



Identification of a threshold value for the DEMATEL method using the maximum mean de-entropy algorithm to find critical services provided by a semiconductor intellectual property mall

Chung-Wei Li^{a,*}, Gwo-Hshiung Tzeng^{a,b,c,1}

^a Institute of Management of Technology, National Chiao Tung University, 33060 Hsinchu, Taiwan

^b Department of Business and Entrepreneurial Management, Kainan University, Taoyuan, Taiwan

^c Department of Banking and Finance, Kainan University, Taoyuan, Taiwan

ARTICLE INFO

Keywords:

DEMATEL
Multiple criteria decision-making (MCDM)
Entropy
Maximum mean de-entropy (MMDE)
algorithm

ABSTRACT

To deal with complex problems, structuring them through graphical representations and analyzing causal influences can aid in illuminating complex issues, systems, or concepts. The DEMATEL method is a methodology which can confirm interdependence among variables and aid in the development of a chart to reflect interrelationships between variables, and can be used for researching and solving complicated and intertwined problem groups. The end product of the DEMATEL process is a visual representation—the impact-relations map—by which respondents organize their own actions in the world. In order to obtain a suitable impact-relations map, an appropriate threshold value is needed to obtain adequate information for further analysis and decision-making. In the existing literature, the threshold value has been determined through interviews with respondents or judged by the researcher. In most cases, it is hard and time-consuming to aggregate the respondents and make a consistent decision. In addition, in order to avoid subjective judgments, a theoretical method to select the threshold value is necessary. In this paper, we propose a method based on the entropy approach, the maximum mean de-entropy algorithm, to achieve this purpose. Using a real case to find the interrelationships between the services of a Semiconductor Intellectual Property Mall as an example, we will compare the results obtained from the respondents and from our method, and show that the impact-relations maps from these two methods could be the same.

© 2009 Elsevier Ltd. All rights reserved.

1. Introduction

The DEMATEL (Decision-Making Trial and Evaluation Laboratory) method, developed by the Science and Human Affairs Program of the Battelle Memorial Institute of Geneva between 1972 and 1976, was used to research and solve complicated and intertwined problem groups (Fontela & Gabus, 1974, 1976). DEMATEL was developed in the hope that pioneering the appropriate use of scientific research methods could improve the understanding of a specific *problematique*, a cluster of intertwined problems, and contribute to the identification of workable solutions through a hierarchical structure. The DEMATEL method is based on graph theory, enabling us to plan and solve problems visually, so that we may divide the relevant factors into cause and effect groups in order to

better understand causal relationships. The methodology can confirm interdependence among variables and aid in the development of a directed graph to reflect the interrelationships between variables.

The applicability of the DEMATEL method is widespread, ranging from analyzing world *problematique* decision-making to industrial planning (Chiu, Chen, Shyu, & Tzeng, 2006; Hori & Shimizu, 1999; Huang, Shyu, & Tzeng, 2007; Tzeng, Chiang, & Li, 2006). The most important property of the DEMATEL method used in the multi-criteria decision-making (MCDM) field is to construct interrelations between criteria. After the interrelations between criteria were determined, the results derived from the DEMATEL method could be used for fuzzy integrals to measure the super-additive effectiveness value or for the Analytic Network Process method (ANP) (Liou, Yen, & Tzeng, 2008; Saaty, 1996; Tsai & Chou, 2009) to measure dependence and feedback relationships between certain criteria. When the DEMATEL method is used as part of a hybrid MCDM model, the results of the DEMATEL will influence the final decision.

* Corresponding author. Tel.: +886 3 3706190.

E-mail addresses: samli0707@gmail.com (C.-W. Li), ghtzeng@mail.knu.edu.tw (G.-H. Tzeng).

¹ Distinguished Chair Professor.

There are four steps in the DEMATEL method: (1) calculate the average matrix, (2) calculate the *normalized initial direct-influence matrix*, (3) derive the *total relation matrix*, and (4) set a threshold value and obtain the *impact-relations map* (in Fig. 1, we divided Step 4 into two steps). In Step 4, an appropriate threshold value is necessary to obtain a suitable impact-relations map as well as adequate information for further analysis and decision-making. The traditional method followed to set a threshold value is conducting discussions with experts. The researcher sets an adequate threshold value and then outlines an impact-relations map to discuss whether the impact-relations map is suitable for the structure of the problematique. If not, the threshold value is replaced by another value, and another impact-relations map is obtained until there is a consistent opinion among the majority. Sometimes, after the researcher obtains the input data for Step 1 using questionnaires, it is difficult to choose a consistent threshold value, especially if there are too many experts to aggregate at the same time. When the factors of the problem are many, the work involved in obtaining a consistent threshold value becomes more complex. In order to obtain a reasonable threshold value with respect to difficulty in the discussions with experts, the researcher may choose the value subjectively. The results of the threshold values may differ among different researchers.

In contrast to the traditional method, which confronts the loop from a “set a threshold value” to obtain “the needed impact-relations map”, as shown in Fig. 1, we propose the maximum mean de-entropy (MMDE) algorithm to obtain a threshold value for delineating the impact-relations map. This algorithm based on the entropy approach can be used to derive a set of *dispatch-nodes*, the factors which strongly dispatch influences to others, and a set of *receive-nodes*, which are easily influenced by another factor. According to these two sets, a unique threshold value can be obtained for the impact-relations map.

In the numerical example, a real case is used to discover and illustrate the key services needed to attract Semiconductor Intellectual Property Mall (SIP) users and SIP providers to an SIP Mall. Research in the current study enabled the derivation of the interrelated services and their structural interrelationships using the DEMATEL method, where the threshold value is selected through discussions with experts. By using the proposed MMDE algorithm to choose the threshold value, both impact-relations maps from the traditional method and the algorithm we propose are the same, although the procedures are different.

The rest of this paper is organized as follows: Section 2 briefly describes the DEMATEL method. The steps of the maximum mean de-entropy algorithm will be described, explained, and discussed in Section 3. In Section 4, a numerical example, a real case where the goal is to find out the interrelated services that should be provided by a semiconductor intellectual properties mall and the structural interrelationship between them, is shown in order to explain the proposed algorithm and discuss the results. Finally, in Section 5, we draw conclusions.

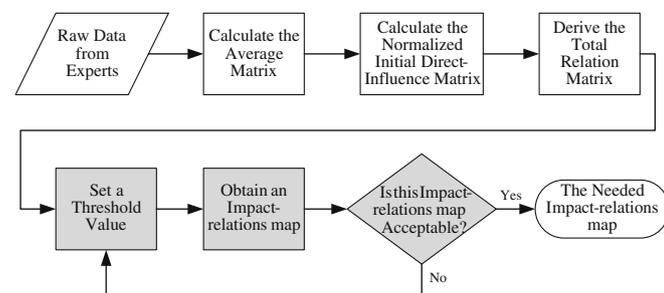


Fig. 1. The steps of the DEMATEL method.

2. DEMATEL method

The end product of the DEMATEL process—the impact-relations map—is a visual representation of the mind by which the respondent organizes his or her own action in the world. This organizational process must occur for the respondent to keep internally coherent and to reach his or her personal goals. The steps of the DEMATEL method (Tzeng et al., 2006) are described as follows:

Step 1: Find the average matrix. Suppose there are h experts available to solve a complex problem and there are n factors to be considered. The scores given by each expert give us a $n \times n$ non-negative answer matrix X^k , with $1 \leq k \leq h$. Thus X^1, X^2, \dots, X^h are the answer matrices for each of the h experts, and each element of X^k is an integer denoted by x_{ij}^k . The diagonal elements of each answer matrix X^k are all set to zero. We can then compute the $n \times n$ average matrix A by averaging the h experts' score matrices. The (i, j) element of matrix A is denoted by a_{ij} ,

$$a_{ij} = \frac{1}{h} \sum_{k=1}^h x_{ij}^k. \tag{1}$$

In application, respondents were asked to indicate the direct-influence that they believe each factor exerts on each of the others according to an integer scale ranging from 0 to 4. A high score from a respondent indicates a belief that greater improvement in i is required to improve j . From any group of direct matrices of respondents, it is possible to derive an average matrix A .

Step 2: Calculate the normalized initial direct-relation matrix. We then create a matrix D by using a simple matrix operation on A . Suppose we create matrix D and $D = s \cdot A$ where

$$s = \text{Min} \left[\frac{1}{\max_{1 \leq i \leq n} \sum_{j=1}^n |a_{ij}|}, \frac{1}{\max_{1 \leq j \leq n} \sum_{i=1}^n |a_{ij}|} \right]. \tag{2}$$

Matrix D is called the *normalized initial direct-relation matrix*. The (i, j) element d_{ij} denotes the direct-influence from factor x_i to factor x_j . Suppose d_i denotes the row sum of the i th row of matrix D .

$$d_{i\bullet} = \sum_{j=1}^n d_{ij}. \tag{3}$$

The d_i shows the sum of influence directly exerted from factor x_i to the other factors. Suppose d_j denotes the column sum of the j th column of matrix D .

$$d_{\bullet j} = \sum_{i=1}^n d_{ij}. \tag{4}$$

Then d_j shows the sum of influence that factor x_j received from the other factors. We can normalize d_i and d_j as

$$w_i(d) = \frac{d_{i\bullet}}{\sum_{i=1}^n d_{i\bullet}}, \tag{5}$$

$$v_j(d) = \frac{d_{\bullet j}}{\sum_{j=1}^n d_{\bullet j}}. \tag{6}$$

Matrix D shows the initial influence which a factor exerts and receives from another. Each element of matrix D portrays a contextual relationship among the elements of the system and can be converted into a visible structural model—an *impact-relations map*—of the system with respect to that relationship. For example, as shown in Fig. 2, the respondents are requested to indicate only direct links. In the directed graph represented in Fig. 2, factor i directly affects only factors j and k ; while indirectly, it also affects

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات