Neutrosophic Group Decision for Modeling of Post Earthquake Disaster Assessment

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Abstract - An earthquake is the perceptible shaking of the surface of the Earth occurs without prior warning to the society. The occurrence of an earthquake in a populated area may cause numerous casualties and injuries as well as extensive damage to property [4-5]. At present there is no tool available to an Engineer or Expert to assess the quantum of an earthquake disaster of an area with degree of certainty except the process of prediction on the available data or information from the extensive post earthquake survey of the affected area. The survey is done by obtaining views and opinions from local people in addition to the comments of earthquake experts because local communities have an active role to play before, during and after disaster [2]. The accuracy of predictions is dependent on a variety of factors such as lack of precise perceptions of the expert or non-availability of precise data. Thus uncertainty plays a vital role and an integral part of prediction for assessment of any data of post earthquake survey. This paper presents a methodology of neutrosophic logic [5-7] to minimize this uncertainty and model a tool to assess the quantum of post earthquake disaster of an area.

Keywords: FAS, SVNS, neutrosophic logic, score function, weighted average, etc.

I. INTRODUCTION

Any occurrence of major earthquake always makes a dance of deaths and destruction of major civil structures: buildings, bridges, pipelines, dams, power stations, railway & tunnels, etc [5-6]. Naturally to tackle the adverse impact of such damage on the existing environment, it is very essential to assess the quantum of severity of earthquake with degree of certainty. This type of job is a very complicated task and requires extensive post earthquake survey of the affected area. An earthquake expert or engineer can only gives his views on the scenario of damages from his expertise qualities. Major sources of required data and information are the local public, local panchayet, local administrators etc. who can enlighten so many unforeseen valuable resources about the earthquake. But all these data and information are not always crisp or precise numeric, rather linguistic and hedges like “good”, “bad”, “long period”, “little bit”, “not less than 30%”, “approximately 10-20 thousand”, “severe damage”, “large cracks”, “fast motion”, “long duration”, “high scarcity”, “huge debris”, etc. to list a few only out of infinity. Such types of imprecise data are fuzzy in nature [10]. Evaluation of such fuzzy data is not always possible with numerical valued description, because some part of the evaluation contribute to truthness, some part contribute to falseness and the rest part remain indeterministic. Every expert or decision-maker hesitates more or less, on every evaluation activity due to their certain limitation of knowledge or intellectual functionaries and thus outcome result of their perceptions becomes with full of uncertainty[2-3]. This study has solved this problem more precisely using ‘Neutrosophic’ logic of Prof. Florentin Smarandache [7-8]. Generally this type of real life problems were being tackled by the ‘Intuitionistic’ fuzzy logic of Prof. K.T.Atanassov [1] where the summation of membership value , non-membership value and hesitation always consider as one within sub set[0,1]. An intuitionistic fuzzy set is expressed as A = {(x : t_A (x), f_A(x)) | x ϵ E} where the functions , $t_A(x) : E \rightarrow [0,1]$ and $f_A(x) : E \rightarrow [0,1]$ define the degree of membership and the degree of non-membership of the element x ϵ E, respectively, and for every x ϵ E there is a condition that $0 \leq t_A(x) + f_A(x) \leq 1$. The main novelty of Atanassov's approach is that [t_A (x) + f_A (x) + i_A (x)] = 1 , where the value of hesitation or indeterministic part of an IFS can estimate by $i_A(x) = [1- t_A(x) - f_A(x)]$. But in the present case study we use the neutrosophic logic of Florentin Smarandache where we do not even assume that 'incompleteness' or 'indeterminacy degree' is always given by $[1- t_A(x) - f_A(x)]$. Instead of that it estimate the percentage of truth in a subset T where $t_A(x) : X \rightarrow [0,1]$, percentage of indeterminacy in a subset I, where $i_A(x) : X \rightarrow [0,1]$, percentage of falsity in a subset F, where $f_A(x) \rightarrow [0,1]$ individually and independently. In the neutrosophic logic the T, I, F are defined as standard or non-standard subsets of the non-standard interval $]^-0,1^+[$ instead of [0, 1]. Thus there is no restriction on the summation of $t_A(x)$, $i_A(x)$ and $f_A(x)$, a condition exist in such that $[0 \leq \sup t_A(x) \leq \sup i_A(x) \leq \sup f_A(x) \leq 3]$. Naturally 'Neutrosophic Logic' is presumed more powerful than any other higher order fuzzy logic at present day of research field. To validate the model we considered few existing post earth quake scenarios from reliable sources in this case study.

II. PRELIMINARIES

This section gives a brief knowledge on the core concepts of different logics that are independently directly related with the concept of neutrosophic logic.

A. Fuzzy Set (FS) [10]

Fuzzy set (FS) theory is first generalized by Prof. Latfi Zadeh in 1965 from normal crisp set theory. By crisp set, our fillings, opinions, decisions, assessment , results etc can express only by one way either yes or no, true or false, good or bad, white or black, day or night, accepted or not accepted, etc. It clearly indicate that a given statement should either be truth or false and can't never be in between the zone of this two phases. Accordingly the membership value of the statement should either be 0 or 1 and never in between of 0 and1. But in fuzzy set, there is no clear boundary in between the phases of truth and false, rather it is vague & doubt zone. Thus it is presumed that when a statement is completely true, the membership value, $t_A(x_n)$ is 1 and when a statement is completely false the membership value, $f_A(x_n)$ is 0 and when the statement is partly true or partly false then the membership value can claim any value in between 0 and 1. It is defined as the set of ordered pairs, $A = \{(x_1, t_A(x_1)), (x_2, t_A(x_2)),...,(x_n, t_A(x_n))\}$, where $t_A(x_i)$, is the degree of truthness of element x_i in set A with the condition that $t_A(x_n) + f_A(x_n) = 1$

B. Intuitionistic Fuzzy Set (IFS) [1]

This logic has been introduced by Prof. K.T Atanasov in 1986 and presumed as a higher order fuzzy logic as compared to Zadeh's fuzzy logic. He introduces how the indeterministic part, $\pi_B(x)$ of an evaluation can vary the actual assessment result of an attribute and give more precise result than result obtained from normal fuzzy logic of Prof. Zadeh. According to his statement, in an intuitionistic fuzzy set B, the degree of truthness $t_B(x)$ and degree of falseness $f_B(x)$ in a universe of discourse X is defined as : B = {(x, $t_B(x)$, $f_B(x)$) | x ϵ X }, where the functions , $t_B : X \rightarrow [0,1]$, and $f_B : X \rightarrow [0,1]$ are assess independently with the condition that $t_B(x_n) + f_B(x_n) + \pi_B(x) = 1$.

C. Neutrosophic Fuzzy Set (NFS) [7-8]

Neutrosophic Fuzzy Set (NFS) introduced by Prof. Florentin Smarandache in 1999 is a general framework for unification of many existing fuzzy logics. The main idea of NFS is to characterize each logical statement in a 3D neutrosophic space, where each dimension of the space represents respectively the truth membership function $T_C(x)$, an indeterminacy function $I_C(x)$ and a falsity membership function $F_C(x)$ within sub sets of $]^-0,1^+[$, where $1^+ = 1 + \varepsilon$ and $^-0 = 0-\varepsilon$. Here "1" and "0" are the standard part and "ε" its non-standard part. That is $T_C(x) : x \rightarrow]^-0, 1^+[$, $I_C(x) : x \rightarrow]^-0, 1^+[$ and $F_C(x) : x \rightarrow]^-0, 1^+[$. There is no restriction on the sum of $T_C(x)$, $I_C(x)$ and $F_C(x)$ so $^-0 \leq t_A(x) + i_{C(x)} + f_{C(x)} \leq 3^+$. In general refined neutrosophic logic, T can be split into subcomponents $T_1, T_2, T_3, \ldots ..Tp$ and I into $I_1, I_2, I_3, \ldots, Ir$ and F into $F_1, F_2, F_3, \ldots., Fs$ where $t_C(x) : X \rightarrow [0,1]$, $i_C(x) : X \rightarrow [0,1]$ and $f_C(x) : X \rightarrow [0,1]$ with $0 \leq t_C(x) + i_{C(x)} + f_{C(x)} \leq 3$ for all x ϵ X .

D. Single Valued Neutrosophic Sets (SVN Set) [9]

If A is the single valued neutrosophic set of the universe X and $t_A(x)$, $i_A(x)$ and $f_A(x)$ denote the truth-membership degree, the indeterminacy-membership degree and the falsity membership degree of x to the universal set X, then

$$A = \{(x : t_A(x) , i_A(x) , f_A(x))) \mid x \in E \}$$

where $t_A(x) : X \rightarrow [0,1]$, $i_A(x) : X \rightarrow [0,1]$ and $f_A(x) : X \rightarrow [0,1]$ with $0 \leq t_A(x) + i_{A(x)} + f_{A(x)} \leq 3$ for all x ϵ X

E. Score Function Fuzzy Sets [9]

If A = [$t_A(x)$, $i_A(x)$, $f_A(x)$] be a single valued neutrosophic set, then the membership function (S_F) of a score function fuzzy set $S_F(x)$ is defined by the crisp number as

$$S_F = \frac{[t_A(x) + i_A(x)/2] + [1 - \{f_A(x) + i_A(x)/2\}]}{2}$$

where, $S_F \rightarrow [-1, 1]$ and $t_A(x) + i_A(x) + f_A(x) \leq 3$ for all x ϵ X.

III. METHODOLOGY

To understand the functional approach of 'Neutrosophic Fuzzy Model', the below given definitions are very useful.

A. Fuzzy Alternatives Statement (FAS)

To assess the disaster scenarios of an earthquake, expert's perception and views are obtained on interviewing or questionnaires method and their results are always found in non-numerical & linguistic statements form like 'long period', 'little bit', 'not less than 30%', 'approximately 100-250', 'severe damage', 'large cracks', 'fast motion', 'long duration', 'high scarcity', 'huge debris', etc. All these data are obviously called fuzzy data but in the present model of NFS, these are called as fuzzy alternatives statements (FAS).

B. Universe of Fuzzy Alternatives Statement (UFAS)

Collection of all fuzzy alternatives statements is called the Universe of Fuzzy Alternatives Statement (UFAS).

C. Weighted Average of Neutrosophic Set

If the score function fuzzy sets are set-$S_A(x)$, set-$S_B(x)$, set-$S_C(x)$, set-$S_D(x)$….. and if for each element x ∈X, there is an associated weight $W_i \in R+$ (which could be prefixed by the common decision of all experts before commencement of case study), then the 'weighted average' of the NFS is the non-negative number a(x) given by

$$a(x) = \frac{\sum [\sum S_{Ai}.W_{Ai} + \sum S_{Bi}.W_{Bi} + \sum S_{Ci}.W_{Ci} + \sum S_{Di}.W_{Di} + ...]}{\sum [\sum W_{Ai} + \sum W_{Bi} + \sum W_{Ci} + \sum W_{Di} + \ldots]}$$

where i = 1, 2, 3…

D. Grading of Disaster Assessment Output [3]

In NFS modeling, evaluations of all FASs are done either based on their negative aspects (draw backs) or positive aspects. If negative aspects of all FASs are consider then grading of output results of NFS could be proposed as below:

Very severe Impact = grade A, if $0.8 < a(X) \leq 1$

Severe Impact = grade B, if $0.6 < a(X) \leq 0.8$

Moderate Impact = grade C, if $0.4 < a(X) \leq 0.6$

Mild Impact = grade D, if $0.2 < a(X) \leq 0.4$

Very Mild Impact = grade E, if $0 \leq a(X) \leq 0.2$

Obviously, the best grade is "**E**", and the worst grade is "**A**" here.

Similarly for positive aspects, grading of output result of NFS could be proposed as:

Very Mild Impact = grade A, if $0.8 < a(X) \leq 1$

Mild Impact = grade B, if $0.6 < a(X) \leq 0.8$

Moderate Impact = grade C, if $0.4 < a(X) \leq 0.6$

Severe Impact = grade D, if $0.2 < a(X) \leq 0.4$

Very severe Impact = grade E, if $0 \leq a(X) \leq 0.2$

Here obviously, the best grade is "**A**", and the worst grade is "**E**".

In the present case study we considered the negative aspects of all FASs to assess the degree of severity level according to grading as given above.

IV. CASE-STUDY

Consider a project *"Assessment the Severity of Post Earthquake Disaster"*. To assess the quantum of post earthquake disaster with more degree of certainty, we defined the whole algorithm into two phases:

Phase-1: Fuzzy assessment of *"Structural Damages"* like 'damage of buildings'; 'damage of bridges'; 'damage of dams'; etc. where expert can able to physically judged the structure by direct inspection and can share its severity of damage from his own perception.

Phase-2: Fuzzy assessment of *"Non-Structural Damages"* like 'lot of people died', 'weak transport facilities', 'large amount of debris accumulated', 'many landslides', 'crisis of refugee shelters', 'acute food scarcity', 'acute drinking water scarcity', 'many people injured', etc. which can't be judged without collecting data directly from the local sources. The truthness values of all these data are not same for the whole affected disaster area rather they may vary dramatically from location to location of the affected area.

Now the job is to assess the degree of severity level of phase-I first and then phase-II. Before commencement of both phases case studies, we selected thirty experts to collect the opinion infavour of truth-membership [t(x)] from ten experts, the opinion infavour of indeterminacy-membership [i(x)] from another ten experts, and the opinion infavour of falsity membership [f(x)] from rest ten experts of all SVN sets-A independently.

A. Fuzzy assessment of structural damages

To validate the phase-I case study of NFS model, we considered 10(ten) 'Structural Damages' of an existing earthquake phenomena (*Source: Google website*) which are represented by F_1, F_2, F_3, F_4, F_5, F_6, F_7, F_8, F_9 and F_{10}, Where

F_1 = Figure-1

F_2 = Figure-2

F_3 = Figure-3

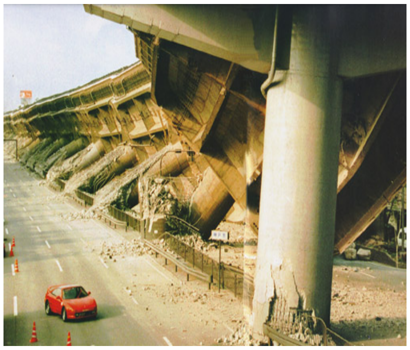
F_4 = Figure-4

F

-

5

F_6 = Figure-6



F_7= Figure-7

F_8= Figure-8

F_9= Figure-9

F_{10} = Figure-10

Now **'x = severe damage'** considered as FAS for evaluation of it's truth-membership degree [t(x)], indeterminacy-membership degree [i(x)] and falsity membership degree [f(x)] of SVN sets- A_i (i= 1,2,3…,10) individually from the views of thirty experts and is written as follows :-

Now *'x = severe damage'* considered as FAS for evaluation of it's truth-membership degree [t(x)], indeterminacy-membership degree [i(x)] and falsity membership degree [f(x)] of SVN sets- A_i (i= 1,2,3…,10) individually from the views of thirty experts and is written as follows :-

A_1 = (0.8,0.2,0.1), A_2 = (0.7,0.3,0.4),

A_3 = (0.6,0.3,0.2), A_4 = (0.7,0.2,0.3),

A_5 = (0.1,0.5,0.7), A_6 = (0.4,0.4,0.6),
A_7 = (0.6,0.2,0.7), A_8 = (0.4,0.3,0.8),

A_9 = (0.5,0.4,0.6), A_{10} = (0.8,0.2,0.3) .

Next the score function fuzzy set $S_F(A)$ of the above SVNS are calculated as :

$S_F(A)$ = (A_{F1},0.85), (A_{F2},0.65), (A_{F3},0.70), (A_{F4},0.70), (A_{F5},0.20), (A_{F6},0.40), (A_{F7},0.45), (A_{F8},0.30), (A_{F9},0.45), (A_{F10},0.75).

Considering the importance of each structure in the locality, the weight (W_i) of each structure has been prefixed by the thirty experts jointly and given as follows: for W_{F1} = 90, for W_{F2} = 60, for W_{F3} = 30, for W_{F4} = 50, for W_{F5} = 80, for W_{F6} = 20, for W_{F7} = 70, for W_{F8} = 60, for W_{F9} = 40, and for W_{F10} = 70 respectively.

Now the value of $\sum W_{Fi} = 570$ *and* $\sum A_{Fi.}W_{Fi} = 315.5$ is calculated which would be used for evaluation of weighted average a(x) after completion of phase-2 assessment. The individual weighted average of phase-I is found as, $a(x)_{phase\text{-}I}$ = 315.5/570 = 0.554 which may be awarded as 'Moderate Impact' of the post earth quake disaster.

B. Fuzzy assessment of Non-Structural damage

For fuzzy assessment of non-structural damages we considered 25 no. of FASs with no loss of generality. The affect of each FAS is not same in whole disaster area rather widely varies their impact from locality to locality. Thus to minimize the error of the assessment, we divided the whole affected area into ten locations and then evaluate the following FASs.

x_1 = lots of people died during shaking

x_2 = lots of animal died during shaking

x_3 = many trees uprooted during shaking

x_4 = many tree parts broken during shaking

x_5 = weak transportation facilities after earthquake

x_6 = large amount of debris accumulated after earthquake

x_7 = long time shaking during earthquake

x_8 = huge amount of domestic goods damaged

x_9 = badly collapsed local administration

x_{10} = many landslides occurred

x_{11} = lots of people injured during shaking

x_{12} = very less activity of rescue people during shaking

x_{13} = poor availability of refugee shelters

x_{14} = long period without electricity

x_{15} = poor sanitation management after earthquake

x_{16} = acute crisis of drinking water

x_{17} = acute crisis of foods

x_{18} = badly damaged semi permanent structures

x_{19} = acute crisis of medicines

x_{20} = acute crisis of fuel

x_{21} = severe degradation in economical conditions of people

x_{22} = severe outbreak of epidemics

x_{23} = huge damage of agricultural lands

x_{24} = many motor vehicles damaged

x_{25} = many roads closed due to debris & damages

The evaluations of all FASs are done by obtaining views from the three individual groups of experts independently that followed in phase-1 also. Suppose for the location-1, the SVN set-L_1 is assigned as below:-

L_1 = {(x_1,0.2,0.3,0.5), (x_2,0.5,0.3,0.2), (x_3,0.5,0.6,0.2), (x_4,0.8,0.1,0.2), (x_5,0.7,0.1,0.2), (x_6,0.6,0.2,0.4), (x_7,0.5,0.5,0.1), (x_8,0.6,0.4,0.2), (x_9,0.7,0.6,0.1), (x_{10},0.8,0.2,0.1), (x_{11},0.5,0.6,0.2), (x_{12},0.2,0.7,0.4),(x_{13},0.2,0.6,0.2), (x_{14},0.5,0.3,0.4), (x_{15},0.4,0.6,0.2),(x_{16},0.8,0.1,0.1), (x_{17},0.4,0.2,0.6), (x_{18},0.5,0.4,0.2),(x_{19},0.7,0.3,0.3),(x_{20},0.7,0.6,0.1), (x_{21},0.5,0.2,0.4),(x_{22},0.7,0.3,0.2),(x_{23},0.5,0.6,0.2), (x_{24},0.5,0.5,0.3), (x_{25},0.5,0.2,0.3)}.

The Score Function fuzzy set $S_{L1}(x)$ of the above SVNS is calculated as

$S_{L1}(x)$ = {(x_1,0.35), (x_2,0.65), (x_3,0.65), (x_4,0.80), (x_5,0.75), (x_6,0.60), (x_7,0.70), (x_8,0.70), (x_9,0.80), (x_{10},0.85),(x_{11},0.65),(x_{12},0.4),(x_{13},0.5),(x_{14},0.55), (x_{15},0.6), (x_{16},0.85), (x_{17},0.4), ($x_{18,}$.65), (x_{19},0.70), (x_{20},0.80),(x_{21},0.55),(x_{22},0.75,),(x_{23},0.65), (x_{24},0.60), (x_{25},0.60)}

Similarly for rest nine locations, the assigned Score Function fuzzy sets are suppose as follows:

$S_{L2}(x)$ = {(x_1,0.25), (x_2,0.35), (x_3,0.05), ($x_{4,0}$.70), (x_5,0.65), (x_6,0.40), (x_7,0.20), (x_8,0.30), (x_9,0.20), (x_{10},0.65),(x_{11},0.05),(x_{12},0.3),(x_{13},0.10),(x_{14},0.25), (x_{15},0.45),(x_{16},0.75),(x_{17},0.2),($x_{18,0}$.25), (x_{19},0.40), (x_{20},0.2),(x_{21},0.35),(x_{22},0.45),(x_{23},0.05), (x_{24},0.10), (x_{25},0.40)}

$S_{L3}(x)$ = {(x_1,0.35), (x_2,0.55), (x_3,0.50), ($x_{4,}$0.40), (x_5,0.25), (x_6,0.45), (x_7,0.60), (x_8,0.60), (x_9,0.30), (x_{10},0.25),(x_{11},0.25),(x_{12},0.10),(x_{13},0.5),(x_{14},0.55), (x_{15},40),(x_{16},0.55),(x_{17},0.50),($x_{18,}$0.20),(x_{19},0.20), (x_{20},0.25), (x_{21},0.65), (x_{22},0.25), (x_{23},0.35), (x_{24},0.15), (x_{25},0.45)}

$S_{L4}(x)$ = {(x_1,0.05), (x_2,0.45), (x_3,0.25), ($x_{4,}$0.30), (x_5,0.40), (x_6,0.20), (x_7,0.60), (x_8,0.30), (x_9,0.20), (x_{10},0.45),(x_{11},0.15),(x_{12},0.60),(x_{13},0.3),(x_{14},0.25), (x_{15},0.25),(x_{16},0.55),(x_{17},0.25),($x_{18,}$0.25),(x_{19},0.50) ,(x_{20},0.30), (x_{21},0.45), (x_{22},0.75), (x_{23},0.35), (x_{24},0.55), (x_{25},0.65)}

$S_{L5}(x)$ = {(x_1,0.75), (x_2,0.35), (x_3,0.25), ($x_{4,}$0.30), (x_5,0.25), (x_6,0.60), (x_7,0.20), (x_8,0.80), (x_9,0.10), (x_{10},0.65),(x_{11},0.75),(x_{12},0.3),(x_{13},0.10),(x_{14},0.25), (x_{15},0.6),(x_{16},0.75),(x_{17},0.2),($x_{18,}$0.35),(x_{19},0.20), (x_{20},0.20), (x_{21},0.15), (x_{22},0.55), (x_{23},0.45), (x_{24},0.05), (x_{25},0.20)}

$S_{L6}(x)$ = {(x_1,0.35), (x_2,0.15), (x_3,0.35), ($x_{4,}$0.50), (x_5,0.25), (x_6,0.40), (x_7,0.20), (x_8,0.30), (x_9,0.20), (x_{10},0.65),(x_{11},0.05),(x_{12},0.30),(x_{13},0.1),(x_{14},0.25), (x_{15},0.25), (x_{16},0.55), (x_{17},0.50), ($x_{18,}$0.55), (x_{19},0.4),(x_{20},0.10),(x_{21},0.45),(x_{22},0.25), (x_{23},0.65), (x_{24},0.40), (x_{25},0.20)}

$S_{L7}(x)$ = {(x_1,0.65), (x_2,0.65), (x_3,0.25), ($x_{4,}$0.50), (x_5,0.85), (x_6,0.90), (x_7,0.20), (x_8,0.10), (x_9,0.60), (x_{10},0.65),(x_{11},0.25),(x_{12},0.40),(x_{13},0.10),(x_{14},0.15) ,(x_{15},0.45),(x_{16},0.95), (x_{17},0.6),($x_{18,}$0.2), (x_{19},0.45), (x_{20}, 0.35),(x_{21},0.65), (x_{22},0.35), (x_{23},0.25), (x_{24},0.20), (x_{25},0.40)}

$S_{L8}(x)$ = {(x_1,0.85), (x_2,0.35), (x_3,0.65), ($x_{4,}$0.70), (x_5,0.55), (x_6,0.80), (x_7,0.40), (x_8,0.40), (x_9,0.20), (x_{10},0.25),(x_{11},0.15),(x_{12},0.10),(x_{13},0.4),(x_{14},0.25), (x_{15},0.4),(x_{16},0.7),(x_{17},0.50),($x_{18,}$0.20), (x_{19},0.70), (x_{20}, 0.20), (x_{21},0.65), (x_{22},0.45), (x_{23},0.05), (x_{24},0.45), (x_{25},0.20)}

$S_{L9}(x)$ = {(x_1,0.05), (x_2,0.35), (x_3,0.05), ($x_{4,}$0.70), (x_5,0.65), (x_6,0.4), (x_7,0.20), (x_8,0.30), (x_9,0.20), (x_{10},0.65),(x_{11},0.05),(x_{12},0.30),(x_{13},0.10),(x_{14},0.25) ,(x_{15},0.65),(x_{16},0.75),(x_{17},0.2),($x_{18,}$0.25),(x_{19},0.4), (x_{20},0.20), (x_{21},0.35), (x_{22},0.45,), (x_{23},0.05), (x_{24},0.10), (x_{25},0.40)].

$S_{L10}(x)$ = {(x_1,0.25), (x_2,0.35), (x_3,0.55), (x_4,0.65), (x_5,0.45), (x_6,0.80), (x_7,0.20), (x_8,0.20), (x_9,0.60), (x_{10},0.65),(x_{11},0.75),(x_{12},0.5),(x_{13},0.30),(x_{14},0.95), (x_{15},0.45),(x_{16},0.45),(x_{17},0.8),(x_{18},0.65), (x_{19},0.40), (x_{20}, 0.60),(x_{21},0.30), (x_{22},0.50,), (x_{23},0.65), (x_{24},0.70), (x_{25},0.85}

Now, mean of above ten score function fuzzy sets is also a new score function fuzzy set $S_L(X)$, where

$S_L(X)$ = {(x_1,0.39), (x_2,0.42), (x_3,0.355), (x_4,0.555), (x_5,0.505), (x_6,0.555), (x_7,0.35), (x_8,0.40), (x_9,0.34), (x_{10},0.57), (x_{11},0.31), (x_{12},0.33), (x_{13},0.25), (x_{14},0.37), (x_{15},0.45), (x_{16},0.685), (x_{17},0.415), (x_{18},0.355), (x_{19},0.435), (x_{20},0.32), (x_{21},0.455), (x_{22},0.475), (x_{23},0.35), (x_{24},0.33), (x_{25},0.435)}

Suppose the weight(W_{Xi}) of each FAS is prefixed by the thirty experts before commencement of the job which are as: for x_1 = 90, for x_2 = 60, for x_3 = 10, for x_4 = 20, for x_5 = 80, for x_6 = 35, for x_7 = 50, for x_8 = 90, for x_9 = 80, for x_{10} = 95, for x_{11} = 80, for x_{12} = 60, for x_{13} = 55, for x_{14} = 40, for x_{15} = 80, for x_{16} = 35, for x_{17} = 50, for x_{18} = 90, for x_{19} = 80, for x_{20} = 95, for x_{21} = 10, for x_{22} = 60, for x_{23} = 55, for x_{24} = 40, for x_{25} = 80 respectively.

Now from above new score function fuzzy set $S_L(X)$, the value of $\sum W_{Xi} = 3625$ *and* $\sum x_i.W_{Xi} = 621.95$ is calculated. Naturally the individual *weighted average of phase-II is found as,* $a(x)_{phase-II} = 621.95/3625 = 0.172$ which may be awarded as ‘Very Mild Impact’ of the post earth quake disaster.

Next we calculate the overall weighted average for the assessment

$$a(x) = \frac{\sum [\sum A_{Fi}.W_{Fi} + \sum x_i.W_{Xi}]}{\sum [\sum W_{Fi} + \sum W_{Xi}]}$$

$$= \frac{\mathbf{315.5 + 621.95}}{\mathbf{570 + 3625}}$$

$$= \mathbf{0.223}$$

CONCLUSION

The overall weighted average of the case study is **0.223** which is grade **‘D’**. Thus the overall assessment reveals that impact of post earthquake disaster in the affected area is in the scale of **‘Mild Impact’**. But the impact of earthquake disaster for the case of structural damage is more than the non-structural damage which are found ‘Moderate Impact’ and ‘Very Mild Impact’. Naturally Govt. needs to plan steps to decrease the consequences through suitable measures especially for structural damages. In the present paper, ‘Neutrosophic fuzzy model’ applied successfully to assess the impact of post earthquake disaster because the data and information so available in post disaster survey are fuzzy in nature. Thus expert’s perception will influence him in a specific track of knowledge and their resultant will give him capability to express the outcome result of that parameter which involved lots of uncertainties. This ‘Neutrosophic fuzzy model’ has the capability to minimize such type of uncertainty and can appeal to stand virtually aiming at rescue, safety and returned to normality.

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