Chapter V

CHAPTER V

APPLICATION OF NEUTROSOPHIC MATRICES AND NEUTROSOPHIC BIMATRICES TO NEUTROSOPHIC MODELS

As an application of neutrosophic matrices, the child labor problem prevalent in India is modeled and this model is demonstrated in this section.

Let us consider the child labor problem with the following conceptual nodes:

C_1 - Child Labor

C_2 - Political Leaders

C_3 - Good Teachers

C_4 - Poverty

C_5 - Industrialists

C_6 - Public practicing/encouraging Child Labor

C_7 - Good Non-Governmental Organizations (NGOs)

C_1 - Child labor, it includes all types of labor of children below 14 years which include domestic workers, rag pickers, working in restaurants / hotels, bars etc. (It can be part time or fulltime).

C_2 - We include political leaders with the following motivation: Children are not vote banks so political leaders are not directly concerned with child labor but they indirectly help in the flourishing of it as industrialists who utilize child laborers or cheap labor are the decision makers for the winning or losing of the political leaders. Also industrialists financially control political interests. So we are forced to include political leaders as a node in this problem.

C_3 - Teachers are taken as a node because mainly school dropouts or children who have never attended the school are child laborers. So if the motivation by the teacher is very good, there would be less school dropouts and therefore there would be a decrease in child laborers.

C_4 - Poverty which is the most responsible reason for child labor.

C_5 - Industrialists – when we say industrialists we include one and all starting from a match factory or beady factory, bars, hotels etc.

C_6 - Public who promote child labor as domestic servants, sweepers etc.

C_7 - We qualify the NGOs as good for some NGOs may not take up the issue fearing the rich and the powerful. Here "good NGOs" means NGOs who try to stop or prevent child labor.

The directed graph as well as the neutrosophic graph of two experts are given in the following Figures 1 and 2:

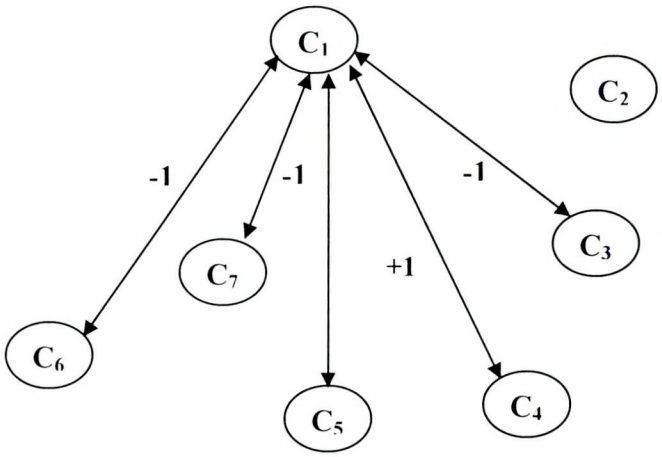


Figure 1

Figure 1 gives the directed graph with $C_1, C_2, \ldots, C_7$ as nodes and Figure 2 gives the neutrosophic directed graph with the same nodes.

The connection matrix E related to the graph in Figure 1 is given below:

$$E = \begin{bmatrix} 0 & 0 & 0 & 1 & 1 & 1 & -1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}.$$

According to this expert no connection however exists between political leaders and industrialists.

After reformulating a different format of the questionnaire where the expert is permitted to give answers like the relation between certain nodes is indeterminable or not known. Now based on the expert's opinion also about the notion of indeterminacy we obtain the following neutrosophic directed graph is obtained.

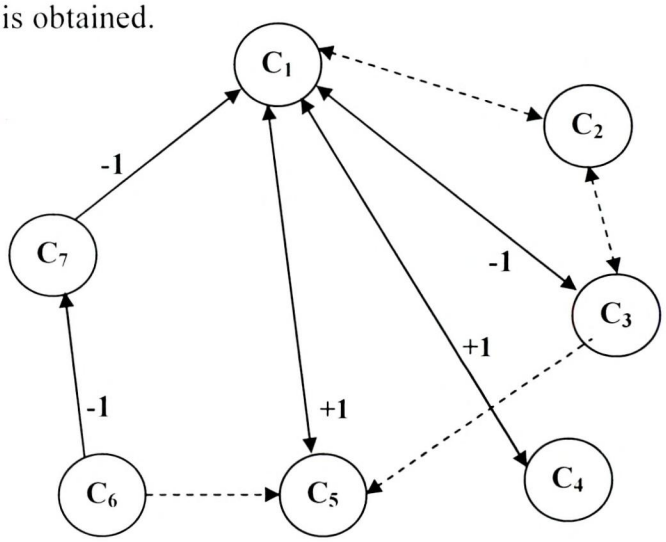


Figure 2

The corresponding neutrosophic adjacency matrix N(E) related to the neutrosophic directed graph (Figure 2) is given below:

$$N(E) = \begin{bmatrix} 0 & I & -I & 1 & 1 & 0 & 0 \\ I & 0 & I & 0 & 0 & 0 & 0 \\ -I & I & 0 & 0 & I & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & I & 0 & -I \\ -I & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Suppose we take the state vector $A_1 = (1\ 0\ 0\ 0\ 0\ 0\ 0)$. We will see the effect of A_1 on E .

$A_1E = (0\ 0\ 0\ 1\ 1\ 1\ -1) \rightarrow (1\ 0\ 0\ 1\ 1\ 1\ 0) = A_2$

$A_2E = (2\ 0\ 0\ 1\ 1\ 1\ 0) \rightarrow (1\ 0\ 0\ 1\ 1\ 1\ 0) = A_3 = A_2$.

Thus child labor flourishes with parents' poverty and industrialists' action. Public practicing child labor also flourish but good NGOs are absent in such a scenario. The state vector gives the fixed point.

Now we find the effect of $A_1 = (1\ 0\ 0\ 0\ 0\ 0\ 0)$ on N(E).

$A_1\ N(E) = (0\ I\ -1\ 1\ 1\ 0\ 0) \rightarrow (1\ I\ 0\ 1\ 1\ 0\ 0) = A_2$

$A_2\ N(E) = (I + 2, I, -1 + I, 1\ 1\ 0\ 0) \rightarrow (1\ I\ 0\ 1\ 1\ 0\ 0) = A_2$

Thus $A_2 = (1\ I\ 0\ 1\ 1\ 0\ 0)$, according to this expert the increase or the on state of child labor certainly increases with the poverty of parents and other factors are indeterminate to him. This mainly gives the indeterminates relating to political leaders and teachers in the neutrosophic cognitive model and the parents poverty and Industrialist become to on state.

However, the results by FCM give as if there is no effect by teachers and politicians for the increase in child labor. Actually the increase in school dropout increases the child labor hence certainly the role of teachers play a part. At least if it is termed as an indeterminate one would think or reflect about their (teachers) effect on child labor.

Also the role played by political leaders has a major part; for if the political leaders were stern about stopping the child labor, certainly it cannot flourish in the society. They are ignored for two reasons: First, if children were vote banks

certainly their position would be better. The second reason is, industrialists who practice child labor, are a main source of help to politicians, and their victory/defeat depends on their (financial) support so the causes for politicians ignoring child labor is two-fold.

The opinion of another expert who is first asked to give a FCM model and then a provocative questionnaire discussing about the indeterminacy of relation between nodes is suggested, the following neutrosophic graph is obtained.

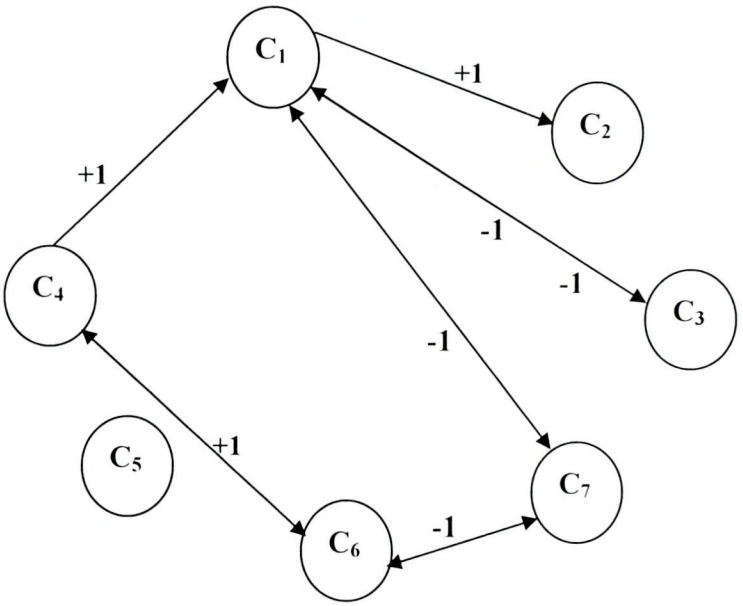


Figure 3

Figure 3 is the directed graph of the expert. The related connection matrix E_1 is as follows:

$$E_1 = \begin{bmatrix} 0 & 1 & -1 & 1 & 0 & 0 & -1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & -1 \\ -1 & 0 & 0 & 0 & 0 & -1 & 0 \end{bmatrix}$$

Take $A_1 = (1\ 0\ 0\ 0\ 0\ 0\ 0)$ the effect of A_1 on the system E_1 is

$A_1E_1 = (0\ 1\ -1\ 1\ 0\ 0\ -1) \rightarrow (1\ 1\ 0\ 1\ 0\ 0\ 0) = A_2$

$A_2E_2 = (1\ 1\ -1\ 1\ 0\ 1\ -1) \rightarrow (1\ 1\ 0\ 1\ 0\ 1\ 0) = A_3$

$A_3E_2 = (1\ 1\ -1\ 2\ 0\ 1\ -2) \rightarrow (1\ 1\ 0\ 1\ 0\ 1\ 0) = A_4 = A_3$.

Thus according to this expert child labor has direct effect on political leaders, no effect on good teachers, effect on poverty and industrialists and no-effect on the public who encourage child labor; and good NGOs.

The same person was now put with the neutrosophic questions i.e. terms like "can you find any relation between the nodes or are you not in apposition to decide any relation between two nodes and so on"; so that a idea of indeterminacy is introduced to them. Now the neutrosophic directed graph is drawn using this experts opinion given in Figure 4.

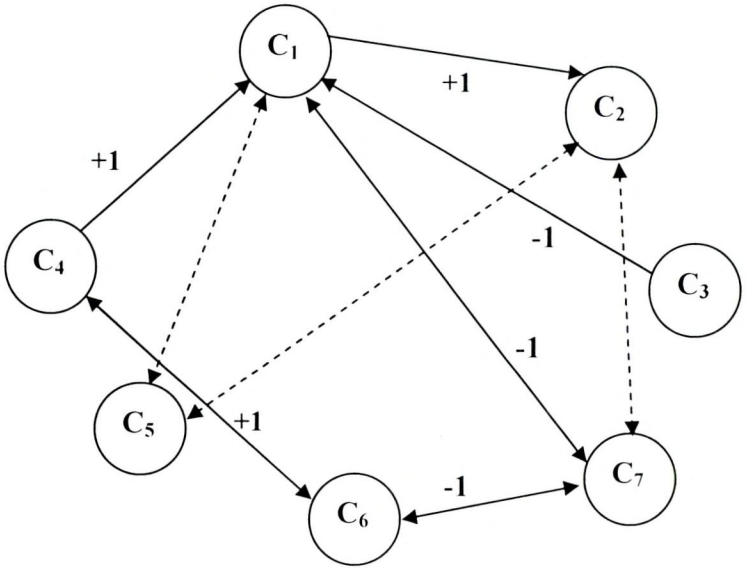


Figure 4

The corresponding neutrosophic connection matrix $N(E_1)$ is as follows:

$$N(E_1) = \begin{bmatrix} 0 & 1 & -1 & 1 & I & 0 & -1 \\ 0 & 0 & 0 & 0 & I & 0 & I \\ -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 & 0 \\ I & I & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & -1 \\ -1 & 0 & 0 & 0 & 0 & -1 & I \end{bmatrix}.$$

Suppose $A_1 = (1, 0, 0, 0, 0, 0, 0)$ is the state vector whose effect on the neutrosophic system $N(E_1)$ is to be considered.

$A_1N(E_1) = (0\ 1\ -1\ 1\ I\ 0\ -1) \rightarrow (1\ 1\ 0\ 1\ I\ 0\ 0) = A_2$

$A_2N(E_1) = (1+I, 1+I, -1, 1, 2I+1, 0\ -1+I)$

$\rightarrow (1\ 1\ 0\ 1\ 1\ 0\ 0) = A_3$

$A_3N(E_1) = (1+I, 1+I, -1, 2\ I+1\ 0\ -1 + I)$

$\rightarrow (1\ 1\ 0\ 1\ 1\ 0\ 0\ ) = A_4.$

We see $A_2 = A_3$.

But according to the NCM when the conceptual node child labor is on it implies that the cause of it is political leaders, poverty and industrialists participation by employing children as laborers.

As an application of neutrosophic bimatrices, a model which describes the important factors influencing good business is illustrated in this section.

Here two experts opinion whose choice of nodes / attributes are not identical.

The first expert feels the factors promoting business are

C_1 – Good business

C_2 – Good investment

C_3 – Customer satisfaction

C_4 – Establishment

C_5 – Marketing strategies

The second expert gives the following nodes.

D_1 – Good business

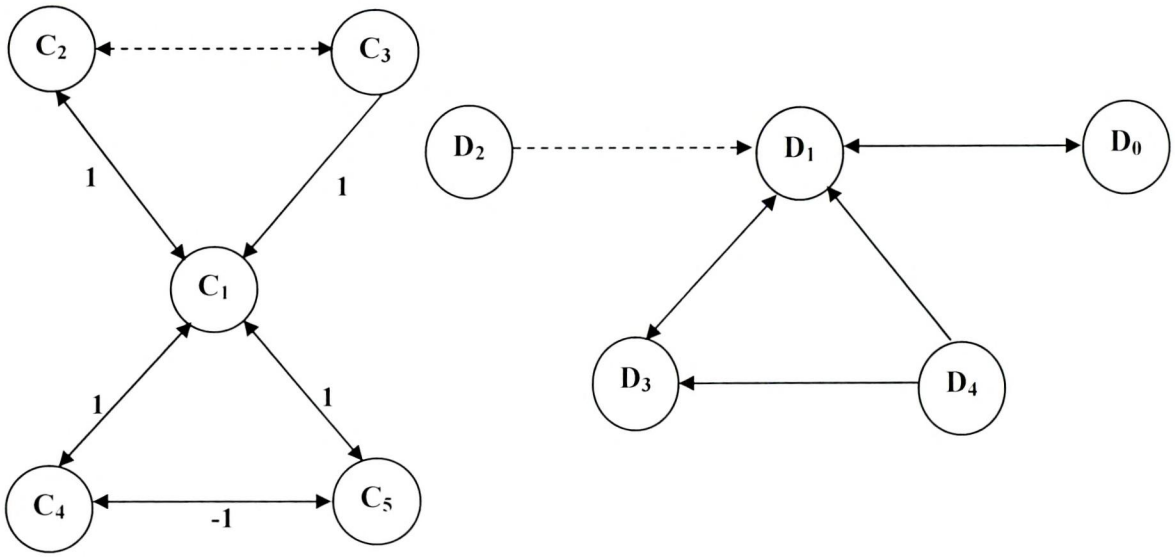
D_2 – Geographical situation

D_3 – Rendering good service

D_4 – Previous experience of the owner

D_5 – Demand and supply.

The neutrosophic bigraph related with the model is given in figure.



Now the related adjacency neutrosophic bimatrix N (E_B) is given as

$$\begin{bmatrix} 0 & 1 & 0 & 1 & 1 \\ 1 & 0 & I & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & -1 \\ 1 & 0 & 0 & -1 & 0 \end{bmatrix} \cup \begin{bmatrix} 0 & 0 & 1 & 0 & 1 \\ I & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \end{bmatrix}$$

i.e. $N(E_B) = N(E_1) \cup N(E_2)$

This is clearly a square 5×5 neutrosophic bimatrix.Suppose we wish to study the effect of the state bivector A, where

$$A = A_1 \cup A_2$$
$$= (1\ 0\ 0\ 0\ 0) \cup (1\ 0\ 0\ 0\ 0)$$
$$AN(E_B) = A_1N(E_1) \cup A_2N(E_2)$$
$$= (0\ 1\ 0\ 1\ 1) \cup (0\ 0\ 1\ 0\ 1).$$

After updating we get

$$B = (1\ 1\ 0\ 1\ 1) \cup (1\ 0\ 1\ 0\ 1)$$
$$BN(EB) = (3\ 1\ I\ 0\ 0) \cup (2\ 0\ 1\ 0\ 1)$$
$$C = (1\ 1\ I\ 0\ 0) \cup (1\ 0\ 1\ 0\ 1)$$

be the resultant vector after updating and thresholding

$$CN(EB) = (I + 1, 1, I\ 1\ 1) \cup (1\ 0\ 1\ 0\ 1).$$

Let D be the resultant vector after updating and thresholding the resultant is given by

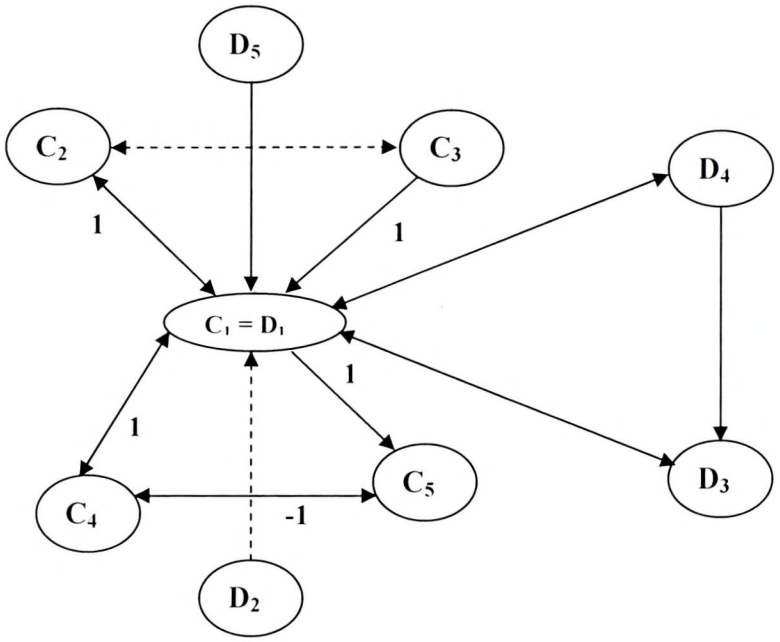
$$F = (1\ 1\ I\ 1\ 1) \cup (1\ 0\ 1\ 0\ 1).$$

Thus the bihidden pattern is a fixed bipoint given by the binary neutrosophic bivector.

$$F = (1\ 1\ I\ 0\ 1) \cup (1\ 0\ 1\ 0\ 1).$$

It is clearly seen that the opinions as well as the nodes are different. For the first expert feels Good business has a direct effect on Good investment and establishment, no effect on Marketing strategies while customer satisfaction is an indeterminate concept to it.

According to the second expert Good business has direct effect on Rendering good service while it has no effect on other factors. Thus we have seen an example of a NCBM which studies the opinion of experts on the same problem but with different nodes / attributes. Now the same neutrosophic bigraph can also be given as a connected neutrosophic bigraph we obtain the following figure.



This is the same bigraph but as "good business" i.e. $D = C_1$ we have drawn the neutrosophic bigraph with a vertex $C_1 = D_1$ which is common. This model can be represented as disconnected neutrosophic bigraph or as connected neutrosophic bigraph for the problem of drawing the neutrosophic graphs with given vertices and edges are only in the hands of the expert.