200
C_{10}	0.4178	0.2537	0.1060
C_{11}	0.4178	0.2208	0.0922
C_{12}	0.4178	0.2383	0.0996

Step 4. Construct the standardized and weighted standardized appraisal matrix

The decision-making committee is asked to establish the appraisal matrix by comparing 4 alternatives with respect to each criterion on the basis of Likert 9 point scale. After the appraisal matrix is generated, utilize Eq. (5) to obtain standardized appraisal matrix, showing in Table 8. The criteria weights derived from ANP showing in Table 7 are multiplied by standardized appraisal matrix to get the weighted standardized appraisal matrix, showing in Table 9.

Step 5. Identify the positive ideal solution and negative ideal solution

The positive ideal solution and negative ideal solution are defined according to Eq. (7) as

Table 8
Standardized appraisal matrix.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
A_1	0.6330	0.5629	0.7198	0.5203	0.4662	0.4194	0.3844	0.5175	0.3093	0.4981	0.4207	0.5277
A_2	0.5605	0.4851	0.4480	0.4897	0.5528	0.5370	0.6202	0.4563	0.4884	0.5416	0.5338	0.4543
A_3	0.4389	0.4608	0.3419	0.4187	0.5202	0.5248	0.5098	0.4849	0.5620	0.5365	0.5070	0.4543
A_4	0.3043	0.4851	0.4053	0.5605	0.4544	0.5101	0.4557	0.5374	0.5916	0.4133	0.5301	0.5556

Table 9
Weighted standardized appraisal matrix.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
A_1	0.0394	0.0386	0.0519	0.0449	0.0275	0.0286	0.0284	0.0475	0.0371	0.0528	0.0388	0.0526
A_2	0.0349	0.0333	0.0323	0.0422	0.0326	0.0366	0.0459	0.0419	0.0586	0.0574	0.0492	0.0452
A_3	0.0273	0.0316	0.0247	0.0361	0.0307	0.0357	0.0377	0.0445	0.0674	0.0569	0.0468	0.0452
A_4	0.0190	0.0333	0.0293	0.0483	0.0268	0.0347	0.0337	0.0493	0.0710	0.0438	0.0489	0.0553

Table 10
Results of TOPSIS.

	S_i^*	S_i^-	C_i^*	Rank
A_1	0.0412	0.0381	0.4809	4
A_2	0.0280	0.0389	0.5817	1
A_3	0.0361	0.0372	0.5074	3
A_4	0.0365	0.0406	0.5264	2

$$\begin{aligned} A^* &= (0.0394, 0.0386, 0.0519, 0.0483, 0.0326, 0.0366, 0.0459, 0.0493, 0.0710, \\ &\quad 0.0574, 0.0492, 0.0553), \\ A^- &= (0.0190, 0.0316, 0.0247, 0.0361, 0.0268, 0.0286, 0.0284, 0.0419, \\ &\quad 0.0371, 0.0438, 0.0388, 0.0452). \end{aligned}$$

Step 6. Calculate the Euclidean distance between the positive ideal solution and negative ideal solution for each alternative

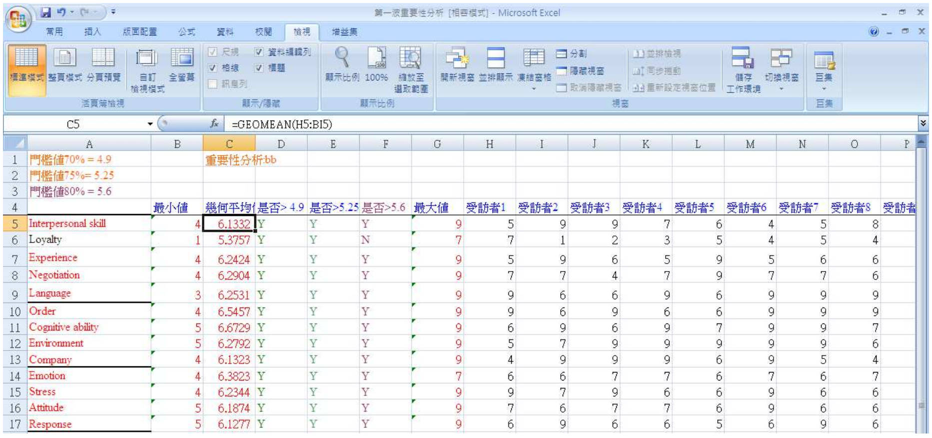
The Euclidean distance between the positive ideal solution and negative ideal solution for each alternative can be measured by Eq. (8).

Step 7. Calculate the relative closeness to the positive ideal solution for each alternative

C_i^* value of each alternative can be obtained by Eq. (9).

Step 8. Select the best alternative

According to Table 10, the preferred candidate is selected. Therefore, it is obvious that the ranking for the optimal candidates is Alternative 2, Alternative 4, Alternative 3 and Alternative 1.



C5 =GEOMEAN(H5:BI5)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	門檻值70% = 4.9		重要性分析bb													
2	門檻值75%= 5.25															
3	門檻值80% = 5.6															
4		最小值	幾何平均	是否> 4.9	是否>5.25	是否>5.6	最大值	受訪者1	受訪者2	受訪者3	受訪者4	受訪者5	受訪者6	受訪者7	受訪者8	受訪者
5	Interpersonal skill	4	6.1332	Y	Y	Y	9	5	9	9	7	6	4	5	8	
6	Loyalty	1	5.3757	Y	Y	N	7	7	1	2	3	5	4	5	4	
7	Experience	4	6.2424	Y	Y	Y	9	5	9	6	5	9	5	6	6	
8	Negotiation	4	6.2904	Y	Y	Y	9	7	7	4	7	9	7	7	6	
9	Language	3	6.2531	Y	Y	Y	9	9	6	6	9	6	9	9	9	
10	Order	4	6.5457	Y	Y	Y	9	9	6	9	6	6	9	9	9	
11	Cognitive ability	5	6.6729	Y	Y	Y	9	6	9	6	9	7	9	9	7	
12	Environment	5	6.2792	Y	Y	Y	9	5	7	9	9	9	9	9	6	
13	Company	4	6.1323	Y	Y	Y	9	4	9	9	9	6	9	5	4	
14	Emotion	4	6.3823	Y	Y	Y	7	6	6	7	7	6	7	6	7	
15	Stress	4	6.2344	Y	Y	Y	9	9	7	9	6	6	9	6	6	
16	Attitude	5	6.1874	Y	Y	Y	9	7	6	7	7	6	9	6	6	
17	Response	5	6.1277	Y	Y	Y	9	6	9	6	6	5	6	9	6	

Fig. 2. The computing interface of fuzzy Delphi method.

7. Conclusion

This study presents an effective model applying fuzzy Delphi method, ANP and TOPSIS to select the optimal public relations personnel for tourism industry in Taiwan. Fuzzy Delphi method widely gathers information and effectively conducts the vagueness and imprecision within the experts' judgments in order to identify the public relations personnel selection criteria. To solve the problem of selection criteria interdependency, ANP is used to obtain the weights of the criteria. To prevent excessive calculation and additional pairwise comparisons of ANP, TOPSIS is used to rank the alternatives. TOPSIS eliminates many procedures that are performed in ANP and enable the system to reach a conclusion in a shorter time. In this paper, the C.R. of each pairwise comparison is less than 0.1, which means that the reliability of the data is acceptable. By combining fuzzy Delphi method, ANP, and TOPSIS, this study can make better decisions in selecting the public relations personnel. The proposed model has increased the efficiency of the decision-making process in public relations personnel selection. We employ EXCEL software to compute the data made by the decision makers. The computing interfaces of fuzzy Delphi method, ANP, and TOPSIS are shown in Figs. 2–4.

This study is conducted with expert sample groups. A larger sample that brings more explanatory power may have allowed more sophisticated evaluation analysis. Moreover, we only retain 12 important criteria in this paper to structure the hierarchy for selecting the optimal public relations personnel. We suggest that future research studies incorporate more criteria in order to make more accurate estimates. Besides, some criteria could have a qualitative structure or have an uncertain structure which cannot be measured precisely. In such cases, fuzzy numbers can be applied to obtain the evaluation matrix. In other words, ANP and TOPSIS ignore the fuzziness of the executives' judgment during the decision-making process. We suggest that follow-up researchers analyze this topic with the concept of fuzzy sets.

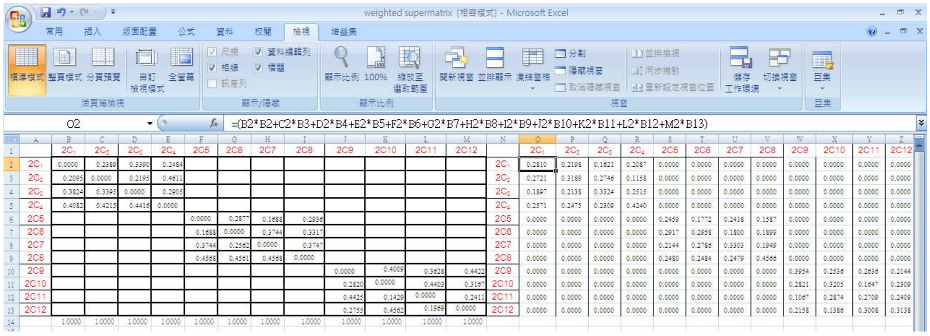


Fig. 3. The computing interface of ANP.

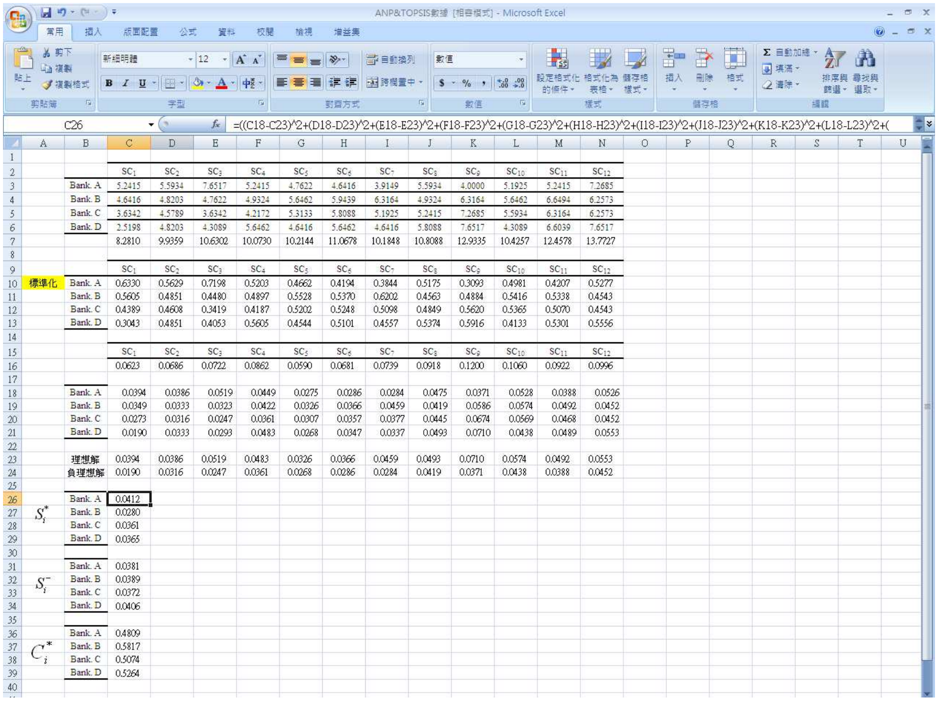


Fig. 4. The computing interface of TOPSIS.

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Hibridinio MCDM modelio taikymas viešųjų ryšių personalui atrinkti

Kuei-Lun Chang

Šio tyrimo tikslas yra taikyti hibridinį daugiakriterinio sprendimų priėmimo (MCDM) metodą viešųjų ryšių darbuotojams parinkti Taivano turizmo sektoriuje. Neraiškusis Delfų (Delphi) metodas, kuris įgalina geriau parinkti kriterijus, naudojamas kriterijų aibei patikslinti. Atsižvelgiant į tai, kad tarp atrankos kriterijų yra ryšių, analitinio tinklinio proceso (ANP) metodas yra naudojamas kriterijų svoriams gauti. Siekiant išvengti skaičiavimų ir papildomų palyginimų poromis taikant ANP metodą, artumo idealiajam taškui metodas (TOPSIS) naudojamas reitinguoti alternatyvas. Apjungtas neraiškiojo Delfų, ANP ir TOPSIS metodų taikymas, MCDM modelio pasiūlymas viešųjų ryšių personalui atrinkti, ir pritaikymas realiam uždaviniui spręsti yra šio tyrimo išskirtinės savybės.