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A Study on Youth Violence and Aggression using DEMATEL with FCM Methods

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Abstract - The DEMATEL method is then a good technique for making decisions. In this paper we analyzed the risk factors of youth violence and what makes them more aggressive. Since there are more risk factors of youth violence, to relate each other more complex to construct FCM and analyze them. Moreover the data is an unsupervised one obtained from survey as well as interviews. Hence fuzzy alone has the capacity to analyses these concepts.

I. INTRODUCTION

Cognitive map were initially introduced by Robert Axelrod [1] in 1976 and applied in political science. Bart Kosko [9] in 1986 enhances power of cognitive maps considering fuzzy values for the concepts of the cognitive map and fuzzy degrees of interrelationships between concepts. FCM can successfully represent the knowledge and human experience, introduced concepts to represent the essential elements and the cause and effect relationship among the concepts to the model the behavior of any system. It is very convenient and simple and powerful too, which was used in numerous fields such as analysis of electrical circuits, medicine, supervisory system, organization and strategy planning, economical etc. As the environment is getting more complicated, effective decision-making is more desired. Decision-makers are always obliged to assess a complex and confusing situation, identify the causal relationship of a problem, decide the appropriate solution, and ensure an effective action plan. Their effectiveness depends largely on the ability to think logically about the cause- effect relationship and make decisions according to this analysis. That is, to take meaningful decisions or actions in a problem with complex situation requires an essential understanding of the cause-effect relationship within the problem. The DEMATEL method is a potent system analysis tool, originated from the Geneva research center of battle memorial institute (Fontela &Gabus 1976, 1973) [5,6]. It is especially practical and useful for visualizing the structure of complicated causal relationship with matrices or digraphs. In recent years, DEMATEL method has been applied successfully in many fields to analyze correlation among factors and service or requirements in the background software system design (Hori and Schimizu 1999)[13] semiconductor – intellectual property (SIP), mall construction (Li and Tzeng 2009)[22]. On the other hand, The DEMATEL method has also been combined with analytic network process (ANP), goal programming and technique for order preference by similarity to an ideal solution (TOPSIS) to solve problems of core competency analysis (Shieh et.al 2010) [20]and preference evaluation (Chen et.al 2010; Hsu et.al 2010)[3,14]. The Decision-Making Trial and Evaluation Laboratory (DEMATEL) method, as a sort of structural modeling approach, can separate the involved criteria of a system into the cause group and effect group. The DEMATEL method is then a good technique for making decisions. In this paper we analyzed the risk factors of youth violence and what makes them more aggressive. Since there are more risk factors of youth violence, to relate each other more complex to construct FCM and analyze them. Moreover the data is an unsupervised one obtained from survey as well as interviews. Hence fuzzy alone has the capacity to analyses these concepts. The rest of this paper is organized as follows: In Section2, theoretical background of Fuzzy Cognitive maps (FCMs) and DEMATEL are reviewed. In Section 3Adaptation of the problem to the method. Finally, conclusions are presented.

II. THEORETICAL BACKGROUND

A. Fuzzy cognitive maps

A Fuzzy Cognitive map F is 4 tuple (N, W, C, f) [17] where

- $N = \{N_1, N_2, \ldots, N_n\}$ is the set of n concepts forming the nodes oaf a graph
- $W : (N_i, N_j) \rightarrow w_{ij}$ is a function of $N \times N$ to K associating w_{ij} to a pair of concepts (N_i, N_j), with w_{ij} denoting a weight of directed edge from N_i to N_j, if $i \neq j$ and w_{ij} equal to zero if $i = j$. Thus $W(N \times N) = w_{ij} \in K^{n \times n}$ is a connection matrix.

- $C : N_i \rightarrow C_i$ is a function that at each concept N_i associates the sequence of its activation degree such as for $t \in N$, $C_i(t) \in L$ given its activation degree at the moment t. $C(0) \in L^n$ indicates the initial vector and specifies initial values of all concepts node and $C(t) \in L^n$ is a state vector at certain iteration t. $f : R \rightarrow L$ is a transformation function, which includes recurring relationship on $t \geq 0$ between $C(t+1)$ and $C(t)$.
- The calculation rule that was initially introduced to calculate the value of each concept is based only on the influence of the interconnected concepts

$$C_j(t+1) = f\left(\sum_{\substack{i=1 \\ i \neq j}}^{n} C_i(t) w_{ij}\right)$$

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Where n is the number of concepts, $C_j(t+1)$ is the value of concept C_j at time step $t+1$, $C_i(t)$ is the value of concept C_i at time step t, and w_{ij} is the weight of the causal interconnection from concept i^{th} toward concept j^{th}.The transformation function is used to confine (clip) the weighted sum to a certain range, which is usually set to [0, 1]. The normalization hinders quantitative analysis, but allows for comparisons between nodes, which can be defined as active (value of 1), inactive (value of 0), or active to a certain degree (value between 0 and 1). Four most commonly used transformation functions are shown below:

1. Bivalent : $f(x) = \begin{cases} 0, & x \le 0 \\ 1, & x \ge 0 \end{cases}$
2. Trivalent : $f(x) = \begin{cases} -1, & x \le -0.5 \\ 0, & 0.5 < x < 0.5 \\ 1, & x \ge 0.5 \end{cases}$
3. Sigmoidal : $f(x) = \dfrac{1}{1+e^{-\lambda x}}$
4. Hyperbolic tangent: $f(x) = \tanh(\lambda x) = \dfrac{e^{\lambda x} - e^{-\lambda x}}{e^{\lambda x} + e^{-\lambda x}}$

Where λ is a parameter used to determine proper shape of the function.

B. Dematel Method

The Battelle Memorial Institute conducted the DEMATEL method project through its Geneva Research Centre (1973) [4, 5]. The original DEMATEL method was aimed at the fragmented and antagonistic phenomena of world societies and searched for integrated solutions. In recent years, the DEMATEL method has become very popular in Japan, because it is especially practical and useful for visualizing the structure of complicated causal relationships with matrices or digraphs. The matrices or digraph portrays 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. The DEMATEL method has been successfully applied in many fields. For examples, Tamura et al. [22] (2002) used the DEMATEL method to extract various uneasy factors in life, Yamazaki et al. (1997) [24] analysed the obstructive factors of welfare service with the DEMATEL method, Hori and Shimizu (1999) [14] employed the DEMATEL method to design and evaluate the software of displaying-screen structure in analysing a supervisory control system.The DEMATEL method assumes a system contains a set of components C={C_1, C_2…C_n}, with pairwise relations that can be evaluated. The methodology, according to the properties of objective affairs, can confirm the interdependence among the variables/attributes and restrict the relation that reflects the properties with an essential system and development trend. The end product of the DEMATEL process is a visual representation an individual map of the mind by which the respondent organizes his or her own action in the world.

The procedures of the DEMATEL method (Fontela & Gabus, 1973) [4] are discussed below

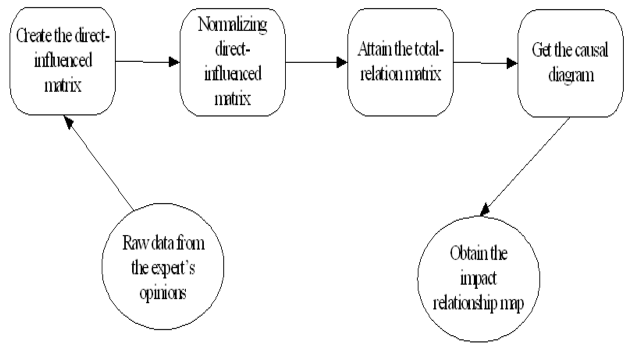

Fig 1 Illustrate steps of DEMATEL in diagram

Step1: set up the initial direct- relation matrix.
Let z_{ij} represent the judgment on the existence and intensity of the correlation between factors C_i and C_j. Particularly, there does not exist a correlation between C_i and itself. From this, the initial direct-relation matrix $Z=[z_{ij}]_{nxn}$ can be built up.

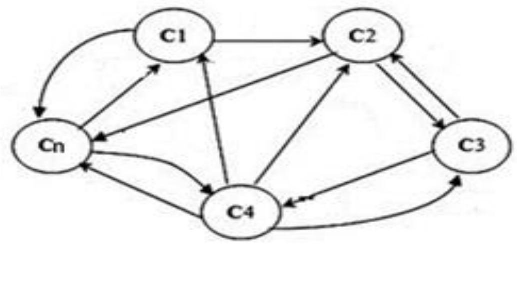

Fig. 2 Causal relationship

Step 2: Construct the normalized direct-relation matrix.
Let $X=[x_{ij}]_{nxn}$be the normalized direct relation matrix, and x_{ij} is calculate by

$$x_{ij} = z_{ij} \Big/ \max_{1\le i\le n} \left\{ \sum_{j=1}^{n} z_{ij} \right\}, \quad i, j = 1, 2, \ldots, n \tag{1}$$

Where $0 \le x_{ij} \le 1$, generally, the condition of in equation is satisfied in real world particularly, matrix X is characterized as a sub-stochastic matrix obtained from an absorbing Markov chain matrix by deleting all rows and columns associated with absorbing states.It satisfies the following properties:

1. $\lim_{n\to\infty} X^n = O$, Where O is the null matrix.
2. $\lim_{n\to\infty} (1 + X^1 + X^2 + \ldots + X^n) = (1-X)^{-1}$, Where I is the identity matrix.

Step 3: Construct the overall-relation matrix.
Let $T=[t_{ij}]_{nxn}$ be the overall-relation matrix, and it can be derived by

$$T = \lim_{n\to\infty} (1 + X^1 + X^2 + \ldots + X^n) = X(1-X)^{-1}, \tag{2}$$

Where t_{ij} denotes the overall intensity of correlation between factors C_i and C_j.Let c_i denote the overall intensity of correlation between C_i and C_j influences others and it can be calculated by

$$c_i = \sum_{j=1}^{n} t_{ij}, \quad i = 1, 2 \ldots n \tag{3}$$

Let h_i denote the overall intensity that factor C_i is influenced by others, and it can be derived by

$$h_i = \sum_{j=1}^{n} t_{ji}, \quad i = 1, 2 \ldots n \tag{4}$$

Step 4: Calculate the prominence and relation of each factor. Let p_i be the prominence of factor C_i, and it is calculated by

$$p_i = c_i + h_i, \; 1 = 1, 2, \ldots n \tag{5}$$

Based on prominence P_i, the importance of factor F_i is determined. Based on prominence P_i, the importance of factor C_i is determined. The large P_i, the more important factor C_i. If the importance of a factor is greater, then the decision maker should pay much attention to it.Let r_i be the relation of factor C_i and it can be obtained by

$$r_i = c_i - h_i, \; 1 = 1, 2, \ldots n \tag{6}$$

Relation r_i is an indicator that is used to judge role of factor F_i, if $r_i>0$, then C_i is a cause factor. If $r_i<0$, then C_i is an effect factor.Step 5: Construct the causal diagramBased on prominence p_i and relation r_i, a causal diagram can be plotted to visualize the importance and classification of all factor. In the causal diagram, horizontal axis P denote the importance of factors the importance of factors while vertical axis R denotes the sort of factors.

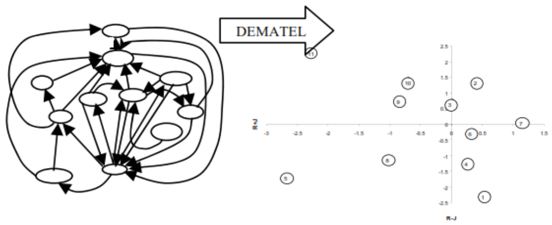

Fig 3

III. ADAPTATION OF THE PROBLEM TO THE MODEL

Violence is a problem which affects our day today life in a severe way. Even though human beings have been struggling to create civilized societies for many years, they have not able to get free from the influence of violence and aggression yet. Aggressiveness among youth is considered to be a global public health problem in many parts of the world. To analyse this problem the risk factors of youth violence that stimulate aggressive behavior in them are chosen based on youth perception. The following twelve attributes of risk factor for youth violence is chosen by interviewing the 100 youths in Chennai at the different ages. C_1 **-** Hyperactivity / C_2 **-** Poor monitoring and supervision of children by parents / Harsh, lax or inconsistent parental disciplinary practices. C_3 - Impulsiveness / poor behavioral control. / C_4- Seeking recognition. / C_5- Poverty and unemployment./ C_6- Delinquent peers / gang membership./ C_7- Academic failure and dropping out of school./ C_8- Concentration problem, restlessness and risk taking./ C_9- Parental criminality / Parental attitudes favorable to substance use and violence./ C_{10}-Anti social beliefs and attitudes./ C_{11}- Early involvement with alcohol drugs and tobacco./ C_{12}- Castisem / inequality.

Then, five expert's sociologist, psychologist and three victims of the youth different places are called to give their judgements on the existences and intensities of the correlation among the risk factors and the opinion provided by the experts are collected by the questionnaires.

For example, one of the experts revealed that when parents are failed to monitor and supervise of their children, children's will get the relationship with the bad gang membership so there is a relation. Nowadays, most of the youths are involving robbery, terrorism… etc., because of poverty and the job opportunities are denied with very high intensities.The following five steps were conducted.*Step1:* Once the relationships between each pair of criteria were measured, through the use of FCM scale, the data from each individual assessment may be obtained. We get the initial direction-relation matrix A. By calculating (Lin& Lin, 2008) for all the experts opinion by obtaining the mean of H scores as follows:

$$a_{ij} = \frac{1}{H}\sum_{k=1}^{H} x_{ij}^{k}$$

The graphical representation (the prominence-causal diagram) and di graphical relationships are now constructed. This step will allow a clearer visualization of the structure and relationships amongst the attributes of youth violence. The evaluation criteria were visually divided into the cause group, including C_2 **-** Poor monitoring and supervision of children by parents / Harsh, lax or inconsistent parental disciplinary practices. C_8- Concentration problem, restlessness and risk taking / C_9- Parental criminality / Parental attitudes favorable to substance use and violence / C_{11}-Early involvement with alcohol drugs and tobacco and the effect group, including C_1 **-** Hyperactivity /C_3 - Impulsiveness / poor behavioral control. / C_4- Seeking recognition. C_5- Poverty and unemployment / C_6- Delinquent peers / gang membership. / C_7- Academic failure and dropping out of school./ C_{10}-Anti social beliefs and attitudes./ C_{12}- Castisem / inequality /

Table 1: The initial direct –relation Average fuzzy matrix A

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}
C_1	0	0	1	0.6	0.6	0.6	0.2	0.6	0.6	0.8	1	0.8
C_2	0.8	0	0.8	0.6	1	1	1	0.2	0	0.6	0.8	0.6
C_3	1	0.2	0	0.8	0.6	1	0	0.4	0.2	0.4	0.8	0.8

C_4	0.4	0.4	1	0	0.4	0.8	0.4	0.6	0.6	0.8	1	0.8
C_5	0.8	0.8	0.4	0	0	1	1	0.6	0.8	0.6	1	0.8
C_6	0.8	0.6	0.8	0.8	1	0	0.4	0.6	0.4	1	1	1
C_7	0.6	0.6	0	0	1	0.8	0	1	0.8	0.8	0.2	0.4
C_8	0.6	0.2	0	1	0.6	0.8	1	0	0.2	0.4	0.2	0.6
C_9	1	0.4	0.6	0.8	1	1	1	0.2	0	0.8	1	0.4
C_{10}	0.6	0.2	0	0.8	0.6	0.8	1	0.6	0.2	0	0.2	0.8
C_{11}	0.8	0.6	1	1	1	1	1	0.4	0.2	0	0	1
C_{12}	1	0.6	1	1	1	1	1	0.2	0	0.6	0.6	0

Step 2: From the initial direct- relation fuzzy matrix A, the normalized direct-relation fuzzy matrix X obtained by formula (1).

Table 2: The normalized direct –relation fuzzy matrix X

	C_1	**C_2**	**C_3**	**C_4**	**C_5**	**C_6**	**C_7**	**C_8**	**C_9**	**C_{10}**	**C_{11}**	**C_{12}**
C_1	0.00	0.00	0.10	0.06	0.06	0.06	0.02	0.06	0.06	0.08	0.10	0.08
C_2	0.08	0.00	0.08	0.06	0.10	0.10	0.10	0.02	0.00	0.06	0.08	0.06
C_3	0.10	0.02	0.00	0.08	0.06	0.10	0.00	0.04	0.02	0.04	0.08	0.08
C_4	0.04	0.04	0.10	0.00	0.04	0.08	0.04	0.06	0.06	0.08	0.10	0.08
C_5	0.08	0.08	0.04	0.00	0.00	0.10	0.10	0.06	0.08	0.06	0.10	0.08
C_6	0.08	0.06	0.08	0.08	0.10	0.00	0.04	0.06	0.04	0.10	0.10	0.10
C_7	0.06	0.06	0.00	0.00	0.10	0.08	0.00	0.10	0.08	0.08	0.02	0.04
C_8	0.06	0.02	0.00	0.10	0.06	0.08	0.10	0.00	0.02	0.04	0.02	0.06
C_9	0.10	0.04	0.06	0.08	0.10	0.10	0.10	0.02	0.00	0.08	0.10	0.04
C_{10}	0.06	0.02	0.00	0.08	0.06	0.08	0.10	0.06	0.02	0.00	0.02	0.08
C_{11}	0.08	0.06	0.10	0.10	0.10	0.10	0.10	0.04	0.02	0.00	0.00	0.10
C_{12}	0.10	0.06	0.10	0.10	0.10	0.10	0.10	0.02	0.00	0.06	0.06	0.00

Step 3: The total-relation matrix *S* is acquired using equ (3) from the generalized direct-relation matrix. The total-relation matrix is shown below as table 3

Table 3: The total direct –relation fuzzy matrix S

	C_1	**C_2**	**C_3**	**C_4**	**C_5**	**C_6**	**C_7**	**C_8**	**C_9**	**C_{10}**	**C_{11}**	**C_{12}**
C_1	0.188	0.110	0.249	0.226	0.251	0.272	0.193	0.184	0.153	0.227	0.271	0.262
C_2	0.277	0.121	0.243	0.230	0.306	0.325	0.278	0.163	0.110	0.226	0.268	0.259
C_3	0.268	0.122	0.152	0.232	0.238	0.292	0.160	0.157	0.110	0.183	0.246	0.252
C_4	0.238	0.154	0.257	0.177	0.246	0.303	0.222	0.191	0.157	0.236	0.280	0.272
C_5	0.291	0.203	0.214	0.190	0.229	0.339	0.297	0.205	0.187	0.235	0.295	0.285
C_6	0.303	0.191	0.265	0.276	0.330	0.262	0.252	0.213	0.156	0.280	0.309	0.320
C_7	0.227	0.158	0.134	0.149	0.273	0.270	0.166	0.212	0.167	0.220	0.179	0.205
C_8	0.208	0.113	0.127	0.225	0.218	0.251	0.237	0.111	0.106	0.172	0.166	0.209
C_9	0.316	0.172	0.242	0.267	0.328	0.350	0.300	0.178	0.121	0.263	0.308	0.262
C_{10}	0.214	0.116	0.130	0.211	0.224	0.257	0.243	0.171	0.107	0.137	0.169	0.232
C_{11}	0.295	0.189	0.279	0.282	0.323	0.346	0.292	0.191	0.138	0.187	0.212	0.311
C_{12}	0.309	0.185	0.274	0.278	0.318	0.341	0.288	0.173	0.119	0.239	0.265	0.216

Step 4: The sum of rows and the sum of columns are separately denoted as c_i and h_i within the total relation matrix *S* and Using Equ (5 - 6), we obtain the degree of the influence of cause and effect group of youth violence.

Table 4 the values of c_i h_i p_i and r_i

c_i	h_i	p_i	r_i
2.5861	3.1340	5.7201	-0.5479
2.8054	1.8343	4.6396	0.9711
2.4135	2.5662	4.9797	-0.1528
2.7315	2.7431	5.4747	-0.0116
2.9707	3.2847	6.2555	-0.3140
3.1573	3.6075	6.7648	-0.4502

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2.3589	2.9280	5.2869	-0.5691
2.1437	2.1485	4.2922	-0.0048
3.1064	1.6307	4.7371	1.4757
2.2107	2.6060	4.8167	-0.3953
3.0448	2.9672	6.0120	0.0776
3.0055	3.0842	6.0897	-0.0787

Step 5: Causal diagram:

Using the value of p_i and r_i causal diagram is constructed.

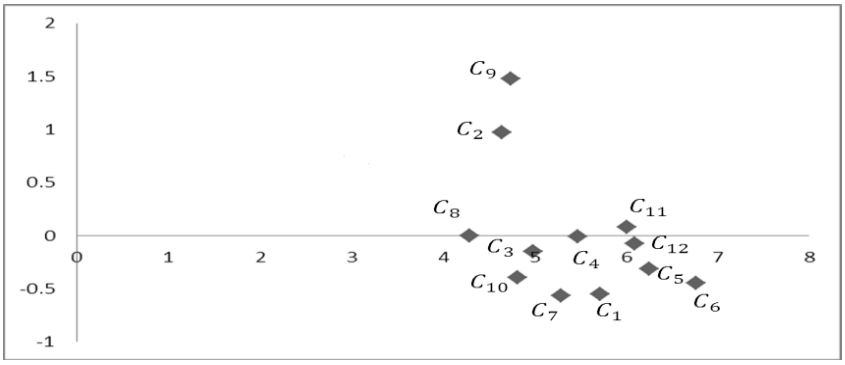

Fig 4 causal diagram

IV. CONCLUSION

The DEMATEL method is appropriate for solving a group decision-making problem in a fuzzy environment, with this method; the interactions between criteria can be transformed into a visible structural model, making it easier to capture the complexity of a problem, whereby excellent decisions can be made. Further research may represent linguistic variables by trapezoidal and octagonal fuzzy numbers of membership function and their type-2 membership function in DEMATEL.

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