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A hybrid MCDM model for evaluating the environmental impacts of regional shopping centers

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ABSTRACT

In 1990s, there were fervent oppositions from the point of economic, social, cultural or physical impacts to regional shopping centers in Britain. Not occasionally, there are similar issues on regional shopping centers in Taiwan in 2000s. In order to peel off the cocoon of the silkworm, quantitative measurement of the four-dimensional indices is the goal-achieving of this paper. Those previous efforts to evaluate different kinds of impacts relationship are individual or separate. Here a hybrid MCDM (multiple criteria decision-making) model to address dependent relationships among criteria, using a DEMATEL (decision-making trial and evaluation laboratory) technique along with an analytical network process, to decide the relative weights of criteria, showing inter-dependence and feedback. We can also propose a design to evaluate and improve the gaps in each criterion for reducing the gaps to achieve the aspired/desired level. An empirical case is used to demonstrate that the hybrid MCDM model can be used to measure and evaluate regional shopping center problems in real cases. Results can be used to provide the decision-maker to choice the regional shopping center location.

1. Introduction

A regional shopping center is a large retail shopping complex (300,000 to 900,000 square feet) that includes one or two full-line department stores. Regional shopping center typically draws customers from a radius of 40 to 50 miles. They are no longer for dist spaces that encourage mass consumption and sameness, but post-for dist spaces that attempt to create social distinctions (Salcedo, 2003).

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In Taiwan, there was a strong demand for third sector industry's land use during early 1990s. Strict land use controls meant that the commercial use of urban land was banned and retail warehouses were confined to industrial or residential land use zone. To solve these problems, the first version of the Mixed Industrial/Commercial Zones Establishment Guide and Application Requirements was released in 1994, and the second version (which included additional related regulations) was released in 2001. Applications for the development of regional shopping centers reached their peak in the latter half of the 1990s, and 54 applications were filed

between 1995 and 2007. Currently, however, twenty-one of these applications have been withdrawn and just three regional shopping centers are in operation: the Tai Mall in Taoyuan (opened in 1999), the Metro Walk shopping center in Taoyuan (opened in 2001) and the Sugar Mall in Tainan (opened in 2003). The reasons for this are not simple, and one year ago the Research, Development and Evaluation Commission (RDEC) of the Executive Yuan in Taiwan decide to evaluate regional shopping center development policy (Thomas & Bromley, 2002).

In 1993 Britain's Department of the Environment argued that regional shopping centers would not be appropriate in certain areas. These included areas where there is unlikely to be a significant growth in population or retail expenditure; where continued investment in nearby town centers is likely to be seriously jeopardized; where there would be a loss of Green Belt, open space, countryside or high-quality agricultural land; where public transport could not adequately serve a wide population; or where the effect on the road network and on the overall level of car travel would be unacceptable. in 2004 Britain's Department of the Environment pointed out that, in the comparison retail sector, one of the most marked effects of PPG6 has been to effectively bring an end to the development of new regional shopping centers. Why are regional shopping centers so opposed in Britain? Williams 1995 suggests that although it is unclear whether such complexes have positive or negative economic, social and environmental impacts, the cultural impacts of regional shopping centers are more obvious. However, the relative importance of each of these four factors and the interactions among them are not well understood.

The RDEC of the Executive Yuan in Taiwan has tried to use an analytic hierarchy process (AHP) to evaluate regional shopping center development policy, but the data are insufficient. This paper attempts to solve this problem by using an expert group and a hybrid MCDM model. A decision-making trial and evaluation laboratory (DEMATEL) technique is used to detect complex relationships and build a network relation map (NRM) among the various factors and criteria that are considered to be important in the development of regional shopping centers. An analysis network process (ANP) was used by Saaty (1996) to overcome problems of dependence and feedback among various factors and criteria based on DEMATEL technique. Therefore, the objective of this paper is to offer a quantitative decision model that can help practitioners set priorities and reap the most benefits from decision making. We use data from a Taiwanese regional shopping centers to demonstrate this model. This genetic model can be easily extended to other fields, helping other types of firms to maximize their decision quality.

The proposed model could be used to evaluate the effectiveness of policies, to find the most important factors for evaluation, to illustrate the interrelationship among factors based on an NRM, to find evaluation gaps among factors to improve the effectiveness of regional shopping centers development, and to make strategic target plans for achieving the aspired/desired levels of elevating living standards and balancing the regional development. Moreover, the results show that the effectiveness calculated by the proposed model is consistent with the results calculated by DEMATEL and ANP.

The remainder of this paper is organized as follows: Section 2 reviews the literature on the impact of regional shopping centers development; Section 3 introduces the DEMATEL and ANP techniques and establishes a model using these methods; Section 4 presents and discusses the results of an empirical study of regional shopping centers development

using the proposed evaluation model; and Section 5 summarizes our conclusions and offers final remarks.

2. Regional shopping center development measurements

Regional shopping centers are often evaluated by their economic, social, cultural and environmental impacts (Whitehead, 1993 and Williams, 1995). Williams (1995) has argued that there is inconclusive evidence about whether the economic, social and environmental impacts of regional shopping centers development are positive or negative and has focused his attention on the cultural impacts of regional shopping centers. Regional shopping center development measures involve a number of complex factors, including local economic development, local social structure, cultural impact, and the local physical environment. The effects of a development policy on a single consideration can be evaluated, but this may be unsatisfactory in the real world.

Anecdotal evidence has suggested that regional retail developments have a negative effect on life in the town centers, but there is limited academic literature on this subject. A report from the Department of the Environment identified three types of effects that result from these developments: economic, social, and environmental. Williams also addressed the economic, social and environmental arguments that are used against regional shopping centers (Williams, 1995). In economic terms, regional shopping centers are often viewed as parasitic sites that have a negative effect on overall job numbers and destroy city centers by diverting trade away from existing retail facilities (Thomas & Bromley, 1995, 2002, 2003 and Williams, 1995). On the other hand, regional shopping centers clearly fall into "basic" sector activity (Finn & Erdem,1995), which can have a positive effect on tax revenues and generate local jobs (Lowe, 1991, 2005 and Williams, 1993). The social impact of any economic development is always complex and difficult to assess.

In social terms, regional shopping centers are seen to be inaccessible, especially for marginalized social groups. However, regional shopping centers can also allow a shopper to satisfy his or her shopping needs more quickly than dispersed smaller shops and shopping centers can. The time saved can then be allocated to perhaps more productive endeavors, such as voluntary service or more hours at work. If nothing else, the time saved shopping may allow a person to pursue leisure activities that leave him or her more rested and thus more productive on the job (Lowe, 1991 and Williams, 1993). Mathieson & Wall (1982) have used social and cultural impacts to evaluate tourism. They consider factors such as changes in value systems, morals and conduct, as well as changes in individual behavior, family relationships, collective lifestyles, creative expressions, traditional ceremonies and community organization. Social impacts usually involve more immediate changes in quality of life that stem from local adjustment to the tourist industry. In contrast, cultural impacts appear as long-term changes in a society's norms and standards that alter the community's social relationships as well as its material forms and artifacts (Mathieson & Wall, 1982). The development of major grocery retailers in Britain has transformed the retail systems of many urban areas and has had a substantial impact on patterns of consumer behavior and shopping provision. In cultural terms, regional shopping centers shape identity by affecting both the social interactions that take places within the space (Williams, 1995) and the consumption activities of the shoppers (Guy, 1996, Howard, 1993, Lee & Yong, 1998, and Williams, 1995).

Many researchers argue that regional shopping centers have negative

environmental impacts and focus especially on "greenfield" sites, traffic pollution and increased resource consumption that results from greater travel distances. In contrast, Lowe (2005) argues that regional shopping center have had a fundamental impact on the built form and on urban identity. The concept of the shopping center as a fully integrated business enterprise is significantly more sophisticated and ambitious than it was in the past. Sizable complexes include at least several dozen businesses that purvey not only routine goods and services but also a variety of more specialized ones as well. The shopping center has therefore become more than a place of convenience; it is a destination, a focus of activity and a physical landmark in the fast-growing suburban landscape. Some of the shopping centers are highly individualistic in appearance and other physical characteristics, and reflect the vision and taste of the developers who created them (Longstreth, 1997).

In summary, while the economic, social, cultural and environmental impacts of regional shopping centers can be either positive or negative, those four dimensions are central to the evaluation of regional shopping center development. However, none of the previous cited studies clearly identify the structural relations between those four factors and regional shopping center development. It is not clear whether one factor is more important or effective as an evaluation tool than others or how the various factors may interact. This articleaddress these issues by using a hybrid model that combines the DEMATEL method with an ANP.

3. Proposed model: a hybrid MCDM model for evaluating the regional shopping center development

It can be difficult to quantify precise values in complex evaluation systems. A complex evaluation environment can, however, be divided into subsystems to more easily judge differences and measure scores. The DEMATEL method is developed to construct the interrelations among dimensions, factors, or criteria, and an ANP (which measures interdependence and feedback) is used to determine the relative weights of each dimension, factor or criterion.

3.1 Using the DEMATEL technique to build a network relation map (NRM)

In a complex system, all system factors are directly or indirectly related. As a result, it is difficult for a decision maker to define a specific objective or to identify a specific aspect of the system in isolation. While the vision of an interdependent system can lead to passive positioning, a clearer hierarchical structure can lead to linear activity that creates new problems because dependence and feedback are not considered (Tzeng et al., 2007).

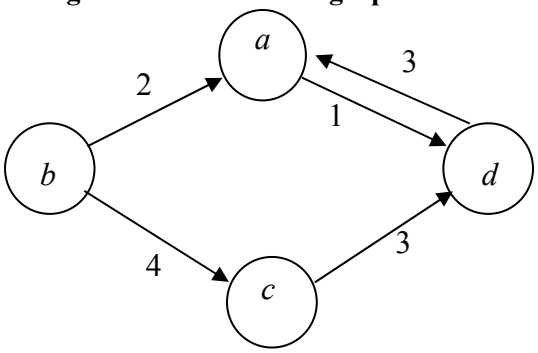
The DEMATEL technique is used to investigate complicated problem groups. The development of DEMATEL was based on the belief that the proper use of scientific research methods could help to illuminate specific and intertwined phenomena and contribute to the development of practical solutions with a hierarchical structure. This methodology, according to the concrete characteristics of objective affairs, can verify interdependence among a series of variables or attributes and confine the relationships that reflect the characteristics within an essential systemic and evolutional trend. The end product of the DEMATEL process is a visual representation by which a respondent organizes his or her action in the world (Chiu et al., 2006; Huang et al., 2005).

DEMATEL has been successfully applied to many situations, including the development of marketing strategies and the evaluation of e-learning methods, control systems and safety problems (Hori & Shimizu, 1999; Liou et al., 2007; Tzeng et al., 2007; Ou Yang et al., 2008; Chen et

al., 2008; Chen et al., 2009; Chen et al., 2010). The method can be summarized as follows:

Step 1: *Calculate the direct-influence matrix by scores*. Experts are asked to indicate the direct effect that they believe each factor *i* exerts on another factor *j*, as indicated by a_{ij} . Their responses are used to evaluate the relationships among elements (also called variables or attributes) of mutual influence. An integer scale ranging from 0 to 4 is used to represent each score as follows: "No influence"_(0), "Low influence"_(1), "Medium influence"_(2), "High influence"_(3), and "Very high influence"_(4). A digraph portrays the contextual relationship among the elements of the system, and a numeral represents the strength of influence. For example, in Figure 1**,** an arrow from *b* to *a* represents the fact that *b* affects *a*, and its influence score is 2. The direct-influence matrix $\boldsymbol{A}$ can be obtained.

Figure 1: The directed graph.



Step 2: *Normalizing the direct-influence matrix.* Based on the direct-influence of matrix $\boldsymbol{A}$, the normalized direct-influence matrix $\boldsymbol{D}$ is acquired by using formulas (1) and (2).

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

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

$$i, j \in \{1, 2, ..., n\} \tag{2}$$

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

$$\begin{aligned}\boldsymbol{T} = \boldsymbol{D} + \boldsymbol{D}^2 + \boldsymbol{D}^3 + ... + \boldsymbol{D}^k &= \boldsymbol{D}(\boldsymbol{I} + \boldsymbol{D} + \boldsymbol{D}^2 + ... + \boldsymbol{D}^{k-1}) \\ &\quad [(\boldsymbol{I} - \boldsymbol{D})(\boldsymbol{I} - \boldsymbol{D})^{-1}] \\ &= \boldsymbol{D}(\boldsymbol{I} - \boldsymbol{D}^k)(\boldsymbol{I} - \boldsymbol{D})^{-1}\end{aligned}$$

Then,

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

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

Step 4: *Analyzing the results*. In this stage, the sum of the rows and the sum of the columns are separately expressed as vector $\boldsymbol{r} = (r_1, ..., r_i, ..., r_n)'$ and vector $\boldsymbol{c} = (c_1, ..., c_j, ..., c_n)'$ by using formulas (4), (5) and (6). Let $i = j$ and $i, j \in \{1, 2, ..., n\}$, the horizontal axis vector (***r***+***c***) is made by adding ***r*** to ***c***, which illustrates the importance of the criterion. Similarly, the vertical axis vector (***r***-***c***) is made by deducting ***r*** from ***c***, which may separate criteria into a cause group and an affected group. In general, when (***r***-***c***) is positive, the criterion is part of the cause group. On the other hand, if (***r***-***c***) is negative, the criterion is part of the affected group. Therefore, a causal graph can be created by mapping the dataset of (***r***+***c***, ***r***-***c***); this provides a valuable approach to decision-making.

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

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

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

where vector $\boldsymbol{r}$ and vector $\boldsymbol{c}$ express the sum of rows and the sum of columns from total-influence matrix $\boldsymbol{T} = [t_{ij}]_{n\times n}$ respectively, and superscript $'$ denotes transposition.

3.2 Finding the preference of criteria weights by ANP based on the NRM

The ANP can be used as an MCDM method to systematically select the most suitable locations for each facility. The ANP is a relatively simple and systematic approach that can be used by decision makers. MCDM techniques have also been widely used to select facility sites. The ANP is an extension of AHP by Saaty (1996) that helps to overcome the problem of interdependence and feedback among criteria and alternatives. Although the AHP and the ANP both derive ratio scale priorities by making pairwise comparisons of elements (such as dimensions, factors or criteria), there are important differences between them. First, the AHP is a special version of the ANP; the ANP handles dependence within a cluster (inner dependence) and among different clusters (outer dependence). Second, the ANP is a nonlinear structure based on dynamic concepts of the Markov chain, while the AHP is linear and hierarchical, with goals at the top level and alternatives in the lower level (Saaty, 1996 & 1999).

The first step of the ANP is to use the criteria of the entire system to form a supermatrix through pair-wise comparisons. This is done by asking, "How importance is one criterion compared to another criterion with respect to our interests or preferences?" The relative importance is determined using a scale of 1-9 scale, which represents a range from equal importance to extreme importance [14]. The general form of the supermatrix is seen in Equation (7), where C_m denotes the m-th cluster, e_{mn} denotes the n-th element in the m-th cluster and matrix $\boldsymbol{W}_{ij}$ is the principal eigenvector of the influence of the elements comparing the j-th cluster to the i-th cluster. The form of the supermatrix depends on the variety of the structure. For example, if the system is structured as an unweighted supermatrix $\boldsymbol{W}$ (Figure 2), then the local priorities derived from the pair-wise comparisons throughout the network are contained as in Equation (8).

$$
\begin{array}{c}
\quad\quad C_1 \qquad\qquad\quad C_2 \qquad \cdots \qquad\quad C_m \\
e_{11}\ \cdots\ e_{1n_1}\ \ e_{21}\ \cdots\ e_{2n_2}\ \cdots\ e_{m1}\ \cdots\ e_{mn_m} \\
\boldsymbol{W} = \begin{array}{c} e_{11} \\ \vdots \\ C_1 \\ e_{1n_1} \\ e_{21} \\ e_{22} \\ \vdots \\ C_2 \\ e_{2n_2} \\ \vdots \\ \vdots \\ e_{m1} \\ e_{m2} \\ C_m \\ \vdots \\ e_{mn_m} \end{array}
\begin{bmatrix}
\boldsymbol{W}_{11} & \cdots & \boldsymbol{W}_{12} & \cdots & \boldsymbol{W}_{1m} \\
 & & & & \\
 & & & & \\
 & & & & \\
 & & & & \\
\boldsymbol{W}_{21} & \cdots & \boldsymbol{W}_{22} & \cdots & \boldsymbol{W}_{2m} \\
\vdots & & \vdots & & \vdots \\
\vdots & & \vdots & & \vdots \\
 & & & & \\
\boldsymbol{W}_{m1} & \cdots & \boldsymbol{W}_{m2} & \cdots & \boldsymbol{W}_{mm}
\end{bmatrix}
\end{array} \tag{7}
$$

$$
\boldsymbol{W} = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \end{array}
\begin{array}{c}
\begin{array}{ccc} C_1 & C_2 & C_3 \end{array} \\
\begin{bmatrix} 0 & 0 & \boldsymbol{W}_{13} \\ \boldsymbol{W}_{21} & 0 & 0 \\ 0 & \boldsymbol{W}_{32} & \boldsymbol{W}_{33} \end{bmatrix}
\end{array} \tag{8}
$$

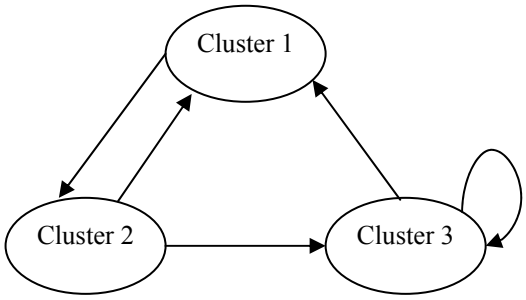
where $\boldsymbol{W}_{21}$ is a matrix that represents the weights of cluster 2 in respect to cluster 1, matrix $\boldsymbol{W}_{32}$ represents the weights of cluster 3 with respect to cluster 2 and matrix $\boldsymbol{W}_{13}$ represents the weights of cluster 1 with respect to cluster 3. In addition, matrix $\boldsymbol{W}_{33}$ denotes the inner dependence and feedback within cluster 3.

The weighted supermatrix is derived by setting the "all columns sum" to unity by normalization. This step is very similar to the use of the Markov chain to ensure that the sum of the probabilities of all states equals 1 (Huang et al., 2005). The weighted supermatrix can then be raised to

limiting powers, as in Equation (9), to calculate the overall priorities of weights.

$$\lim_{k\to\infty} \boldsymbol{W}^k \quad (9)$$

Figure 2: Illustration of system structure.



4. An Empirical Case of RSC development

Only three regional shopping centers are in operation in Taiwan, and twenty-one applications have been withdrawn; as a result, Taiwan's government has been forced to amend some land use regulations to accelerate the reviewing process of the Planning Permission System. Although the issues related to the development of regional shopping centers in Taiwan are different from those that led to fervent oppositions in Britain throughout the 1990s, Taiwan's government must evaluate the impacts of RSC development by the same indexes. Economic, social, cultural and environmental factors are included in an AHP model. The proper measurement of these impacts is challenging, however, as insufficient data make objective assessment difficult. To reflect the real-world interrelationships among these factors, this paper reviewed related literature (see section 2) to identify more precise criteria that can form the quantitative measurement of the four-dimensional-index evaluation model (see Table 1).

Table 1: Dimensions and criteria for regional shopping center development systems

Dimensions	Criteria
Local economic development (D_1)	The number of jobs produced and **personal income** raised (C_1)
	Increase of **tax revenues** (C_2)
	Changes in the pattern of **local retailing** (C_3)
Local physical environment (D_2)	**Traffic pollution** (C_4)
	Landscape beautification (C_5)
	The improvement of shopping and leisure space (C_6)
Local social structure (D_3)	Service for certain customers (C_7)
	The provision of a more efficient shopping and recreation environment (C_8)
Cultural impact (D_4)	Changes in consumer behavior (C_9)
	Changes in work attitudes (C_{10})

4.1 Building an influence relationship matrix of an NRM for regional shopping center development analysis

The aim of this approach is not only to determine the most important policy criteria but also to measure relationships among criteria to build an NRM. A questionnaire was used to gather these assessments from twenty-one academic scholars, government officers and industrial experts. They rated each criterion with respect to efficient development on a 5-point scale ranging from 0 (no effect) to 4 (extremely important influence). The highest scoring two or three criteria from each dimension were extracted to construct a system for measuring the development of a regional shopping center. Since the comprehensive conservation of regional shopping center development systems rates is an important

factor in development measurements, this rate was used as a further criterion.

The regional shopping center development experts were asked to determine the importance of the relationships among the dimensions. The average initial direct-influence 4×4 matrix ***A,*** obtained by pair-wise comparisons of influences and directions between dimensions, is shown as Table 2.

As matrix ***A*** shows, the normalized direct-influence ***D*** is calculated from Equations (1) and (2). Equation (3) is then used to derive the total influence ***T*** as seen in Table 3. By using Equations (5) and (6), the sum of the total influence given and received by each dimension can be derived (see Table 4).

Finally, the DEMATEL method can be used to draw the impact-relations-map (IRM) shown in Figure 3.

Table 2: The initial influence matrix *A* of regional shopping center development

Dimensions	Local economic development	Local physical environment	Local social structure	Cultural impact
Local economic development	0.000	2.909	2.818	2.545
Local physical environment	3.182	0.000	2.364	2.091
Local social structure	2.909	2.455	0.000	2.273
Cultural impact	2.455	2.091	2.273	0.000

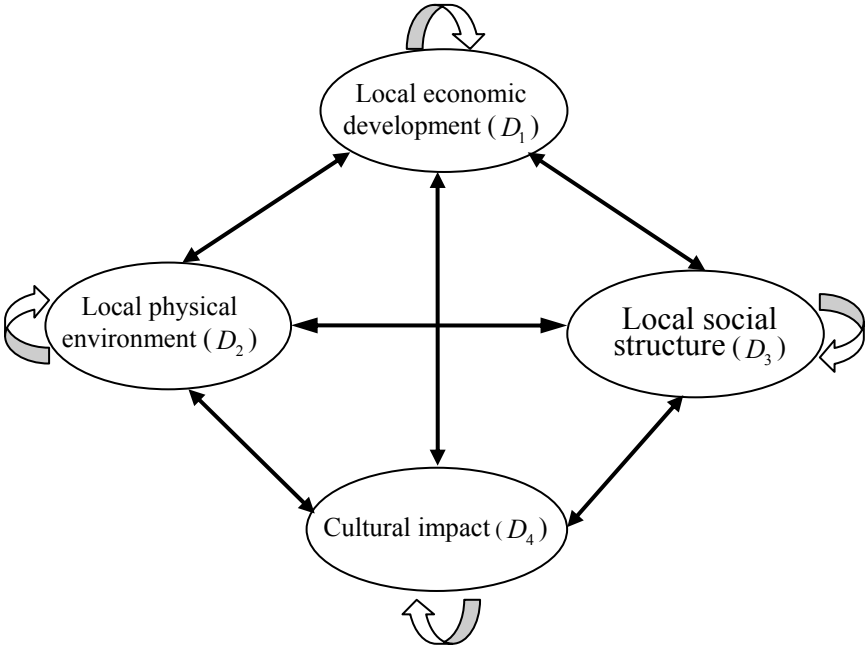
Table 3: The total influence matrix *T* of regional shopping center development

Dimensions	Local economic development	Local physical environment	Local social structure	Cultural impact	Total influence normalized
Local economic development	2.190 ($w_{D_1D_1}=0.244$)	2.236 ($w_{D_1D_2}=0.262$)	2.228 ($w_{D_1D_3}=0.259$)	2.091 ($w_{D_1D_4}=0.235$)	- (1.00)
Local physical environment	2.345 ($w_{D_2D_1}=0.276$)	1.878 ($w_{D_2D_2}=0.232$)	2.092 ($w_{D_2D_3}=0.258$)	1.9606 ($w_{D_2D_4}=0.235$)	- (1.00)
Local social structure	2.318 ($w_{D_3D_1}=0.275$)	2.093 ($w_{D_3D_2}=0.258$)	1.868 ($w_{D_3D_3}=0.230$)	1.966 ($w_{D_3D_4}=0.236$)	- (1.00)
Cultural impact	2.106 ($w_{D_4D_1}=0.274$)	1.904 ($w_{D_4D_2}=0.257$)	1.915 ($w_{D_4D_3}=0.258$)	1.603 ($w_{D_4D_4}=0.210$)	- (1.00)

Table 4: The sum of influences given and received on dimensions of regional shopping center development

Dimensions	r_i	c_i	$r_i + c_i$	$r_i - c_i$
Local economic development	8.746	8.959	17.705	(-0.213)
Local physical environment	8.276	8.111	16.386	0.165
Local social structure	8.244	8.103	16.348	0.141
Cultural impact	7.529	7.621	15.150	(-0.093)

Figure 3: The impact-relations-map (IRM) of relations within regional shopping



4.2 Weighting of criteria in regional shopping center development systems

After determining the relationship among the development factors, the ANP method is applied to obtain criterion weights. Initially, the importance of the relationships between each criterion was based on the impact-relations-map. For example, the experts were asked to respond to a series of questions, such as, "For the efficient development of a regional shopping center, how much more important is one operation factor over another?" These pair-wise comparisons are based on the AHP concept and the relative importance uses a 9-point scale with a score of (1) indicating equal importance and (9) indicating the extreme importance of one element over another. The local weights of these criteria are obtained through the principal eigenvector of comparison, and an unweighted supermatrix can be generated (Table 5).

Table 5: The unweighted supermatrix of regional shopping center development

	Local economic development			Local physical environment			Local social structure		Cultural impact	
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
C_1	1.000	0.000	0.000	0.256	0.222	0.206	0.258	0.263	0.290	0.378
C_2	0.000	1.000	0.000	0.233	0.333	0.294	0.161	0.184	0.194	0.243
C_3	0.000	0.000	1.000	0.512	0.444	0.500	0.581	0.553	0.516	0.378
C_4	0.341	0.306	0.256	1.000	0.000	0.000	0.212	0.184	0.182	0.290
C_5	0.268	0.194	0.282	0.000	1.000	0.000	0.242	0.263	0.273	0.290
C_6	0.390	0.500	0.462	0.000	0.000	1.000	0.545	0.553	0.545	0.419
C_7	0.296	0.273	0.345	0.355	0.357	0.333	1.000	0.000	0.417	0.438
C_8	0.704	0.727	0.655	0.645	0.643	0.667	0.000	1.000	0.583	0.563
C_9	0.563	0.581	0.656	0.654	0.727	0.741	0.750	0.667	1.000	0.000
C_{10}	0.438	0.419	0.344	0.346	0.273	0.259	0.250	0.333	0.000	1.000

The development of regional shopping centers will have economic, social, cultural and environmental effects, and these factors are interrelated and influence each other. Therefore, we developed a new method that combines the DEMATEL total influence matrix and the unweighted supermatrix in an ANP. First, we calculated the total influences (seen in parentheses in Table 3), in the normalized matrix T, obtained each dimension's weight, and then weighted the unweighted supermatrix (Table 6). Based on the values in Table 6, the normalization unweighted supermatrix power limit $k \to \infty$ can be obtained (Table 7). The outcomes of a new hybrid MCDM model that are seen in Table 7 can be used to derive feedback for the dimensions and the relationships between each criterion.

Table 6: Weighting the unweighted supermatrix based on total influence normalized matrix

Dimensions	Local economic development (D_1)	Local physical environment (D_2)	Local social structure (D_3)	Cultural impact (D_4)
Local economic development (D_1)	$w_{D_1D_1}\boldsymbol{W}_{D_1D_1}$	$w_{D_2D_1}\boldsymbol{W}_{D_2D_1}$	$w_{D_3D_1}\boldsymbol{W}_{D_3D_1}$	$w_{D_4D_1}\boldsymbol{W}_{D_4D_1}$
Local physical environment (D_2)	$w_{D_1D_2}\boldsymbol{W}_{D_1D_2}$	$w_{D_2D_2}\boldsymbol{W}_{D_2D_2}$	$w_{D_3D_2}\boldsymbol{W}_{D_3D_2}$	$w_{D_4D_2}\boldsymbol{W}_{D_4D_2}$
Local social structure (D_3)	$w_{D_1D_3}\boldsymbol{W}_{D_1D_3}$	$w_{D_2D_3}\boldsymbol{W}_{D_2D_3}$	$w_{D_3D_3}\boldsymbol{W}_{D_3D_3}$	$w_{D_4D_3}\boldsymbol{W}_{D_4D_3}$
Cultural impact (D_4)	$w_{D_1D_4}\boldsymbol{W}_{D_1D_4}$	$w_{D_2D_4}\boldsymbol{W}_{D_2D_4}$	$w_{D_3D_4}\boldsymbol{W}_{D_3D_4}$	$w_{D_4D_4}\boldsymbol{W}_{D_4D_4}$

Table 7: Weighting the unweighted supermatrix based on total influence normalized matrix of RSC development

	Local economic development			Local physical environment			Local social structure		Cultural impact	
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
C_1	0.244	0.000	0.000	0.066	0.058	0.053	0.067	0.068	0.076	0.100
C_2	0.000	0.244	0.000	0.060	0.086	0.076	0.042	0.047	0.051	0.064
C_3	0.000	0.000	0.244	0.132	0.115	0.129	0.149	0.142	0.136	0.099
C_4	0.065	0.056	0.052	0.232	0.000	0.000	0.097	0.068	0.076	0.099
C_5	0.059	0.084	0.074	0.000	0.232	0.000	0.062	0.047	0.051	0.064
C_6	0.129	0.112	0.126	0.000	0.000	0.232	0.097	0.142	0.136	0.099
C_7	0.075	0.069	0.087	0.091	0.091	0.085	0.230	0.000	0.110	0.116
C_8	0.177	0.183	0.165	0.165	0.164	0.170	0.000	0.230	0.154	0.149
C_9	0.141	0.146	0.165	0.166	0.185	0.189	0.192	0.171	0.210	0.000
C_{10}	0.110	0.106	0.087	0.088	0.069	0.066	0.064	0.085	0.000	0.210

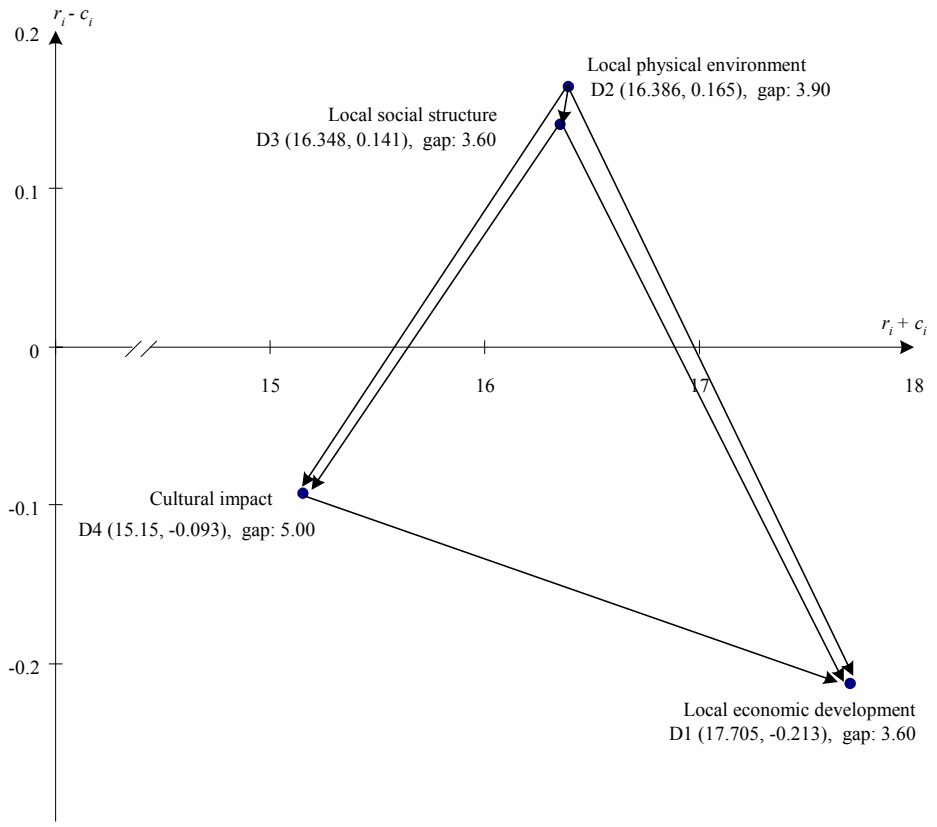
By calculating the limiting power of the weighted supermatrix, $\lim_{k\to\infty}\boldsymbol{W}^k$ Eq. (9) is applied by ANP until a steady-state condition is reached (Table 8). Table 8 shows the regional shopping center development weighted supermatrix indexes. Each row represents the weight of each criterion. If means of C_8 precede C_1 in Table 8, then the regional shopping center development indicates the criterion C_8 is the best development record because it influences other criteria. As seen in the table, the highest priority is Changes in consumer behavior (16.4%), while the lowest priority is Increase of **tax revenues** (5.7%). For local physical environment criteria, the priority are the space of shopping and leisure improved (12.1%), traffic pollution and landscape

beautification; for local social structure criteria, the priority are more efficient environment of shopping and recreation provided (16.0%) and certain customers served; for cultural impact criteria, the priority are the consumer's behavior changed (16.4%) and the work attitude changed. The Cultural impact is determined to be the most important criterion within the best regional shopping center development policy (**Fig**. 4). It implies that those experts who are questionnaire's respondents give the highest attentions to Cultural impact because of the most obvious and initial positive effect affected by regional shopping center.

Table 8: The stable matrix of ANP of regional shopping center development when power limit $k \to \infty$

	Local economic development			Local physical environment			Local social structure		Cultural impact	
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}
C_1	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069
C_2	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057
C_3	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130
C_4	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071
C_5	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
C_6	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.121	0.121
C_7	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091
C_8	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160	0.160
C_9	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164
C_{10}	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079

Figure 4: The impact-direction map of regional shopping center development



The objective of regional shopping center development is to elevate living standards and to balance regional development; this is the same goal of the impact-direction map determined by DEMATEL (Figure 4). The integration of regional shopping center development performance index scores into the ANP shows that local economic development receives the highest score of 6.40, and the gap score is 3.60 away from the goal or the aspire level (Table 9). This means that the performance of local economic development in regional shopping center development is better than the other three factors/dimensions, but there still is a gap of 3.6 between it and the aspired level.

Table 9: The RSC development for integrating plan index of criteria weightings by ANP

	Local economic development			Local physical environment			Local social structure		Cultural impact		
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	Summary
Integrating important index	0.069	0.057	0.130	0.071	0.059	0.121	0.091	0.160	0.164	0.079	1.00
	(8)	(10)	(3)	(7)	(9)	(4)	(5)	(2)	(1)	(6)	-
Local weight	0.268	0.264	0.508	0.282	0.234	0.484	0.362	0.638	0.675	0.325	4.000
Performance values (A)	6.550	6.640	5.910	5.090	6.180	6.910	5.820	6.910	5.000	5.000	6.000
Aspired levels (B)	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000	10.000
Gaps (B-A)	3.45	3.36	4.09	4.91	3.82	3.09	4.18	3.09	5.00	5.00	4.00
Dimensions weight	D_1=0.256			D_2 =0.251			D_3 =0.251		D_4 =0.243		1.000
Performance values (C)	6.400			6.100			6.400		5.000		6.000
Aspired levels (D)	10.000			10.000			10.000		10.000		10.000
Gaps (D-C)	3.600			3.900			3.600		5.000		4.000

Parentheses ( ) denote the rankings in integrating important index based on ANP.

4.3 Discussion

Via Table 4 (the sum of influences given and received for dimensions) values, we then draw the impact-direction map shown in Fig. 4. It shows that "D_2 Local physical environment" is more important than the other three. Thus, we can sequence $D_2 \succ D_3 \succ D_4 \succ D_1$.

According to ANP, we designed and obtained Table 7 in order to calculate the weighted and the unweighted supermatrix based on the total influence normalized matrix. Table 8 shows the **regional shopping center development** weighted supermatrix indexes. Each row represents the weight of each criterion.

This article presents an efficient way to improve regional shopping center development by using a novel hybrid MCDM method combined with DEMATEL technique ANP. The final results, as shown in Figure 4 and Table 9, demonstrate that the best regional shopping center development policy is performed as an average score of 6.000, with a gap of 4.000 from the aspired level. The local physical environment is the key factor among the four dimension indexes. Although local economic development gets the highest score of 6.400 and is only 3.400 away from the aspired level, a decision maker can yield twice the result with half the effort by focusing more on the local physical environment than on local economic development. The focus on the local physical environment can stir local economic development directly and

indirectly. In other word, the decision maker should pay special attention to three particular factors: the improvement of shopping and leisure space (C_6), traffic pollution (C_4) and landscape beautification (C_5). Furthermore, a influential criteria that should be improved include changes in consumer behavior (C_9). Using our method that combines the local physical environment with three other dimensions, the individual local physical environment may be more easily distinguished.

From the results given earlier, using the DEMATEL in conjunction with an ANP, we can determine the relative weights of the criteria. The DEMATEL works in an ANP to construct a new measurement model for regional shopping center development policy. For future study, we make the following recommendations that may be worthy of further research. We can design and plan the regional shopping center development policy and use "VIKOR" or "PROMETHEE" for the regional shopping center development policy strategy.

5. Conclusions

The following summarizes the important findings of this study. Using the DEMATEL in conjunction with an ANP, we can discover the relative weights of various criteria. The DEMATEL works in an ANP to construct a new measurement model for regional shopping center development policy, which may be worthy subjects of further research. The proposed model uses DEMATEL to find influence factors, and ANP is used to discover the most important criteria/factors that will influence the efficiency of regional shopping center development policy. The DEMATEL technique carries out the comparisons in pairs of mutual relationships. This surveys the materials and clarifies the essence of problems based on the novel hybrid MCDM model method, and it may help to make future development policy. In addition, the model is well suited to deal with decision problems, whose constructs are complicated and whose criteria are interdependent. MCDM can be applied to many fields, such as environmental plans, psychology, consumer behavior, and human resources management. The study sets up a causal model of development policy, and the relational structure model is verified through satisfactory statistical techniques to confirm the model efficiency. In the past, these methods have had a poor plan record. Therefore, over the past decade, the poor regional shopping center development record has led the department of the environment pointed out to reexamine the problems of applicants who are still hanging on the application procedure of regional shopping center development. Traditionally, the regional shopping center development on revision of a certain policy assesses a single concern at a time or results in vague solution. Based on several aspects of regional shopping center development, we have combined the DEMATEL and ANP method to form a hybrid MCDM approach that considers the importance of a range of criteria and the interdependence among them. An empirical test of the approach using a Taiwanese case study illustrates its usefulness of our model and the meaningful implications for decision makers.

From the results given earlier, as demonstrated above the regional shopping center development policy, using the DEMATEL in conjunction with an ANP can decide the relative weights of criteria. The DEMATEL works in an ANP to construct a new measurement model for the effects of regional shopping center development policy. Some recommendations have been made for further research. We can design and plan in the regional shopping center development policy, using "VIKOR" or "PROMETHEE", to create a regional shopping center development policy strategy.

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