

## **Study of the Problems of Persons with Disability (PWD) Using FRMs**

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**Abstract:** In this paper we find the interrelations and the hidden pattern of the problems faced by the PWDs and their caretakers using Fuzzy Relational Maps (FRMs). Here we have taken the problems faced by the rural persons with disabilities in Melmalayanur and Kurinjipadi Blocks, Tamil Nadu, India. This paper is organized with the following four sections. Section one is introductory in nature giving the overall contents from the survey made about PWDs in the above said Blocks. Section two gives description of FRM models and the attributes taken for the study related with the PWDs and the caretakers, the FRM model formed using these attributes and their analysis. The third section gives the suggestions and conclusions derived from the survey as well as the FRM model.

**Key Words:** FRM model, fixed point, hidden pattern, relational matrix, limit cycle.

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### **§1. Introduction**

A study was conducted taking 93 village panchayats from the Kurinjipadi and Melmalayanur Blocks. The data reveals only 1.64 percent of the population are PWDs. The male population is comparatively higher. (60% males and 40% females). 51% are orthopedic followed by 16% with speech and hearing impaired. Also it is observed from the data that 60% are not married in the reproductive age group; however 73% are found married in the non reproductive age group. It is still unfortunate to see among the 3508 PWDs in the age group 4 yrs and above 59% of them have not even entered school. Further in the age group 4 to 14, 37% are yet to be enrolled in the school. Thus the education among the PWDs is questionably poor. Their living conditions are poor with no proper toilet facilities who are under nourished.

We use FRMs to study the problem taking the attributes of the domain space as the problems faced by the PWD and the range attributes are taken as the problems felt by the caretakers of the PWD. We just describe the FRM model and proceed on to justify why FRM model is used in this study.

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## §2. Description of FRM Model and its Application to the Problem

Fuzzy Relational Maps (FRMs) are constructed analogous to FCMs. FRMs are divided into two disjoint units. We denote by  $R$  the set of nodes  $R_1, \dots, R_m$  of the range space where  $R_j = \{(x_1, \dots, x_m) | x_j = 0 \text{ or } 1\}$  for  $j = 1, 2, \dots, m$ .  $D_1, \dots, D_n$  denote the nodes of the domain space where  $D_i = \{(y_1, \dots, y_n) | y_i = 0 \text{ or } 1\}$  for  $i = 1, 2, \dots, n$ . Here,  $y_i = 0$  denotes the *off state* and  $y_i = 1$  the *on state* of any state vector. Similarly  $x_i = 1$  denotes the *on state* and  $x_i = 0$  the *off state* of any state vector.

Thus a FRM is a directed graph or a map from  $D$  to  $R$  with concepts like policies or events etc as nodes and causalities as edges. It represents causal relations between the spaces  $D$  and  $R$ .

Let  $D_i$  and  $R_j$  denote the nodes of an FRM. The directed edge from  $D_i$  to  $R_j$  denotes the causality of  $D_i$  on  $R_j$  called relations. Every edge in the FRM is weighted with a number of the set  $\{0, +1\}$ . Let  $e_{ij}$  be the weight of the edge  $D_i R_j$ ;  $e_{ij} \in \{0, +1\}$ . The weight of the edge  $D_i R_j$  is positive if increase in  $D_i$  implies increase in  $R_j$  or decrease in  $D_i$  implies decrease in  $R_j$  i.e., causality of  $D_i$  on  $R_j$  is 1. If  $e_{ij} = 0$  then  $D_i$  does not have any effect on  $R_j$ . When increase in  $D_i$  implies decrease in  $R_j$  or decrease in  $D_i$  implies increase in  $R_j$  then the causality of  $D_i$  on  $R_j$  is  $-1$ .

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For the FRM with  $D_1, \dots, D_n$  as nodes of the domain space  $D$  and  $R_1, \dots, R_n$  as the nodes of the range space  $R$ ,  $E$  defined as  $E = (e_{ij})$ , where  $e_{ij}$  is the weight of the directed edge  $D_i R_j$  (or  $R_j D_i$ );  $E$  is called the relational matrix of the FRM.  $A = (a_1, \dots, a_n)$ ,  $a_i \in \{0, 1\}$ ;  $A$  is called the instantaneous state vector of the domain space and it denotes the on-off position of the nodes at any instant. Similarly for the range space  $a_i = 0$  if  $a_i$  is off and  $a_i = 1$  if  $a_i$  is on. Let the edges form a directed cycle. A FRM with directed cycle is said to be a FRM with feed back. A FRM with feed back is said to be the dynamical system and the equilibrium of the dynamical system is called the hidden pattern; it can be a fixed point or a limit cycle.

For example let us start the dynamical system by switching on  $R_1$  (or  $D_1$ ). Let us assume that the FRM settles down with  $R_1$  and  $R_m$  or ( $D_1$  and  $D_n$ ) on i.e., (10000...1) or (100...01). Then this state vector is a fixed point. If the FRM settles down with a state vector repeating in the form, i.e.,  $A_1 \rightarrow A_2 \rightarrow \dots \rightarrow A_i \rightarrow A_1$  or  $B_1 \rightarrow B_2 \rightarrow \dots \rightarrow B_i \rightarrow B_1$ , then this equilibrium is called a limit cycle.

Now we would be using FRM models to study the problem.

### 2.1 Justification for Using FRM

(1) We see the problems of Persons With Disability (PWD) is distinctly different from the problems of the caretakers of the PWD. Thus at the outset we are justified in using FRM i.e., a set of domain attributes and a set of range attributes.

(2) All the attributes under study cannot be quantified as numbers. So the data is one involving a large quantity of feelings. Hence fuzzy models is the best suited, as the data is an unsupervised one.

(3) Also this model alone can give the effect of problems faced by the caretakers on the PWDs and vice versa. So this model is best suited for our problem.

(4) Finally this model gives hidden pattern i.e., it gives a pair of resultant state vectors i.e., hidden pattern related with the PWDs as well as hidden pattern related with the caretakers. Thus we use this model to analyze the problem.

Now the attributes related with the PWDs are taken as the domain space of the FRM and the attributes related with the caretakers of the PWDs are taken as the range space of the FRM. We shall describe each of the attributes related with the PWDs and that of the caretakers in a line or two.

## 2.2 Attributes Related with the PWDs

The following attributes are given by an expert. The problems of PWDs are taken as the nodes of the domain space and the attributes associated with the close caretakers are taken as the nodes of the range space. The attributes associated with the PWDs are given below. They are in certain cases described in line or two.

$D_1$  – Depressed. From the survey majority of the PWDs looked and said they were depressed because of their disability and general treatment.

$D_2$  – Suffer from inferiority complex.

$D_3$  – Mental stress/agonny - They often were isolated and sometimes kept in a small hut outside the house which made them feel sad as well as gave time to think about their disability with no other work. So they were often under stress and mental tension.

$D_4$  – Self Image - Majority did not possess any self image. It was revealed from the discussions and survey.

$D_5$  – Happy and contented.

$D_6$  – Uninterested in life.

$D_7$  – Dependent on others for every thing.

$D_8$  – Lack of mobility.

$D_9$  – Illtreated by close relatives.

Now the attributes  $D_1, D_2, \dots, D_9$  are taken as the nodes of the domain space of the FRM. We give the attributes associated with the range space.

$R_1$  – Poor. So cannot find money to spend on basic requirements. The PWDs go to work for their livelihood.

$R_2$  – Ashamed - relatives were ashamed of the PWDs.

$R_3$  – Indifferent - They were treated indifferently by their caretakers.

$R_4$  – PWDs are a burden to them. So they neglected them totally.

$R_5$  – Fatalism - They said it was fate that they have a PWD as their child / relative.

$R_6$  – Sympathetic.

$R_7$  – Caring.

$R_8$  – Show hatred towards the PWDs.

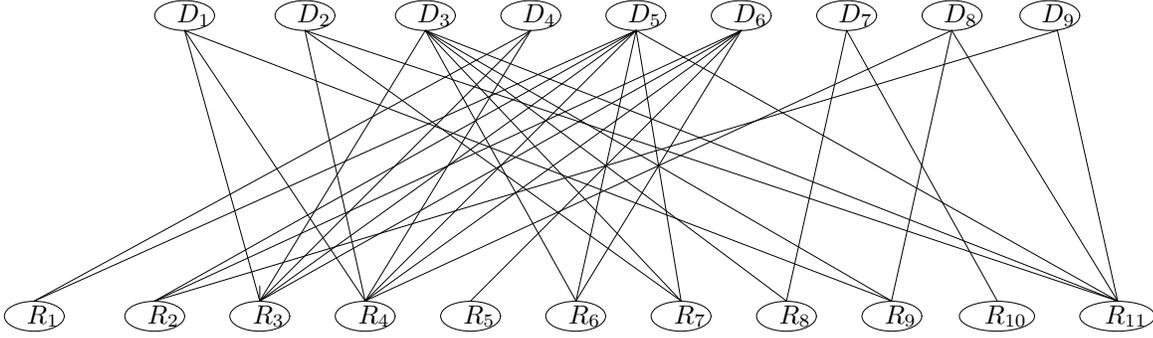
$R_9$  – The caretakers were not interested in marrying them off.

$R_{10}$  – The PWDs are an economic burden to them.

$R_{11}$  – They were isolated from others for reasons best known to the caretakers.

Thus  $R_1, R_2, \dots, R_{11}$  are taken as the nodes of the range space of the FRM.

The directed graph related with the FRM is shown in Fig.2.1, in which we have omitted the direction  $D_i \rightarrow R_j$  on each edge  $D_i R_j$  for simplicity.



**Fig.2.1**

Let the relation matrix associated with the directed graph be given by  $T$ , where  $T$  is a  $9 \times 11$  matrix with entries from the set  $\{0, -1, 1\}$  following.

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

Now we study the effect of the state vectors on the dynamical system  $T$ .

Suppose the expert wishes to study the *on state* of the node  $D_1$  and all other nodes are in the *off state*. Let the state vector be  $X = (100000000)$ . The effect of  $X$  on the dynamical system  $T$  is given by

$$XT = (00110000100) = Y(\text{say}),$$

$$YT^t = (312 \ -2 \ -2 \ 2020) \rightarrow (111001010) = X_1(\text{say}),$$

where  $\rightarrow$  denotes that the resultant state vector  $YT^t$  is updated and thresholded, i.e., all negative values and 0 are replaced by 0 and all positive values greater than or equal to one are

replaced by 1. By updating we mean the co ordinate which we started in the *on state* should remain in the *on state* till the end.

Now we find that

$$X_1T \rightarrow (01111001101) = Y_1(\text{say}),$$

$$Y_1T^t \rightarrow (111001111) = X_2(\text{say}),$$

$$X_2T \rightarrow (01111001111) = Y_2(\text{say}),$$

$$Y_2T^t \rightarrow (111001111) = X_3(\text{say}) = X_2.$$

Thus the hidden pattern gives a fixed pair given by  $\{(111001111), (01111001111)\}$ .

Thus when the node depressed alone in the domain space is in the *on state* we see this makes the nodes  $D_2, D_3, D_6, D_7, D_8, D_9$  to come to *on state* in the domain space and  $R_2, R_3, R_4, R_5, R_8, R_9, R_{10}$  and  $R_{11}$  in the *on state* in the range space.

Thus we see except the nodes the PWD has self image and she/he is happy and contented all other nodes come to *on state*. Thus this reveals if a PWD is depressed certainly he has no self image and he is not happy and contented. Further it also reveals from the state vector in the domain space poverty is not a cause of depression for  $R_1$  is in the *off state*. Also  $R_6$  and  $R_7$  alone do not come to *on state* which clearly shows that the caretakers are not sympathetic and caring which is one of the reasons for the PWDs to be depressed. Thus we see all negative attributes come to *on state* in both the spaces when the PWD is depressed.

Next the expert is interested in studying the effect of the *on state* of the node in the range space viz.  $R_6$  i.e., the caretakers are sympathetic towards the PWDs. Let  $Y = (00000100000)$  be the state vector of the range space. To study the effect of  $Y$  on the dynamical system  $T^t$ .

$$YT^t \rightarrow (000110000) = X_1(\text{say}),$$

$$X_1T \rightarrow (00000110000) = Y_1(\text{say}),$$

$$Y_1T^t \rightarrow (000110000) = X_2(\text{say}).$$

But  $X_2 = X_1$ . Thus we see the hidden pattern of the state vector is a fixed pair of points given by  $\{(00000110000), (000110000)\}$ . It is clear when the PWD is treated with sympathy it makes him feel their caretakers are caring. So  $R_1$  come to *on state*. On the other hand, we see she/he is happy and contented with a self image. Next the expert wishes to find the hidden pattern of the *on state* of the domain node  $D_4$  i.e., self image of the PWD alone is in the *on state*.

Let  $P = (000100000)$  be the given state vector. The effect of  $P$  on  $T$  is given by

$$PT \rightarrow (00000110000) = S_1(\text{say}),$$

$$S_1 T^t \rightarrow (000110000) = P_1(\text{say}),$$

$$P_1 T \rightarrow (00000110000) = S_2(\text{say}).$$

But  $S_2 = S_1$  resulting in a fixed pair. Thus the hidden pattern of  $P$  is a fixed pair. We see self image of the PWD makes him happy and contented. He/she also feel that the caretakers are caring and sympathetic towards them. Now the expert studies the effect of the state vector in the range space when the PWD is isolated from the other, i.e., when  $R_{11}$  is in the *on state*.

Let  $X = (00000000001)$  be the given state vector. Its effect on the dynamical system  $T$  is given by

$$X T^t \rightarrow (011000010) = Y(\text{say}),$$

$$Y T \rightarrow (00110001101) = X_1(\text{say}).$$

The effect of  $X_1$  on  $T$  is given by

$$X_1 T^t \rightarrow (111001111) = Y_1(\text{say}),$$

$$Y_1 T \rightarrow (01111001111) = X_2(\text{say}),$$

$$X_2 T^t \rightarrow (111001111) = Y_2(\text{say}).$$

We see  $Y_2 = Y_1$ . Thus the hidden pattern of the state vector is a fixed pair given by  $\{(01111001111), (111001111)\}$ . Thus when the PWD is isolated from others he/she suffers all negative attributes and it is not economic condition that matters. Isolation directly means they are taken care of and the caretakers are not sympathetic towards them. When they are isolated they are not happy and contented and they do not have self image. All this is evident from the hidden patterns in which  $R_1, R_6$  and  $R_7$  are 0 and  $D_4$  and  $D_5$  are 0, i.e., in the *off state*. We have worked with the several *on states* and the conclusions are based on that as well as from the survey we have taken. This is given in the following sections of this paper.

### §3. Suggestions and Conclusions

#### 3.1 Conclusions based on the model

1. From the hidden pattern given by the FRM model we see when the PWDs suffer from depression all negative attributes from both the range space and the domain space come to *on state* and their by showing its importance and its impact on the PWDs. It is clear that the nodes *self image* and *happy and contented* is in the *off states* where as all other nodes in the domain of attributes are in the *on state*. Further the nodes economic condition, caring and

sympathetic are in the *off state* in the range of attributes. Thus it is suggested the caretakers must be caring and sympathetic towards the PWDs to save them from depression.

**2.** When the node the caretakers are sympathetic towards the PWDs alone was in the *on state* the FRM model gave the hidden pattern which was a fixed pair in which only the nodes self image and happy and contented was alone in the *on state* from the domain vectors. In fact it was surprising to see all other negative nodes in the domain space was in the *off state*. Further in the range space of vectors we saw only the node caring came to *on state* and all other nodes were in the *off state*. Thus we see a small positive quality like sympathetic towards the PWDs can make a world of changes in their lives.

**3.** When the node PWDs are isolated from others was in the *on state* in the state vectors of the range space it is surprising to see that in the hidden pattern only the nodes happy and contented and self image are in the *off state* and all other nodes come to *on state* in the domain attributes and in the range attributes only the nodes poor cannot find time to spend with PWDs, caring and sympathetic remain in the *off state* and all other nodes in the range off attributes come to *on state*. Thus when the PWD is isolated from others he is depressed, not interested in life under goes mental stress, suffers from inferiority complex has no self image, is not happy or contented and is illtreated by the relatives. Also when the caretakers isolates a PWD it clearly implies they are not sympathetic or caring for the PWD and infact they are ashamed of the PWD and are indifferent to him/her. They also feel he/she is a burden and it is a fate that he/she is present in their house and show hatred towards him/her and are least bothered marrying off the PWD and infact feel the PWD is an economic burden on them.

**4.** It is verified the 'on state' of any one of the negative attributes gives the hidden pattern of the model in which all the negative attributes in both the domain and range space come to *on state* and the positive attributes remain in the *off state*.

**5.** Further the hidden pattern in almost all the cases resulted only in the fixed point which clearly proves that the changes in the behavioral pattern of the PWDs or the caretakers do not fluctuate infact remains the same.

### **3.2 Observations and suggestions based on the survey and the data**

**1.** The survey proved the family in which PWDs were present were looked down by others in the rural areas. Thus it was difficult to perform the marriages of PWDs as well as their close relatives. This is one of the reasons the PWDs are not given in marriage at the productive age however data proved they got married after the non productive age. This is clearly evident from the data that out of 1191 PWDs in the marriageable age group a majority of 715 PWDs are not married i.e., 60% of them are not married. Above the reproductive age we find out of 1589 PWDs the majority 1163 constituting 73 percent are found to be married. One has to make analysis in this direction alone.

**2.** From the data it is surprising to see that out of a total of 3316 PWDs 56% of them are not educated. Out of 580 children in the age group 7 – 18 years 105 children dropped out. Out of 483 children in the age group 4 to 14, 37% are yet to be enrolled in the school. Thus

we see from the data that they deny education to PWDs. The study of education and related problems faced by PWDs will have to be taken up separately.

**3.** 44% of caretakers have not planned about the future of the PWDs. This is also a sensitive issue for the PWDs may be feeling insecure about their future.

**4.** Providing money to these PWDs as stipend or to their caretakers will not solve the problems of PWDs. It is thus suggested these PWDs are taught some trade and paid for their work. When they are earning naturally the caretakers have to take proper care of the PWD for otherwise the PWD can opt to stay away from them. Also when they (PWD) earn their bread they will have self image also can be contended to some extent.

**5.** Further the survey showed the PWDs were happy and interactive in the group of PWDs so it would be nice if some opt to work for them so that the PWDs live in communities taken care of by some one. This will at large solve several of the problems addressed. Also this is possible if they earn on their own.

**6.** It is also suggested that a marriage bureau should operate solely for the PWDs so that their marriage is not unnecessarily delayed.

**7.** The caretakers must be given counseling to deal the PWDs with care and sympathy. We have considered PWD who are not employed in this study. We thank Lamp Net for giving information.

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