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A TECHNIQUE TO ADDRESS FOUR-LAYED DANP METHOD

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ABSTRACT

This study attempt to diagnose DANP (DEMATEL based ANP) method with their characteristics that applied on three layer Multi-criteria decision making, MCDM, (goal, dimension, criteria) still unable to utilized on fourth layer MCDM scenario (dimension, criteria, sub- criteria, or sub-sub criteria). From previous research studies on DANP (DEMATEL based ANP) where the normalized total influential matrix (U_D^{∞}) belongs to dimension use to multiple with un-weighted super matrix W_c that belong to criteria that obtained weighted supermatrix W the major limitation of such technique is the interdependency among dimensions and criteria restricted to three layered Multicriteria decision making. This study explores a novel technique to utilize DANP (DEMATEL based ANP) as applicable for four layers Multicriteria decision-making tool. The proposed technique addresses the potential inadequacy from prior studies and offers more agile approach that allows decision makers to respond according to complex situation.*

Key words: DEMATEL; ANP; DEMATEL based ANP; MCDM.

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1. INTRODUCTION

Over the period of past twenty years, several studies have been published on Multicriteria decision making (MCDM) investigating in several operational sectors. Generally, the Multicriteria decision-making issue spotted primarily on the distinctive valuation of criteria

on the decisive preference structure (i.e., weights). As a result of estimating and differentiating alternatives are depending upon policy-makers precedence. However, some scholars have identified that utilizing such traditional technique is not always suitable due to the interdependency and feedback in between criteria's somewhat diverse in the real circumstances [1,2]. Traditionally, when the significance-based technique is implied to represents the criterion weight, the way of multi-criteria decision analysis is often based on the approximation of interdependency known as DEMATEL (Decision-Making Trial and Evaluation Laboratory). But, researchers have identified that using such conventional technique (i.e., additive model) is not always incompatible due to relevant dependency and feedback in between criteria to the extent different degrees in a real scenario. To reduce the problem of interdependence and feedback in between criteria or sub-criteria' more relaxed approach preferred to resolve such issue, Analytical network process (ANP) was recommended by the number of research scholar [3-5]. The initially ANP algorithm used to address selection issues but over period of time it rectify more complicated problem of interdependency and feedback among criteria[6].

A hybrid model based on DEMATEL and ANP (DEMATEL based ANP) has extensively involved rectifying various applications in cracking several MCDM problems. Based on the Literature review, we find that research studies on DANP (DEMATEL based ANP) where normalized total influential matrix $\boldsymbol{U_D^{\propto}}$ belong to dimension use to multiple with un-weighted super matrix of criteria W_c that obtained weighted supermatrix W* the major limitation of such technique is the interdependency among dimensions and criteria's restricted to three layered multi-criteria decision-making scenario [7, 8]. However, limited number of studies highlights the four layed decision Multicriteria decision making problem which involve (Dimension, criteria, sub-criteria and sub sub-criteria) in most cases selection of sub-sub criteria involves, other methods were preferred such as Vikor or TOPSIS in order to identify the best alternative [9-13]. The scope of problem is further increased as small variation in entrance of data may cause to replace best alternative from the worst one when there is slight variation in weighting for the criteria has observed

In case of Four-layed MCDM scenario several research studies followed the traditional approach by applying another method such as VIKOR or TOPSIS to identified the sustainable alternative index in order to avoid such complexity, this research study proposed the Novel approach by calculating each criterion individually first by using DANP technique and then applying DEMATEL traditional method in order to avoid any complexity.

2. LITERATURE REVIEW

In case of resolving traditional four-layed MCDM problem, The DEMATEL approach is just not only applied to develop Impact Relation Map (IRM) with comprehensive interconnectivity in between criteria/ factors, but it also used to convert un-weighted super matrix to weighted supermatrix in case of addressing traditional four layed decisions making approach. The traditional way to control the normalization of weighted supermatrix in between dimension and criteria is by implementing ANP technique that overcomes interdependence and feedback problem by presuming uniform weights for each element in cluster. However, due to such assumption ignores the incompatible outcomes among clusters during the selection of sub-criteria [14]. In current practice to overcome such unaccommodating assumption of uniform weights most research applying novel approach by combining DEMATAL and ANP techniques in order to an observed different degree of influences among clusters. To resolve traditional four-layed MCDM scenarios shows in Figure.1 followed by DEMATEL based ANP (DANP) approach that includes 6steps. (1) Calculate the initial average matrix by scores [15]. (2) Estimate the initial influence matrix (3)

Estimate the full direct and indirect influence matrix [16, 17]. (4) Formulate the threshold value and develop the IRM [16]. (5) Determining threshold values α. (6) Mapping causal relation depends upon all the coordinates sets of (X_(i)+ Y_(i);X_(i)-Y_(i)) in order to visualize the complicated interdependencies and express the sequence to identify significant factor and how they weight to other components.

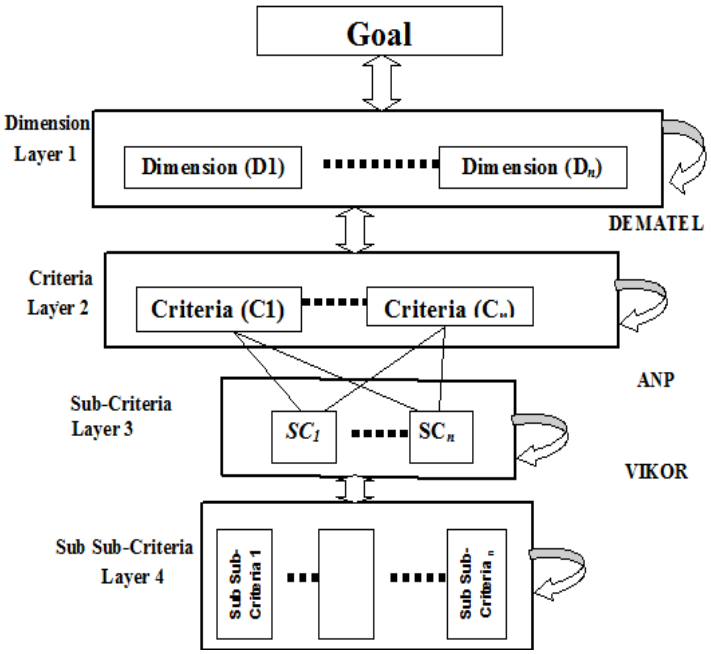

Figure 1. Traditional Four Layer MCDM Case

After constructing causal relationship Map to weighted coefficient of criteria simple ANP technique applied in Next stage. The traditional ANP method allow to compute weighted supermatrix by simply normalizing in which the individual column divided by relevant criteria's so that each column total sum equal to 1 which translates each decisive factor has a uniform value. Conversely, in hypothetical views, this considers as terrible appropriation, because the unify impact between two criteria may be unusual in nature while it seems to be uncomplicated to normalize by utilizing such technique. But that ignores the fact that different groups have a diverse level of impact. Therefore new way required to adjust standardizing the unweighted supermatrix that justifies that postulation of identical influence among criteria [11, 18]. To address above issue direct influence matrix allow calculating the weighted coefficient of criteria from DEMATEL technique [19]. Hence, the above complex issue can easily neutralize by integrating DEMATEL and ANP (DANP). In order to obtained the result that translates real circumstance. The hybrid model has address traditional four layed criterion scenarios that include following steps: (1) calculate the direct influence matrix. (2) Normalizes the total influence matrix $U_C^{\propto}$ (3) identifying the normalized matrix $U_D^{\propto}$ of dimensions (3) construct un-weighted super matrix of criteria W_c (4) the influential weights of DANP $W^*=U_D^{\propto} \times W_c$ (5). The weighted supermatrix is increased to the g^{th} power until the supermatrix become a reliable matrix in order to obtain the global priority-influential vectors $W^*= \lim_{g\to\infty} (\boldsymbol{W}_w)^g$ [11]. Now to identify the sustainable alternative index in order to avoid such complexity, most researchers preferred VIKOR [20]. VIKOR was recognized as an MCDM tool for rectifying decision problem that has incompatible criteria. In offering such integrated solution. VIKOR utilizes the basic theory of 'adequate advantage' to identifying the highest 'group consensus of the mainstream and the 'individual participant regret for the adversary. VIKOR algorithm depends on four steps (1) Develop an adequate level. (2)

Measure the mean of group effectiveness and maximal disagreement. (3) Measure the index value. (4) Rank the alternative on the base of compromised solution [21]**.**

3. PROPOSED TECHNIQUE

To avoid complexities of three different methods, a new approach has been proposed in this article. In the case of four layered MCDM approach, each dimension is measured separately by applying DANP (DEMATEL Based ANP) method to assess individual impact as shown in Fig. 2. Then, in the final round a traditional DEMATEL technique is used to visualize the complicated interdependencies The Fig. 2 is designed based on the Fig. 1. The separately developed mathematical equations in each criterion evaluation can be same way as the traditional DANP

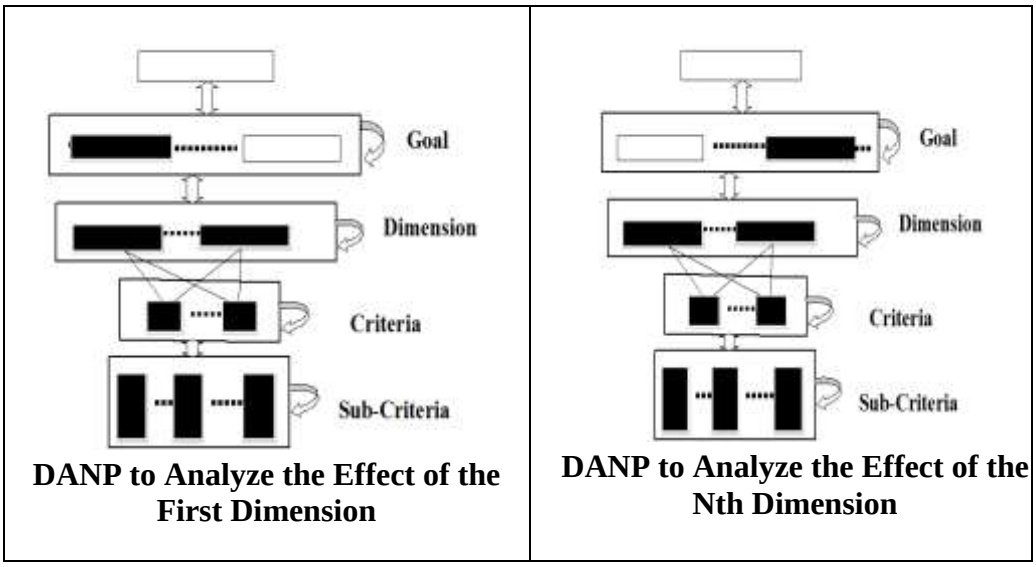

Figure 2. Proposed technique

The overall estimation of first stable super matrix in order to obtain the global priority-influential vectors proposed as equation 1. The overall estimation of second stable super matrix in order to obtain the global priority-influential vectors proposed as equation 2. The overall estimation of third stable super matrix in order to obtain the global priority-influential vectors proposed as equation 3.

$$W_{DANP_1}{}^{*} = \lim_{g\to\infty} (\boldsymbol{W}_w)^g \quad (1)$$

$$F_{DANP_2}{}^{*} = \lim_{g\to\infty} (\boldsymbol{F}_f)^g \quad (2)$$

$$J_{DANP_n}{}^{*} = \lim_{g\to\infty} (\boldsymbol{J}_n)^g \quad (3)$$

5. DISCUSSION

Applying traditional DEMATEL techniques in order to avoid multiple methods approach the traditional DEMATEL used to visualize the complicated interdependencies. In traditional DEMATEL, direct relation matrix R which is a drive from Table.1 through pair-wise comparison, where R is non-negative (m×m) matrix; where m represents the number of criteria drive from an extensive literature review.

Table 1 Direct relation matrix

Pair-wise (*i,j*)	W_{DANP_1}*	F_{DANP_2}*	J_{DANP_n}*
W_{DANP_1}*			
F_{DANP_2}*			
J_{DANP_n}*			

Pair-wise assessment in between (W_{DANP_1}*, F_{DANP_2}*, J_{DANP_n}*) correspond as criteria implies direct pair-wise relation which represent number of criteria involve in direct relation matrix that correspond to R_{ij} shows the level to which criteria *Ci* (row) influence C_j (column). In This technique, the relative influence among criteria is represented in terms of linguistic equation therefore aggregated? The number of "e" experts involves evaluating 'm' the number of criteria by calculating the degree of influence in between two criteria by simply applying pair-wise comparison that can be represented as R_{ij}. Therefore each participant an (m×m) positive matrix is developed where m corresponds to overall numbers of criteria [22]

$$R^e = \left[R_{ij}^e\right] \quad (4)$$

Stage1: In this step, the influence due to pair-wise comparison among criteria's are denoted in shape of linguistic equation as combination of participants with proficient Judgement represents as in last matrix

$$R^e = \left[r_{ij}\right]$$

$$r_{ij} = \sqrt[k]{\prod_{i=1}^{k} r_{ij}^e} \quad (5)$$

Where r_{ij}^e express the precedence from 'e' number of expert's consensus while k correspond to number of participants

Stage 2: The standardized direct-influence matrices can be express O= $\left[o_{ij}\right]$, where the value each component in matrix O is fluctuated in between [0, 1]

$$O = \begin{bmatrix} o_{11} & \cdots & o_{1n} \\ \vdots & \ddots & \vdots \\ o_{n1} & \cdots & o_{nn} \end{bmatrix} \quad (6)$$

While, the component of preliminary direct- influence matrix is considered as

$$o_{ij=\frac{r_{ij}}{R}} \quad (7)$$

$$E = \max\left(\sum_{ij}^{n} r_{ij}\right) \quad (8)$$

Stage 3: The total relation matrix B is achieved by enabling equation (5-7) in which I is represented as $(n \times n)$ positive diagonal matrix. All components of b_{ij} express the implicit influence that component *i* had on component *j* to avoid any complexity standardized direct-influence matrix can be correspond into separate secondary-matrix i.e.; (O_1, O_2, O_3, O_4 O_n)

$$\lim_{k\to\infty}(O_s)^w = 0 \quad (9)$$

$$\lim_{k\to\infty}(I + O_s + O_s^2 + O_s^3 + \cdots + O_s^k) = (I - O_s^2)^{-1} \quad (10)$$

While '0' corresponds to null- matrix

'I' corresponds to diagonal matrix

$$B = \lim_{w\to\infty}(I + O_s + O_s^2 + O_s^3 + \cdots + O^w) = O(I - O)^{-1} \quad (11)$$

The total relational matrix for the criteria (*B*) can be express as

$$B=\begin{bmatrix} b_{11} & \cdots & b_{1n} \\ \vdots & \ddots & \vdots \\ b_{n1} & \cdots & b_{nn} \end{bmatrix} \quad (12)$$

Where b_{ij}corresponds tooverall influence weighting of policy makers for every factor i adjacent to criteria j

Stage 4: Sum of columns and sum of rows of matrix B each sub-matrix (B_1, B_2, B_3) can be represented by $O_i$andE_i respectively can be express through equation (9) and (10)

$O_i = \sum_{i=1}^{n} b_{ij}$, i=1, 2, 3... .n (13)

$E_i = \sum_{i=1}^{m} b_{ij}$, i=1, 2, 3... .m (14)

'n' and 'm' corresponds to number of criteria

Stage 5: determining minimum values α. The basic theory behind threshold value of α is to develop causal map among the relationship between criteria's

Threshold value of α is express in shape of average of element (b_{ij}) from B matrix therefore

$$\propto = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}}{N} \quad (15)$$

'n' corresponds to overall numbers of component in Matrix B

IRM depends upon all the coordinates sets of ($\boldsymbol{O_i}$+ $\boldsymbol{E_i}$;$\boldsymbol{O_i}$-$\boldsymbol{E_i}$) in order to visualize the complicated interdependencies and express the sequence to identify significant factor and illustrates the procedure that they weight to other components [23]

5. CONCLUSIONS

To summarize a hybrid approach, Integrated DEMATEL and ANP technique has been extensively adapted and effectively employ in several fields. The DEMATEL approach is just not only applied to develop IRM with comprehensive interconnectivity in between criteria's, but it also used to convert an un-weighted super matrix to weighted supermatrix. In case of addressing four-layed MCDM scenarios the traditional way to estimate normalization of weighted supermatrix in between dimension and criteria. By implementing ANP technique that overcome interdependence and feedback problem by presuming uniform weights for each element in cluster. However, due to such assumption ignore the incompatible outcomes among clusters during the selection of sub-criteria. In current practice to overcome such unaccommodating assumption of uniform weights most research applying novel approach by combining DEMATAL and ANP techniques in order to observe a different degree of influences among clusters. In case of four-layed MCDM scenarios to select more stable sub-sub criteria, VIKOR methods also included in order to obtain sustainable ranking index. However, this multiple hybrids approaches always a matter of deep concern in case of precise outcome in order to address such problem This research study uses DANP with different approach by resolving each dimension individually by using DANP technique and then applying traditional DEMATEL pair wise approach to construct the IRM map for assess the influence of overall dimension. For future works, many past MCDM analysis (such as [24,25]) could be reconsidered with DANP for deeper multi sub-criteria breakdown.

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