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On Improper m- Polar Soft Fuzzy Graph and its Application for Medical Diagnosis in the Current COVID-19 Scenario

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Abstract

Objectives: To introduce the concepts of improper $m-$ polar soft fuzzy graphs and related terms. **Methods:** An algorithm has been established to apply $m-$ polar soft fuzzy graph to make a decision for medical diagnosis in the current COVID-19 scenario. It has been demonstrated with examples. **Findings:** The newly integrated ideas of the soft sets and $m-$ polar fuzzy sets will lead to numerous prospective applications in the $m-$ polar fuzzy set theoretical domain by adding extra fuzziness in analysing. $m-$ polar soft sets that are most useful in practical applications. The concepts such as improper $m-$ polar soft fuzzy graphs, totally improper $m-polar$ soft fuzzy graphs, neighbourly improper $m-$ polar soft fuzzy graphs, neighbourly totally improper $m-$ polar soft fuzzy graphs, highly improper $m-$ polar soft fuzzy graphs and highly totally improper $m-$ polar soft fuzzy graphs are defined. **Novelty:** The identical condition of neighbourly improper 3 - polar soft fuzzy graphs and highly improper 3-polar soft fuzzy graphs are discussed and validated. Various results related to these concepts have been established.

Keywords: Improper; Totally Improper; Neighbourly Improper; Neighbourly Totally Improper; Highly Improper m- Polar Soft Fuzzy Graphs

1 Introduction

Akram M, Shahzadi S developed novel intuitionistic fuzzy soft multiple- attribute using decision -making Methods[1]. The concept of m- Polar Interval-valued Fuzzy Graph and domination in m-polar interval-valued fuzzy graph was introduced by Bera. S, Pal. M[2,3]. In 2019 Khan. M J et.al., presented a method to deal with decision support systems on Generalized picture fuzzy soft sets[4]. Liu. P et.al., gave Multi attribute group decision making based on intuitionistic fuzzy partitioned Maclaurin symmetric mean operators[5]. Mondal. U, Mahapatra. T, and Xin. Q introduced isometric and antipodal concept in m-polar fuzzy graph using Solution of road network problem[6]. Meenakshi. A et.al., developed Mathematical Model of Analyzation of COVID-19 by using Graphical method[7]. Muhiuddin. G et.al., discussed Integrity on m-Polar Fuzzy Graphs and Its Application[8]. Mohanty R. K, and Tripathy B. K presented some application approach to group decision-making problem in intuitionistic fuzzy soft set[9]. Ramkumar. S and Sridevi. R introduced their perception on proper $m-$ polar soft fuzzy graphs and domination in $m-$ polar soft fuzzy graphs[10,11]. Sultana. F et.al., applied plithogenic graphs in finding application of coronavirus disease[12]. Saeed M et.al., introduced Theoretical framework for a decision support novel picture fuzzy soft hyper graph[13] . The current paper proposes the theory of improper $m-$ polar soft fuzzy graphs, totally improper $m-$ polar soft fuzzy graphs, neighbourly improper $m-$ polar soft fuzzy graphs, neighbourly totally $m-$ polar fuzzy graphs, highly improper $m-$ polar soft fuzzy graphs and highly totally improper $m-$ polar fuzzy graphs. Moreover, an investigation was carried out on certain results of neighbourly improper $m-$ polar soft fuzzy graphs. We have proved the result for $m=3$. In the entire paper, the set of values is represented by m that was taken by the vertex and edge membership functions.

2 Methodology

We have collected data's of the patient who were affected due to COVID-19. We Considered their health conditions and various other issues. We have formulated the problem using m-polar soft fuzzy concept and find a solution for the treatment of COVID-19

3 $m-$polar soft fuzzy graphs

Definition 3.1[10] An $m-$polar soft fuzzy graph $\widetilde{G}_{P,V} = (G^*, \widetilde{\rho}, \widetilde{\mu}, P)$ is a 4-tuple such that

(a) $G^* = (V,E)$ is a simple graph

(b) P is a nonempty set of parameters

(c) $\widetilde{\rho} : P \to F(V)$ (collection of all $m-$ polar fuzzy subset in V)

$e \mapsto \widetilde{\rho}(e) = \widetilde{\rho}_e$ (say) and $\widetilde{\rho}_e : V \to [0,1]^m$

$(x_1, x_2, \ldots, x_m) \mapsto \widetilde{\rho}_e(x_1, x_2, \ldots, x_m)$

$(\widetilde{\rho}, P)$ is an $m-$polar soft fuzzy set over V

(d) $\widetilde{\mu} : P \to F(V \times V)$ (collection of all $m-$ polar fuzzy subset in $V \times V$)

$e \mapsto \widetilde{\mu}(e) = \widetilde{\mu}_e$ (say) and $\widetilde{\mu}_e : V \times V \to [0,1]^m$

$$(x_1, x_2, \ldots, x_m) \mapsto \widetilde{\mu}_e(x_1, x_2, \ldots, x_m)$$

$(\widetilde{\mu}, P)$ is an m-polar soft fuzzy set over E

(c) $(\widetilde{\rho}_e, \widetilde{\mu}_e)$ is an $m-$polar fuzzy (sub) graph of G^* for all $e \in P$.

That is,

$$\tilde{\mu}_e x_1(uv) \leq (\tilde{\rho}_e x_1(u) \wedge \tilde{\rho}_e x_1(v))$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

$$\tilde{\mu}_e x_m(uv) \leq (\tilde{\rho}_e x_m(u) \wedge \tilde{\rho}_e x_m(v))$$

for all $e \in P$ and $u, v \in V$. The $m-$polar fuzzy graph $(\widetilde{\rho}_e, \widetilde{\mu}_e)$ is denoted by $\widetilde{H}_{P,V}(e)$ for convenience. In other words, an $m-$polar soft fuzzy graph is a parameterized family of $m-$polar fuzzy graphs.

Definition 3 .2 Let $G_{A,V} = ((\rho, A), (\mu, A))$ be a fuzzy soft graph. The degree of a vertex u is defined as $d_{G_{A,V}}(u) = \sum_{e_i \in A} (\sum_{u \neq v} \mu_{e_i}(u,v))$.

Definition 3.3 Let $G_{A,V} = ((\rho, A), (\mu, A))$ be a fuzzy soft graph. The total degree of a vertex **u** is defined as $td_{G_{A,V}}(u) = \sum_{e_i \in A} \left(\sum_{u \neq v} \mu_{e_i}(u,v) + \rho_{e_i}(u)\right)$ which is equivalent to $td_{G_{A,V}}(u) = d_{G_{A,V}}(u) + \sum_{e_i \in A} \rho_{e_i}(u)\Big)$

4 Improper, Neighbourly improper, Highly improper m- polar soft fuzzy Graphs

In this paper, m-psf graph denotes $m-$polar soft fuzzy graph.

Definition 4 .1 An $m-$polar soft fuzzy graph (m-psf graph) $\widetilde{G}_{P,V} = (G^*, \widetilde{\rho}, \widetilde{\mu}, P)$ is said to be an improper $m-$psf -graph if $\widetilde{H}_{P,V}(e)$ is an improper $m-$pf -graph for some $e \in P$, that is atleast two vertices in $\widetilde{H}_{P,V}(e)$ has different degree.

Example 4 .2 Consider 3-psf -graph $\widetilde{G}_{P,V} = ((\widetilde{\rho}, P), (\widetilde{\mu}, P))$ such that $G^* = (V, E)$ where $V = \{a_1, a_2, a_3\}$ and $P = \{e_1, e_2\}$ be a parameter $E = \{a_1a_2, a_2a_3, a_3a_1\}$.

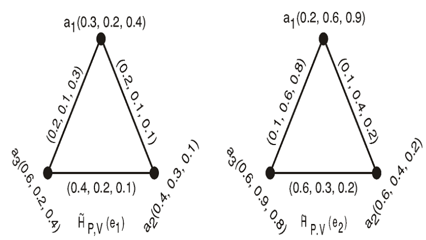

Fig 1. Improper 3-psf- graph

In Figure 1 By performing routine computations, we have $d_{\widetilde{H}_{P,V}}(e_1)(a_1)$ $(0.4, 0.2, 0.4)$, $d_{\widetilde{H}_{P,V}}(e_1)(a_2) = (0.6, 0.3, 0.2)$, $d_{\widetilde{H}_{P,V}}(e_1)(a_3) = (0.6, 0.3, 0.4)$ in 3-pf-graph $\widetilde{H}_{P,V}(e_1)$, so $\widetilde{H}_{P,V}(e_1)$ is an improper 3-pf-graph. $d_{\widetilde{H}_{P,V}}(e_2)(a_1) = (0.2, 1.0, 1.0)$,$d_{\widetilde{H}_{P,V}}(e_2)(a_2) = (0.7, 0.7, 0.4)$, $d_{\widetilde{H}_{P,V}}(e_2)(a_3) = (0.7, 0.9, 1.0)$ in 3-pf-graph $\widetilde{H}_{P,V}(e_2)$, so, $\widetilde{H}_{P,V}(e_2)$ is an improper 3-pf-graph. And also $d_{\widetilde{G}_{P,V}}(a_1) = (0.6, 1.2, 1.4)$, $d_{\widetilde{G}_{P,V}}(a_2) = (1.3, 1.0, 0.6)$, and$d_{\widetilde{G}_{P,V}}(a_3) = (1 \cdot 3, 1 \cdot 2, 1.4)$. Hence $\widetilde{G}_{P,V}$ is an improper 3-psf- graph.

Definition 4 .3 An $m-$psf graph $\widetilde{G}_{P,V} = (G^*, \widetilde{\rho}, \widetilde{\mu}, P)$ is said to be a totally improper $m-$psf -graph if $\widetilde{H}_{P,V}(e)$ is a totally improper $m-$pf -graph for some $e \in P$, that is at least two vertices in $\widetilde{H}_{P,V}(e)$ has different total degree.

Consider the above example 4.2. By performing routine computations, we have $td_{\widetilde{H}_{P,V}}(e_1)(a_1) = (0.7, 0.4, 0.8)$, $\text{td}_{\widetilde{H}_{P,V}}(e_1)(a_2) = (1.0, 0.6, 0.3)$, *and* $td_{\widetilde{H}_{P,V}}(e_1)(a_3) = (1.2, 0.5, 0.8)$ in 3-pf-graph $\widetilde{H}_{P,V}(e_1)$, so $\widetilde{H}_{P,V}(e_1)$ is a totally improper 3-pf-graph. $td_{\widetilde{H}_{P,V}}(e_2)(a_1) = (0.4, 1.6, 1.9)$, $td_{\widetilde{H}_{P,V}}(e_2)(a_2) = (1.3, 1.1, 0.6)$, and $td_{\widetilde{H}_{P,V}}(e_2)(a_3) = (1.3, 1.8, 1.8)$ in 3-pf graph $\widetilde{H}_{P,V}(e_2)$, so, $\widetilde{H}_{P,V}(e_2)$ is a totally improper 3-pf-graph. And also $td_{\widetilde{G}_{P,V}}(a_1) = (1.1, 2.0, 2.7)$, $td_{\widetilde{G}_{P,V}}(a_2) = (2.3, 1.7, 0.9)$, and $td_{\widetilde{G}_{P,V}}(a_3) = (2.5, 2.3, 2.6)$. Hence $\widetilde{G}_{P,V}$ is a totally improper 3-psf-graph.

Definition 4 .4 An $m-$psf-graph $\widetilde{G}_{P,V} = (G^*, \widetilde{\rho}, \widetilde{\mu}, P)$ is said to be a neighbourly improper $m-$psf-graph if $\widetilde{H}_{P,V}(e)$ is a neighbourly improper $m-$pf-graph for some $e \in P$, that is every two adjacent vertices of $\widetilde{H}_{P,V}(e)$ have different degree.

Example 4 .5 Consider 3-polar soft fuzzy (3-psf graph) graph $\widetilde{G}_{P,V} = ((\widetilde{\rho}, P), (\widetilde{\mu}, P))$ such that $G^* = (V, E)$ where $V = \{a_1, a_2, a_3, a_4, a_5, a_6, a_7\}$ and $P = \{e_1, e_2\}$ be a parameter $E = \{a_1a_3, a_5a_3, a_5a_2, a_2a_4, a_1a_4, a_3a_7, a_6a_7, a_6a_3\}$.

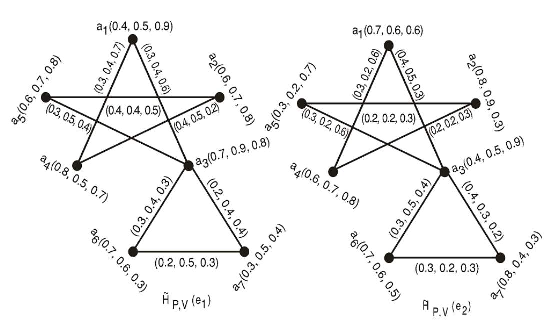

Fig 2. Neighbourly improper 3-psf-graph

Here in both $\widetilde{H}_{P,V}(e_1)$, *and* $\widetilde{H}_{P,V}(e_2)$ no two adjacent vertices have same degree and hence it is an example of neighbourly improper 3-psf-graph.

Definition 4 .6 An $m-$psf-graph $\widetilde{G}_{P,V} = (G^*, \widetilde{\rho}, \widetilde{\mu}, P)$ is said to be a neighbourly totally improper $m-$psf-graph if $\widetilde{H}_{P,V}(e)$ is a neighbourly totally improper $m-$pf-graph for some $e \in P$, that is every two adjacent vertices of $\widetilde{H}_{P,V}(e)$ have different total degree.

Consider the above example 4.5. Here no two adjacent vertices have same total degree and hence it is an example of neighbourly totally improper $m-$pf-graph.

Definition 4 .7 An $m-$psf graph $\widetilde{G}_{P,V} = (G^*, \widetilde{\rho}, \widetilde{\mu}, P)$ is said to be a highly improper $m-$psf -graph if $\widetilde{H}_{P,V}(e)$ is a highly improper $m-$pf-graph for some $e \in P$, that is every vertex of $\widetilde{H}_{P,V}(e)$ is adjacent to vertices with different degrees.

Example 4 .8 Consider 3-polar soft fuzzy (3-psf graph) graph $\widetilde{G}_{P,V} = ((\widetilde{\rho}, P), (\widetilde{\mu}, P))$ such that $G^* = (V, E)$ where $V = \{a_1, a_2, a_3, a_4\}$ and $P = \{e_1, e_2, e_3\}$ be a parameter set and $E = \{a_1a_2, a_2a_4, a_3a_4, a_3a_1\}$.

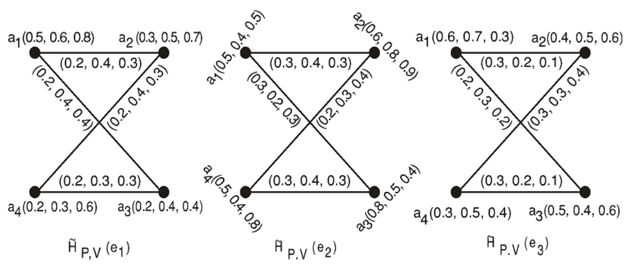

Fig 3. Highly improper 3$-$psf graph

Here every vertex in $\widetilde{H}_{P,V}(e_i)$ for all $i = 1, 2, 3$. is adjacent only to vertices with different degrees. Hence $\widetilde{G}_{P,V}$ is highly improper 3-psf-graph.

Definition 4 .9 An $m-$psf-graph $\widetilde{G}_{P,V} = (G^*, \widetilde{\rho}, \widetilde{\mu}, P)$ is said to be a highly totally improper $m-$psf-graph if $\widetilde{H}_{P,V}(e)$ is a highly totally improper $m-$pf-graph for some $e \in P$, that is every vertex of $\widetilde{H}_{P,V}(e)$ is adjacent to vertices with different total degrees.

Consider the above example 4.8. Here every vertex in $\widetilde{H}_{P,V}(e_i)$ for all $i = 1, 2, 3$. is adjacent only to vertices with different total degrees. Hence, it is highly totally improper $m-$psf-graph.

5 Some Properties of Improper 3-Polar Soft Fuzzy Graph

Proposition 5.1. A highly improper 3-psf-graph redundant to be a neighbourly improper 3 -psf -graph.

Example 5.2. Consider 3-polar soft fuzzy (3-psf graph) graph $\widetilde{G}_{P,V} = ((\widetilde{\rho}, P), (\widetilde{\mu}, P))$ such that $G^* = (V, E)$ where $V = \{a_1, a_2, a_3, a_4\}$ and $P = \{e_1, e_2\}$ be a parameter set and $E = \{a_1a_2, a_2a_3, a_3a_4, a_3a_1\}$.

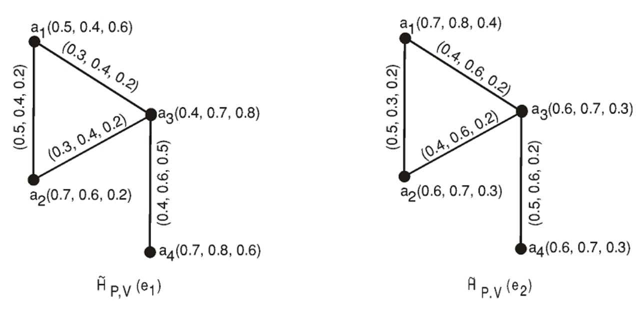

Fig 4. Highly improper 3$-$psf graph

Here in every $\widetilde{H}_{P,V}(e)$, every vertex is adjacent to the vertices having different degrees and hence, it is highly improper 3-pf-graph. Hence $\widetilde{G}_{P,V} = \left\{ \widetilde{H}_{P,V}(e_1), \widetilde{H}_{P,V}(e_2), \right\}$ is a highly improper 3-psf-graph. But the adjacent vertices a_1 and a_2 have same degree in $\widetilde{H}_{P,V}(e_1)$ and $\widetilde{H}_{P,V}(e_2)$ and hence, it is not neighbourly improper 3-pf-graph. Hence $\widetilde{G}_{P,V} = \left\{\widetilde{H}_{P,V}(e_1), \widetilde{H}_{P,V}(e_2), \right\}$ is not neighbourly improper 3- psf-graph.

Proposition 5.3 . A neighbourly improper 3-psf-graph redundant to be highly improper 3 -psf graph.

Example 5.4. Consider 3-polar soft fuzzy (3-psf-graph) graph $\widetilde{G}_{P,V} = ((\widetilde{\rho}, P), (\widetilde{\mu}, P))$ such that $G^* = (V, E)$ where $V = \{a_1, a_2, a_3, a_4, a_5, a_6\}$ and $P = \{e_1, e_2\}$ be a parameter set and $E = \{a_1a_2, a_2a_3, a_6a_1, a_3a_4, a_4a_5, a_5a_6\}$.

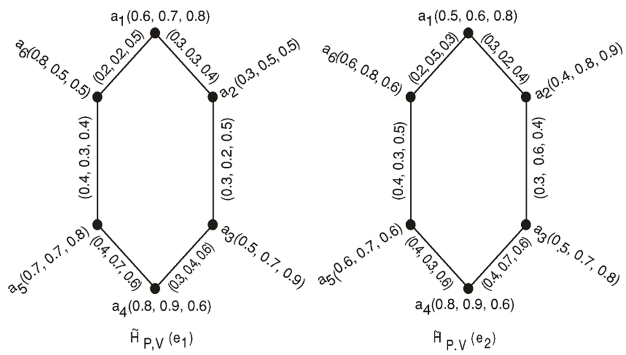

Fig 5. Neighbourly improper 3-psf-graph

Figure 5 shows that in $\widetilde{H}_{P,V}(e_1)$ and $\widetilde{H}_{P,V}(e_2)$ any two adjacent vertices have no similar degree. Therefore, for neighbourly improper 3-pf-graph, this can be an example. However, the vertices a_2 and a_6 that contain similar degree in $\widetilde{H}_{P,V}(e_1)$ and $\widetilde{H}_{P,V}(e_2)$ are adjacent to vertex a_1. Thus, it cannot be highly improper 3-pf-graphs. Hence, $\widetilde{G}_{P,V} = \left\{\widetilde{H}_{P,V}(e_1), \widetilde{H}_{P,V}(e_2), \right\}$ is a neighbourly improper 3-psf-graph but not a highly improper 3-psf-graph.

Proposition 5.5. A neighbourly improper 3-psf-graph redundant to be neighbourly totally improper 3 -psf-graph.

Example 5.6. Consider 3-polar soft fuzzy (3-psf graph) graph $\widetilde{G}_{P,V} = ((\widetilde{\rho}, P), (\widetilde{\mu}, P))$ be a crisp graph on $G^* = (V, E)$. Such that $V = \{a_1, a_2, a_3, a_4, a_5\}$ and $P = (e_1, e_2\}$ be a parameter set and $E = \{a_1a_2, a_2a_3, a_5a_1, a_3a_4, a_4a_5, a_2a_5\}$.

In the following Figure 6$\widetilde{H}_{P,V}(e)$ be any two adjacent vertices that have no similar degree and thus, for neighbourly improper 3-psf-graph, this can be an example. Yet, in $\widetilde{H}_{P,V}(e_1)$ and $\widetilde{H}_{P,V}(e_2)$, the adjacent vertices a_3 and a_4 contain similar total degree and this shows that these cannot be neighbourly totally improper 3-pf graph. Hence, $\widetilde{G}_{P,V}$ is not neighbourly totally improper 3-psf-graph.

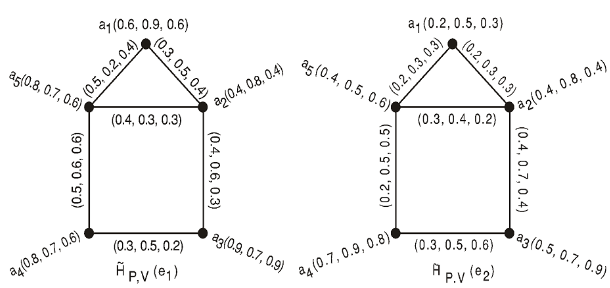

Fig 6. Neighbourly improper 3-psf-graph

Proposition 5.7 A neighbourly totally improper 3-psf-graph redundant to be neighbourly improper 3-psf-graph.

Example 5.8. Consider 3-polar soft fuzzy (3-psf graph) graph $\widetilde{G}_{P,V} = ((\widetilde{\rho}, P), (\widetilde{\mu}, P))$ be a crisp graph on $G^* = (V, E)$. Such that $V = \{a_1, a_2, a_3, a_4\}$ and $P = (e_1, e_2, e_3\}$ be a parameter set and $E = \{a_1a_2, a_2a_3, a_3a_4, a_4a_1\}$.

Here, a neighbourly totally improper 3-psf-graph is denoted as $\widetilde{G}_{P,V} = \left\{\widetilde{H}_{P,V}(e_1), \widetilde{H}_{P,V}(e_2), \widetilde{H}_{P,V}(e_3)\right\}$. However, it cannot be a neighbourly improper 3-psf -graph.

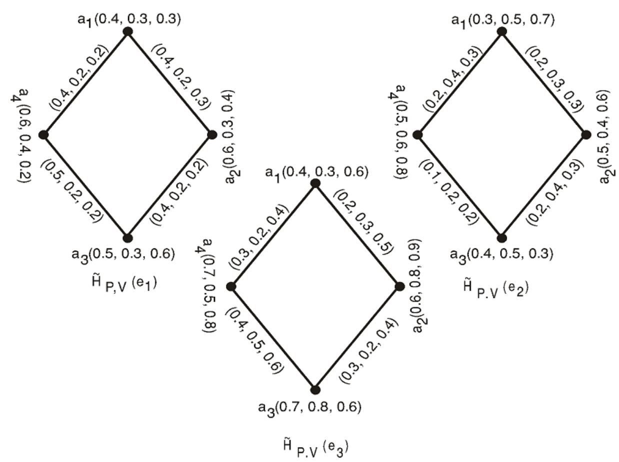

Fig 7. Neighbourly totally improper 3-psf-graph

Theorem 5.9. Let $\widetilde{G}_{P,V}$ be a 3-polar soft fuzzy graph (3-psf graph). If $\widetilde{\rho}$ is a constant function in every $\widetilde{H}_{P,V}(e_i)$ for all $e_i \in P$, then $\widetilde{G}_{P,V}$ is a neighbourly improper 3-psf-graph if and only if $\widetilde{G}_{P,V}$ is a neighbourly totally improper 3-psf-graph.

Proof: Let $\widetilde{G}_{P,V}$ is a neighbourly improper 3-psf-graph. Every $\widetilde{H}_{P,V}(e_i)$ is a neighbourly improper 3-psf-graph for all $e_i \in P$ for $i = 1,2,3,\ ..,n$. Let a_1 and a_2 be two adjacent vertices of $\widetilde{H}_{P,V}(e_i)$ for all $e_i \in P$ for $i = 1,2,3,\ ..,n$.

$\Rightarrow d_{\widetilde{H}_{P,V}}(e_i)(a_1) = (p_1, p_2, p_3)$ and $d_{\widetilde{H}_{P,V}}(e_i)(a_2) = (t_1, t_2, t_3)$

$$\Rightarrow p_1 \neq t_1, p_2 \neq t_2, p_3 \neq t_3$$

Assume that, $\widetilde{\rho}$ is a constant function in every $\widetilde{H}_{P,V}(e_i)$ for all $e_i \in P$ and $i = 1,2,3,\ ..,n$.

$\Rightarrow \widetilde{\rho}(e_i)(a_1) = \widetilde{\rho}(e_i)(a_2) = (c_1, c_2, c_3)$ where (c_1, c_2, c_3) are constant, $(c_1, c_2, c_3) \in [0,1]^m$ for all $e_i \in P$ and $i = 1,2,3,\ ..,n$.

Now $td_{\widetilde{H}_{P,V}}(e_i)(a_1) = d_{\widetilde{H}_{P,V}}(e_i)(a_1) + \widetilde{\rho}(e_i)(a_1)$ for all $e_i \in P$ and $i = 1,2,3,\ ..,n$. $= (p_1, p_2, p_3) + (c_1, c_2, c_3) = (p_1 + c_1, p_2 + c_2, p_3 + c_3)$ and $td_{\widetilde{H}_{P,V}}(e_i)(a_2) = d_{\widetilde{H}_{P,V}}(e_i)(a_2) + \widetilde{\rho}(e_i)(a_2)$ for all $e_i \in P$ and $i = 1,2,3,\ ..,n$.

$$= (t_1, t_2, t_3) + (c_1, c_2, c_3)$$

$$= (t_1 + c_1, t_2 + c_2, t_3 + c_3)$$

We claim that $td_{\widetilde{H}_{P,V}}(e_i)(a_1) \neq td_{\widetilde{H}_{P,V}}(e_i)(a_2)$.

Suppose on the contrary that, $td_{\widetilde{H}_{P,V}}(e_i)(a_1) = td_{\widetilde{H}_{P,V}}(e_i)(a_2)$ i.e., $(p_1, p_2, p_3) + (c_1, c_2, c_3) = (t_1, t_2, t_3) + (c_1, c_2, c_3)$

$\Rightarrow (p_1, p_2, p_3) = (t_1, t_2, t_3)$, that is $p_1 = t_1, p_2 = t_2, p_3 = t_3$, which is a contradiction to the fact that $p_1 \neq t_1, p_2 \neq t_2, p_3 \neq t_3$. Therefore, $td_{\widetilde{H}_{P,V}}(e_i)(a_1) \neq td_{\widetilde{H}_{P,V}}(e_i)(a_2)$. Hence any two adjacent vertices a_1 and a_2 with different degree and its different total degrees with $\widetilde{\rho} = (c_1, c_2, c_3)$ is a constant function. This is true for every pair of adjacent vertices in $\widetilde{H}_{P,V}(e_i)$ for $e_i \in P$ and $i = 1,2,3,\ ..,n$.

$\Rightarrow \widetilde{H}_{P,V}(e_i)$ is neighbourly improper 3-pf-graph for some $e_i \in P$ for $i = 1,2,3,\ ..,n$. Hence, $\widetilde{G}_{P,V}$ is a neighbourly totally improper 3-psf-graph.

Conversely, suppose that $\widetilde{G}_{P,V}$ is neighbourly totally improper 3-psf-graph, $\Rightarrow$Every $\widetilde{H}_{P,V}(e_i)$ is neighbourly improper 3-pf-graph for some $e_i \in P$ for $i = 1,2,3,\ ..,n$. Let a_1 and a_2 be two adjacent vertices of $\widetilde{H}_{P,V}(e_i)$ for all $e_i \in P$ for $i = 1,2,3,\ ..,n$.

Then $td_{\widetilde{H}_{P,V}}(e_i)(a_1) = (p_1, p_2, p_3)$ and $td_{\widetilde{H}_{P,V}}(e_i)(a_2) = (t_1, t_2, t_3)$ for all $e_i \in P$ and $i = 1,2,3,\ ..,n$. Where $p_1 \neq t_1, p_2 \neq t_2, p_3 \neq t_3$. Assume that $\widetilde{\rho}(e_i)(a_1) = \widetilde{\rho}(e_i)(a_2) = (c_1, c_2, c_3)$ where (c_1, c_2, c_3) are constant, $(c_1, c_2, c_3) \in [0,1]^m$ for all $e_i \in P$ and $i = 1,2,3,\ ..,n$. and

$td_{\widetilde{H}_{P,V}}(e_i)(a_1) \neq td_{\widetilde{H}_{P,V}}(e_i)(a_2)$. We claim that $d_{\widetilde{H}_{P,V}}(e_i)(a_1) \neq d_{\widetilde{H}_{P,V}}(e_i)(a_2)$. By our supposition, $td_{\widetilde{H}_{P,V}}(e_i)(a_1) \neq td_{\widetilde{H}_{P,V}}(e_i)(a_2)$

$$\Rightarrow (p_1, p_2, p_3) + (c_1, c_2, c_3) \neq (t_1, t_2, t_3) + (c_1, c_2, c_3)$$

$$\Rightarrow (p_1+c_1, p_2+c_2, p_3+c_3) \neq (t_1+c_1, t_2+c_2, t_3+c_3)$$

$$\Rightarrow p_1 \neq t_1, p_2 \neq t_2, p_3 \neq t_3$$

$$\Rightarrow d_{\widetilde{H}_{P,V}}(e_i)(a_1) \neq d_{\widetilde{H}_{P,V}}(e_i)(a_2)$$

Hence, any two adjacent vertices a_1 and a_2 in $\widetilde{H}_{P,V}(e_i)$ *are* with different degrees, its total degrees are also different. This is true for every pair of adjacent vertices in $\widetilde{H}_{P,V}(e_i)$ for all $e_i \in P$ and $i = 1,2,3, \ldots, n$.

$\Rightarrow \widetilde{H}_{P,V}(e_i)$ is neighbourly improper 3-pf-graph for all $e_i \in P$ and $i = 1,2,3, \ldots, n$.

$\Rightarrow \widetilde{G}_{P,V}$ is neighbourly improper 3-psf-graph.

Proposition 5.10. Let $\widetilde{G}_{P,V}$ be a 3-psf-graph. Then $\widetilde{G}_{P,V}$ is both neighbourly improper and neighbourly totally improper 3-psf-graph then $\widetilde{\rho}$ is redundant to be a constant function**.**

Example 5.11. Consider 3-polar soft fuzzy (3-psf graph) graph $\widetilde{G}_{P,V} = ((\widetilde{\rho}, P), (\widetilde{\mu}, P))$ be a crisp graph on $G^* = (V, E)$. Such that $V = \{a_1, a_2, a_3, a_4, a_5, a_6\}$ and $P = \{e_1, e_2\}$ be a parameter set and $E = \{a_1a_2, a_2a_3, a_3a_1, a_1a_4, a_4a_5, a_4a_6, a_7a_6, a_5a_7\}$.

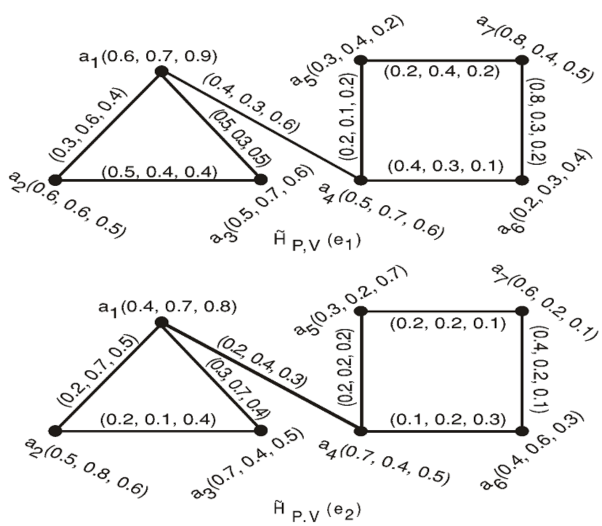

Fig 8. Neighbourly improper and Neighbourly totally improper 3-psf -graph

Here, in $\widetilde{H}_{P,V}(e_1) = (\widetilde{\rho}(e_1), \widetilde{\mu}(e_1))$ and $\widetilde{H}_{P,V}(e_2) = (\widetilde{\rho}(e_2), \widetilde{\mu}(e_2))$ any two adjacent vertices do not have similar degree and similar total degree. It is an example of both neighbourly improper and neighbourly totally improper 3-pf-graph. Hence, $\widetilde{G}_{P,V}$ is both neighbourly improper and neighbourly totally improper 3-psf-graph.

Theorem 5 .12 Let $\widetilde{G}_{P,V}$ be a 3-polar soft fuzzy graph. Then $\widetilde{G}_{P,V}$ is both highly improper and neighbourly improper 3-psf-graph if and only if *all the vertices* of $\widetilde{H}_{P,V}(e_i)$ are distinct for some $e_i \in P$,for $i = 1,2,3, \ldots, n$.

Proof: Let $\widetilde{G}_{P,V}$ be a 3-psf-graph with n vertices $a_1, a_2, \ldots, a_n$. Assume that $\widetilde{G}_{P,V}$ is both highly improper and neighbourly improper 3-psf-graph. $\Rightarrow \widetilde{H}_{P,V}(e_i)$ is both highly improper and neighbourly improper 3-pf-graph for some $e_i \in P$, for $i = 1,2,3, \ldots, n$. Let the adjacent vertices of a_1 be $a_2, a_3, \ldots, a_n$ with degrees (p_1, p_2, p_3),(t_1, t_2, t_3),……..,(k_1, k_2, k_3) respectively. Since $\widetilde{H}_{P,V}(e_i)$ is highly improper for all $e_i \in P$, and $i = 1,2,3, \ldots, n$.

$$(p_1, p_2, p_3) \neq (t_1, t_2, t_3) \neq \cdots \neq (k_1, k_2, k_3)$$

Also, since $\widetilde{H}_{P,V}(e_i)$ is neighbourly improper for all $e_i \in P$, for $i = 1,2,3, \ldots, n$.

$$d_{\widetilde{H}_{P,V}}(e_i)(a_1) \neq (p_1, p_2, p_3) \neq (t_1, t_2, t_3) \neq \cdots \neq (k_1, k_2, k_3)$$

$\Rightarrow$Degrees of the vertices of $\widetilde{H}_{P,V}(e_i)$ are all different for some $e_i \in P$ for $i = 1,2,3, \ldots, n$

Conversely, suppose the degree of all vertices of $\widetilde{H}_{P,V}(e_i)$ are all different for some $e_i \in P$ for $i = 1,2,3, \ldots, n$

Claim that $\widetilde{H}_{P,V}(e_i)$is both highly improper and neighbourly improper 3-pf-graph. Let

$d_{\widetilde{H}_{P,V}}(e_i)(a_1) = (s_1, s_2, s_3)$,$d_{\widetilde{H}_{P,V}}(e_i)(a_2) = (p_1, p_2, p_3)$,$d_{\widetilde{H}_{P,V}}(e_i)(a_3) = (t_1, t_2, t_3), \ldots..$,

$d_{\widetilde{H}_{P,V}}(e_i)(a_n) = (k_1, k_2, k_3)$. Then by our supposition $s_1 \neq p_1 \neq t_1, \ldots\ldots, \neq k_1$, $s_2 \neq p_2 \neq t_2, \ldots\ldots, \neq k_2, s_3 \neq p_3 \neq t_3, \ldots\ldots, \neq k_3$. Which implies that every two adjacent vertices have different degree and every vertex adjacent to vertices have different degree.

$\Rightarrow \widetilde{G}_{P,V}$ is both highly improper 3-psf-graph and neighbourly improper 3-psf graph.

Theorem 5.13. Let $\widetilde{G}_{P,V}$ be a 3-psf-graph. If $\widetilde{\rho}$ is a constant function in every $\widetilde{H}_{P,V}(e_i)$ for all $e_i \in P$, then $\widetilde{G}_{P,V}$ is a highly improper 3-psf-graph if and only if $\widetilde{G}_{P,V}$ is a highly totally improper 3-psf -graph.

Proof: Assume $\widetilde{G}_{P,V}$ is highly improper 3-psf-graph. i.e., every vertex is adjacent to vertices with different degrees. Every $\widetilde{H}_{P,V}(e_i)$ is highly improper 3-pf-graph for all $e_i \in P$ for $i = 1,2,3, \ldots, n$. Let a_1 be a vertex adjacent to a_2 and $a_3$with different degrees (t_1, t_2, t_3) and (p_1, p_2, p_3) respectively in $\widetilde{H}_{P,V}(e_i)$ for all $e_i \in P$ for $i = 1,2,3, \ldots, n$.

$\Rightarrow d_{\widetilde{H}_{P,V}}(e_i)(a_2) = (t_1, t_2, t_3)$ and $d_{\widetilde{H}_{P,V}}(e_i)(a_3) = (p_1, p_2, p_3)$

$$\Rightarrow t_1 \neq p_1, t_2 \neq p_2, t_3 \neq p_3$$

Assume that, $\widetilde{\rho}$ is a constant function in every $\widetilde{H}_{P,V}(e_i)$ for all $e_i \in P$ and $i = 1,2,3, \ldots, n$.$\Rightarrow \widetilde{\rho}(e_i)(a_1) = \widetilde{\rho}(e_i)(a_2) = \widetilde{\rho}(e_i)(a_3) = (c_1, c_2, c_3)$ where (c_1, c_2, c_3) are constant, $(c_1, c_2, c_3) \in [0,1]^m$ for all $e_i \in P$ and $i = 1,2,3, \ldots, n$.

Now $td_{\widetilde{H}_{P,V}}(e_i)(a_2) = d_{\widetilde{H}_{P,V}}(e_i)(a_2) + \widetilde{\rho}(e_i)(a_2)$ for all $e_i \in P$ and $i = 1,2,3, \ldots, n$.

$= (t_1, t_2, t_3) + (c_1, c_2, c_3)$

$= (t_1 + c_1, t_2 + c_2, t_3 + c_3)$ and

$td_{\widetilde{H}_{P,V}}(e_i)(a_3) = d_{\widetilde{H}_{P,V}}(e_i)(a_3) + \tilde{\rho}(e_i)(a_3)$ for all $e_i \in P$ and $i = 1,2,3, \ldots, n$.

$= (p_1, p_2, p_3) + (c_1, c_2, c_3)$

$= (p_1 + c_1, p_2 + c_2,\ p_3 + c_3)$ in $\widetilde{H}_{P,V}(e_i)$ for all $e_i \in P$ and $i = 1,2,3, \ldots, n$.

We claim that $td_{\widetilde{H}_{P,V}}(e_i)(a_2) \neq td_{\widetilde{H}_{P,V}}(e_i)(a_3)$. Suppose on the contrary that, $td_{\widetilde{H}_{P,V}}(e_i)(a_2) = td_{\widetilde{H}_{P,V}}(e_i)(a_3)$

Then $(t_1 + c_1, t_2 + c_2, t_3 + c_3) = (p_1 + c_1, p_2 + c_2, p_3 + c_3)$

i.e., $(t_1 - p_1, t_2 - p_2, t_3 - p_3) = (c_1 - c_1, c_2 - c_2, c_3 - c_3) = 0$

$\Rightarrow (t_1, t_2, t_3) = (p_1, p_2, p_3)$, which is a contradiction to the fact $(t_1, t_2, t_3) \neq (p_1, p_2, p_3)$. Therefore, $td_{\widetilde{H}_{P,V}}(e_i)(a_2) \neq td_{\widetilde{H}_{P,V}}(e_i)(a_3)$ in 3-pf-graph in $\widetilde{H}_{P,V}(e_i)$ for $e_i \in P$ and $i = 1,2,3, \ldots, n$.

$\Rightarrow$ every vertex is adjacent to the vertices with different total degrees in $\widetilde{H}_{P,V}(e_i)$ for $e_i \in P$ for $i = 1,2,3, \ldots, n$.

$\Rightarrow \widetilde{H}_{P,V}(e_i)$ is highly totally improper 3-pf-graph for some $e_i \in P$ for $i = 1,2,3, \ldots, n$. Hence $\widetilde{G}_{P,V}$ is a highly totally improper 3-psf-graph.

Conversely, suppose that $\widetilde{G}_{P,V}$ is a highly totally improper 3-psf-graph i.e., every vertex is adjacent to vertices with different total degrees.

$\Rightarrow$Every $\widetilde{H}_{P,V}(e_i)$ is highly totally improper 3-pf-graph for some $e_i \in P$ for $i = 1,2,3, \ldots, n$. Let $a_1$be the vertex adjacent to $a_2$and a_3 with different total degrees (t_1, t_2, t_3) and (p_1, p_2, p_3) respectively in $\widetilde{H}_{P,V}(e_i)$ for all $e_i \in P$ and $i = 1,2,3, \ldots, n$.

$\Rightarrow td_{\widetilde{H}_{P,V}}(e_i)(a_2) = (t_1, t_2, t_3)$ and $td_{\widetilde{H}_{P,V}}(e_i)(a_3) = (p_1, p_2, p_3)$ for all $e_i \in P$ and $i = 1,2,3, \ldots, n$.

$\Rightarrow\ t_1 \neq p_1, t_2 \neq p_2, t_3 \neq p_3$. Also assume that $\widetilde{\rho}$ is a constant function in every $\widetilde{H}_{P,V}(e_i)$ for all $e_i \in P$ for $i = 1,2,3, \ldots, n$. and $\widetilde{\rho}(e_i)(a_1) = \widetilde{\rho}(e_i)(a_2) = \widetilde{\rho}(e_i)(a_3) = (c_1, c_2, c_3)$ where (c_1, c_2, c_3) are constant, $(c_1, c_2, c_3) \in [0,1]^m$ for $i = 1,2,3, \ldots, n$.

Now $td_{\widetilde{H}_{P,V}}(e_i)(a_2) = d_{\widetilde{H}_{P,V}}(e_i)(a_2) + \widetilde{\rho}(e_i)(a_2)$

$$(t_1, t_2, t_3) = d_{\widetilde{H}_{P,V}}(e_i)(a_2) + (c_1, c_2, c_3)$$

$d_{\widetilde{H}_{P,V}}(e_i)(a_2) = (t_1 - c_1, t_2 - c_2, t_3 - c_3)$ and

$$td_{\widetilde{H}_{P,V}}(e_i)(a_3) = d_{\widetilde{H}_{P,V}}(e_i)(a_3) + \widetilde{\rho}(e_i)(a_3)$$

$$(p_1, p_2, p_3) = d_{\widetilde{H}_{P,V}}(e_i)(a_3) + (c_1, c_2, c_3)$$

$d_{\widetilde{H}_{P,V}}(e_i)(a_3) = (p_1 - c_1, p_2 - c_2, p_3 - c_3)$ in $\widetilde{H}_{P,V}(e_i)$ for all $e_i \in P$ and $i = 1, 2, 3, \ .., n$.

$\Rightarrow d_{\widetilde{H}_{P,V}}(e_i)(a_2) \neq d_{\widetilde{H}_{P,V}}(e_i)(a_3)$.

$\Rightarrow$Every vertex is adjacent to the vertices with different degrees in $\widetilde{H}_{P,V}(e_i)$ for all $e_i \in P$ and $i = 1, 2, 3, \ .., n$.

$\Rightarrow \widetilde{H}_{P,V}(e_i)$ is a highly improper 3-pf-graph for all $e_i \in P$ and $i = 1, 2, 3, \ .., n$.

$\Rightarrow \widetilde{G}_{P,V}$ is a highly improper 3-psf-graph.

6 Applications

We have used the above proposed $m-$ psf-graph to derive algorithm for decision making in the medical diagnosis in current COVID-19 scenario. The notation P denotes the attributes, $\widetilde{\rho}$ and $\widetilde{\mu}$ are the mapping from P to $F(V)$ and $F(V \times V)$ and denote the $m-$ psf-graphs. The algorithm proposed for this $m-$ psf-graphs is as follows:

6.1 Algorithm

Step 1: The set P of choice parameters of Mr X is given as an input. A is a subset of P.

Step 2: Given the m-polar soft fuzzy set $(\widetilde{\rho}, P)$ and $(\widetilde{\mu}, P)$ as input.

Step 3: Construct the m-polar soft fuzzy graph $\widetilde{G}_{P,V} = (G^*, \widetilde{\rho}, \widetilde{\mu}, P)$.

Step 4: Take into account of the m-polar fuzzy graph $\widetilde{H}_{P,V}(e)$ along with its adjacency matrix form.

Step 5: Calculate the resultant m-polar fuzzy graph $\widetilde{H}_{P,V}(e) = \cap_k \widetilde{H}_{P,V}(e)$ for $e = \wedge_k e_k$ for all k.

Step 6: Calculate the score S_k of a_k for all k. Score function $S_k = \frac{1+x_1+x_2+x_3}{3}$

Step 8: The decision is a_k if $a_k^{'} = max_i a_k^{'}$.

Step 9: Any one of a_k could be taken if it is more than one value in k.

6.2 Illustration

According to WHO, the coronavirus family is responsible for infections ranging from the common cold to more serious conditions including the Middle East respiratory syndrome (MERS) and severe acute respiratory syndrome (SARS). Different people are being impacted by the pandemic in various ways. While some people try to adjust working in online, homeschooling their kids, and using Instacart to get groceries, others are forced to be exposed to the virus in order to maintain society. The current COVID-19 pandemic has an impact on all of us. However, depending on our status as individuals and as members of society, the effects of pandemic and repercussions were felt in different ways. Fever, coughing, and breathing issues are common indicators of infection. In extreme circumstances, it may result in multiple organ failure, pneumonia, and even death. It is believed that COVID-19 takes one to fourteen days to incubate. Contagiousness begins before symptoms do, which explains why so many people contract the illness. We have been imprisoned by the pandemic for almost a year, and we are still struggling and terrified of COVID-19. Treatment of all the patients presents a challenge for the medical staff. The choice of the sickest person to receive treatment is a crucial decision made by the medical team. If something is delayed in choosing the patients' therapy, it can be potentially fatal. The major goal is to identify and prevent COVID in people who are at high risk for it. It must be taken as the first and foremost step to preserve patients away from further severe sufferings. We suggest a decision-making algorithm for the treatment of a patient who is at high risk for contracting a virus. Let's think about a group of six patients to examine the COVID-19 hypothesis. The selection of the person who will be most impacted is a challenging and time-consuming process. Let $V = \{a_1, a_2, a_3, a_4, a_5\}$ the set of six person be considered as the universal set and $P = \{e_1, e_2\}$ be the set of parameters that characterize the risk for patients, the parameters e_1 and e_2 represent the patients having diabetes and heart problem respectively. Consider the 3-polar soft fuzzy set $(\widetilde{\rho}, P)$ over V which defines the "impact of the virus on patients" in relation to the specified parameters. $(\widetilde{\mu}, P)$ is a 3-polar soft fuzzy set over E.

$E = \{a_1a_2, a_1a_5, a_2a_5.a_2a_3, a_3a_4, a_4a_5\}$.

$\widetilde{\rho}(e_1) = \left\{ \frac{a_1}{(0.7,0.9,0.6)}, \frac{a_2}{(0.4,0.5,0.4)}, \frac{a_3}{(0.6,0.7,0.5)}, \frac{a_4}{(0.8,0.7,0.9)}, \frac{a_5}{(0.8,0.7,0.6)} \right\}$,

$\widetilde{\rho}(e_2) = \left\{ \frac{a_1}{(0.2,0.5,0.3)}, \frac{a_2}{(0.4,0.8,0.4)}, \frac{a_3}{(0.5,0.7,0.9)}, \frac{a_4}{(0.7,0.9,0.8)}, \frac{a_5}{(0.4,0.5,0.6)} \right\}$.

$\widetilde{\mu}(e_1) = \left\{ \frac{a_1a_2}{(0.3,0.5,0.4)}, \frac{a_1a_5}{(0.5,0.2,0.4)}, \frac{a_2a_3}{(0.4,0.3,0.3)}, \frac{a_2a_5}{(0.4,0.3,0.4)}, \frac{a_3a_5}{(0.2,0.3,0.4)}, \frac{a_3a_1}{(0.5,0.6,0.4)}, \frac{a_3a_4}{(0.3,0.5,0.2)}, \frac{a_4a_5}{(0.5,0.6,0.6)}, \frac{a_2a_5}{(0.4,0.3,0.4)} \right\}$,

$\widetilde{\mu}(e_2) = \left\{ \frac{a_1a_2}{(0.2,0.3,0.3)}, \frac{a_1a_5}{(0.2,0.3,0.3)}, \frac{a_3a_4}{(0.3,0.5,0.6)}, \frac{a_2a_3}{(0.4,0.7,0.4)}, \frac{a_2a_4}{(0.4,0.5,0.3)}, \frac{a_3a_1}{(0.2,0.5,0.1)}, \frac{a_3a_5}{(0.4,0.5,0.4)}, \frac{a_4a_5}{(0.2,0.5,0.5)} \right\}$.

Where E represents the set of persons for whom the disease spread from $a_i \ to \ a_j \ for \ i, j = 1, 2, 3, 4, 5$. Here each vertex set takes 3 values, which represents fever, cough and breathing issues of a person affected by COVID. Each edge set takes 3 values, which represents fever, cough and breathing issues spread one person to other. The 3-polar fuzzy graph's (3-pf-graphs) e_1 and e_2 corresponding to parameters is given in Figure 10. Respectively.

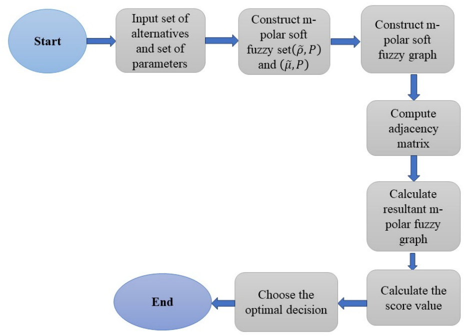

Fig 9. Flowchart of Algorithm 6.1

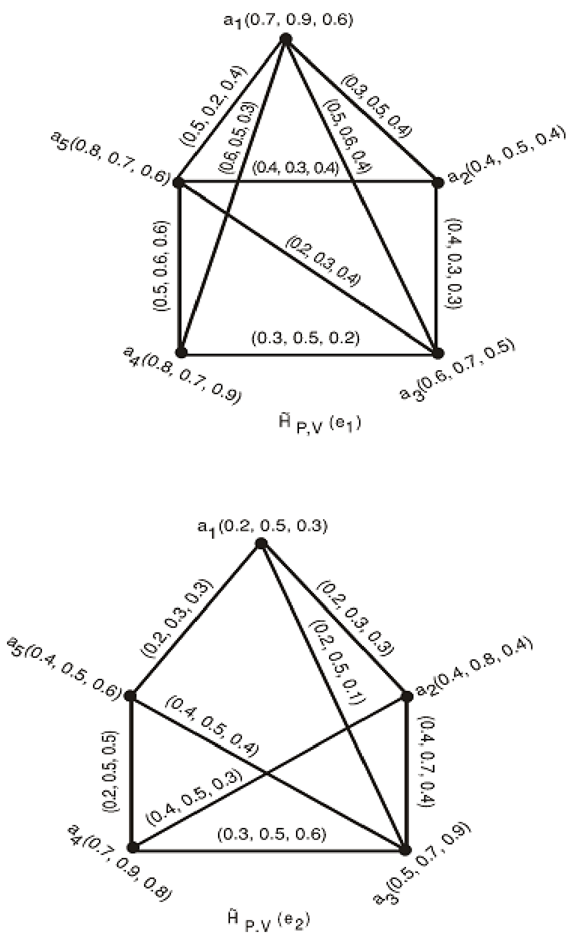

Fig 10. Corresponding parametere_1 and e_2

The following adjacency matrices represent the two parameters such as having diabetes and heart problem parallel to the 3-pf-graph $\widetilde{H}_{P,V}(e_1)$ and $\widetilde{H}_{P,V}(e_2)$

$$\widetilde{H}_{P,V}(e_1) = \begin{pmatrix} (0.0,0.0,0.0) & (0.3,0.5,0.4) & (0.5,0.6,0.4) & (0.6,0.5,0.3) & (0.5,0.2,0.4) \\ (0.3,0.5,0.4) & (0.0,0.0,0.0) & (0.4,0.3,0.3) & (0.0,0.0,0.0) & (0.4,0.3,0.4) \\ (0.5,0.6,0.4) & (0.4,0.3,0.3) & (0.0,0.0,0.0) & (0.3,0.5,0.2) & (0.2,0.3,0.4) \\ (0.6,0.5,0.3) & (0.0,0.0,0.0) & (0.3,0.5,0.2) & (0.0,0.0,0.0) & (0.5,0.6,0.6) \\ (0.5,0.2,0.4) & (0.4,0.3,0.4) & (0.2,0.3,0.4) & (0.5,0.6,0.6) & (0.0,0.0,0.0) \end{pmatrix}$$

and

$$\widetilde{H}_{P,V}(e_2) = \begin{pmatrix} (0.0,0.0,0.0) & (0.2,0.3,0.3) & (0.2,0.5,0.1) & (0.0,0.0,0.0) & (0.2,0.3,0.3) \\ (0.2,0.3,0.3) & (0.0,0.0,0.0) & (0.4,0.7,0.4) & (0.4,0.5,0.3) & (0.0,0.0,0.0) \\ (0.2,0.5,0.1) & (0.4,0.7,0.4) & (0.0,0.0,0.0) & (0.3,0.5,0.6) & (0.4,0.5,0.4) \\ (0.0,0.0,0.0) & (0.4,0.5,0.3) & (0.3,0.5,0.6) & (0.0,0.0,0.0) & (0.2,0.5,0.5) \\ (0.2,0.3,0.3) & (0.0,0.0,0.0) & (0.4,0.5,0.4) & (0.2,0.5,0.5) & (0.0,0.0,0.0) \end{pmatrix}$$

We have acquired the result on subsequent performance of a few operations (AND or OR): 3-pf-graph $\widetilde{H}_{P,V}(e)$, where $e = e_1 \wedge e_2$. The following is 3-pf-graphs adjacency matrix.

$$\widetilde{H}_{P,V}(e) = \begin{pmatrix} (0.0,0.0,0.0) & (0.2,0.3,0.3) & (0.2,0.5,0.1) & (0.0,0.0,0.0) & (0.2,0.2,0.3) \\ (0.2,0.3,0.3) & (0.0,0.0,0.0) & (0.4,0.3,0.3) & (0.0,0.0,0.0) & (0.0,0.0,0.0) \\ (0.2,0.5,0.1) & (0.4,0.3,0.3) & (0.0,0.0,0.0) & (0.3,0.5,0.2) & (0.2,0.3,0.4) \\ (0.0,0.0,0.0) & (0.0,0.0,0.0) & (0.3,0.5,0.2) & (0.0,0.0,0.0) & (0.2,0.5,0.5) \\ (0.2,0.2,0.3) & (0.0,0.0,0.0) & (0.2,0.3,0.4) & (0.2,0.5,0.5) & (0.0,0.0,0.0) \end{pmatrix}$$

Tabular representation of score values of adjacency matrix of resultant 3-pf-graph graph $\widetilde{H}_{P,V}(e)$ with average score function $S_k = \frac{1+x_1+x_2+x_3}{3}$ and choice value for each patient a'_k for $k = 1,2,3,4,5$.

Table 1. Tabular representation of score values with choice values

Patients	a_1	a_2	a_3	a_4	a_5	$a_k^{'}$
a_1	0.3333	0.6000	0.6000	0.3333	0.5667	2.4333
a_2	0.6000	0.3333	0.6667	0.3333	0.3333	2.2666
a_3	0.6000	0.6667	0.3333	0.6667	0.6333	2.9
a_4	0.3333	0.3333	0.6667	0.3333	0.7333	2.3999
a_5	0.5667	0.3333	0.6333	0.7333	0.3333	2.5999

Apparently a_3 scored the maximum value of 2.9. Thus, patients a_3 has highest risk, first treatment is given for a_3. From Table 1, the optimal decision is to select patient a_3 that she/he has a high risk of COVID-19.

6.3 Comparison analysis

Sultana. F (2022) analysed application of plithogenic graphs in spreading of COVID-19. They have considered only one attribute by which it was somewhat difficult in finding the affected person. Moreover, they have considered only one parameter. But we have considered m attributes with n parameter by which the affected person can be identified easily. So, $m-$psf-graph is more flexible than fuzzy or intuitionistic fuzzy. In particular, $m-$psf-graph is shown to be useful in adapting accurate problems if it is necessary to make judgements with a group of agreements.

7 Conclusion

The introduction of these new improper m-polar soft fuzzy graphs is a growing new concept that has the potential to mature into a variety of graph theoretical conceptions. We developed an improper m-polar soft fuzzy graph, examined its properties, and established corresponding theorems to add to the theoretical section of fuzzy graph theory. By applying m-polar soft fuzzy sets to m-polar fuzzy graphs, improper m-polar soft fuzzy graphs have been developed. Because soft sets are most useful in real-world applications, the newly combined concepts of the m-polar and soft fuzzy sets will lead to many possible applications in the fuzzy set theoretical area by adding extra fuzziness in analysing. As a practical application, we created a model based on this defined graph and used it to make decisions for medical diagnosis in the present COVID situation.

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