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Improving tourism policy implementation – The use of hybrid MCDM models

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ABSTRACT

Few studies have presented a holistic approach to evaluating complex national tourism policies, successfully quantified the dynamics at play, or proposed an improvement model. The corresponding purpose of this study is to address this problem, using the method of hybrid MCDM (multiple criteria decision-making) to examine the dependent relationships among various dimensions and criteria of tourism policies and, ultimately, to suggest an optimal improvement plan for Taiwan tourism policy. A decision-making trial and evaluation laboratory (DEMATEL) is employed to construct a network relationship map (NRM), which then is used to illustrate the influential network of the tourism policy improvement model. The DEMATEL-based analytic network process (DANP) and VIKOR are adopted to evaluate the weights and the gaps to the aspired level of implementation. The model is useful in identifying both an influential network and a priority sequence of dimensions/criteria related to tourism policies and, thus, is helpful to tourism policy management.

1. Introduction

The travel and tourism industry is one of the largest industries in the world. The ascent of tourism to the position of the world's largest industry has been rapid, and the growth of global travel continues to be robust (UNWTO, 2006; WTTC, 2005). Taiwan has not failed to recognise the important role of tourism, and in response, the government has rapidly developed its tourism policies to meet demand and produce related benefits. The Taiwan Tourism Bureau, the central administrative authority overseeing national tourism affairs and facilitating the development of the tourism industry, has launched a series of policies for tourism development. In the new millennium, these policies are presented in 'Project Vanguard for Excellence in Tourism (2009–2012)', the 'Medium-term Plan for Construction of Major Tourist Sites (2008–2011)', 'Taiwan Easy Go' and other similar materials (Taiwan Tourism Bureau, 2010a,b).

Because tourism is a 'mixed industry' comprised of private firms, public agencies and not-for-profit associations (Andersson & Getz, 2009), a sustainable tourism industry requires a commitment by all parties involved in the planning process (Hall, 2000; Richins & Pearce, 2000). Governments turn to individual communities for commitment, attempting to achieve sustainable tourism and benefits from the industry. All of the policies are planned carefully, and they consider the human and environmental impacts of tourism (Lin, 2006; Theobald, 2004). Nevertheless, the rapid development of the tourism industry introduces several concerns: What are the influential dimensions of current tourism policies? What level have the current policies reached? What might be a more effective approach to improve these policies? The WTO (1980) has warned that many plans for tourism have been prepared at the national level but are rarely implemented as intended, often because they are too complex, financially impractical, or disconnected among the institutional arrangements of particular destinations. Moreover, such plans involve unrealistic expectations regarding coordination, cooperation, participation and political management (Hall, 2000; Yasarata, Altinay, Burns, & Okumus, 2010).

In light of these debates, one assumption underpinning the present paper is that a tourism policy must take into account community commitment and a focus on the environment, examining the relationship between contextual aspects of the problem rather than only considering the techniques and methods involved in preparing a plan. Previous research on tourism planning/

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implementation has often overemphasised the process of developing such plans and neglected to consider the priority levels of the various policies and how to improve them (e.g., Farrell & Twining-Ward, 2004; Kuo, 2005; Pforr, 2005; Wray, 2009). In other instances, the research has considered these questions to be a pure matter of perception or highlighted them in broad strokes as part of a concluding argument (e.g., Chen, 2003; Lin, 2006; Wang, 2007; Yang, 2006). On this basis, this paper is intended to consider perceptions held by policymakers (both from governments and communities) as criteria, and these criteria can be managed individually (the criterion itself) and interdependently (criterion to criterion, criterion to other criteria). The aim was to develop a model that shows the network of relationships between the policy criteria and to propose a strategy for improving tourism policy implementation.

For this purpose, a hybrid MCDM model is proposed using expert groups. A decision-making trial and evaluation laboratory (DEMATEL) is used to detect complex relationships and to build a network relation map (NRM), including the criteria for tourism policy measurement and evaluation. Then, the DANP (DEMATEL-based ANP) approach can be used to calculate the influential weights of policy criteria to overcome problems of dependence and feedback among criteria and alternatives, according to the concept of ANP (analytic network of process) theory by Saaty (1996). Finally, VIKOR is used to evaluate the total performance of national tourism policy to discover the performance scores and gaps. To date, no published work has linked such a hybrid MCDM theory with relationship modelling improvement strategy in the context of tourism policy planning and management. This study attempts to bridge this gap, using an empirical case of an improvement plan for Taiwan's tourism policy, and hopefully contributes to a complex national tourism policy system with a useful evaluation model based on a hybrid MCDM method.

The remainder of this paper is organised as follows: In Section 2, tourism policy implementation in Taiwan is reviewed. In Section 3, a hybrid MCDM model for a tourism policy implementation evaluation system is built. An empirical case of an improvement plan for Taiwan's tourism policy is illustrated to show the usefulness of our proposed model in Section 4. Finally, conclusions are presented in Section 5.

2. Review of tourism policy implementation of Taiwan

Understanding the policy environment in which decision-making occurs is crucial to improving our understanding of the formulation and implementation of the tourism policy process (Hall, 1994). This Section reviews the background information on tourism policymaking and the approach to relevant policy implementation in Taiwan, thereby providing the conceptual framework for the research.

2.1. Public sector-led decision-making

At the present time, tourism policymaking in Taiwan tends to involve public sector-led decision-making. Tourism policy is a public policy issue (Chen, 2003). Public policy involves the implementation of government policy for the benefit of the public; it addresses what is in the public interest (or what benefits the majority). The attention paid to public policy is an enduring principle of public administration in democratic systems of government (Anastasiadou, 2008; Hall, 1999). In recent decades, changing structures of government and the shift towards democratic governance has led to increase public interest in social relationships between government, business and civil society (Dredge, 2006); the emphasis is less on conventional government institutions or closed business-parliament-government iron triangles of interaction (Homeshaw, 1995). Thus, the role of the government in tourism has undergone a dramatic shift, transitioning from a public administration model to a model that emphasises efficiency, investment returns, the role of the market and the role of stakeholders (Hall, 1999).

The shift from public administration to public management has involved a decrease in bureaucratic power, a breakdown in overarching notions of public interest and a strengthening of special interests (Considine, 1994; Marsh, 1998; Wray, 2009). Consequently, the paradox of policymaking has emerged. There is the demand for less government involvement in the market, and some suggest that industries should be allowed to develop and trade without government assistance. However, tourism interest groups seek to have government policy developed in their favour (Hall & Jenkins, 2004). In any event, the shift has amply illustrated the critical role of the government in enhancing public interest campaigns for sustainable development and conservation to facilitate greater integration (Dredge & Thomas, 2009).

With this in mind, the Tourism Bureau, the central tourism authority of Taiwan, has turned to communities for policymaking support while still playing a dominant role in guiding policy, as empowered by the Statute for the Development of Tourism: to facilitate the development of the tourism industry (Article 1), the Tourism Bureau has been established by the central administrative authority to oversee national tourism (Article 4) and empowered to determine policy and oversee its implementation (Taiwan Tourism Bureau, 2010a,b). Responding to global trends, Taiwan's public policymaking has shifted from the 'institutional' model of the 1950s to the 'policy community' model of the 1980s, and since then, tourism policy has included a much more varied set of relationships and interactions (Chen, 2003). Nevertheless, this policy area remains under the control of the government, which thereby seeks to protect the interests of the nation at large (Lin, 2006).

2.2. Community-oriented policymaking approach

Policy communities are usually made up of people who interact within networks, including the sub-government and the 'attentive public', as defined by Homeshaw (1995). These communities have special interest in the particular arena of policy and can influence the decision-making process within the sub-government without participating in central decision-making processes. A sub-government is defined as a small group of people intimately connected with the core processes of policy formulation and implementation that usually occupy top positions in their agencies and organisations (Pross, 1992). For tourism to be sustainable, planning and implementation efforts must be effective, and the success of such efforts is dependent on the cooperation of many players. This is due to the global, multi-sectoral nature of tourism and the socio-political complexities involved (Burns, 2003). Consequently, a community-oriented approach that emphasises the role that the community plays in the tourism experience (Getz, 2007) is increasingly being adopted.

The actors are considered the most influential actors in a policy community and possess the authority to make both important and routine decisions in a policy arena (Bouwen, 2002). They are policymakers, including federal and state ministers, senior public servants, chairpersons of advisory committees or executive boards of statutory agencies, and key spokespersons for interest groups and private organisations in the field (Pross, 1992). Both public and private actors need each other and are keen to establish stable relationships (Bouwen, 2002) in their efforts to shape policy outcomes; they negotiate and bargain to achieve their own organisation's objectives, whereas private actors wish to influence the policymaking process to their own advantage (Greenwood, 2003).

Taking up this perspective on policymaking, the government of Taiwan has adopted a community-oriented approach that uses key actors and groups of actors who are interested in making policy decisions within a particular policy domain and who are keen to point out the inadequacies of current policies. Policymaker comments tend to reflect their real perceptions regarding the current tourism policy environment and can be used to help construct the implementation improvement model.

2.3. Implementation of tourism policies

In the new millennium, Taiwan's Tourism Bureau has continued to pursue previous policies and has worked to use them to ensure sustainability along with attention to economic goals. The guidelines advocated in 2010 are included in 'Project Vanguard for Excellence of Tourism', which is intended to facilitate the development of international tourism, enhance the domestic travel quality and increase foreign-exchange revenues. The aim is to make tourism in Taiwan newly alluring on a global scale.

The priorities associated with tourism policy include the following: (1) the implementation of 'Project Vanguard for Excellence in Tourism (2009–2012)' and the promotion of the 'Project Summit', 'Project Keystone' and 'Project Propeller' action plans intended to enhance Taiwan's image as a high-quality tourist destination; (2) the implementation of the 'Medium-Term Plan for Construction of Major Tourist Sites (2008–2011)' to facilitate the development of national scenic areas by focussing on the unique features of different localities, conducting graded reconstruction of recreational and service facilities at major tourist sites and reviving traditional tourist spots; (3) the promotion of healthy travel, the development of Green Island and Little Liuqiu as low-carbon tourist islands and the creation of new tourist destinations, as well as the continued implementation of the 'Eastern Taiwan Bikeway Network Demonstration Plan', the reconstruction of classic bikeway facilities, the introduction of LOHAS itineraries, the organisation of large-scale international cycling competitions and the development of 'green tourism' through energy conservation and carbon reduction; (4) efforts to coordinate with Taiwan for its centennial a 'Tour Taiwan and Experience the Centennial' action plan designed to highlight the alluring tourist attractions in Taiwan and attract international tourists; and (5) the promotion of the 'Taiwan Easy Go' program, a 'seamless travel service plan for tourist sites' and the provision of assistance to local governments that will help them to offer a full range of convenient travel information and other services (e.g., linked transportation networks and tickets) (Taiwan Tourism Bureau, 2010a,b).

The order of priority of this implementation plan was determined by the central government, although community commitment to tourism policymaking is commonly acknowledged (Chen, 2003). Thus, this plan does not reflect the perceptions of domain policymakers towards Taiwan's real tourism policy environment, and it does not provide an optimal model. Rather, to create such a model, we must evaluate the real-world context of tourism policy. Because policy formulation can be conceptualised as a process of issue identification and management in which multiple issues are simultaneously identified, framed, prioritised and de-prioritised (Lawrence & Dredge, 2007), the evaluation system can be formulated based on the structure of the tourism policy context. Thus, Chen, Liu, Kuo, Tzeng, and Lee (2010) reviewed the contextual aspects of Taiwan's tourism policies from 2006 to 2010, and then initiated a pioneer MCDM evaluation system, which includes four dimensions and 14 criteria.

The four dimensions of influence identified are the following: (1) tourism resources, (2) an industry environment, (3) a socio-economic environment and (4) a safe environment. The 14 affiliated criteria are as follows: (1) natural resources: the need to preserve, conserve, and sustain natural resources while still meeting the needs of tourists; (2) ecology: the need to ensure the sustainable development of tourism by using ecologically sound construction techniques; (3) cultural activities: the need to provide facilities and hold events and festivals that will enrich cultural understanding; (4) innovation: the need to integrate the essence of creativity and culture into tourism policy; (5) human resources: the need to improve human resources; (6) policy implementation: the need to facilitate policy implementation in line with established plans; (7) information exchange: the need to increase information exchange to enhance mutual understanding between industries and tourists; (8) competitiveness: the need to enhance competitiveness by minimising document control; (9) marketing: the need to conduct strategic marketing to secure a proper place for Taiwan's tourist industry in the world market; (10) amendments to relevant laws: the need to amend laws in accordance with global trends; (11) local development: the need to rejuvenate rural development via national tourism policy; (12) safety and security: the need to establish efficient law enforcement to ensure the safety and security of residents and tourists; (13) disaster reduction: the need to establish a sound disaster reduction system; and (14) accessibility: the need to improve transportation. This set of criteria provides the paper with an overall evaluation system that will facilitate further prioritisation by the techniques of DEMATEL, DANP and VIKOR.

3. Building a hybrid MCDM model for a tourism policy implementation evaluation system

Tzeng and Huang (2011) indicate that Multiple Criteria Decision-Making (MCDM) is a methodology that is able to consider multiple criteria at the same time and also helps the decision-maker to estimate the best case by sorting cases according to the characteristics or criteria (Tseng, 2009a,b) of each from limited available cases. The hybrid MCDM tools of analysis used in this research were the techniques of DEMATEL, DANP and VIKOR. First, DEMATEL was used to confirm the effect on each criterion and to explore the relevance of the policy parameters, probing the influence of tourism policies on the environment and human society. Subsequently, the DANP approach, a novel combination of DEMATEL and ANP (Saaty, 1996), was adopted to calculate the weight of policy criteria. Ou Yang, Shieh, Leu, and Tzeng (2008) proposed these methods to solve the dependence and feedback problems of factors. The application of DANP is proved more useful in the real world than the ANP (Kuan, Hsiang, & Tzeng, in press). Finally, VIKOR was used to evaluate the total performance of national tourism policy by performance values and gaps.

3.1. Clarifying interrelations between criteria

In Section 2, this paper identified the criteria that exert an influence on tourism policy implementation. When the government, not-for-profit organisations, and industry sectors work together and conduct their planning as part of a joint effort, they must jointly determine the different dimensions and criteria for success associated with tourism policy, decide the relationships between these criteria, and produce priorities for tourism policy. Thus, a tourism improvement plan must be created that incorporates the perspective of the communities involved in the initiatives and that thereby reflects the context in which the overall policies will go into effect (Figure 1).

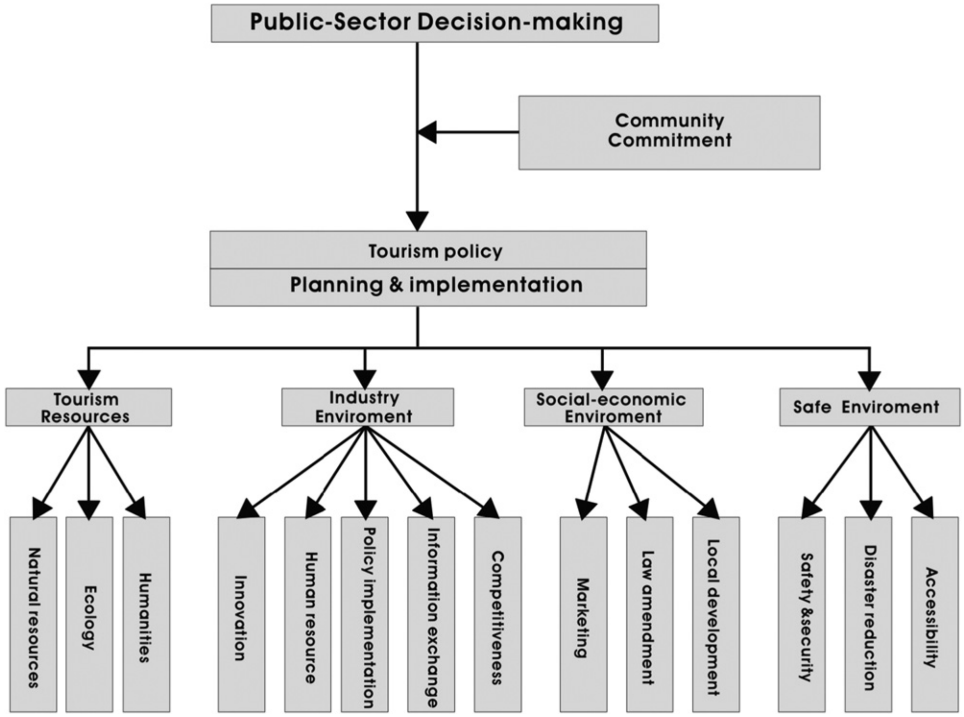

Fig. 1. The conceptualised framework of national tourism polices improvement plan.

It can be difficult to determine precise values for particular criteria in such complex evaluation systems. However, a complex evaluation system or plan can also be divided into subsystems to more easily evaluate differences and measure scores. The DEMATEL technique is intended to serve this purpose, determining the relationships included in a particular network structure and the degree of interdependence of the criteria (Tseng, 2009a,b). In this study, a tourism policy evaluation system including four dimensions and 14 criteria that will exert an influence on national tourism policy implementation is established, as given in Table 1. A survey was conducted via questionnaires distributed to three groups comprised of 18 expert-policymakers: six of them from various industries, another six from various governments, and the last six from different non-profit organisations. All are on the expert list provided by the Bureau. Their ratings for each criterion's relationship to sustainable development using a five-point scale ranging from 0 (no effect) to 4 (extremely influential) were collected. Subsequently, the DEMATEL technique was used to analyse the data and determine the relationships among the dimensions and criteria.

3.2. DEMATEL technique for building a network relation map (NRM)

The DEMATEL technique was used to investigate and solve a complicated problem (ex Huang, Shyu, & Tzeng, 2007; Huang, Tzeng, & Ho, 2011; Shen, Lin, & Tzeng, 2011; Yang & Tzeng, 2011). DEMATEL uses matrix and related math theories to calculate the cause and effect on each element. The matrices or digraphs portray a contextual relation between the elements of the system, in which a numeral represents the strength of influence. Hence, the DEMATEL method can convert the relationship between the causes and effects of criteria into an intelligible structural model of the system (Tseng, 2010; Tseng & Lin, 2009). This method is widely used to solve various types of complex studies that can effectively understand complex structures and provide viable options for problem-

Table 1
The dimensions of influence and criteria associated with tourism.

Dimensions	Criteria	Context of criteria
Tourism Resources (D_1)	Natural resources (C_1)	Preserve, conserve, and sustain natural resources while meeting the needs of tourists
	Ecology (C_2)	Ensure sustainable development of tourism by using ecologic construction
	Humanities (C_3)	Provide facilities and held events and festivals to enrich humanity resources
Industry Environment (D_2)	Innovation (C_4)	Integrate the essences of creativity and culture
	Human resource (C_5)	Upgrade the excellence of human resources
	Policy implementation (C_6)	Facilitate policy implementation as it is planned
	Information exchange (C_7)	Increase the information exchange to enhance the mutual understanding between industries and tourists
	Competitiveness (C_8)	Enhance the competitiveness abilities via minimising document control
Socio-economic Environment (D_3)	Marketing (C_9)	Make strategic marketing to combat the world market
	Law amendment (C_{10})	Amend law to meet the trend of the world
	Local development (C_{11})	Rejuvenate rural development via national tourism policy
Safe Environment (D_4)	Safety & security (C_{12})	Efficient law enforcements to ensure the safety and security of residences and tourists
	Disaster reduction (C_{13})	Establish a sounded disaster reduction system
	Accessibility (C_{14})	Improve the transportation system so that it can reach all destinations safely and efficiently

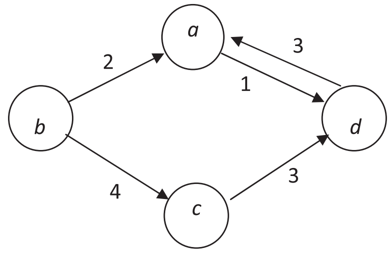

Fig. 2. The directed graph.

solving (ex Hori & Shimizu, 1999; Liou, Tzeng, & Chang, 2007; Ou Yang et al., 2008; Tsai & Hsu, 2010; Tsai, Leu, Liu, Lin, & Shaw, 2010; Tzeng, Chiang, & Li, 2007). However, DEMATEL has not often been used in the context of tourism (Tsai, Chou, & Lai, 2010) and hospitality (Tsai, Hsu, Chen, Lin, & Chen, 2010; Tseng, 2009b). The method employed can be summarised as follows.

Step 1: *Calculating the direct-influence matrix using scores*. The experts are asked to indicate the direct effect that they believe factor i will have on factor j as indicated by a_{ij}. The contextual relationships between the factors can be shown in Fig. 2. The matrix $\boldsymbol{A}$ of direct relations thus can be obtained.

Step 2: *Normalising the direct-influence matrix.* Based on the direct-influence of matrix $\boldsymbol{A}$, the normalised direct-relation matrix $\boldsymbol{D}$ is acquired using Eqs. (1) and (2).

$$\boldsymbol{D} = k\boldsymbol{A} \tag{1}$$

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

Step 3: *Attaining the total-influence matrix* $\boldsymbol{T}$. Once the normalised direct-influence matrix $\boldsymbol{D}$ is obtained, the total-influence matrix $\boldsymbol{T}$ of NRM can be obtained using Eq. (3), in which $\boldsymbol{I}$ denotes the identity matrix.

$$\begin{aligned}\boldsymbol{T} &= \boldsymbol{D} + \boldsymbol{D}^2 + \boldsymbol{D}^3 + \cdots + \boldsymbol{D}^h \\ &= \boldsymbol{D}\left(\boldsymbol{I} + \boldsymbol{D} + \boldsymbol{D}^2 + \cdots + \boldsymbol{D}^{h-1}\right)\left[(\boldsymbol{I}-\boldsymbol{D})(\boldsymbol{I}-\boldsymbol{D})^{-1}\right] \\ &= \boldsymbol{D}\left(\boldsymbol{I} - \boldsymbol{D}^h\right)(\boldsymbol{I}-\boldsymbol{D})^{-1}\end{aligned}$$

Then,

$$\boldsymbol{T} = \boldsymbol{D}(\boldsymbol{I}-\boldsymbol{D})^{-1}, \text{ when } h \to \infty, \boldsymbol{D}^h = [0]_{n\times n} \tag{3}$$

where $\boldsymbol{D} = [d_{ij}]_{n\times n}$, $0 \le d_{ij} < 1$, $0 < \sum_{j=1}^{n} d_{ij} \le 1$, $0 < \sum_{i=1}^{n} d_{ij} \le 1$. If at least one row or column of summation is equal to 1 (but not all) in $\sum_{j=1}^{n} d_{ij}$ and $\sum_{i=1}^{n} d_{ij}$, then we can guarantee $\lim_{h\to\infty} \boldsymbol{D}^h = [0]_{n\times n}$.

Step 4: *Analysing the results*. In this stage, the sum of rows $\sum_{j=1}^{n} t_{ij} = t_i$ and the sum of columns $\sum_{i=1}^{n} t_{ij} = t_j$ are separately expressed as vector $\boldsymbol{r} = (r_1, \ldots, r_i, \ldots, r_n)'$ and vector $\boldsymbol{c} = (c_1, \ldots, c_j, \ldots, c_n)'$ by using Eqs. (4)–(6). Let $i = j$ and $i, j \in \{1,2, \ldots, n\}$; the horizontal axis vector $(\boldsymbol{r}+\boldsymbol{c})$ is then created by adding $\boldsymbol{r}$ to $\boldsymbol{c}$, which illustrates the importance of the criterion. Similarly, the vertical axis vector $(\boldsymbol{r}-\boldsymbol{c})$ is constructed by deducting $\boldsymbol{r}$ from $\boldsymbol{c}$, which may separate criteria into a cause group and an effect group. In general, when $(\boldsymbol{r}-\boldsymbol{c})$ is positive, the criterion is part of the cause group. In contrast, if vector $(\boldsymbol{r}-\boldsymbol{c})$ is negative, the criterion is part of the effect group. Therefore, the causal graph can be achieved by mapping the dataset of vectors $(\boldsymbol{r}+\boldsymbol{c}, \boldsymbol{r}-\boldsymbol{c})$, providing a valuable approach to decision-making.

$$\boldsymbol{T} = [t_{ij}]_{n\times n}, \quad i,j = 1,2, \ldots, n \tag{4}$$

$$\boldsymbol{r} = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} = [t_{i\cdot}]_{n\times 1} = (r_1, \ldots, r_i, \ldots, r_n)' \tag{5}$$

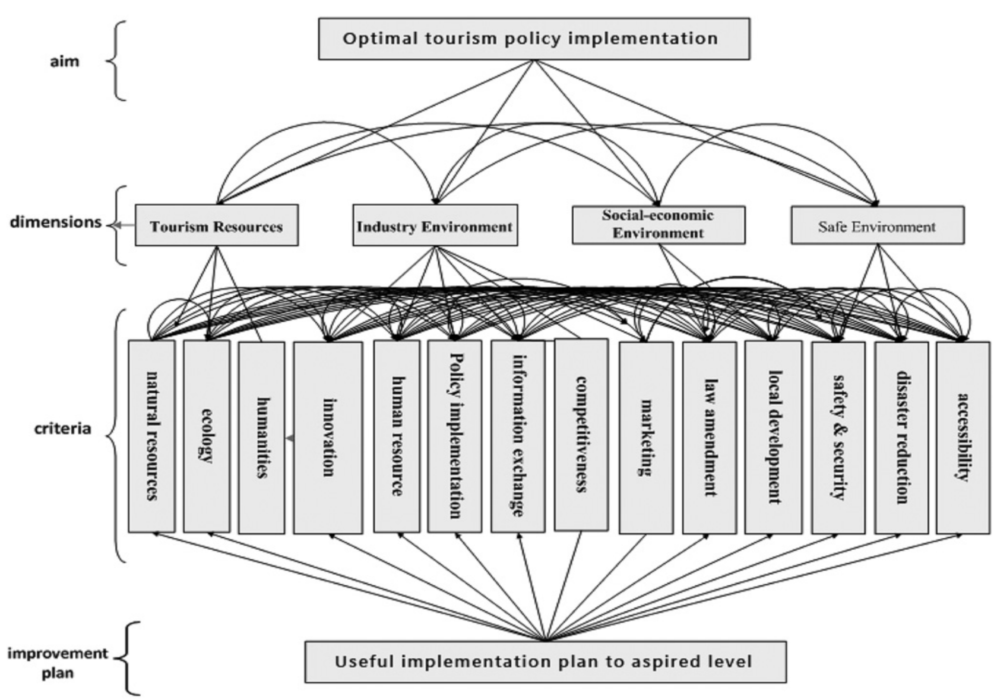

Fig. 3. Analytic framework of tourism policy influence network.

$$\boldsymbol{c} = \left[\sum_{i=1}^{n} t_{ij}\right]'_{1\times n} = [t_{\cdot j}]_{n\times 1} = (c_1, \ldots, c_j, \ldots, c_n)' \quad (6)$$

where vector $\boldsymbol{r}$ and vector $\boldsymbol{c}$ express the sum of the rows and the sum of the columns from total-influence matrix $\boldsymbol{T} = [t_{ij}]_{n\times n}$, respectively, and the use of superscript denotes transpose.

3.3. Finding the influential weights by DANP based on the NRM

This research not only uses DEMATEL to confirm the relationships between the factors but also to obtain the most accurate weights. A novel combination of DEMATEL and ANP was then used to derive more practical results, determining the actual performance values of tourism policy factors and the necessary performance levels. The ANP feedback approach replaces hierarchies with networks which allows for complex interrelationships among decision levels and criteria and generates more complex with the change in scope and depth of the decision-making problems (Lin, Cheng, Tseng, & Tsai, 2010; Tseng, 2010) and is most suitable for problem-solving (Saaty, 1996). Using this strength of the ANP with DEMATEL, the influential weights can thus be found based upon the NRM of DEMATEL. The DANP involves the following steps (Kuan et al., in press; Lee, Tzeng, & Cheng, 2009, pp. 1460–1474). The first step is to develop the structure of the influence network, as illustrated in Fig. 3.

The second step is to develop the unweighted supermatrix. First, normalise each level with the total degree of effect based on the total effect matrix **T** using DEMATEL, as shown in Eq. (7).

$$\boldsymbol{T}_C = \begin{array}{c} \\ D_1 \; \begin{smallmatrix} c_{11} \\ c_{12} \\ \vdots \\ c_{1m_1} \end{smallmatrix} \\ \vdots \\ D_i \; \begin{smallmatrix} c_{i1} \\ c_{i2} \\ \vdots \\ c_{im_i} \end{smallmatrix} \\ \vdots \\ D_n \; \begin{smallmatrix} c_{n1} \\ c_{n2} \\ \vdots \\ c_{nm_n} \end{smallmatrix} \end{array} \begin{array}{c} \begin{matrix} D_1 & & D_j & & D_n \\ c_{11}\cdots c_{1m_1} & \cdots & c_{j1}\cdots c_{jm_j} & \cdots & c_{n1}\cdots c_{nm_n} \end{matrix} \\ \begin{bmatrix} \boldsymbol{T}_c^{11} & \cdots & \boldsymbol{T}_c^{1j} & \cdots & \boldsymbol{T}_c^{1n} \\ \vdots & & \vdots & & \vdots \\ \boldsymbol{T}_c^{i1} & \cdots & \boldsymbol{T}_c^{ij} & \cdots & \boldsymbol{T}_c^{in} \\ \vdots & & \vdots & & \vdots \\ \boldsymbol{T}_c^{n1} & \cdots & \boldsymbol{T}_c^{nj} & \cdots & \boldsymbol{T}_c^{nn} \end{bmatrix} \end{array} \quad (7)$$

Next, normalise $\boldsymbol{T}_C$ with the total degree of influence and obtain $\boldsymbol{T}_C^{\alpha}$, as shown in Eq. (8);

$$\boldsymbol{T}_C^{\alpha} = \begin{array}{c} \\ D_1 \; \begin{smallmatrix} c_{11} \\ c_{12} \\ \vdots \\ c_{1m_1} \end{smallmatrix} \\ \vdots \\ D_i \; \begin{smallmatrix} c_{i1} \\ c_{i2} \\ \vdots \\ c_{im_i} \end{smallmatrix} \\ \vdots \\ D_n \; \begin{smallmatrix} c_{n1} \\ c_{n2} \\ \vdots \\ c_{nm_n} \end{smallmatrix} \end{array} \begin{array}{c} \begin{matrix} D_1 & & D_j & & D_n \\ c_{11}\cdots c_{1m_1} & \cdots & c_{j1}\cdots c_{jm_j} & \cdots & c_{n1}\cdots c_{nm_n} \end{matrix} \\ \begin{bmatrix} \boldsymbol{T}_c^{\alpha 11} & \cdots & \boldsymbol{T}_c^{\alpha 1j} & \cdots & \boldsymbol{T}_c^{\alpha 1n} \\ \vdots & & \vdots & & \vdots \\ \boldsymbol{T}_c^{\alpha i1} & \cdots & \boldsymbol{T}_c^{\alpha ij} & \cdots & \boldsymbol{T}_c^{\alpha in} \\ \vdots & & \vdots & & \vdots \\ \boldsymbol{T}_c^{\alpha n1} & \cdots & \boldsymbol{T}_c^{\alpha nj} & \cdots & \boldsymbol{T}_c^{\alpha nn} \end{bmatrix} \end{array} \quad (8)$$

then, normalise $\boldsymbol{T}_C^{\alpha 11}$ via Eqs. (9) and (10), and repeat to obtain $\boldsymbol{T}_C^{\alpha nn}$.

$$d_i^{11} = \sum_{j=1}^{m_1} t_{C^{ij}}^{11}, \; i = 1, 2, \ldots, m_1 \quad (9)$$

$$\boldsymbol{T}_C^{\alpha 11} = \begin{bmatrix} t_{C^{11}}^{11}/d_1^{11} & \cdots & t_{C^{1j}}^{11}/d_1^{11} & \cdots & t_{C^{1m_1}}^{11}/d_1^{11} \\ \vdots & & \vdots & & \vdots \\ t_{C^{i1}}^{11}/d_i^{11} & \cdots & t_{C^{ij}}^{11}/d_i^{11} & \cdots & t_{C^{im_1}}^{11}/d_i^{11} \\ \vdots & & \vdots & & \vdots \\ t_{C^{m_1 1}}^{11}/d_{m_1}^{11} & \cdots & t_{C^{m_1 j}}^{11}/d_{m_1}^{11} & \cdots & t_{C^{m_1 m_1}}^{11}/d_{m_1}^{11} \end{bmatrix} = \begin{bmatrix} t_{C^{11}}^{\alpha 11} & \cdots & t_{C^{1j}}^{\alpha 11} & \cdots & t_{C^{1m_1}}^{\alpha 11} \\ \vdots & & \vdots & & \vdots \\ t_{C^{i1}}^{\alpha 11} & \cdots & t_{C^{ij}}^{\alpha 11} & \cdots & t_{C^{im_1}}^{\alpha 11} \\ \vdots & & \vdots & & \vdots \\ t_{C^{m_1 1}}^{\alpha 11} & \cdots & t_{C^{m_1 1}}^{\alpha 11} & \cdots & t_{C^{m_1 m_1}}^{\alpha 11} \end{bmatrix} \quad (10)$$

The total effect matrix had been normalised into a supermatrix according to the relying relationship in group; this allows us to obtain the unweighted supermatrix as shown in Eq. (11).

$$\boldsymbol{W} = (\boldsymbol{T}_c^{\alpha})' = \begin{array}{c} \\ D_1 \; \begin{smallmatrix} c_{11} \\ c_{12} \\ \vdots \\ c_{1m_1} \end{smallmatrix} \\ \vdots \\ D_j \; \begin{smallmatrix} c_{j1} \\ c_{j2} \\ \vdots \\ c_{jmj} \end{smallmatrix} \\ \vdots \\ D_n \; \begin{smallmatrix} c_{n1} \\ c_{n2} \\ \vdots \\ c_{nm_n} \end{smallmatrix} \end{array} \begin{array}{c} \begin{matrix} D_1 & & D_i & & D_n \\ c_{11}\cdots c_{1m_1} & \cdots & c_{i1}\cdots c_{im_i} & \cdots & c_{n1}\cdots c_{nm_n} \end{matrix} \\ \begin{bmatrix} \boldsymbol{W}^{11} & \cdots & \boldsymbol{W}^{i1} & \cdots & \boldsymbol{W}^{n1} \\ \vdots & & \vdots & & \vdots \\ \boldsymbol{W}^{1j} & \cdots & \boldsymbol{W}^{ij} & \cdots & \boldsymbol{W}^{nj} \\ \vdots & & \vdots & & \vdots \\ \boldsymbol{W}^{1n} & \cdots & \boldsymbol{W}^{in} & \cdots & \boldsymbol{W}^{nn} \end{bmatrix} \end{array} \quad (11)$$

In addition, $\boldsymbol{W}^{11}$ and $\boldsymbol{W}^{12}$ can be obtained using Eq. (12). If a blank space or 0 appears in the matrix, this means that the group or criterion is independent. In the same way, $\boldsymbol{W}^{nn}$ can be obtained.

$$\boldsymbol{W}^{11} = (\boldsymbol{T}^{11})' = \begin{array}{c} \\ c_{11} \\ \vdots \\ c_{1j} \\ \vdots \\ c_{1m_1} \end{array} \begin{array}{c} \begin{matrix} c_{11} & \cdots & c_{i1} & \cdots & c_{m_1 1} \end{matrix} \\ \begin{bmatrix} t_{c^{11}}^{\alpha 11} & \cdots & t_{c^{i1}}^{\alpha 11} & \cdots & t_{c^{m_1 1}}^{\alpha 11} \\ \vdots & & \vdots & & \vdots \\ t_{c^{1j}}^{\alpha 11} & \cdots & t_{c^{ij}}^{\alpha 11} & \cdots & t_{c^{m_1 j}}^{\alpha 11} \\ \vdots & & \vdots & & \vdots \\ t_{c^{1m_1}}^{\alpha 11} & \cdots & t_{c^{im_1}}^{\alpha 11} & \cdots & t_{C^{m_1 m_1}}^{\alpha 11} \end{bmatrix} \end{array} \quad (12)$$

The third step is to obtain the weighted supermatrix, which is the total effect relationship matrix of the dimensions matrix $\boldsymbol{T}_D$ as in Eq. (13). Each level and the dimensions of matrix $\boldsymbol{T}_D$ are normalised with the total degree of effect to obtain $\boldsymbol{T}_D^{\alpha}$, as shown in Eq. (14).

$$\boldsymbol{T}_D = \begin{bmatrix} t_D^{11} & \cdots & t_D^{1j} & \cdots & t_D^{1n} \\ \vdots & & \vdots & & \vdots \\ t_D^{i1} & \cdots & t_D^{ij} & \cdots & t_D^{in} \\ \vdots & & \vdots & & \vdots \\ t_D^{n1} & \cdots & t_D^{nj} & \cdots & t_D^{nn} \end{bmatrix} \quad (13)$$

$$\boldsymbol{T}_D^{\alpha} = \begin{bmatrix} t_D^{11}/d_1 & \cdots & t_D^{1j}/d_1 & \cdots & t_D^{1n}/d_1 \\ \vdots & & \vdots & & \vdots \\ t_D^{i1}/d_i & \cdots & t_D^{ij}/d_i & \cdots & t_D^{in}/d_i \\ \vdots & & \vdots & & \vdots \\ t_D^{n1}/d_n & \cdots & t_D^{nj}/d_n & \cdots & t_D^{nn}/d_n \end{bmatrix} = \begin{bmatrix} t_D^{\alpha 11} & \cdots & t_D^{\alpha 1j} & \cdots & t_D^{\alpha 1n} \\ \vdots & & \vdots & & \vdots \\ t_D^{\alpha i1} & \cdots & t_D^{\alpha ij} & \cdots & t_D^{\alpha in} \\ \vdots & & \vdots & \vdots & \\ t_D^{\alpha n1} & \cdots & t_D^{\alpha nj} & \cdots & t_D^{\alpha nn} \end{bmatrix} \quad (14)$$

Then, the authors normalise $\boldsymbol{T}_D^{\alpha}$ into the unweighted supermatrix to obtain the weighted supermatrix as shown in Eq. (15).

$$\boldsymbol{W}^{\alpha} = \boldsymbol{T}_D^{\alpha}\boldsymbol{W} = \begin{bmatrix} t_D^{\alpha 11}\times \boldsymbol{W}^{11} & \cdots & t_D^{\alpha i1}\times \boldsymbol{W}^{i1} & \cdots & t_D^{\alpha n1}\times \boldsymbol{W}^{n1} \\ \vdots & & \vdots & & \vdots \\ t_D^{\alpha 1j}\times \boldsymbol{W}^{1j} & \cdots & t_D^{\alpha ij}\times \boldsymbol{W}^{ij} & \cdots & t_D^{\alpha nj}\times \boldsymbol{W}^{nj} \\ \vdots & & \vdots & & \vdots \\ t_D^{\alpha 1n}\times \boldsymbol{W}^{1n} & \cdots & t_D^{\alpha in}\times \boldsymbol{W}^{in} & \cdots & t_D^{\alpha nn}\times \boldsymbol{W}^{nn} \end{bmatrix} \quad (15)$$

The fourth step is to obtain the limit supermatrix. The weighted supermatrix is multiplied by itself multiple times to obtain the limit supermatrix (the concept based on the Markov Chain). Then, the influential weights of each criterion can be obtained by $\lim_{z\to\infty}(\boldsymbol{W}^{\alpha})^z$; in other word, the influential weights of ANP can be obtained and denoted by the limit supermatrix $\boldsymbol{W}^{\alpha}$ with power z (z representing any number for power). This is the process of DANP.

3.4. Evaluating the total performance by VIKOR

VIKOR was developed by Opricovic (1998), using the concept of compromise to evaluate the standard of different projects in the competition from MCDM model (Opricovic & Tzeng, 2004). It is based on the basic concept of the Positive-ideal (or the Aspired level) solution and Negative-ideal (or the Worst level) solution, and thus can put the results in order (Lee et al., 2009). VIKOR can be divided into the following steps (Kuan et al., in press).

The first step is to check the best value f_j^* and the worst value f_j^- in assessment criteria of the policy criteria. There, f_j^* the positive-ideal point, represents the best value (aspired levels) in each criterion evaluated by the experts. By contrast, f_j^-, the negative-ideal point, represents the worst values in each criterion. Eqs. (16) and (17) are then used to obtain the results.

$$\begin{aligned} & f_j^* = \max_k f_{kj},\ j = 1,2,\ \ldots,\ n(\text{traditional approach}) \\ & \text{or setting the aspired levels(our propose), vector} \quad \boldsymbol{f}^* = \left(f_1^*, f_2^*,\ \ldots,\ f_n^*\right) \end{aligned} \quad (16)$$

$$\begin{aligned} & f_j^- = \min_k f_{kj},\ j = 1,2,\ \ldots,\ n(\text{traditional approach}) \\ & \text{or setting the worst values(our propose), vector} \quad \boldsymbol{f}^- = \left(f_1^-, f_2^-,\ \ldots,\ f_n^-\right) \end{aligned} \quad (17)$$

The second step is to calculate the mean group utility S_k and maximal regret Q_k. There, S_k represents the ratios of distance to the positive-ideal (the aspired level); it represents the synthesised gap for all criteria. w represents the influential weights of the criteria from DANP; $r_{kj} = |f_j^* - f_{kj}|/|f_j^* - f_j^-|$ represents the normalised gap of k alternative in j criterion. Q_k represents the maximal gap in j criterion ($\forall j$ and $j = 1,2,\ \ldots,\ n$) of k alternative for improvement priority. Those values can be computed by Eqs. (18) and (19).

$$S_k = \sum_{j=1}^{n} w_j r_{kj} = \sum_{j=1}^{n} w_j\left(\left|f_j^* - f_{kj}\right|\right)\Big/\left(\left|f_j^* - f_j^-\right|\right) \quad (18)$$

$$Q_k = \max_j\left\{r_{kj}\middle| j = 1,2,\ldots,n\right\} \quad (19)$$

The third step is to obtain the comprehensive indicator R_k and sort out the results. The values can be computed by Eq. (20).

$$R_k = v\left(S_k - S^*\right)\Big/\left(S^- - S^*\right) + (1-v)\left(Q_k - Q^*\right)\Big/\left(Q^- - Q^*\right) \quad (20)$$

Those values derived from $S^* = \min_k S_k$ or setting $S^* = 0$ (the aspired level), $S^- = \max_k S_k$ or setting $S^- = 1$ (the worst situation), $Q^* = \min_k Q_k$ or setting $Q^* = 0$ (the aspired level), and $Q^- = \max_k Q_k$ or setting $Q^- = 1$ (the worst situation). Eq. (20) can be re-written as $R_k = vS_k + (1-v)Q_k$, when $S^* = 0$ and $Q^* = 0$ (i.e., all criteria have been achieved to the aspired level) and $S^- = 1$ and $Q^- = 1$ (i.e., the worst situation). When $v = 1$, it represents only to consider the average gap (average regret) weight. As $v = 0$, it represents only to consider the max gap of improvement priority.

4. An empirical case: an improvement plan for Taiwan's tourism policy

As stated, the aim of this paper is to determine perceptions regarding tourism in Taiwan by considering the input of the government and corporate and non-profit organisations engaged in tourism policy planning and management as associated with national tourism policy. Based on the comments made, this paper produces an optimal tourism policy improvement model based on hybrid MCDM (multiple criteria decision-making), shows the network relationships of the policy criteria and proposes a strategy for improving tourism policy implementation.

4.1. Problem descriptions

In the new millennium, the Taiwanese government has recognised the important role of tourism, and it is rapidly developing its own tourism programs to meet demand and produce related benefits. It is more essential than ever to plan carefully and consider the human and environmental impact of tourism. As discussed in Section 2, these tourism policies are developed under the guidance of the central government along with domain experts who are in the top positions and interact within various networks. Because these policies can be made on a national scale or on the local level and affect (and are influenced by) the real-world human context in various ways, they should be developed using comprehensive evaluation systems with long-term development goals in mind. Such evaluation systems are complex organisms that take into account resources, socio-economic considerations, safety, and industry. These considerations are difficult to quantify.

To date, there has been hardly any published work that has assessed this complex organism, either to identify or prioritise the influential factors associated with national tourism policies or to propose an improvement model based on the comments of domain

Table 2
The normalisation matrix ***D***.

Criteria	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_{13}	C_{14}
C_1	0	0.098	0.076	0.069	0.067	0.083	0.064	0.067	0.078	0.079	0.060	0.052	0.067	0.066
C_2	0.100	0	0.081	0.073	0.067	0.085	0.067	0.073	0.073	0.086	0.062	0.059	0.062	0.060
C_3	0.071	0.076	0	0.090	0.083	0.092	0.079	0.078	0.078	0.079	0.064	0.054	0.064	0.060
C_4	0.064	0.069	0.076	0	0.092	0.093	0.081	0.079	0.088	0.062	0.076	0.055	0.064	0.066
C_5	0.050	0.066	0.076	0.083	0	0.083	0.074	0.074	0.081	0.062	0.069	0.064	0.071	0.062
C_6	0.079	0.086	0.085	0.086	0.081	0	0.076	0.067	0.073	0.078	0.073	0.064	0.067	0.067
C_7	0.069	0.073	0.074	0.079	0.067	0.073	0	0.083	0.081	0.060	0.064	0.052	0.060	0.064
C_8	0.064	0.069	0.073	0.083	0.085	0.083	0.081	0	0.093	0.078	0.064	0.060	0.054	0.071
C_9	0.071	0.073	0.074	0.078	0.083	0.078	0.079	0.086	0	0.067	0.074	0.059	0.055	0.074
C_{10}	0.092	0.095	0.093	0.071	0.062	0.067	0.054	0.076	0.059	0	0.069	0.069	0.067	0.062
C_{11}	0.059	0.066	0.071	0.071	0.071	0.064	0.060	0.060	0.073	0.074	0	0.060	0.050	0.078
C_{12}	0.071	0.074	0.073	0.059	0.060	0.057	0.045	0.060	0.055	0.074	0.059	0	0.078	0.067
C_{13}	0.081	0.086	0.083	0.059	0.054	0.057	0.055	0.055	0.043	0.060	0.054	0.078	0	0.069
C_{14}	0.066	0.069	0.066	0.064	0.062	0.071	0.060	0.078	0.073	0.060	0.081	0.060	0.066	0

policymakers. Chen et al. (2010) have developed an evaluation system; however, they do not propose an improvement model with gaps to aspired level. This study attempts to address these issues using an integrated approach of hybrid MCDM with the DEMATEL, the DANP and the VIKOR methods. The purpose is to propose an optimal improvement plan for national tourism policy implementation.

4.2. Results and analyses

This paper intends to propose a tourism policy improvement strategy for Taiwan and to bring these policies up to the desired level of quality. The hybrid MCDM method is used to identify relationships of dependence among various dimensions of tourism policies. The DEMATEL technique is used to construct an NRM (network relation map) that illustrates influential networks of dimensions of tourism policies. The results not only indicate the influential priorities and the most important sequences of dimensions and criteria but also demonstrate the relationships between those criteria. Subsequently, this research employs DANP to obtain the weight of each criterion and achieve the desired level of tourism policy implementation by VIKOR, based on NRM from DEMATEL technique.

4.2.1. Clarifying interrelations between policy criteria

For tourism policy criteria, a 0–4 scale to measure the interrelationships at play was used. Once the relationships between these criteria are measured by the expert panel, the initial direct-relation matrix can be obtained and further normalised as the matrix ***D*** using DEMATEL (Table 2). Then, the relation matrix $\boldsymbol{T_c}$, based on vectors ***d*** (affecting/influence) and ***c*** (affected), is derived in Table 3. The results for the criteria, based on values of $r_i + c_i$ and $r_i - c_i$, are presented in Table 4, which allows us to map network relations (as shown in Figure 4).

4.2.2. Measuring relationships among policy dimensions for building NRM

The aim was not only to determine the most important system criteria but also to measure the relationships among the criteria as a necessary step in building a network relation map. The average initial direct-relation 4×4 matrix ***A*** is obtained by pair-wise comparisons that indicate the direction of various influences of the dimensions on one another. The normalised direct-relation ***D*** is calculated using Eqs. (1) and (2). Then, using Eq. (3), the total-influence matrix $\boldsymbol{T}_D$ of the dimensions can be derived, as indicated in Table 5. Using Eqs. (5) and (6), the sum of the total influence given and received by each dimension can be derived, as indicated in Table 6. Via the values in Table 6, the NRM of influential relationships can be created, as shown in Fig. 4.

According to the influential relation ($r_i - c_i$), it can be found that a safe environment (D_4) is the highest degree of an impact relationship that affects other dimensions directly. Otherwise, Tourism Resources (D_1) is the most vulnerable to impact. This is further illustrated in Fig. 4, indicating that influential priority can be sequenced as: D_4 _ D_2 _ D_3 _ D_1. When considering the improvement, the panel experts all regard safety first and agree the first priority for improvement should be a safe environment (D_4), which can then produce an influential effect to the remaining dimensions: industry environment (D_2), socio-economic environment (D_3) and tourism resources (D_1). The result does reflect the current challenges for Taiwan's tourism development: how to overcome fatal traffic chaos, reduce damages of disasters, or fight the tourism-related crimes. The sound system of safety and security appears to be urgently necessary.

Table 3
The total-influence matrix of criterion $\boldsymbol{T_c}$.

Criteria	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_{13}	C_{14}
C_1	1.791	0.929	0.910	0.880	0.855	0.910	0.808	0.856	0.873	0.854	0.794	0.717	0.763	0.794
C_2	0.898	1.857	0.932	0.900	0.872	0.928	0.827	0.877	0.886	0.876	0.810	0.736	0.773	0.804
C_3	0.888	0.943	1.874	0.931	0.901	0.951	0.853	0.897	0.907	0.885	0.827	0.745	0.788	0.819
C_4	0.878	0.934	0.941	1.846	0.906	0.949	0.852	0.896	0.913	0.867	0.835	0.744	0.785	0.821
C_5	0.826	0.888	0.898	0.880	1.781	0.897	0.807	0.850	0.865	0.827	0.791	0.718	0.755	0.780
C_6	0.906	0.963	0.962	0.938	0.909	1.877	0.859	0.898	0.912	0.894	0.843	0.763	0.800	0.834
C_7	0.832	0.882	0.885	0.866	0.833	0.877	1.728	0.847	0.855	0.815	0.776	0.698	0.737	0.772
C_8	0.872	0.927	0.931	0.916	0.894	0.934	0.846	1.816	0.911	0.874	0.819	0.743	0.771	0.820
C_9	0.873	0.925	0.927	0.906	0.887	0.924	0.839	0.891	1.820	0.860	0.823	0.737	0.768	0.818
C_{10}	0.880	0.932	0.931	0.886	0.856	0.902	0.804	0.868	0.862	1.786	0.806	0.736	0.767	0.796
C_{11}	0.786	0.838	0.843	0.820	0.799	0.831	0.749	0.791	0.810	0.791	1.682	0.674	0.695	0.750
C_{12}	0.776	0.823	0.822	0.787	0.768	0.802	0.715	0.769	0.772	0.770	0.717	1.600	0.701	0.721
C_{13}	0.787	0.835	0.833	0.789	0.763	0.804	0.725	0.766	0.763	0.760	0.714	0.673	1.631	0.724
C_{14}	0.806	0.856	0.853	0.829	0.806	0.851	0.763	0.820	0.824	0.793	0.770	0.687	0.721	1.691

Table 4
The results of the criteria analysis.

Criteria	r_i	c_i	$r_i + c_i$	$r_i - c_i$
Natural resources (C_1)	3.630	3.577	7.207	0.053
Ecology (C_2)	3.688	3.729	7.417	−0.042
Humanities (C_3)	3.705	3.716	7.421	−0.012
Innovation (C_4)	5.449	5.445	10.894	0.003
Human resources (C_5)	5.215	5.324	10.539	−0.109
Policy implementation (C_6)	5.482	5.535	11.017	−0.054
Information exchange (C_7)	5.152	5.090	10.242	0.062
Competitiveness (C_8)	5.405	5.308	10.713	0.097
Marketing (C_9)	3.504	3.492	6.996	0.011
Law amendment (C_{10})	3.454	3.437	6.891	0.017
Local development (C_{11})	3.282	3.310	6.593	−0.028
Safety & security (C_{12})	3.022	2.959	5.981	0.063
Disaster reduction (C_{13})	3.027	3.053	6.080	−0.026
Accessibility (C_{14})	3.099	3.136	6.235	−0.037

The network relation can also be seen as influencing in each dimension as well. For example, within the category of safe environment (D_4), it can be observed that safety & security (C_{12}) exert a direct effect on accessibility (C_{14}) and disaster reduction (C_{13}). However, disaster reduction (C_{13}) exerts an effect on accessibility (C_{14}) as well. This indicates that safety and security improvements deserve to be prioritised, because they produce effects on the remaining criteria. The finding is consistent with the analysis above. Such influential network relationships also emerge for the rest of the criteria in the individual dimension, as illustrated in detail in Fig. 4. For the decision-makers, this solution is not only intelligent but also makes it easy to identify improvement priority from among the complex criteria.

4.2.3. Calculating the weights by DANP model

After the DEMATEL, which confirms the interfering relationship with the criteria, this research thus can move on to obtain the most accurate weights. The purpose of ANP is to solve the dependence and feedback problems of each criterion (Saaty, 1996). Therefore, it needs to structure the tourism policy model by DEMATEL in combination with an ANP-to-DNP model to obtain the weight of each criterion. The initial step of the DANP is to compare the criteria in the entire systems (see Figure 3) and then to form an unweighted supermatrix (Table 7) and weighted supermatrix (Table 8) through pair-wise comparisons. Finally, the limiting power of the weighted supermatrix is obtained until a steady-state condition is reached (Table 9). Each row represents the weight of each criterion. These synthesised scores obtained via the DANP method are then calculated to derive the total satisfaction and performance by SAW and VIKOR methods.

4.2.4. Evaluating the total performance by VIKOR

To propose an optimal tourism policy improvement model was ultimately the purpose of this research. To this end, the VIKOR is employed to evaluate the total performance of national policy, as shown in Table 1. The score of each criterion and total gap (S_k) in Taiwan's tourism policy is obtained by using the influential weights from the DANP to multiply the gap (r_{kj}). Consequently, the total performance is obtained according to the scored value, as shown in Table 10. The manager can find the problem-solving points according to this integrated index, either from the perspective of criteria as a whole or from the perspective of dimensions.

In the criteria, for reaching the aspired level, the priority sequence can be determined by the weights of the performance

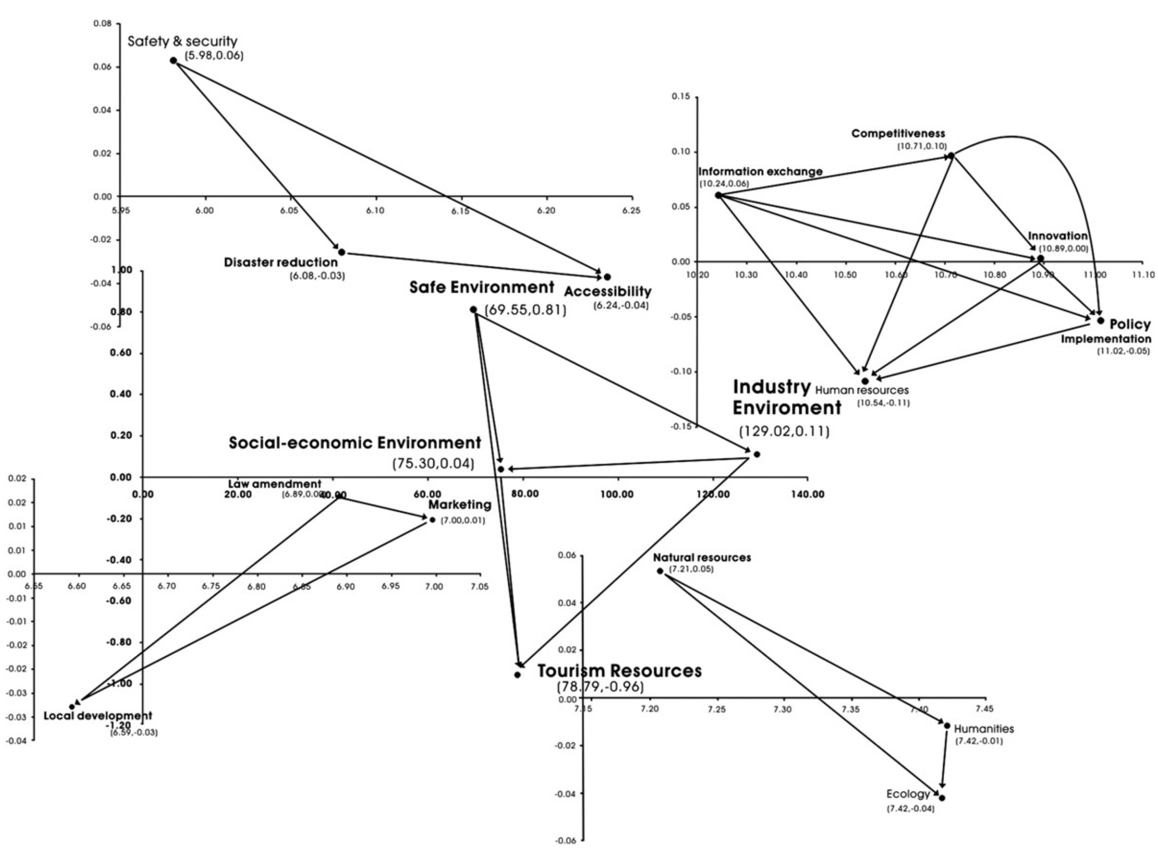

Fig. 4. The NRM of influential relationships within the policy system.

Table 5
The total-influence matrix $\boldsymbol{T}_D$ of the examined dimensions.

Dimensions	Tourism Resources (D_1)	Industry Environment (D_2)	Socio-economic Environment (D_3)	Safe Environment (D_4)
Tourism Resources (D_1)	11.022	13.244	7.711	6.938
Industry Environment (D_2)	13.526	26.702	12.796	11.541
Socio-economic Environment (D_3)	7.934	12.752	10.240	6.742
Safe Environment (D_4)	7.392	11.756	6.882	9.148

Table 6
The sum of the influences (given and received) of the different dimensions.

Dimensions	Sum of row $\{r_i\}$	Sum of column $\{c_i\}$	Prominence $\{r_i + c_i\}$	Relation $\{r_i - c_i\}$
Tourism Resources (D_1)	38.916	39.874	78.791	−0.958 (4)
Industry Environment (D_2)	64.565	64.455	129.019	0.110 (2)
Socio-economic Environment (D_3)	37.668	37.629	75.297	0.039 (3)
Safe Environment (D_4)	35.178	34.370	69.548	0.809 (1)

values from high to low and the gap value from low to high. Accessibility (C_{14}), with a high performance value of 6.55 and a low gap value of 0.34, is apparently the first criterion to be improved. It is followed by Humanities (C_3) and Natural resources (C_1). The Law amendment (C_{10}) is last, due to its lower performance value (5.398) and larger gap value (0.461). This indicates the improvement priority sequence necessary for the overall criteria to reach the desired level.

The rule can be applied to the rest of the criteria within the individual dimension as well. In Tourism Resources (D_1), for instance, the performance values of the priorities are ordered as follows: Humanities (C_3) _ Natural resources (C_1) _ Ecology (C_2). For decision-makers, enriching the cultural environment should be an easier way to achieve the desired level of the tourism resources.

Regarding the dimensions, Tourism Resources *(*D_1) has a high performance value of 6.31 (to 10) and a low gap value of 0.369 (to 0), indicating improvements are prioritised to reach the aspired-to level. The high performance value reveals that the dimension has been regarded as more important and receives sufficient support from the government. Consequently, it has a lower gap value to the optimal scale and becomes the easy start for decision-makers to make improvements, if their goal is set to reach the aspired level. Hence, the sequence priority can be ordered for policy decision-makers: $\boldsymbol{D}_1$ _ $\boldsymbol{D}_4$ _ $\boldsymbol{D}_2$ _ $\boldsymbol{D}_3$, if the strategy targets at the aspired-to level. Overall with 10 as the aspired-to level, all of the performance values averaged 6.02, whereas the gap for improvement averaged 0.398 (to 0). This denotes the gap that Taiwan's tourism policy implementation needs to bridge. Generally, by the performance values given by the panel experts, the schemes for improvement priority can be unique, comprehensive and inspiring, either from the respective individual or overall points of view (as shown in Table 11).

4.3. Discussions and implications

For Taiwan's tourism policies, the dimensions of influence and criteria are calculated and illustrated using a NRM (Figure 4). According to the degree of influential impact, the improvement priorities are sequenced as a safe environment, an industry environment, a socio-economic environment and tourism resources. Policymakers should direct their attention to this point. These dimensions reflect tourism policies based on a broader understanding of the political, societal and human contexts at play (Stevenson, Airey, & Miller, 2008) and, ultimately, the question of sustainability (Gunn & Var, 2002; Hall, 2000; Weaver, 2006). The panel experts all recognise that safety must come first and that efforts in that direction will produce network effects on the remaining dimensions and spontaneously resolve multiple issues. The influential network of criteria has the same effect within individual dimensions. In particular, safety and security (C_{12}), information exchange (C_7), law amendment (C_{10}) and natural resources (C_1) are confirmed to be more influential in affecting the other criteria in the individual dimensions. This implies that the easy point for improving environment safety resides in the assurance of safety and security of residents and tourists, and the

Table 7
Unweighted Supermatrix $\boldsymbol{W}$ based on DANP.

Criteria	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_{13}	C_{14}
C_1	0.493	0.256	0.251	0.204	0.198	0.211	0.188	0.199	0.346	0.339	0.315	0.315	0.336	0.349
C_2	0.244	0.504	0.253	0.204	0.198	0.211	0.188	0.199	0.344	0.341	0.315	0.318	0.334	0.348
C_3	0.240	0.255	0.506	0.205	0.199	0.210	0.188	0.198	0.346	0.338	0.316	0.317	0.335	0.348
C_4	0.319	0.339	0.342	0.339	0.166	0.174	0.156	0.164	0.349	0.332	0.319	0.317	0.334	0.349
C_5	0.316	0.340	0.344	0.169	0.342	0.172	0.155	0.163	0.348	0.333	0.318	0.318	0.335	0.346
C_6	0.320	0.340	0.340	0.171	0.166	0.342	0.157	0.164	0.344	0.337	0.318	0.318	0.334	0.348
C_7	0.320	0.340	0.340	0.168	0.162	0.170	0.335	0.164	0.349	0.333	0.317	0.316	0.334	0.350
C_8	0.319	0.340	0.341	0.169	0.165	0.173	0.156	0.336	0.350	0.336	0.314	0.318	0.330	0.351
C_9	0.320	0.339	0.340	0.204	0.199	0.208	0.189	0.200	0.520	0.246	0.235	0.317	0.330	0.352
C_{10}	0.321	0.340	0.339	0.205	0.198	0.209	0.186	0.201	0.250	0.517	0.233	0.320	0.334	0.346
C_{11}	0.319	0.340	0.342	0.206	0.200	0.208	0.188	0.198	0.247	0.241	0.512	0.318	0.328	0.354
C_{12}	0.321	0.340	0.339	0.205	0.200	0.209	0.186	0.200	0.342	0.341	0.317	0.529	0.232	0.239
C_{13}	0.321	0.340	0.339	0.205	0.198	0.209	0.189	0.199	0.341	0.340	0.319	0.222	0.539	0.239
C_{14}	0.321	0.340	0.339	0.204	0.198	0.209	0.187	0.201	0.345	0.332	0.323	0.222	0.233	0.546

Note: $\boldsymbol{W} = (\boldsymbol{T}_c^{\alpha})\prime$.

Table 8
Weighted Supermatrix $\boldsymbol{W}^{\alpha}$ based on DANP.

Criteria	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_{13}	C_{14}
C_1	0.140	0.069	0.068	0.067	0.066	0.067	0.067	0.067	0.067	0.068	0.067	0.067	0.067	0.067
C_2	0.072	0.143	0.072	0.071	0.071	0.071	0.071	0.071	0.071	0.072	0.072	0.071	0.072	0.071
C_3	0.071	0.072	0.143	0.072	0.072	0.071	0.071	0.071	0.072	0.071	0.072	0.071	0.071	0.071
C_4	0.069	0.070	0.070	0.140	0.070	0.071	0.070	0.070	0.069	0.070	0.070	0.068	0.069	0.068
C_5	0.068	0.067	0.068	0.069	0.141	0.069	0.067	0.068	0.068	0.067	0.068	0.067	0.066	0.066
C_6	0.072	0.072	0.071	0.072	0.071	0.142	0.070	0.071	0.070	0.071	0.070	0.070	0.070	0.070
C_7	0.064	0.064	0.064	0.065	0.064	0.065	0.139	0.065	0.064	0.063	0.064	0.062	0.063	0.063
C_8	0.068	0.068	0.067	0.068	0.067	0.068	0.068	0.139	0.068	0.068	0.067	0.067	0.067	0.067
C_9	0.069	0.068	0.069	0.069	0.069	0.068	0.069	0.069	0.141	0.068	0.067	0.067	0.067	0.068
C_{10}	0.067	0.067	0.067	0.066	0.066	0.067	0.066	0.067	0.067	0.141	0.065	0.067	0.066	0.065
C_{11}	0.062	0.062	0.063	0.063	0.063	0.063	0.063	0.062	0.064	0.063	0.139	0.062	0.062	0.063
C_{12}	0.056	0.057	0.056	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.138	0.058	0.058
C_{13}	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.059	0.059	0.060	0.059	0.060	0.140	0.061
C_{14}	0.062	0.062	0.062	0.062	0.062	0.062	0.063	0.063	0.063	0.062	0.063	0.062	0.062	0.142

Note: $\boldsymbol{W}^{\alpha} = \boldsymbol{T}_D^{\alpha} \times \boldsymbol{W}$,

Table 9
The stable matrix of DANP.

Criteria	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_{13}	C_{14}
C_1	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073
C_2	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
C_3	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
C_4	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
C_5	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073
C_6	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076
C_7	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069
C_8	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073	0.073
C_9	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074	0.074
C_{10}	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072
C_{11}	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068
C_{12}	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
C_{13}	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065
C_{14}	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068

Note: when power $\lim_{z\to\infty} (\boldsymbol{W}^{\alpha})^{z}$.

disaster reduction system and efficient accessibility can be improved as it results. Furthermore, improved information exchange can improve industry environment aspects, including cultural innovation, human resources, policy implementation and competitiveness. Moreover, improved law amendment to meet global trends will ameliorate the balance between the world market and local development. Finally, improved tourism resources will ensure sustainable development of ecology and humanities as

Table 10
Integrated index of tourism policy dimensions and criteria.

	Local weights (based on global weights)	Global weights (based on DANP)	Performance Value by SAW	Relative gaps from desired value (r_{kj}) by VIKOR
Tourism Resources (D_1)	**0.227**		**6.313 (1)**	**0.369 (1)**
Natural resources (C_1)	0.320	0.073	6.389	0.361
Ecology (C_2)	0.340	0.077	6.111	0.389
Humanities (C_3)	0.340	0.077	6.444	0.356
Industry Environment (D_2)	**0.366**		**5.896 (3)**	**0.410 (3)**
Innovation (C_4)	0.204	0.075	6.111	0.389
Human resources (C_5)	0.199	0.073	5.889	0.411
Policy implementation (C_6)	0.209	0.076	5.722	0.428
Information exchange (C_7)	0.189	0.069	6.222	0.378
Competitiveness (C_8)	0.199	0.073	5.556	0.444
Social-economic Environment (D_3)	**0.213**		**5.719 (4)**	**0.428 (4)**
Marketing (C_9)	0.345	0.074	5.833	0.417
Law amendment (C_{10})	0.336	0.072	5.389	0.461
Local development (C_{11})	0.319	0.068	5.944	0.406
Safe Environment (D_4)	**0.195**		**6.236 (2)**	**0.376 (2)**
Safety & security (C_{12})	0.318	0.062	6.278	0.372
Disaster reduction (C_{13})	0.333	0.065	5.861	0.414
Accessibility (C_{14})	0.348	0.068	6.556	0.344
Total average performance	–	–	**6.019**	–
Total average gap	–	–	–	**0.398**

[Note] Relative gaps to aspired value: $f_{kj} = (x_j^{*} - x_{kj})/(x_j^{*} - x_j^{-})$, where f_{kj} denotes the relative gap with k alternative in j criterion, x_{kj} denotes the performance value in each criterion j with k alternative (only one case of Taiwan) and scales from 0 (complete dissatisfaction) to 10 (very very satisfaction), x_j^{*} denotes the aspired value (setting $x_j^{*} = 10$) in j criterion, and x_j^{-} denotes the worst value (setting $x_j^{-} = 0$) in j criterion. The level aspired is pursued (i.e., reduce gaps to zero) in the tourism policy implementation of each criteria.

Table 11
The tourism policy implementation improvement plan.

Formula	Plan (sequence of improvement priority)
F1: Influential network of dimensions	D_4 _ D_2 _ D_3 _ D_1
F2: Influential network of criteria within individual dimensions	D_1: (C_1)_ (C_3)_ (C_2) (C_3) _ (C_2) D_2: (C_7) _ (C_8) _ (C_4) _ (C_6) _ (C_5) (C_8) _ (C_4) _ (C_6) _ (C_5) (C_4) _ (C_6) _ (C_5) (C_6) _ (C_5) D_3: (C_{10}) _ (C_9) _ (C_{11}) (C_9) _ (C_{11}) D_4: (C_{12}) _ (C_{13}) _ (C_{14}) (C_{13}) _ (C_{14})
F3: Sequence of dimensions to raise to desired level (by gap value from low to high)	D_1 _ D_4 _ D_2 _ D_3
F4: Sequence of criteria to raise to desired level within individual dimensions (by gap value from low to high)	D_1: (C_3) _ (C_2) _ (C_1) D_2: (C_7) _ (C_4) _ (C_5) _ (C_6) _ (C_8) D_3: (C_{11}) _ (C_9) _ (C_{10}) D_4: (C_{14}) _ (C_{12}) _ (C_{13})

Note: 1. Dimensions: D_1 Tourism Resources, D_2 Industry Environment, D_3 Social-economic Environment, D_4 Safe Environment. 2. Criteria: natural resources (C_1), ecology (C_2), humanities (C_3) innovation (C_4), human resources (C_5), policy implementation (C_6), information exchange (C_7), and competitiveness (C_8) marketing (C_9), and law amendment (C_{10}), local development (C_{11}), safety & security (C_{12}), disaster reduction (C_{13}), accessibility (C_{14}).

well. This offers the decision-makers multiple solutions to improvement priorities. Considering the influence effect, the strategies can be schemed as shown in Table 11.

In addition, as shown in Table 10, the performance values overall have an average of 6.02, with 10 as the desired level. The average gap, indicating room for improvement, is 0.398 (this is the distance from 1.0). The dimension of tourism resources, with the smallest gap value (0.369), should be the first priority for improvement if the authorities attempt to achieve the desired level. The results are also consistent with the current national tourism policy guidelines as outlined in the Project Vanguard for Excellence in Tourism. These guidelines address how quickly and on how grand of a scale tourism resources need to be developed to meet increasing tourism demand. Most of the investments and efforts shift onto developing tourism resources and make it most satisfying. Nevertheless, it is notable that other factors are more influential – 'safety' in particular, as we mentioned above. Taking lessons from a series of fatal transport accidents in scenic areas and numerous disasters and social crimes due to tourism development impacts, the issue of safety and security can no longer be ignored. More attention should be paid to law enforcement, disaster reduce management, and a safe and efficient transportation network. It will not be easy because the finding also reveals that law amendment is the least satisfying criteria among them all, demonstrating policymaking is not an easy game in Taiwan. However, the above does underscore how Taiwan's tourism policy implementation gets involved. The authorities should bear this in mind as they attempt their long-term planning.

Because Taiwan's tourism policymaking and policy implementation occur under the guidance of the nation's various governments, sustainable tourism development and implementation require decision-making by the authorities, which in turn requires real comments and judgements by representatives of the communities dealing with such a complex system (Leiper, 1990; Mills & Morrison, 2002). All responsible tourism policies should be holistically planned in current and future human activity (Connell et al., 2009) and within the framework of sustainable development. From this standpoint, our results as holistically formulated in Table 11 hopefully fulfil the purpose of this research.

5. Conclusions

This research modelled the improvement strategy that should be pursued as part of tourism policy implementation in Taiwan. A novel hybrid MCDM method was used to address dependent relationships among the various criteria together with DEMATEL (as used to construct the NRM) and the DANP (as used to decide the relative weights of the criteria) and VIKOR (as used to determine the improvement priority). In this study, of the various tourism policy implementation evaluations, those provided by the domain experts from the MCDM produced the most useful results. The sequence of influence priorities was as follows: a safe environment, an industry environment, a socio-economic environment and tourism resources. The average gap between the actual and desired levels of policy implementation was 0.398, denoting the level that current Taiwan's tourism policy implementation needs to reach. The implications of these results for management and improvement plans have been raised and formulated. The underlying concepts applied here are found to be intelligible to decision-makers, and the computation for the techniques required is straightforward and simple, through the use of Excel Program. Most importantly, the findings can reduce the worry associated with tourism master plans that are rarely implemented or that are unworkable in the real world and emphasise the goal of sustainable development. This empirical test of our approach, conducted using a Taiwanese case study, has illustrated the usefulness of the approach in dealing with complex national tourism policies and the meaningful implications of our study for policy decision-makers. However, there are some limitations. First, this study was conducted with relatively expert sample groups. A larger sample that brought more explanatory power would have allowed more sophisticated evaluation analysis and verified the current findings to increase generalisability (Tseng, 2010). Second, the evaluation criteria were selected from a review of the literatures on tourism policy implementation. Other methodologies, such as longitudinal studies and in-depth interviews, should have been applied to identify some other possible criteria. Further research is thus needed in the field of developing more elaborated multi-criteria structure incorporating a large sample using the hybrid MCDM methods in the future.

Appendix 1. Explanation for the illustrating of NRM

Taiwan's MCDM group, led by nationally distinguished Professor, G.H. Tzeng, has developed a novel way for constructing the NRM by DEMATEL without the threshold value and using single-headed arrows to represent the impact direction. In Table A1, it can be demonstrated as follows:

If $t_{21} > t_{12}$, the flow is drawn from D_2 to D_1, $D_2 \rightarrow D_1$;
If $t_{12} > t_{21}$, the flow is drawn from D_1 to D_2, $D_1 \rightarrow D_2$.

Using this paper as an example, in Table A2, the value of D_1 influencing D_2 is 13.244, but the value of D_2 influencing D_1 is 13.526. Apparently the influence value of D_2 is larger than D_1 of 0.281 (13.526–13.244) (see Table A3). Thus, the authors draw $D_2 \rightarrow D_1$, and so on. Using this pair-wise comparison, the NRM of the policy system can thus be created, as illustrated in Fig. A1.

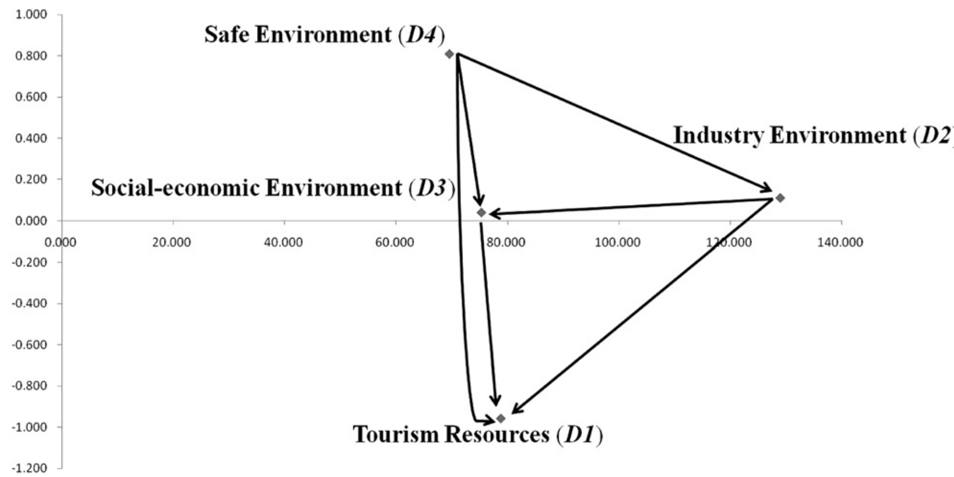

Fig. A1. The NRM of relationships within the policy system.

Table A1
The total-influence matrix by dimensions.

Dimensions	D_1	D_2	D_3	D_4
D_1	t_{11}	t_{12}	t_{13}	t_{14}
D_2	t_{21}	t_{22}	t_{23}	t_{24}
D_3	t_{31}	t_{32}	t_{33}	t_{34}
D_4	t_{41}	t_{42}	t_{43}	t_{44}

Table A2
The total-influence matrix by dimensions of tourism policy.

Dimensions	D_1	D_2	D_3	D_4
D_1	11.022	13.244	7.711	6.938
D_2	13.526	26.702	12.796	11.541
D_3	7.934	12.752	10.240	6.742
D_4	7.392	11.756	6.882	9.148

Table A3
Net influential impact in network flow.

	D_1	D_2	D_3	D_4
D_1	–	–	–	–
D_2	0.281	–	0.044	–
D_3	0.223	–	–	–
D_4	0.454	0.215	0.140	–

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