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Single-valued neutrosophic $\mathcal{N}$-soft set and intertemporal single-valued neutrosophic $\mathcal{N}$-soft set to assess and pre-assess the mental health of students amidst *COVID-19*

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Abstract. **Aim** - Stress binds everyone as we face uncertainty in our lives. So, it is notable that we experience anxiety during this coronavirus disease ($COVID-19$) pandemic context. When we try to handle stress for longer duration leads to chronic, and it can affect both physical and mental health. The scientific techniques to precisely pre-assess or assess mental health disorders are hardly available for the students. This paper intends to provide an explication to pre-assess or assess the mental health of the students amidst this pandemic. We present the notions of single-valued neutrosophic $\mathcal{N}$-soft set ($SVN\mathcal{N}SS$) and the quasi-hyperbolic discounting intertemporal single-valued neutrosophic $\mathcal{N}$-soft set ($QHDISVN\mathcal{N}SS$) to show the mental condition of the students. **Design**- We develop a four-phase method to pre-assess or assess the mental health disorders of students. In the initial phase, we present an outline to identify the students, parameters, and the psychosocial aspects of the students. Also, we provide the framework of positive and negative statements for each parameter, rating scales, and scoring norms. In the second phase, we execute case studies based on observation of the students and mention the values using neutrosophic numbers for each counseling session with no loss of information. Then we apply the concept of score function (SF) and weighted single-valued neutrosophic vector ($WSVNV$). In the third phase, we construct $SVN\mathcal{N}SS$ or $QHDISVN\mathcal{N}SS$ to access or pre-access the mental health of the students. Finally, we assess the scores of each student with the help of norms and predict mental health disorders. **Results**- Using $SVN\mathcal{N}SS$, we can assess the mental health of the students and able to pre-assess the mental health of the students by using $QHDISVN\mathcal{N}SS$. Hence, this result supports the psychiatrist or the counselor to focus on those with mental health conditions, as they are known to experience a higher level of emotional distress. **Contributions**- This study shows how the significance of the neutrosophic concept can be modified and implemented in the psychology field to determine the mental health of the students. **Implications**- As pointed out by the counselor and the therapist, the first step to self-care is to take care of our mental health. Here, in this study, we provide a solution to pre-assess and assess the mental health of the students by using these concepts. This method gives a valuable solution to the counselor or the therapist for analyzing the psychosocial aspects.

Keywords: single-valued neutrosophic $\mathcal{N}$-soft set; intertemporal single-valued neutrosophic $\mathcal{N}$-soft set; quasi-hyperbolic discounting function.

1. Introduction

World health organization (WHO) observes 10 October as world health day to understand the enhancing mental health issues. Mental health holds the emotional, psychological, and social wellness within us. Mental health issues have become one of the worlds major causes of the burden of chronic disease, and it frequently begins at an early age and can ruin lives, influencing families, peers, and societies. Students mental wellness is a subject of concern worldwide. The success of the student hinges on mental health. The socially acceptable conduct of student behavior depends on his mental health. Disturbance in his mental health creates a negative impact on the student as well to the community. Hence, mental health plays a significant role in a students life. On 11 March 2020, WHO conceded the spread of $COVID-19$ to be a pandemic. When analyzing the inflation in $COVID-19$, the only approach left to slow the spread of the infection is a complete lockdown. A study carried on over 8,000 people by YourDost [1], an online mental health site, found that college students are the most affected by $COVID-19$. Because of the lockdown effect, many students undergo emotional stress, and there is a need to assess their mental health status. A recent survey conducted by WHO [2] in 130 countries from June to August 2020 showed that there is a disruption in mental health services in 93 percent of countries. The findings show that 89 percent of countries have national mental health and psychological support plans, but only 17 percent of them have funds allocated to implement those plans. They have also found that only 7 percent of countries have reported no service interruption, meaning that some disruption of service has occurred in 93 percent of countries. Based on the global burden of disease research work [3], around 792 million individuals have a mental illness. The representation of the global ratio is 10.7 percent, slightly over one in ten individuals. Hence, there's a need for a therapist to assess the students' mental aspect during this pandemic.

When most of the models apportioned with fuzzy set (FS) [4] and intuitionistic FS (IFS) [5] to solve the problems of uncertainty situations. Smarandache [6] presented the concept of the neutrosophic set (NS), a combination of truth, indeterminate, and falsity membership values. Later, Wang [7] introduced single-valued NS ($SVNS$) to overcome the difficulties faced in NS. Maji [8] established the concept of a single-valued neutrosophic soft set ($SVNSS$) and its properties. During an uncertain condition, the indeterminate membership value plays a vital role in ranking the alternatives, and the domination of neutrosophic theory in various fields started from thereon. We highlight some of the recent works that have used neutrosophic theory in decision making problems. Abdel-Basset et al. [9] proposed the type 2 $SVNS$ and defined some of its operational rules. Abdel-Basset et al. [10] presented a novel approach for estimating smart medical devices in a neutrosophic environment. Abdel-Basset et al. [11] proposed the concept of the analytical network method with $SVNS$ for dealing with multi-criteria decision making ($MCDM$) problems. Abdel-Basset et al. [12] implemented a new technique for project selection in an ambiguous environment. Chinnadurai et al. [13] introduced the concept of a unique ranking for the alternatives using parameters. Chinnadurai and Bobin [14] presented a study to rank the attributes in $MCDM$ problems using prospect theory. Sudan et al. [15] proposed a novel approach for stock value prediction based on real data. Nabeeh et al. [16] illustrated an ideal solution in ranking the personnel selection process by integrating neutrosophic and analytical hierarchy method. Mohana and Smarandache [17] solved $MCDM$ problems using bipolar $SVNS$ ($BSVNS$). Broumi et al. [18] introduced a new algorithm to find out the shortest path between each pair of nodes. Kumar et al. [19] presented shortest path problem using neutrosophic graph. Abdel-Basset [20] presented the framework for the professional candidate selection process using $BSVNS$. Abdel-Basset [21] proposed a concept to solve the supply chain problem by using the combination of the plithogenic set (PS) and the best-worst method. Abdel-Basset [22] integrated PS with different $MCDM$ applications to assess the progress of manufacturing industries. Abdel-Basset [23] implemented smart product-service systems to process a large amount of information in $MCDM$ problems. Abdel-Basset [24] presented a model to diagnose $COVID-19$ by using PS and computerized tomography scans. Rohini et al. [25] presented the concept of single-valued neutrosophic coloring. It is used widely in information technology, banking technology, psychology, sociology, and other fields where the indeterminacy occurs. Edward and Narmadhagnanam [26] developed a concept using rough -$SVNS$ to diagnose the disease. Villamar et al. [27] analyzed Ecuador's gross domestic product by using a neutrosophic cognitive map. The domination of neutrosophic theories in various fields is clear from these research works.

Zadeh [4] proposed the notion of FSs to deal with the concept of vagueness. The thoughts inside the human brain for learning, understanding, and describing are naturally vague and imprecise. The boundaries of these concepts are not precisely defined. Therefore, the judging and rationalizing that develop from human brain also become uncertain. In the late 80s, amid criticism and controversy, FSs gained credibility in psychology [28]. Although psychologists have shown interest on FS theory concepts and fuzzy logic have been slow to take up the field. Rosch [29], Hersh and Caramazza [30], Rubin [31] and Oden [32] conducted experimental research using FS theory. Oden and Massaro [33] explained the perception theory by using a FS. Hesketh et al. [34] introduced the concept of fuzzy logic to study the thought processes which cannot fit into classical mathematical techniques. Broughton [35] insists that typicality and FS helps in refining personality assessment tools and improving abnormal diagnosis. Horowitz and Malle [36] examined depression by using the fuzzy concept. Alliger et al. [37] applied the concept of the fuzzy approach in decision-making problems of personnel assessment and selection. Vasantha et al. [38] defined the concept of a single-valued refined NS. They analyzed the age group of 1 to 10 years to study the imaginative play in children. Hernandex et al. [39] presented the pedagogical validation through ladov technique. Nandita et al. [40] detailed the aspects of mental health and presented the details using soft computing and neuro-fuzzy techniques. Wang et al. [41] identified the various types of psychological dysfunctions in construction designs. They developed a fuzzy mapping to determine the influence of psychological disorders in the context of the time, cost, and quality of construction. Sanpreet [42] designed an expert system to aid the psychiatrists in assessing the mental health of the individuals. Sumathi and Poorna [43] presented the concept of machine learning techniques, Bayesian networks, and fuzzy clustering to study the mental health associated with children. Srivastava et al. [44] analyzed the aspects of psychological behavior by using fuzzy logic rules. Nuovo et al. [45] implemented a method to classify the mental retardation level. It is vital to select the best therapeutic medication and to ensure a quality of life that is sufficient for the particular condition of the patient. Chicaiza et al. [46] studied the state of emotional intelligence of the students. Since a high emotional intelligence guarantees a better future professional and higher quality learning.

Psychologists believe that the FS theory suffers mismatches with human perception, and lacks measurement foundations, from theoretical incoherence or paradoxes. Judgment and decision-making psychologists remained unconvinced that FSs could deliver something not already handled by subjective likelihood and utility. These manuscripts bring out the significance of the FS and other hybrid sets in analyzing personality assessment, diagnosis of disorders, and occupational counseling rather than using traditional set theory. Although the usage of the FS and other hybrid theory is clear in psychology, the preference of using it is not widespread. The psychiatrists are used to analyze scaled data with statistical techniques. They are always in the mindset to follow the traditional method of handling scale construction and classical test-theory. These conventional concepts have forced the psychiatrists to use scale construction rather than FSs and other hybrid sets. Also, most of the psychological study deals with questionnaires to study human behavior. In this process, we can never ignore the prejudice of the subject when the subjects express their thought process using a questionnaire. That's the reason when the information received by a questionnaire are imprecise since 'raw' values include hidden risks. Neutrosophic logic acts as a vital tool to deal with uncertainty. The reason for introducing the neutrosophic concept in the study of mental health is that much of the data received by the questionnaire is vague. Using neutrosophic information instead of raw data has the advantage of reducing vagueness. In psychology, this concept offers an additional benefit and allows us to use vagueness measures to quantify the ambiguity associated with the prediction of mental health parameters. Hence, there is a need to define a novel set that is user friendly for the psychiatrists to assess the psychological behaviors of human beings.

Fatimah et al. [47] introduced the notion of $\mathcal{N}$-soft set ($\mathcal{N}SS$) with real-life illustrations. Later, Akram et al. coined the definition of fuzzy $\mathcal{N}SS$ ($F\mathcal{N}SS$) [48] and hesitant $\mathcal{N}SS$ ($H\mathcal{N}SS$) [49] by combining fuzzy and hesitancy sets with $\mathcal{N}SS$ respectively. Kamaci and Petchimuthu [50] presented the concept of bipolar $\mathcal{N}SS$ and its properties. Zhang et al. [51] studied the properties of Pythagorean fuzzy $\mathcal{N}SS$. Riaz et al. [52] detailed on neutrosophic $\mathcal{N}SS$ along with their properties. The implementation of $\mathcal{N}SS$ in various theories is evident from the above research works. But, we find there are some limitations when the combination of hybrid sets and $\mathcal{N}SS$ happens and maybe insignificant when applied in the psychology field. i) We cannot accommodate the membership value of indeterminacy in $F\mathcal{N}SS$ and $H\mathcal{N}SS$. ii) We would like to refer the Example 2.5 in Akram et al. [53]. They decide the grading criteria based on the membership values in IFS and discard the non-membership values, assigned independently in IFS. Similarly, in Example 5.1, Riaz et al. [52] decides on the grading criteria (Table 21) based on the truth membership values in $SVNSS$ and discard the indeterminacy and falsity membership values, assigned independently in $SVNSS$. By discarding the non-membership values in IFS and the indeterminacy and falsity of membership values in $SVNSS$, may restrict in analyzing the psychological aspects of human beings. This limitation may initiate a research gap in the psychological field.

In 1968, Phelps and Pollak [54] introduced the notion of the quasi-hyperbolic discounting function ($QHDF$). In 1997, David [55] coined the definition of $QHDF$ to capture the qualitative properties. Later, Peter and Botond [56] changed the notion introduced by David to deal with $QHDF$. Takanori [57] analyzed whether smoking status, including cigarette addiction, can be accurately predicted by two-time perception parameters. Nascimento [58] showed that fuzzy temporal logic expresses patterns of perception to interpret decision-making behaviors. Dou et al. [59] implemented a method using fuzzy temporal logic to forecast the passenger flow. Alnahhas and Alkhatib [60] supported a decision system to manage the crisis by combining fuzzy logic and temporal techniques. Alcantud and Torrecillas [61] introduced the intertemporal framework to fill the gap in the fuzzy soft set theory. Lie et al. [62] proposed an intertemporal hesitant fuzzy soft set and showed the significance of the set with $MCDM$ problems. Although the temporal logic plays a significant role in considering the 'immediate effect' from different parameters and sessions, the application of neutrosophic theory is still open for research.

On examining these manuscripts, we impersonate the following research scopes in a nutshell. Initially, during a pandemic, a change in environment is prevalent, which affects the psychosocial aspects substantially among the individuals. So, it is vital to analyze the mental health aspects of the students during this lockdown situations. Second, neutrosophic theory shows competence in decision making across all the fields. But, in psychology, there is still scope for enhancement. Third, the available standardized psychological tool for analyzing psychosocial behavior has limitations. A simple rating scale distribution cannot provide the exact risk level and prohibits the remedy process. Upon further analysis, we found that psychiatrists are comfortable in using raw data and rating scale criteria. So, a novel set that could handle the indeterminacy and the traditional method of assessing the human behaviors aids psychiatrist. Finally, the treatment process has many sessions to diagnose socially unacceptable behaviors. Hence, implementing intertemporal choice for capturing information is being preferred by the psychiatrists. The principal objectives of this manuscript are to overcome the mentioned research gap. i) to define a new set $SVN\mathcal{N}SS$, by combining SF value of $SVNSS$ with $\mathcal{N}SS$. This set enables us to use the SF of $SVNSS$, which represents the information independently in truth, indeterminate, and falsity. Later, with the help of a rating scale distribution, we relate the $\mathcal{N}SS$ to the corresponding SF value. ii) to define a new set of $QHDISVN\mathcal{N}SS$, a combination of intertemporal $SVN\mathcal{N}SS$ ($ISVN\mathcal{N}SS$) with $QHDF$. This set enables us to record the intertemporal information and pre-assess the risk level associated with each session with the help of $QHDF$. We contemplate that these two novel sets will bridge the gap and aid the psychiatrist to use neutrosophic theory.

We organize the structure of this manuscript as below. Section 2 recalls existing definitions. Section 3 defines a new SF and $WSVNV$. Section 4 shows a comparison study between the proposed SF and existing SFs. Section 5 introduces the definition of $SVN\mathcal{N}SS$. Section 6 provides the method, algorithm, and flowchart to assess the mental health of the students. Section 7 illustrates the case studies to assess the mental health of the students by using $SVN\mathcal{N}SS$. Section 8 introduces the definition of $QHDISVN\mathcal{N}SS$. Section 9 provides the method, algorithm, and flowchart to pre-assess the mental health of the students. Section 10 illustrates a case study by using $QHDISVN\mathcal{N}SS$. Section 11 shows the significance and a comparison study of $QHDISVN\mathcal{N}SS$ and finally, section 12 ends with limitations, conclusion and future works.

2. Preliminaries

In this section, we discuss some basic definitions, essential for understanding this manuscript. Let $\mathcal{U}$ denote a universal set, $\mathcal{P}$ a set of parameters, $\mathcal{E} \subseteq \mathcal{P}$ and $2^{\mathcal{U}}$ the power set of $\mathcal{U}$.

Definition 2.1. [7] A single-valued neutrosophic set ($SVNS$) is represented as, $N = \{(u, T_N(u), I_N(u), F_N(u)) \,|u \in \mathcal{U}\}$, where $T_N(u) : \mathcal{U} \to [0,1]$ represents truth-value, $I_N(u) : \mathcal{U} \to [0,1]$ represents indeterminate-value and $F_N(u) : \mathcal{U} \to [0,1]$ represents falsity-value with a condition $0 \leq T_N(u) + I_N(u) + F_N(u) \leq 3 \;\forall\; u \in \mathcal{U}$. Let $N^{\mathcal{U}}$ denote the collection of all SVNSs defined on $\mathcal{U}$.

Definition 2.2. [63] A pair $(F, \mathcal{E})$ is called a soft set (SS) over $\mathcal{U}$, F is a mapping given by $F : \mathcal{E} \to 2^{\mathcal{U}}$. Thus a SS is a parameterized family of subsets of $\mathcal{U}$.

Example 2.3. Let $\mathcal{U}$=$\{c_1, c_2, c_3\}$ be a set of clients with psychosocial conditions and $\mathcal{E}$=$\{p_1, p_2, p_3\}$ be the set of dimensions which stand for anxiety, depression and sleeping disorder respectively. A SS $(F, \mathcal{E})$ is a collection of subsets of $\mathcal{U}$, based on the description (Table 1).

Table 1. Representation of clients with psychosocial conditions in SS form

$\mathcal{U}$	anxiety(p_1)	depression(p_2)	sleeping disorder(p_3)
c_1	1	0	1
c_2	0	1	1
c_3	1	1	0

$F(anxiety) = \{c_1, c_3\}$, $F(depression) = \{c_2, c_3\}$ and $F(sleeping\ disorder) = \{c_1, c_2\}$.

Definition 2.4. [8] A single-valued neutrosophic soft set ($SVNSS$) over $\mathcal{U}$ is defined as a pair $(F, \mathcal{E})$, where $F : \mathcal{E} \to N^{\mathcal{U}}$. A $SVNSS$ is represented as, $\tilde{N} = (F, \mathcal{E}) = \{(p, T_F(p)(u), I_F(p)(u), F_F(p)(u)) \,|u \in \mathcal{U} \text{ and } p \in \mathcal{E}\}$, where $T_F(p)(u)$, $I_F(p)(u)$, $F_F(p)(u) \in [0,1]$, are the membership values of truth, indeterminacy and falsity respectively.

Example 2.5. Let $\mathcal{U}$ and $\mathcal{E}$ represent the same as in Example 2.3. A $SVNSS$ $(F, \mathcal{E})$ describes the subset of clients with psychosocial conditions approximately in terms of membership values of truth, indeterminacy and falsity as in Table 2.

Table 2. Clients with psychosocial conditions in $SVNSS$ form $(F, \mathcal{E})$

$\mathcal{U}$	anxiety(p_1)	depression(p_2)	sleeping disorder(p_3)
c_1	$\langle 0.55, 0.25, 0.45\rangle$	$\langle 0.75, 0.55, 0.55\rangle$	$\langle 0.90, 0.95, 0.20\rangle$
c_2	$\langle 0.70, 0.45, 0.40\rangle$	$\langle 0.35, 0.10, 0.40\rangle$	$\langle 0.35, 0.45, 0.25\rangle$
c_3	$\langle 0.85, 0.60, 0.15\rangle$	$\langle 0.25, 0.35, 0.15\rangle$	$\langle 0.50, 0.20, 0.60\rangle$

Definition 2.6. [64] A $SVNSS$ can be represented in matrix form as,

$$N^* = [n_{ij}] = \begin{bmatrix} n_{11} & n_{12} & \cdots & n_{1n} \\ n_{21} & n_{22} & \cdots & n_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ n_{m1} & n_{m2} & \cdots & n_{mn} \end{bmatrix},$$

where $[n_{ij}] = \langle T_{ij}, I_{ij}, F_{ij}\rangle$; $i = 1, 2, ..., m$ and $j = 1, 2, ..., n$. N^* is an $m \times n$ single-valued neutrosophic soft matrix ($SVNSM$).

Example 2.7. The $SVNSM$ for the Example 2.5 is as below:

$$N^* = \begin{bmatrix} \langle 0.55, 0.25, 0.45\rangle & \langle 0.75, 0.55, 0.55\rangle & \langle 0.90, 0.95, 0.20\rangle \\ \langle 0.70, 0.45, 0.40\rangle & \langle 0.35, 0.10, 0.40\rangle & \langle 0.35, 0.45, 0.25\rangle \\ \langle 0.85, 0.60, 0.15\rangle & \langle 0.25, 0.35, 0.15\rangle & \langle 0.50, 0.20, 0.60\rangle \end{bmatrix}$$

Definition 2.8. [47] Let $\mathcal{G} = \{0, 1, ..., \mathcal{N} - 1\}$ be a set of ordered grades, where $\mathcal{N} \in \{2, 3, ...\}$. Then, $(F, \mathcal{E}, \mathcal{N})$ is a $\mathcal{N}$ - soft set ($\mathcal{N}SS$) on $\mathcal{U}$ if $F : \mathcal{E} \longrightarrow 2^{\mathcal{U}\times\mathcal{G}}$ with the condition that for each $p \in \mathcal{E}$ there exists a unique $(u, g_p) \in \mathcal{U} \times \mathcal{G}$, such that $(u, g_p) \in F(p)$, $u \in \mathcal{U}$, $g_p \in \mathcal{G}$.

Definition 2.9. [56] In a T-horizon game, the quasi-hyperbolic discounting function ($QHDF$) for the period t's is given as,

$$u(q_t) + \beta \sum_{i=1}^{T-t} \delta^i u(q_{t+i}),$$

with $\beta, \delta \in [0, 1]$ and represent the short-term and long-term discounting parameters.

Definition 2.10. Let $\tilde{N} = \left\langle T_{\tilde{N}}, I_{\tilde{N}}, F_{\tilde{N}}\right\rangle$ represent $SVNSS$. Then the framework of existing SF definitions are given in Table 3.

TABLE 3. Representation of existing SFs

Existing author details	*SFs*
Ridvan [65]	$R(\tilde{N}) = \frac{1+T_{\tilde{N}}-2(I_{\tilde{N}})-F_{\tilde{N}}}{2}$
Nancy and Garg [66]	$G(\tilde{N}) = \frac{1+(T_{\tilde{N}}-2(I_{\tilde{N}})-F_{\tilde{N}})(2-T_{\tilde{N}}-F_{\tilde{N}})}{2}$
Pal and Jana [67]	$P(\tilde{N}) = T_{\tilde{N}} + I_{\tilde{N}} + F_{\tilde{N}}$
Broumi et al. [68]	$B(\tilde{N}) = \frac{2+T_{\tilde{N}}-I_{\tilde{N}}-F_{\tilde{N}}}{3}$
Mondal and Pramanik [69]	$M(\tilde{N}) = \frac{1+T_{\tilde{N}}-F_{\tilde{N}}}{2}$
Peng et al. [70]	$P(\tilde{N}) = \frac{T_{\tilde{N}}+1-I_{\tilde{N}}+1-F_{\tilde{N}}}{3}$

3. Score function and weighted vector of neutrosophic

In this section, we introduce two new definitions to solve the case studies mentioned in sections 7 and 11. i) Score function (SF) of a $SVNSM$ helps to integrate the neutrosophic number into a single real number to bring out the importance of truth, indeterminacy, and falsity membership values. ii) In $MCDM$ problems, decision makers (DMs) always consider each parameter uniquely and also provide the weightage value based on their experiences. So, the weighted single-valued neutrosophic vector ($WSVNV$) provides an added advantage to the DMs to consider each criterion uniquely based on the selection of problem.

Definition 3.1. Let $N^* = [n_{ij}] = \left\langle T_{N^*_{ij}}, I_{N^*_{ij}}, F_{N^*_{ij}} \right\rangle$. Then define the SF for the element n_{ij} as,

$$S(N^*) = [s_{ij}] = \frac{\left[T_{N^*_{ij}} + I_{N^*_{ij}}\right] - F_{N^*_{ij}}}{2} \ \forall \ i, j.$$

Example 3.2. The SF values for the Example 2.3 is given below:

$$S(N^*) = \begin{bmatrix} 0.18 & 0.38 & 0.83 \\ 0.38 & 0.03 & 0.28 \\ 0.65 & 0.23 & 0.05 \end{bmatrix}$$

Definition 3.3. Let ζ be the collection of all SFs deduced from neutrosophic values and $M = \{s_1, s_2, ..., s_l\}$ be a neutrosophic vector with components of ζ. Let $W = \{w_1, w_2, ..., w_l\}$ be a weight vector associated with M. w_i can be considered as the significance attached to s_i; $i = 1, 2, ..., l$ with $w_i \in [0, 1]$, $\sum_{i=1}^{l} = 1$. Then the $WSVNV$ corresponding to M and W denoted by WM is defined as, $WM = \{w_1 s_1, w_2 s_2, ..., w_l s_l\}$.

Example 3.4. Let $W = (0.35, 0.35, 0.30)$ be the weight vector assigned to the parameters. Then the $WSVNV$ for the Example 3.2 is as below:

$$WS(N^*) = \begin{bmatrix} 0.06 & 0.13 & 0.25 \\ 0.13 & 0.01 & 0.08 \\ 0.23 & 0.08 & 0.02 \end{bmatrix}$$

4. **Comparison of proposed score function with existing score functions**

In this section, we compare and analyze existing SFs namely; Ridvan [65], Nancy and Garg [66], Pal and Jana [67], Broumi et al. [68], Mondal and Pramanik [69] and Peng et al. [70] with proposed SF to show the ranking constraints in neutrosophic environment. From Table 4, we infer that in some conditions, the existing SFs cannot rank the alternatives whereas the proposed SF can rank the alternatives in the best way.

5. **Single-valued neutrosophic $\mathcal{N}$-soft set**

In this section, we define the notion of single-valued neutrosophic $\mathcal{N}$-soft set and single-valued neutrosophic $\mathcal{N}$-soft matrix with suitable examples.

Definition 5.1. Let $\mathcal{U}$ be the universal set and $\mathcal{P}$ be a set of parameters, $\mathcal{E} \subseteq \mathcal{P}$. Let $\mathcal{G} = \{1, 2, ..., \mathcal{N}\}$ be a set of rating scales, where $\mathcal{N} \geq 2$. Then the triple $(\psi, \mathcal{J}, \mathcal{N})$ is said to be a single-valued neutrosophic $\mathcal{N}$-soft set ($SVN\mathcal{N}SS$), where $\mathcal{J} = (F, \mathcal{E}, \mathcal{N})$ is a $\mathcal{N}$-soft set over $\mathcal{U}$ and ψ maps every parameter in $\mathcal{E}$ with a score function of $SVNSS$, $S(\tilde{N})$ over $F(p)$ which is clearly a subset of $\mathcal{U} \times \mathcal{G}$ and $p \in \mathcal{E}$. That is, for each parameter $p \in \mathcal{E}$, there exists a unique $(u, g_p) \in \mathcal{U} \times \mathcal{G}$ such that $(u, g_p) \in F(p)$, $u \in \mathcal{U}$, $g_p \in \mathcal{G}$ and $\left\langle (u, g_p), S(\tilde{N}) \right\rangle \in \psi(p)$ or $\tilde{N}(\mathcal{N}) = \psi(p)(u) = \left\langle g_p, S(\tilde{N}) \right\rangle$.

TABLE 4. Shows the ranking constraints in existing SFs

SVNSSs	***SFs***	**Score values**	**Remarks**
$\tilde{N}_1 = \langle 0.25, 0.35, 0.15\rangle$	Ridvan [65]	$R\left(\tilde{N}_1\right) = R\left(\tilde{N}_2\right) = R\left(\tilde{N}_3\right) = 0.20$	$\tilde{N}_1 = \tilde{N}_2 = \tilde{N}_3$
$\tilde{N}_2 = \langle 0.70, 0.45, 0.40\rangle$			
$\tilde{N}_3 = \langle 0.45, 0.40, 0.25\rangle$	Proposed	$S\left(\tilde{N}_1\right) = 0.22,\ S\left(\tilde{N}_2\right) = 0.37,\ S\left(\tilde{N}_3\right) = 0.30$	$\tilde{N}_2 > \tilde{N}_3 > \tilde{N}_1$
$\tilde{N}_1 = \langle 0.55, 0.25, 0.45\rangle$	Nancy and Garg [66]	$G\left(\tilde{N}_1\right) = G\left(\tilde{N}_2\right) = G\left(\tilde{N}_3\right) = 0.30$	$\tilde{N}_1 = \tilde{N}_2 = \tilde{N}_3$
$\tilde{N}_2 = \langle 0.50, 0.20, 0.50\rangle$			
$\tilde{N}_3 = \langle 0.60, 0.23, 0.72\rangle$	Proposed	$S\left(\tilde{N}_1\right) = 0.17,\ S\left(\tilde{N}_2\right) = 0.10,\ S\left(\tilde{N}_3\right) = 0.05$	$\tilde{N}_1 > \tilde{N}_2 > \tilde{N}_3$
$\tilde{N}_1 = \langle 0.40, 0.35, 0.45\rangle$	Pal and Jana [67]	$P\left(\tilde{N}_1\right) = P\left(\tilde{N}_2\right) = P\left(\tilde{N}_3\right) = 1.20$	$\tilde{N}_1 = \tilde{N}_2 = \tilde{N}_3$
$\tilde{N}_2 = \langle 0.35, 0.45, 0.40\rangle$			
$\tilde{N}_3 = \langle 0.45, 0.60, 0.15\rangle$	Proposed	$S\left(\tilde{N}_1\right) = 0.15,\ S\left(\tilde{N}_2\right) = 0.20,\ S\left(\tilde{N}_3\right) = 0.45$	$\tilde{N}_3 > \tilde{N}_2 > \tilde{N}_1$
$\tilde{N}_1 = \langle 0.35, 0.45, 0.40\rangle$	Broumi et al. [68]	$B\left(\tilde{N}_1\right) = B\left(\tilde{N}_2\right) = B\left(\tilde{N}_3\right) = 0.50$	$\tilde{N}_1 = \tilde{N}_2 = \tilde{N}_3$
$\tilde{N}_2 = \langle 0.20, 0.25, 0.45\rangle$			
$\tilde{N}_3 = \langle 0.60, 0.55, 0.55\rangle$	Proposed	$S\left(\tilde{N}_1\right) = 0.20,\ S\left(\tilde{N}_2\right) = 0.00,\ S\left(\tilde{N}_3\right) = 0.30$	$\tilde{N}_3 > \tilde{N}_1 > \tilde{N}_2$
$\tilde{N}_1 = \langle 0.55, 0.50, 0.45\rangle$	Mondal and Pramanik [69]	$M\left(\tilde{N}_1\right) = M\left(\tilde{N}_2\right) = M\left(\tilde{N}_3\right) = 0.55$	$\tilde{N}_1 = \tilde{N}_2 = \tilde{N}_3$
$\tilde{N}_2 = \langle 0.35, 0.35, 0.25\rangle$			
$\tilde{N}_3 = \langle 0.60, 0.55, 0.50\rangle$	Proposed	$S\left(\tilde{N}_1\right) = 0.30,\ S\left(\tilde{N}_2\right) = 0.22\ S\left(\tilde{N}_3\right) = 0.32$	$\tilde{N}_3 > \tilde{N}_1 > \tilde{N}_2$
$\tilde{N}_1 = \langle 0.55, 0.50, 0.40\rangle$	Peng et al. [70]	$P\left(\tilde{N}_1\right) = P\left(\tilde{N}_2\right) = P\left(\tilde{N}_3\right) = 0.55$	$\tilde{N}_1 = \tilde{N}_2 = \tilde{N}_3$
$\tilde{N}_2 = \langle 0.55, 0.40, 0.50\rangle$			
$\tilde{N}_3 = \langle 0.75, 0.55, 0.50\rangle$	Proposed	$S\left(\tilde{N}_1\right) = 0.32,\ S\left(\tilde{N}_2\right) = 0.22\ S\left(\tilde{N}_3\right) = 0.37$	$\tilde{N}_3 > \tilde{N}_1 > \tilde{N}_2$

Definition 5.2. Let $\mathcal{U} = \{u_1, u_2, ..., u_m\}$ be the universal set. Let $\mathcal{P} = \{p_1, p_2, ..., p_n\}$ be set of parameters and $\mathcal{G} = \{1, 2, ..., \mathcal{N}\}$ be a set of rating scale. Then $SVN\mathcal{N}SS\ (\psi, \mathcal{J}, \mathcal{N})$ can be expressed in matrix form as,

$$N^*(\mathcal{N}) = \begin{array}{c} \\ u_1 \\ u_2 \\ \vdots \\ u_m \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & \cdots & p_n \end{array} \\ \begin{bmatrix} \langle g_{p_{11}}, s_{11}\rangle & \langle g_{p_{12}}, s_{12}\rangle & \cdots & \langle g_{p_{1n}}, s_{1n}\rangle \\ \langle g_{p_{21}}, s_{21}\rangle & \langle g_{p_{22}}, s_{22}\rangle & \cdots & \langle g_{p_{2n}}, s_{2n}\rangle \\ \vdots & \vdots & \ddots & \vdots \\ \langle g_{p_{m1}}, s_{m1}\rangle & \langle g_{p_{m2}}, s_{m2}\rangle & \cdots & \langle g_{p_{mn}}, s_{mn}\rangle \end{bmatrix} \end{array}$$

such that $N^*(\mathcal{N}) = \left\langle g_{p_{ij}}, s_{ij}\right\rangle,\ i = 1, 2, ..., m$ and $j = 1, 2, ..., n$. Then $N^*(\mathcal{N})$ is called an $m \times n$ single-valued neutrosophic $\mathcal{N}$-soft matrix ($SVN\mathcal{N}SM$) of the $SVN\mathcal{N}SS\ (\psi, \mathcal{J}, \mathcal{N})$.

Example 5.3. Consider a scenario where a mental health counselor (MHC) observes the behavior of students to understand their mental health conditions and provides the values in $SVNSM$ as in Example 2.7. Let's assume the MHC considers a 5 point rating scale (5-soft set) for positive and negative statements with the rating scale distribution as in Tables 5 and 6, respectively. The MHC can amend the values in Tables 5 and 6 as per their needs. The positive statements denote socially acceptable behavior and the negative statements denote socially deviant or problematic behavior. Here, let's assume that the MHC constructs positive statements for the parameters p_1 and p_3 and for p_2 - negative statement. Then, we compute the $N^*(\mathcal{N})$ for Example 3.2 as below.

Table 5. Showing the rating scale details

Positive statement	Negative statement
5	1
4	2
3	3
2	4
1	5

Table 6. Showing the rating scale distribution

Positive statement	Negative statement	Score values
5	1	$0.8 \leq s_{ij} \leq 1.0$
4	2	$0.6 \leq s_{ij} < 0.8$
3	3	$0.3 \leq s_{ij} < 0.6$
2	4	$0.0 \leq s_{ij} < 0.3$
1	5	$-0.5 \leq s_{ij} < 0.0$

$$N^*(5) = \begin{bmatrix} \langle 2, 0.18\rangle & \langle 3, 0.38\rangle & \langle 5, 0.83\rangle \\ \langle 3, 0.38\rangle & \langle 4, 0.03\rangle & \langle 2, 0.28\rangle \\ \langle 4, 0.65\rangle & \langle 4, 0.23\rangle & \langle 2, 0.05\rangle \end{bmatrix}$$

We shall show the significance of $N^*(\mathcal{N})$ in sections 6 and 7 with constructive examples.

6. To assess the mental health of students amidst *COVID-19* using *SVN𝒩SM*

$COVID-19$ has caused the entire world to a lockdown situation. For the progress of the world, it is vital to understand the mental health and psychosocial concerns of the students amidst this pandemic. To deal with this, we construct the concept of $SVN\mathcal{N}SM$, which supports to assess the mental condition of the individuals. In this section, we put forward a method to assess the condition of students amidst $COVID-19$ with an algorithm and flowchart. We explain the feasibility and validity of the application with real-life case studies in the following section.

Consider a scenario where an institution approaches the MHC and wishes to assess the mental health of its students amidst the pandemic, $COVID-19$. Let us assume that the MHC selects a partially standardized method like video conferencing or telephonic conversations to assess the students. Let $\mathcal{U} = \{s_1, s_2, ..., s_m\}$ denote the set of students and $\mathcal{E} = \{p_1, p_2, ..., p_n\}$ the set of parameters to assess the psychosocial conditions. Let us assume the MHC gets in touch with a team of psychiatrist experts and frames the following details namely; positive and negative statements for parameters, rating scales with distribution criteria as in Table

6, weightage criteria to assess the parameters, scoring keys, and mental health norms as in Table 7. These details should be chosen wisely and with extra cautiousness since it plays a significant role in describing the risk level of the students. Also, we signify that high scoring students are under risk and require immediate attention or treatment.

The MHC based on each question, say $r = \{1, 2, ..., k\}$ evaluates the students by considering the parameters and present the results in the form of neutrosophic matrices, N_r^* of order $m \times n$. Now, we have to assess the mental health of the student with the help of pre-determined scores and norms.

6.1. *Methodology to assess the mental health of the students*

Construct the $SVNSMs$, N_r^*, $r = \{1, 2, ..., k\}$ for each positive or negative statement by observing or understanding the behavior of the student based on the parameters. Apply SF Definition 3.1, to the $SVNSMs$ and represent the resultant matrices by $S(N_r^*)$, $r = \{1, 2, ..., k\}$. If weightage criteria are to be considered for each parameter, then calculate $WS(N_r^*)$ by using Definition 3.3. Now compare the entries in each $S(N_r^*)$ or in $WS(N_r^*)$ matrix and construct the $N_r^*(\mathcal{N})$ as below by using Definition 5.2. Also, with the help of the framed rating scale distribution.

$$N_r^*(\mathcal{N}) = \begin{array}{c} \\ s_1 \\ \\ s_2 \\ \vdots \\ s_m \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & \cdots & p_n \end{array} \\ \begin{bmatrix} \langle g^r_{p_{11}}, s^r_{11} \rangle & \langle g^r_{p_{12}}, s^r_{12} \rangle & \cdots & \langle g^r_{p_{1n}}, s^r_{1n} \rangle \\ \\ \langle g^r_{p_{21}}, s^r_{21} \rangle & \langle g^r_{p_{22}}, s^r_{22} \rangle & \cdots & \langle g^r_{p_{2n}}, s^r_{2n} \rangle \\ \vdots & \vdots & \ddots & \vdots \\ \langle g^r_{p_{m1}}, s^r_{m1} \rangle & \langle g^r_{p_{m2}}, s^r_{m2} \rangle & \cdots & \langle g^r_{p_{mn}}, s^r_{mn} \rangle \end{bmatrix} \end{array},$$

where $r = \{1, 2, ..., k\}$.

Determine the $N_+^*(\mathcal{N})$ matrix as below by adding the corresponding entries of $N_1^*(\mathcal{N}), N_2^*(\mathcal{N}), ..., N_k^*(\mathcal{N})$ matrices.

$$N_+^*(\mathcal{N}) = \begin{array}{c} \\ s_1 \\ \\ s_2 \\ \vdots \\ s_m \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & \cdots & p_n \end{array} \\ \begin{bmatrix} g^+_{p_{11}} & g^+_{p_{12}} & \cdots & g^+_{p_{1n}} \\ \\ g^+_{p_{21}} & g^+_{p_{22}} & \cdots & g^+_{p_{2n}} \\ \vdots & \vdots & \ddots & \vdots \\ g^+_{p_{m1}} & g^+_{p_{m2}} & \cdots & g^+_{p_{mn}} \end{bmatrix} \end{array} \begin{array}{c} \\ \sum_{j=1}^n g^+_{p_{1j}} \\ \\ \sum_{j=1}^n g^+_{p_{2j}} \\ \vdots \\ \sum_{j=1}^n g^+_{p_{mj}} \end{array},$$

where

$g^+_{p_{11}} = \sum_{r=1}^k g^r_{p_{11}}$, $g^+_{p_{12}} = \sum_{r=1}^k g^r_{p_{12}}$ and $g^+_{p_{1n}} = \sum_{r=1}^k g^r_{p_{1n}}$.

$g^+_{p_{21}} = \sum_{r=1}^k g^r_{p_{21}}$, $g^+_{p_{22}} = \sum_{r=1}^k g^r_{p_{22}}$ and $g^+_{p_{2n}} = \sum_{r=1}^k g^r_{p_{2n}}$.

similarly,
$g^{+}_{pm1} = \sum_{r=1}^{k} g^{r}_{pm1}$, $g^{+}_{pm2} = \sum_{r=1}^{k} g^{r}_{pm2}$ and $g^{+}_{pmn} = \sum_{r=1}^{k} g^{r}_{pmn}$.

Now assess the risk level for each parameter as well for the overall by using the level norms. If the student attains a low-risk level, then he/she does not require psychological treatment. If otherwise, then MHC should start the remedy process for the students who show a high-risk level towards psychosocial conditions.

Table 7. Shows the qualitative norm details

Parameter	Scores	Norms
p_1, p_4	1-13	low
	14-25	average (avg)
	26-35	high
p_2, p_3	1-15	low
	16-24	avg
	25-30	high
Total	1-56	low
	57-97	avg
	98-130	high

6.2. *Algorithm to assess the mental health of students*

The following steps facilitate the MHC to assess the mental health of students in a better way.

Step 1: MHC identifies the problem, selects the students and the parameters.

Step 2: MHC involves a psychiatrist to frame the required details namely; positive and negative statements, rating scale with distribution, scoring keys and risk level.

Step 3: Constructs N_i^*, where $i = \{1, 2, ..., k\}$ matrices for each question by observing the behavior of the students.

Step 4: Evaluates SN_i^* and WSN_i^* by using Definition 3.1 and 3.3 respectively.

Step 5: Constructs $N_i^*(\mathcal{N})$ by comparing it with rating scale and distribution details.

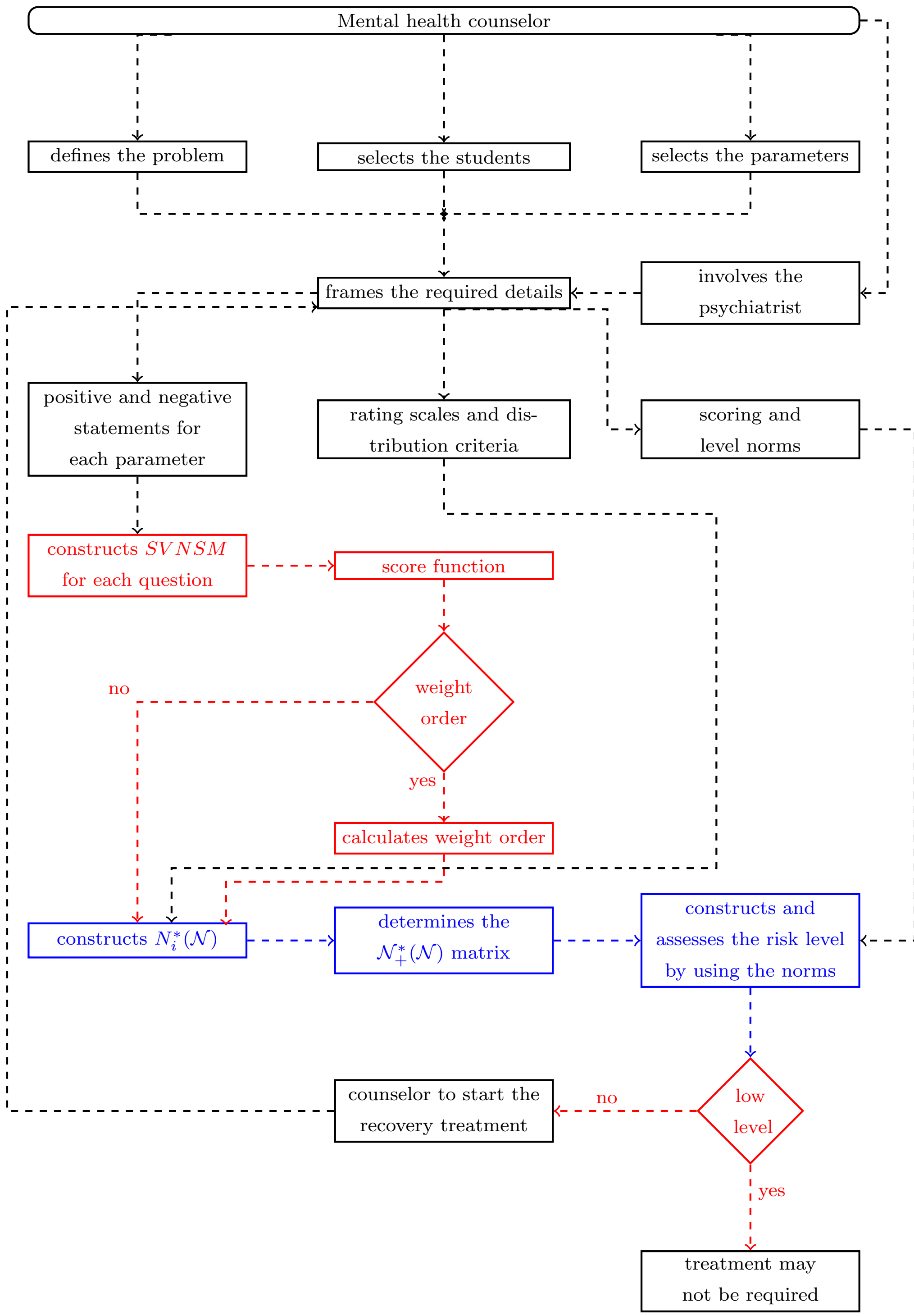
Step 6: Determines $N_+^*(\mathcal{N})$ matrix by summing the corresponding entries of $N_1^*(\mathcal{N}), N_2^*(\mathcal{N}), ..., N_k^*(\mathcal{N})$ matrices.

Step 7: Tabulates and assesses the mental health risk level by using scoring keys and risk level norms.

Step 8: Start the treatment process, if the risk level is found to be high for the students.

6.3. *Flowchart for single-valued neutrosophic $\mathcal{N}$-soft matrix*

In this subsection, we depict the flow of the problem to assess the mental health of students. A step by step process is shown below to understand the nature and the complexity of the problem.



7. Case Studies using $SVNNSM$

In this section, we present two case studies with ill-structured problems faced by the students amidst $COVID-19$. In the Case study Ia, the MHC tries to identify the students who show high-risk level towards mental illness and requires immediate attention. In this illustration, two students are at a high-risk level towards mental illness and require counseling or treatment to overcome the same. In the Case study Ib, MHC starts the process after counseling sessions for the students, who showed a high-risk level in the Case study Ia. After following the same method, we show that the two students are at low-risk levels and have shown progress towards the counseling or the treatment. In the Case study II, we discuss the same process by using $WSVNV$ and show all the students are at an average-risk level towards overall mental health score.

7.1. *Case study Ia*

Let us assume an institution approaches a professional MHC to assess the mental health and psychosocial aspects of the students.

Step 1: Suppose that $\mathcal{U} = \{s_1, s_2, s_3, s_4\}$ be the set of students and $\mathcal{P} = \{p_1, p_2, p_3, p_4\}$ be the set of parameters where p_1= avoiding social activities (ASA), p_2= thinking about suicide (TAS), p_3= extreme mood changes (EMC) and p_4 = stress.

Step 2: The MHC in liaison with the psychiatrist frames seven questions for the parameters p_1 and p_4 and six questions for the parameters p_2 and p_3. For the parameter p_1, question numbers three and six are positive statements and others are negative statements. For the parameter p_2, question number two is a negative statement and others are positive statements. For the parameter p_3, question numbers five and six are positive statements and others are negative statements. Finally, for the parameter p_4, question numbers one, two, and seven are positive statements, and others are negative statements. We provide the above information in a tabular form(Table 8).

Table 8. Shows the positive (pos) and negative (neg) statement details

	q_1	q_2	q_3	q_4	q_5	q_6	q_7
p_1	neg	neg	pos	neg	neg	pos	neg
p_2	pos	neg	pos	pos	pos	pos	-
p_3	neg	neg	neg	neg	pos	pos	-
p_4	pos	pos	neg	neg	neg	neg	pos

Let's assume a 5 point rating scale (5-soft set) for positive and negative statements as in Table 5, the rating scale distribution as in Table 6 and the norms for each parameter and overall parameters as in Table 7.

Step 3: The MHC observes or understands the behavior of each student based on the framed statements and records the values in neutrosophic form, N_i^*, where $i = \{1, 2, ...7\}$ represent the number of questions, for each parameter. The highlighted values in the N_1^*, N_2^*, N_3^*, N_4^*, N_5^*, N_6^* and N_7^* matrices show the values of negative statements for easy understanding and scoring procedures.

$$N_1^* = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 0.90, 0.95, 0.05\rangle & \langle 0.90, 0.80, 0.35\rangle & \langle 0.88, 0.75, 0.12\rangle & \langle 0.71, 0.25, 0.45\rangle \\ \langle 0.45, 0.35, 0.20\rangle & \langle 0.78, 0.68, 0.36\rangle & \langle 0.45, 0.25, 0.35\rangle & \langle 0.90, 0.82, 0.45\rangle \\ \langle 0.24, 0.20, 0.05\rangle & \langle 0.90, 0.15, 0.35\rangle & \langle 0.89, 0.22, 0.32\rangle & \langle 0.12, 0.25, 0.10\rangle \\ \langle 0.45, 0.35, 0.55\rangle & \langle 0.90, 0.85, 0.10\rangle & \langle 0.25, 0.35, 0.25\rangle & \langle 0.80, 0.85, 0.35\rangle \end{bmatrix} \end{array}$$

$$N_2^* = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 0.98, 0.95, 0.10\rangle & \langle 0.90, 0.95, 0.10\rangle & \langle 0.90, 0.85, 0.12\rangle & \langle 0.75, 0.25, 0.55\rangle \\ \langle 0.35, 0.25, 0.35\rangle & \langle 0.55, 0.30, 0.15\rangle & \langle 0.60, 0.55, 0.58\rangle & \langle 0.70, 0.88, 0.12\rangle \\ \langle 0.98, 0.95, 0.10\rangle & \langle 0.48, 0.32, 0.35\rangle & \langle 0.78, 0.42, 0.45\rangle & \langle 0.16, 0.12, 0.13\rangle \\ \langle 0.55, 0.61, 0.23\rangle & \langle 0.33, 0.20, 0.15\rangle & \langle 0.10, 0.45, 0.50\rangle & \langle 0.90, 0.75, 0.05\rangle \end{bmatrix} \end{array}$$

$$N_3^* = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 0.80, 0.60, 0.10\rangle & \langle 0.10, 0.20, 0.25\rangle & \langle 0.91, 0.81, 0.10\rangle & \langle 0.88, 0.78, 0.30\rangle \\ \langle 0.75, 0.65, 0.10\rangle & \langle 0.88, 0.91, 0.05\rangle & \langle 0.25, 0.35, 0.33\rangle & \langle 0.35, 0.55, 0.15\rangle \\ \langle 0.80, 0.60, 0.10\rangle & \langle 0.40, 0.50, 0.20\rangle & \langle 0.45, 0.55, 0.25\rangle & \langle 0.30, 0.20, 0.45\rangle \\ \langle 0.89, 0.79, 0.10\rangle & \langle 0.85, 0.75, 0.35\rangle & \langle 0.15, 0.24, 0.10\rangle & \langle 0.30, 0.20, 0.35\rangle \end{bmatrix} \end{array}$$

$$N_4^* = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 0.90, 0.54, 0.10\rangle & \langle 0.25, 0.45, 0.25\rangle & \langle 0.75, 0.35, 0.16\rangle & \langle 0.87, 0.67, 0.25\rangle \\ \langle 0.25, 0.20, 0.10\rangle & \langle 0.91, 0.88, 0.16\rangle & \langle 0.55, 0.30, 0.45\rangle & \langle 0.48, 0.57, 0.25\rangle \\ \langle 0.90, 0.54, 0.10\rangle & \langle 1.00, 1.00, 0.00\rangle & \langle 0.10, 0.45, 0.20\rangle & \langle 0.65, 0.45, 0.55\rangle \\ \langle 0.15, 0.35, 0.45\rangle & \langle 0.88, 0.78, 0.25\rangle & \langle 0.25, 0.15, 0.10\rangle & \langle 0.45, 0.65, 0.35\rangle \end{bmatrix} \end{array}$$

$$N_5^* = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 0.79, 0.99, 0.10\rangle & \langle 0.25, 0.75, 0.85\rangle & \langle 0.75, 0.10, 0.25\rangle & \langle 0.78, 0.86, 0.25\rangle \\ \langle 0.25, 0.35, 0.40\rangle & \langle 0.77, 0.66, 0.21\rangle & \langle 0.92, 0.93, 0.22\rangle & \langle 0.38, 0.48, 0.19\rangle \\ \langle 0.79, 0.99, 0.10\rangle & \langle 0.75, 0.65, 0.42\rangle & \langle 0.90, 0.85, 0.10\rangle & \langle 0.28, 0.25, 0.46\rangle \\ \langle 0.35, 0.45, 0.55\rangle & \langle 0.88, 0.77, 0.25\rangle & \langle 0.85, 0.75, 0.15\rangle & \langle 0.15, 0.35, 0.45\rangle \end{bmatrix} \end{array}$$

$$N_6^* = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 0.35, 0.40, 0.30\rangle & \langle 0.55, 0.45, 0.80\rangle & \langle 0.74, 0.55, 0.09\rangle & \langle 0.88, 0.78, 0.05\rangle \\ \langle 0.30, 0.32, 0.21\rangle & \langle 0.65, 0.75, 0.19\rangle & \langle 0.55, 0.50, 0.40\rangle & \langle 0.55, 0.15, 0.35\rangle \\ \langle 0.35, 0.40, 0.30\rangle & \langle 0.70, 0.50, 0.40\rangle & \langle 0.65, 0.60, 0.50\rangle & \langle 0.45, 0.20, 0.21\rangle \\ \langle 0.79, 0.89, 0.27\rangle & \langle 0.80, 0.75, 0.35\rangle & \langle 0.85, 0.75, 0.40\rangle & \langle 0.75, 0.55, 0.30\rangle \end{bmatrix} \end{array}$$

Given that there are only six questions for p_2 and p_3, we exclude these two parameters in N_7^*.

$$N_7^* = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cc} p_1 & p_4 \end{array} \\ \begin{bmatrix} \langle 0.95, 0.85, 0.10\rangle & \langle 0.27, 0.21, 0.09\rangle \\ \langle 0.20, 0.10, 0.05\rangle & \langle 0.85, 0.75, 0.25\rangle \\ \langle 0.95, 0.85, 0.10\rangle & \langle 0.80, 0.70, 0.10\rangle \\ \langle 0.45, 0.25, 0.35\rangle & \langle 0.25, 0.85, 0.25\rangle \end{bmatrix} \end{array}$$

Step 4: By applying SF Definition 3.1, we get the following values in matrices form.

$$S(N_1^*) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} 0.900 & 0.675 & 0.755 & 0.255 \\ 0.300 & 0.550 & 0.175 & 0.635 \\ 0.195 & 0.350 & 0.395 & 0.135 \\ 0.125 & 0.825 & 0.175 & 0.650 \end{bmatrix} \end{array} S(N_2^*) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} 0.915 & 0.875 & 0.815 & 0.225 \\ 0.125 & 0.350 & 0.285 & 0.730 \\ 0.915 & 0.225 & 0.375 & 0.074 \\ 0.465 & 0.190 & 0.025 & 0.800 \end{bmatrix} \end{array}$$

$$S(N_3^*) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} 0.650 & 0.025 & 0.810 & 0.680 \\ 0.650 & 0.870 & 0.135 & 0.375 \\ 0.650 & 0.350 & 0.375 & 0.025 \\ 0.790 & 0.625 & 0.145 & 0.075 \end{bmatrix} \end{array} S(N_4^*) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} 0.670 & 0.225 & 0.470 & 0.645 \\ 0.175 & 0.815 & 0.200 & 0.400 \\ 0.670 & 1.000 & 0.175 & 0.275 \\ 0.025 & 0.705 & 0.150 & 0.375 \end{bmatrix} \end{array}$$

$$S(N_5^*) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} 0.840 & 0.075 & 0.300 & 0.695 \\ 0.100 & 0.610 & 0.815 & 0.335 \\ 0.840 & 0.490 & 0.825 & 0.035 \\ 0.125 & 0.700 & 0.725 & 0.025 \end{bmatrix} \end{array} S(N_6^*) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} 0.225 & 0.100 & 0.600 & 0.805 \\ 0.205 & 0.605 & 0.325 & 0.175 \\ 0.225 & 0.400 & 0.375 & 0.220 \\ 0.705 & 0.600 & 0.600 & 0.500 \end{bmatrix} \end{array}$$

and

$$S(N_7^*) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cc} p_1 & p_4 \end{array} \\ \begin{bmatrix} 0.850 & 0.195 \\ 0.125 & 0.675 \\ 0.850 & 0.700 \\ 0.175 & 0.425 \end{bmatrix} \end{array}$$

Step 5: Now by comparing the score values with Table 6, rating scale distribution and by using Definition 5.2, we obtain the following values in matrices form.

$$N_1^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 1, 0.900\rangle & \langle 4, 0.675\rangle & \langle 2, 0.755\rangle & \langle 2, 0.255\rangle \\ \langle 3, 0.300\rangle & \langle 3, 0.550\rangle & \langle 4, 0.175\rangle & \langle 4, 0.635\rangle \\ \langle 4, 0.195\rangle & \langle 3, 0.350\rangle & \langle 3, 0.395\rangle & \langle 2, 0.135\rangle \\ \langle 4, 0.125\rangle & \langle 5, 0.825\rangle & \langle 4, 0.175\rangle & \langle 4, 0.650\rangle \end{bmatrix} \end{array}$$

$$N_2^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 1, 0.915\rangle & \langle 1, 0.875\rangle & \langle 1, 0.815\rangle & \langle 2, 0.225\rangle \\ \langle 4, 0.125\rangle & \langle 3, 0.350\rangle & \langle 4, 0.285\rangle & \langle 4, 0.730\rangle \\ \langle 1, 0.915\rangle & \langle 4, 0.225\rangle & \langle 3, 0.375\rangle & \langle 2, 0.074\rangle \\ \langle 3, 0.465\rangle & \langle 4, 0.190\rangle & \langle 4, 0.025\rangle & \langle 5, 0.800\rangle \end{bmatrix} \end{array}$$

$$N_3^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 4, 0.650\rangle & \langle 2, 0.025\rangle & \langle 1, 0.810\rangle & \langle 2, 0.680\rangle \\ \langle 4, 0.650\rangle & \langle 5, 0.870\rangle & \langle 4, 0.135\rangle & \langle 3, 0.375\rangle \\ \langle 4, 0.650\rangle & \langle 3, 0.350\rangle & \langle 3, 0.375\rangle & \langle 4, 0.025\rangle \\ \langle 4, 0.790\rangle & \langle 4, 0.625\rangle & \langle 4, 0.145\rangle & \langle 4, 0.075\rangle \end{bmatrix} \end{array}$$

$$N_4^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 2, 0.670\rangle & \langle 2, 0.225\rangle & \langle 3, 0.470\rangle & \langle 2, 0.645\rangle \\ \langle 4, 0.175\rangle & \langle 5, 0.815\rangle & \langle 4, 0.200\rangle & \langle 3, 0.400\rangle \\ \langle 2, 0.670\rangle & \langle 5, 1.000\rangle & \langle 4, 0.175\rangle & \langle 4, 0.275\rangle \\ \langle 4, 0.025\rangle & \langle 4, 0.705\rangle & \langle 4, 0.150\rangle & \langle 3, 0.375\rangle \end{bmatrix} \end{array}$$

$$N_5^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 1, 0.840\rangle & \langle 2, 0.075\rangle & \langle 3, 0.300\rangle & \langle 2, 0.695\rangle \\ \langle 4, 0.100\rangle & \langle 4, 0.610\rangle & \langle 5, 0.815\rangle & \langle 3, 0.335\rangle \\ \langle 1, 0.840\rangle & \langle 3, 0.490\rangle & \langle 5, 0.825\rangle & \langle 4, 0.035\rangle \\ \langle 4, 0.125\rangle & \langle 4, 0.700\rangle & \langle 4, 0.725\rangle & \langle 4, 0.025\rangle \end{bmatrix} \end{array}$$

$$N_6^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 2, 0.225\rangle & \langle 2, 0.100\rangle & \langle 4, 0.600\rangle & \langle 1, 0.805\rangle \\ \langle 2, 0.205\rangle & \langle 4, 0.605\rangle & \langle 3, 0.325\rangle & \langle 4, 0.175\rangle \\ \langle 2, 0.225\rangle & \langle 3, 0.400\rangle & \langle 3, 0.375\rangle & \langle 4, 0.220\rangle \\ \langle 4, 0.705\rangle & \langle 4, 0.600\rangle & \langle 4, 0.600\rangle & \langle 3, 0.500\rangle \end{bmatrix} \end{array} \text{and}$$

$$N_7^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cc} p_1 & p_4 \end{array} \\ \begin{bmatrix} \langle 1, 0.850\rangle & \langle 2, 0.195\rangle \\ \langle 4, 0.125\rangle & \langle 4, 0.675\rangle \\ \langle 1, 0.850\rangle & \langle 4, 0.700\rangle \\ \langle 4, 0.175\rangle & \langle 3, 0.425\rangle \end{bmatrix} \end{array}$$

Step 6: Determine $N_+^*(5)$ matrix by summing the corresponding entries of $N_1^*(\mathcal{N}), N_2^*(\mathcal{N}), ..., N_7^*(\mathcal{N})$ matrices.

$$N_+^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} 12 & 13 & 14 & 13 \\ 25 & 24 & 24 & 25 \\ 15 & 21 & 21 & 24 \\ 27 & 25 & 24 & 26 \end{bmatrix} \end{array} \begin{array}{c} \\ 52 \\ 98 \\ 81 \\ 102 \end{array}$$

Step 7: Tabulate the details as in Table 9 and assess the risk level of the students by using the norm details (Table 7).

Analysis: From Table 9, we suggest that for s_1, the risk level is low for each parameter and also for the combined parameter scores, which signify that s_1 does not experience any mental illness and may not require any treatment from MHC. For s_2, the risk level is average for each parameter and high for the combined parameter scores. Although the risk level is

TABLE 9. Shows students' mental health scores and levels for the parameters

s_i	p_1		p_2		p_3		p_4		$Total$	
	score	**level**	**score**	**level**	**score**	**level**	**score**	**level**	**score**	**level**
s_1	12	low	13	low	14	low	13	low	52	low
s_2	25	avg	24	avg	24	avg	25	avg	98	high
s_3	15	avg	21	avg	21	avg	24	avg	81	avg
s_4	27	high	25	high	24	avg	26	high	102	high

average for s_2 in each parameter, the total score is 98, which signifies that s_2 may require the help of the MHC or the psychiatrist to lower the risk level of mental illness. For s_3, the risk level is average for each parameter and also for the combined parameter scores, which signify that s_3 may not experience any mental illness. For s_4, excluding p_3, the risk level is high for other parameters as well for the combined parameter scores, which signifies that s_4 requires aid from the MHC or the psychiatrist to lower the mental illness. Hence, in this study, we analyze the mental health of the students in a traditional method by using $SV\mathcal{NN}SS$.

7.2. *Case study Ib*

In this case study, we select the two students from case study 1a, who show high-risk level towards mental health. Let's assume that MHC records the details after the counseling or the treatment.

Step 1: Consider $\mathcal{U} = \{s_2, s_4\}$ be the set of students who are at high risk level towards mental health and $\mathcal{P} = \{p_1, p_2, p_3, p_4\}$ be the same set of parameters as in earlier case.

Step 2: Let's assume that MHC provides positive and negative information as in Table 10. Let the rating scale distribution and the norms be as in Table 6 and 7.

TABLE 10. Shows the positive (pos) and negative (neg) statement details

	q_1	q_2	q_3	q_4	q_5
p_1	pos	neg	pos	neg	pos
p_2	pos	pos	pos	pos	neg
p_3	neg	pos	pos	pos	pos
p_4	pos	pos	neg	pos	pos

Step 3: The MHC observes the behavior of s_2 and s_4 based on the new set of framed statements and records the values in neutrosophic form, N_i^*, where $i = \{1, 2, ...5\}$ represent the number of questions, for each parameter. The highlighted values in the N_1^*, N_2^*, N_3^*, N_4^* and N_5^* matrices show the values of negative statements.

$$N_1^* = \begin{array}{c} \\ s_2 \\ s_4 \end{array}\begin{array}{c} \begin{array}{cccc} \quad p_1 \quad & \quad p_2 \quad & \quad p_3 \quad & \quad p_4 \quad \end{array} \\ \begin{bmatrix} \langle 0.35, 0.40, 0.25\rangle & \langle 0.67, 0.78, 0.36\rangle & \langle 0.90, 0.85, 0.35\rangle & \langle 0.85, 0.95, 0.40\rangle \\ \langle 0.25, 0.35, 0.19\rangle & \langle 0.65, 0.55, 0.15\rangle & \langle 0.87, 0.88, 0.20\rangle & \langle 0.45, 0.55, 0.45\rangle \end{bmatrix} \end{array}$$

$$N_2^* = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_2 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.88, 0.98, 0.15\rangle & \langle 0.20, 0.30, 0.10\rangle & \langle 0.35, 0.45, 0.58\rangle & \langle 0.41, 0.51, 0.12\rangle \\ \langle 0.88, 0.75, 0.23\rangle & \langle 0.35, 0.25, 0.15\rangle & \langle 0.45, 0.55, 0.32\rangle & \langle 0.25, 0.35, 0.05\rangle \end{bmatrix} \end{array}$$

$$N_3^* = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_2 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.45, 0.55, 0.10\rangle & \langle 0.55, 0.23, 0.10\rangle & \langle 0.20, 0.30, 0.31\rangle & \langle 0.35, 0.45, 0.10\rangle \\ \langle 0.69, 0.79, 0.15\rangle & \langle 0.66, 0.77, 0.24\rangle & \langle 0.20, 0.34, 0.21\rangle & \langle 0.88, 0.78, 0.22\rangle \end{bmatrix} \end{array}$$

$$N_4^* = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_2 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.88, 0.78, 0.10\rangle & \langle 0.34, 0.45, 0.10\rangle & \langle 0.45, 0.32, 0.25\rangle & \langle 0.34, 0.45, 0.10\rangle \\ \langle 0.88, 0.91, 0.45\rangle & \langle 0.45, 0.78, 0.35\rangle & \langle 0.28, 0.48, 0.15\rangle & \langle 0.45, 0.70, 0.30\rangle \end{bmatrix} \end{array}$$

$$N_5^* = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_2 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.25, 0.35, 0.40\rangle & \langle 0.38, 0.48, 0.19\rangle & \langle 0.34, 0.45, 0.22\rangle & \langle 0.77, 0.66, 0.21\rangle \\ \langle 0.38, 0.45, 0.48\rangle & \langle 0.35, 0.35, 0.40\rangle & \langle 0.80, 0.75, 0.20\rangle & \langle 0.78, 0.70, 0.25\rangle \end{bmatrix} \end{array}$$

Step 4: By applying SF Definition 3.1, we get the following values in matrices form.

$$S(N_1^*) = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_2 \\ s_4 \end{array} & \begin{bmatrix} 0.250 & 0.545 & 0.700 & 0.700 \\ 0.205 & 0.525 & 0.775 & 0.275 \end{bmatrix} \end{array} S(N_2^*) = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_2 \\ s_4 \end{array} & \begin{bmatrix} 0.855 & 0.200 & 0.110 & 0.400 \\ 0.700 & 0.225 & 0.340 & 0.275 \end{bmatrix} \end{array}$$

$$S(N_3^*) = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_2 \\ s_4 \end{array} & \begin{bmatrix} 0.450 & 0.340 & 0.095 & 0.350 \\ 0.665 & 0.595 & 0.165 & 0.720 \end{bmatrix} \end{array} S(N_4^*) = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_2 \\ s_4 \end{array} & \begin{bmatrix} 0.780 & 0.345 & 0.260 & 0.345 \\ 0.670 & 0.440 & 0.305 & 0.425 \end{bmatrix} \end{array}$$

$$S(N_5^*) = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_2 \\ s_4 \end{array} & \begin{bmatrix} 0.100 & 0.335 & 0.285 & 0.610 \\ 0.175 & 0.150 & 0.675 & 0.615 \end{bmatrix} \end{array}$$

Step 5: Now by comparing the score values with Table 6, rating scale distribution and by using Definition 5.2, we obtain the following values in matrices form.

$$N_1^*(5) = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_2 \\ s_4 \end{array} & \begin{bmatrix} \langle 2, 0.250\rangle & \langle 3, 0.545\rangle & \langle 2, 0.700\rangle & \langle 4, 0.700\rangle \\ \langle 2, 0.205\rangle & \langle 3, 0.525\rangle & \langle 2, 0.775\rangle & \langle 2, 0.275\rangle \end{bmatrix} \end{array}$$

$$N_2^*(5) = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_2 \\ s_4 \end{array} & \begin{bmatrix} \langle 1, 0.855\rangle & \langle 2, 0.200\rangle & \langle 2, 0.110\rangle & \langle 3, 0.400\rangle \\ \langle 2, 0.700\rangle & \langle 2, 0.225\rangle & \langle 3, 0.340\rangle & \langle 2, 0.275\rangle \end{bmatrix} \end{array}$$

$$N_3^*(5) = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_2 \\ s_4 \end{array} & \begin{bmatrix} \langle 3, 0.450\rangle & \langle 3, 0.340\rangle & \langle 2, 0.095\rangle & \langle 3, 0.350\rangle \\ \langle 4, 0.665\rangle & \langle 3, 0.595\rangle & \langle 2, 0.165\rangle & \langle 2, 0.720\rangle \end{bmatrix} \end{array}$$

$$N_4^*(5) = \begin{array}{c} \\ s_2 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 2, 0.780\rangle & \langle 3, 0.345\rangle & \langle 2, 0.260\rangle & \langle 3, 0.345\rangle \\ \langle 2, 0.670\rangle & \langle 3, 0.440\rangle & \langle 3, 0.305\rangle & \langle 3, 0.425\rangle \end{bmatrix} \end{array}$$

$$N_5^*(5) = \begin{array}{c} \\ s_2 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 2, 0.100\rangle & \langle 3, 0.335\rangle & \langle 2, 0.285\rangle & \langle 4, 0.610\rangle \\ \langle 2, 0.175\rangle & \langle 4, 0.150\rangle & \langle 4, 0.675\rangle & \langle 4, 0.615\rangle \end{bmatrix} \end{array}$$

Step 6: Determine $N_+^*(5)$ matrix by summing the corresponding entries of $N_1^*(\mathcal{N}), N_2^*(\mathcal{N}), ..., N_5^*(\mathcal{N})$ matrices.

$$N_+^*(5) = \begin{array}{c} \\ s_2 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} 10 & 14 & 10 & 17 \\ 12 & 15 & 14 & 13 \end{bmatrix} \end{array} \begin{array}{c} \\ 51 \\ 54 \end{array}$$

Step 7: Tabulate the details as in Table 11 and assess the risk level of the two students.

TABLE 11. Shows students' mental health scores and levels for each parameter

s_i	p_1		p_2		p_3		p_4		$Total$	
	score	**level**	**score**	**level**	**score**	**level**	**score**	**level**	**score**	**level**
s_2	10	low	14	low	10	low	17	avg	51	low
s_4	12	low	15	low	14	low	13	low	54	low

Analysis: From Tables 9 and 11, we infer that for the parameter ASA, the student s_2 had an initial score of 25 with an average-risk level towards mental illness. After the remedy process, the student has attained a score of 10 with a low-risk for the same parameter. Likewise, for other parameters, TAS, EMC, and stress, in the initial stages, the scores are 24, 24, and 25, respectively, with an average-risk level. After the treatment, we find the scores are 14 and 10, with low-risk for the parameters TAS and EMC. For the parameter stress, the score is 17 and has attained an average-risk level. Similarly, the student s_4 showed a high risk with an initial score of 27 for the parameter ASA. After the treatment, a score of 12 with low-risk for the same parameter. Likewise, for other parameters, TAS, EMC, and stress, in the initial stages, the scores are 25, high risk, 24, average risk, and 26, high risk, respectively. After the treatment, we observe that for parameters TAS, EMC, and stress, the scores are 15, 14, and 13, with low-risk levels, respectively. Hence, we conclude that both the students have attained a low-level risk score of 51 and 54, respectively, towards mental illness and have responded well to the treatment.

7.3. *Case study II*

Let us consider the same example as in case study Ia. Let $W = (0.45, 0.15, 0.25, 0.15)$ be the weight vector assigned by the MHC to the parameters. Refer section 7.1, for steps 1 to 4 data information. In this section, we explain the method when MHC uses criteria weights.

Step 4: By applying $WSVNV$ Definition 3.3, we get the values in matrices as below.

$$WS(N_1^*) = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.405 & 0.101 & 0.189 & 0.038 \\ s_2 & 0.135 & 0.083 & 0.044 & 0.095 \\ s_3 & 0.088 & 0.053 & 0.099 & 0.020 \\ s_4 & 0.056 & 0.124 & 0.044 & 0.098 \end{array} \quad WS(N_2^*) = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.412 & 0.131 & 0.204 & 0.034 \\ s_2 & 0.056 & 0.053 & 0.071 & 0.110 \\ s_3 & 0.412 & 0.034 & 0.094 & 0.011 \\ s_4 & 0.209 & 0.029 & 0.006 & 0.120 \end{array}$$

$$WS(N_3^*) = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.293 & 0.004 & 0.203 & 0.102 \\ s_2 & 0.293 & 0.131 & 0.034 & 0.056 \\ s_3 & 0.293 & 0.053 & 0.094 & 0.004 \\ s_4 & 0.356 & 0.094 & 0.036 & 0.011 \end{array} \quad WS(N_4^*) = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.302 & 0.034 & 0.118 & 0.097 \\ s_2 & 0.079 & 0.122 & 0.050 & 0.060 \\ s_3 & 0.302 & 0.150 & 0.044 & 0.041 \\ s_4 & 0.011 & 0.106 & 0.038 & 0.056 \end{array}$$

$$WS(N_5^*) = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.378 & 0.011 & 0.075 & 0.104 \\ s_2 & 0.045 & 0.092 & 0.204 & 0.050 \\ s_3 & 0.378 & 0.074 & 0.206 & 0.005 \\ s_4 & 0.056 & 0.105 & 0.181 & 0.004 \end{array} \quad WS(N_6^*) = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.101 & 0.015 & 0.150 & 0.121 \\ s_2 & 0.092 & 0.091 & 0.081 & 0.026 \\ s_3 & 0.101 & 0.060 & 0.094 & 0.033 \\ s_4 & 0.317 & 0.090 & 0.150 & 0.075 \end{array}$$

and

$$WS(N_7^*) = \begin{array}{c|cc} & p_1 & p_4 \\ \hline s_1 & 0.383 & 0.029 \\ s_2 & 0.056 & 0.101 \\ s_3 & 0.383 & 0.105 \\ s_4 & 0.079 & 0.064 \end{array}$$

Step 5: By comparing the $WSVNV$ values with Table 6, rating scale distribution and by using Definition 5.2, we obtain the following values in matrices form.

$$N_1^*(5) = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & \langle 3, 0.405\rangle & \langle 2, 0.101\rangle & \langle 4, 0.189\rangle & \langle 2, 0.038\rangle \\ s_2 & \langle 4, 0.135\rangle & \langle 2, 0.083\rangle & \langle 4, 0.044\rangle & \langle 2, 0.095\rangle \\ s_3 & \langle 4, 0.088\rangle & \langle 2, 0.053\rangle & \langle 4, 0.099\rangle & \langle 2, 0.020\rangle \\ s_4 & \langle 4, 0.056\rangle & \langle 2, 0.124\rangle & \langle 4, 0.044\rangle & \langle 2, 0.098\rangle \end{array}$$

$$N_2^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 3, 0.412 \rangle & \langle 4, 0.131 \rangle & \langle 4, 0.204 \rangle & \langle 2, 0.034 \rangle \\ \langle 4, 0.056 \rangle & \langle 4, 0.053 \rangle & \langle 4, 0.071 \rangle & \langle 2, 0.110 \rangle \\ \langle 3, 0.412 \rangle & \langle 4, 0.034 \rangle & \langle 4, 0.094 \rangle & \langle 2, 0.011 \rangle \\ \langle 4, 0.209 \rangle & \langle 4, 0.029 \rangle & \langle 4, 0.006 \rangle & \langle 2, 0.120 \rangle \end{bmatrix} \end{array}$$

$$N_3^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 2, 0.293 \rangle & \langle 2, 0.004 \rangle & \langle 4, 0.203 \rangle & \langle 4, 0.102 \rangle \\ \langle 2, 0.293 \rangle & \langle 2, 0.131 \rangle & \langle 4, 0.034 \rangle & \langle 4, 0.056 \rangle \\ \langle 2, 0.293 \rangle & \langle 2, 0.053 \rangle & \langle 4, 0.094 \rangle & \langle 4, 0.004 \rangle \\ \langle 3, 0.356 \rangle & \langle 2, 0.094 \rangle & \langle 4, 0.036 \rangle & \langle 4, 0.011 \rangle \end{bmatrix} \end{array}$$

$$N_4^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 3, 0.302 \rangle & \langle 2, 0.034 \rangle & \langle 4, 0.118 \rangle & \langle 4, 0.097 \rangle \\ \langle 4, 0.079 \rangle & \langle 2, 0.122 \rangle & \langle 4, 0.050 \rangle & \langle 4, 0.060 \rangle \\ \langle 3, 0.302 \rangle & \langle 2, 0.150 \rangle & \langle 4, 0.044 \rangle & \langle 4, 0.041 \rangle \\ \langle 4, 0.011 \rangle & \langle 2, 0.106 \rangle & \langle 4, 0.038 \rangle & \langle 4, 0.056 \rangle \end{bmatrix} \end{array}$$

$$N_5^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 3, 0.378 \rangle & \langle 2, 0.011 \rangle & \langle 2, 0.075 \rangle & \langle 4, 0.104 \rangle \\ \langle 4, 0.045 \rangle & \langle 2, 0.092 \rangle & \langle 2, 0.204 \rangle & \langle 4, 0.050 \rangle \\ \langle 3, 0.378 \rangle & \langle 2, 0.074 \rangle & \langle 2, 0.206 \rangle & \langle 4, 0.005 \rangle \\ \langle 4, 0.056 \rangle & \langle 2, 0.105 \rangle & \langle 2, 0.181 \rangle & \langle 4, 0.004 \rangle \end{bmatrix} \end{array}$$

$$N_6^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 2, 0.101 \rangle & \langle 2, 0.015 \rangle & \langle 2, 0.150 \rangle & \langle 4, 0.121 \rangle \\ \langle 2, 0.092 \rangle & \langle 2, 0.091 \rangle & \langle 2, 0.081 \rangle & \langle 4, 0.026 \rangle \\ \langle 2, 0.101 \rangle & \langle 2, 0.060 \rangle & \langle 2, 0.094 \rangle & \langle 4, 0.033 \rangle \\ \langle 3, 0.317 \rangle & \langle 2, 0.090 \rangle & \langle 2, 0.150 \rangle & \langle 4, 0.075 \rangle \end{bmatrix} \end{array}$$

$$N_7^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cc} p_1 & p_4 \end{array} \\ \begin{bmatrix} \langle 3, 0.383 \rangle & \langle 2, 0.029 \rangle \\ \langle 4, 0.056 \rangle & \langle 2, 0.101 \rangle \\ \langle 3, 0.383 \rangle & \langle 2, 0.105 \rangle \\ \langle 4, 0.079 \rangle & \langle 2, 0.064 \rangle \end{bmatrix} \end{array}$$

Step 6: Determine $N_+^*(5)$ matrix by summing the corresponding entries of $N_1^*(5), N_2^*(5), ..., N_7^*(5)$ matrices.

$$N_+^*(5) = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} 19 & 14 & 20 & 22 \\ 24 & 14 & 20 & 22 \\ 20 & 14 & 20 & 22 \\ 26 & 14 & 20 & 22 \end{bmatrix} \end{array} \begin{array}{c} \\ 75 \\ 80 \\ 76 \\ 82 \end{array}$$

Step 7: Tabulate the details as in Table 12 and assess the risk level of the students.

Analysis: We observe from Table 12 that for the parameter, ASA, the mental health scores for the students, s_1, s_2, and s_3 are 19, 24, and 20 respectively, with an average-risk level. For

Table 12. Shows students' mental health scores and levels for each parameter

s_i	p_1		p_2		p_3		p_4		$Total$	
	score	**level**	**score**	**level**	**score**	**level**	**score**	**level**	**score**	**level**
s_1	19	avg	14	low	20	avg	22	avg	75	avg
s_2	24	avg	14	low	20	avg	22	avg	80	avg
s_3	20	avg	14	low	20	avg	22	avg	76	avg
s_4	26	high	14	low	20	avg	22	avg	82	avg

s_4, the score is 26 and at a high-risk may require a counseling session to lower the same. Similarly, for the parameter, TAS, the scores for all the students are 14 and at low-level risk. For the parameter, EMC, and stress, the scores are 20 and 22 with an average-risk level for all the students. The overall scores for the students are 75, 80, 76, and 82 show an average-risk level associated with mental illness.

8. Intertemporal single-valued neutrosophic $\mathcal{N}$-soft set

Definition 8.1. An intertemporal single-valued neutrosophic $\mathcal{N}$-soft set ($ISVN\mathcal{N}SS$) is represented as a finite sequence of $SVN\mathcal{N}SS$ over $\mathcal{U}$, and denoted by $\left\{(\psi^t, \mathcal{J}^t, \mathcal{N})\right\}_{t=k}^{l}$ for a session $k, l \in \mathbb{N}$ such that $(k \le k^{'} \le l)$.

Definition 8.2. Let $\left\{(\psi^t, \mathcal{J}^t, \mathcal{N})\right\}_{t=k}^{l}$ for a session $k, l \in \mathbb{N}$ be an $ISVN\mathcal{N}SS$, then the quasi-hyperbolic discounting intertemporal single-valued neutrosophic $\mathcal{N}$-soft set ($QHDISVN\mathcal{N}SS$) computed from $\left\{(\psi^t, \mathcal{J}^t, \mathcal{N})\right\}_{t=k}^{l}$ at session $k^{'}$, $(k \le k^{'} \le l)$ is defined as,

$$\tilde{N}(\mathcal{N})_{k'} = \psi^{k^{'}}(p)(u) = \left\langle g_p, \frac{1}{l-k^{'}+1}\left[S(\tilde{N})_{k'} + \beta\left(\sum_{t=1}^{l-k^{'}} \delta^t . S(\tilde{N})_{k'+t}\right)\right]\right\rangle,$$

where $\delta \in [0,1]$ and $\beta \in [0,1)$ are the long-term and short-term discounting parameters respectively and $S(\tilde{N})_{k'}$ and $S(\tilde{N})_{k'+t}$ are the SFs of $SVNSS$ for the session $k^{'}$ and $k^{'}+t$ respectively.

Definition 8.3. Let $\mathcal{U} = \{u_1, u_2, ..., u_m\}$ be the universal set. Let $\mathcal{P} = \{p_1, p_2, ..., p_n\}$ be set of parameters and $\mathcal{G} = \{1, 2, ..., \mathcal{N}\}$ be a set of rating scale. Then the $QHDISVN\mathcal{N}SS$ computed from $\left\{(\psi^t, \mathcal{J}^t, \mathcal{N})\right\}_{t=k}^{l}$ at session $k^{'}$, $(k \le k^{'} \le l)$ is defined as,

$$N^*(\mathcal{N})_{k'} = [q_{ij}] = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & \cdots & p_n \end{array} \\ \begin{array}{c} u_1 \\ u_2 \\ \vdots \\ u_m \end{array} & \begin{bmatrix} q_{11} & q_{12} & \cdots & q_{1n} \\ q_{21} & q_{22} & \cdots & q_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ q_{m1} & q_{m2} & \cdots & q_{mn} \end{bmatrix} \end{array},$$

such that

$$N^*(\mathcal{N})_{k'} = [q_{ij}] = \left\langle g_{p_{ij}}, \frac{1}{l-k'+1}\left[(s_{ij})_{k'} + \beta\left(\sum_{t=1}^{l-k'}\delta^t.(s_{ij})_{k'+t}\right)\right]\right\rangle,$$

$i = 1, 2, ..., m$ and $j = 1, 2, ..., n$. Then $N^*(\mathcal{N})_{k'}$ is called an $m \times n$ quasi-hyperbolic discounting intertemporal single-valued neutrosophic $\mathcal{N}$-soft matrix ($QHDISVN\mathcal{N}SM$) of the $QHDISVN\mathcal{N}SS$ $\left\{(\psi^t, \mathcal{J}^t, \mathcal{N})\right\}_{t=k}^{l}$.

9. An application to pre-assess the mental health of students using *QHDISVN𝒩SM*

Consider the MHC has planned for n counseling sessions in a phased manner to study and change the socially deviant behavior to socially acceptable behavior. To check the progress of the students, MHC would like to pre-assess the students after m sessions i.e., $(m < n)$. Pre-assessment helps the MHC to understand the level of progress shown by the students in their behavior. To deal with this, we construct the concept of $QHDISVN\mathcal{N}SM$, an algorithm, and a flowchart to pre-assess the mental health of the students.

Consider a scenario where the MHC wishes to assess the mental health of the students in a phased manner. Let $\mathcal{U} = \{s_1, s_2, ..., s_m\}$ denote the set of students and $\mathcal{E} = \{p_1, p_2, ..., p_n\}$ the set of parameters to assess the psychosocial conditions. Let us assume the MHC frames the following details namely; positive and negative statements for parameters, rating scales with distribution criteria (Table 13), weightage criteria to assess the parameters, scoring keys, and mental health norms (Table 14). The MHC based on each question, say $r = \{1, 2, ..., h\}$ evaluates the students by considering the parameters and present the results in the form of neutrosophic matrices, $(N_r^*)_{k'}$ of order $m \times n$ for each session k'. Now, we have to pre-assess the mental health of the student with the help of pre-determined scores and norms.

Table 13. Shows the rating scale distribution

Positive statement	Negative statement	Score values
1	5	$0.8 \leq s_{ij} \leq 1.0$
2	4	$0.6 \leq s_{ij} < 0.8$
3	3	$0.3 \leq s_{ij} < 0.6$
4	2	$0.0 \leq s_{ij} < 0.3$
5	1	$-0.5 \leq s_{ij} < 0.0$

9.1. *Methodology to pre-assess the mental health of the students*

Construct the neutrosophic matrices $(N_r^*)_{k'}$, $r = \{1, 2, ..., h\}$ for each positive or negative statement by observing the behavior of the student for each session. Apply SF Definition 3.1, to the neutrosophic matrices and represent the resultant matrices by $S(N_r^*)_{k'}$. If weightage

Table 14. Shows the qualitative norm details

Parameter	Scores	Norms
p_1, p_2, p_3, p_4	1-5	low
	6-10	moderate (mod)
	11-15	borderline (bor)
	16-20	high
	21-25	very high (vh)
Total	1-20	low
	21-40	mod
	41-60	bor
	61-80	high
	81-100	vh

criteria are to be considered for each parameter, then calculate $WSVNV$ by using Definition 3.3. Now compare the entries in each $S(N_r^*)_{k'}$ matrix and construct the $N_r^*(\mathcal{N})_{k'}$ by using Definition 8.3 with the values of δ =0.9, β =0.5 and by comparing the values with the framed rating scale distribution (Table 13). Determine the $N_+^*(\mathcal{N})_{k'}$ matrix by adding the corresponding entries of $N_1^*(\mathcal{N})_{k'}, N_2^*(\mathcal{N})_{k'}, ..., N_k^*(\mathcal{N})_{k'}$ matrices. Now pre-assess the risk level for each parameter as well for the overall by using the level norms (Table 14). If the student attains a low/moderate-risk level in pre-assessment, then he/she responds to the treatment. If otherwise, then MHC should start an alternative remedy process for the students who show a high-risk level towards psychosocial conditions.

9.2. *Algorithm to pre-assess the mental illness among the students*

The following steps provide an insight to pre-assess the mental illness among the students.

Step 1: Identify the problem, select the students and the parameters.

Step 2: Involve a psychiatrist to frame the required details namely; positive and negative statements, rating scale with distribution, scoring keys and risk level.

Step 3: Construct $(N_r^*)_{k'}$, where $r = \{1, 2, ..., h\}$ matrices for each question by observing the behavior of the students at $k^{'}$ session.

Step 4: Evaluate SF and $WSVNV$ by using Definition 3.1 and 3.3, respectively, and compute the risk-level analysis Table for the first session using Algorithm 6.2.

Step 5: Construct $N_r^*(\mathcal{N})_{k'}$ for the sessions by using Definition 8.3 and by comparing it with rating scale and distribution details.

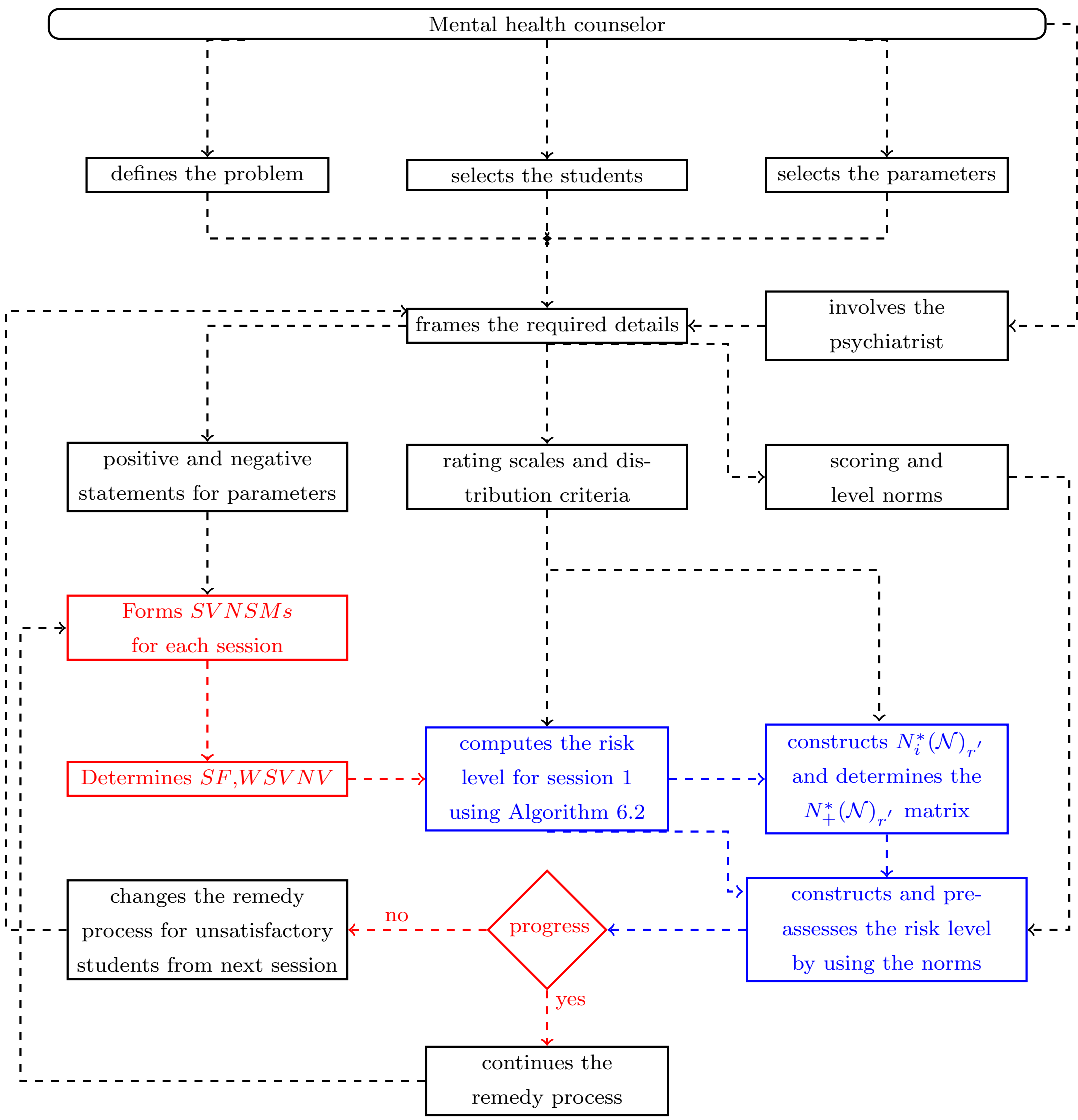
Step 6: Determine $N_+^*(\mathcal{N})_{k'}$ matrix by summing the corresponding entries of $N_1^*(\mathcal{N})_{k'}, N_2^*(\mathcal{N})_{k'}, ..., N_h^*(\mathcal{N})_{k'}$ matrices.

Step 7: Tabulate and pre-assess the mental health risk level by using the Table values determined in Step 4, and by using scoring keys and risk level norms.

Step 8: If the risk level is high for the students then the MHC to terminate the current treatment and initiate an alternative treatment process from the next session.

9.3. *Flowchart for intertemporal neutrosophic $\mathcal{N}$-soft matrix*

In this subsection, we depict the flow of the problem to pre-assess the mental illness of students. A structured process is shown below to understand the nature of the problem.



10. Case study using *QHDISVNN$\mathcal{N}$SM*

The MHC or the psychiatrist might have to encounter multiple sessions to identify the mental health or the psychosocial behavior of the students. When there is a deviation in behavior, the MHC may find it difficult in which session the treatment or counseling failed to work for the students or could also be the students who did not follow the guidelines informed by the MHC. To overcome this gap, we present a method to pre-assess the mental illness of students with the information recorded during every session. Also, this method gives an insight into whether the MHC treatment or the counseling moves forward in the right direction.

Consider a scenario where the MHC observes the behavior of the students and records the information using $SVNSMs$ for every lockdown session during the pandemic. Also, let the MHC compute the risk level for session 1 using Algorithm 6.2 to understand the risk level associated with the students. Let's assume that the students are at the beginning of the fourth lockdown session and the MHC would like to pre-assess the students and determine the risk level connected with the previous lockdown session. In the first case, let's consider the information from sessions 1 to 3, in the second, sessions 2 and 3, and the third, session 3.

Step 1: Suppose that $\mathcal{U} = \{s_1, s_2, s_3, s_4\}$ be the set of students who suffer from mental illness and $\mathcal{P} = \{p_1, p_2, p_3, p_4\}$ be the set of parameters where p_1= avoiding social activities (ASA), p_2= thinking about suicide (TAS), p_3= extreme mood changes (EMC) and p_4 = stress.

Step 2: Let's consider the MHC frames five positive questions for all the parameters across the three lockdown sessions. Let the rating scale distribution and level norms be as in Tables 13 and 14, respectively.

Step 3: Let MHC observes the behavior of each student based on the framed positive statements and provides the value in $SVNSMs$ form, $(N_1^*)_1$, $(N_2^*)_1$, $(N_3^*)_1$, $(N_4^*)_1$ and $(N_5^*)_1$ for the first lockdown session.

$$(N_1^*)_1 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array}\begin{array}{c} \begin{array}{cccc} \quad p_1 \quad & \quad p_2 \quad & \quad p_3 \quad & \quad p_4 \quad \end{array} \\ \begin{bmatrix} \langle 0.30, 0.32, 0.19\rangle & \langle 0.40, 0.42, 0.35\rangle & \langle 0.20, 0.30, 0.12\rangle & \langle 0.40, 0.42, 0.05\rangle \\ \langle 0.35, 0.38, 0.20\rangle & \langle 0.43, 0.45, 0.38\rangle & \langle 0.30, 0.35, 0.13\rangle & \langle 0.30, 0.35, 0.10\rangle \\ \langle 0.32, 0.35, 0.15\rangle & \langle 0.50, 0.55, 0.40\rangle & \langle 0.40, 0.45, 0.14\rangle & \langle 0.20, 0.25, 0.05\rangle \\ \langle 0.23, 0.31, 0.22\rangle & \langle 0.45, 0.50, 0.40\rangle & \langle 0.20, 0.30, 0.05\rangle & \langle 0.33, 0.43, 0.17\rangle \end{bmatrix} \end{array}$$

$$(N_2^*)_1 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array}\begin{array}{c} \begin{array}{cccc} \quad p_1 \quad & \quad p_2 \quad & \quad p_3 \quad & \quad p_4 \quad \end{array} \\ \begin{bmatrix} \langle 0.21, 0.24, 0.20\rangle & \langle 0.40, 0.42, 0.15\rangle & \langle 0.30, 0.32, 0.11\rangle & \langle 0.25, 0.35, 0.06\rangle \\ \langle 0.25, 0.35, 0.20\rangle & \langle 0.30, 0.34, 0.10\rangle & \langle 0.40, 0.42, 0.13\rangle & \langle 0.32, 0.45, 0.20\rangle \\ \langle 0.26, 0.30, 0.25\rangle & \langle 0.20, 0.32, 0.10\rangle & \langle 0.32, 0.35, 0.20\rangle & \langle 0.40, 0.42, 0.15\rangle \\ \langle 0.30, 0.35, 0.23\rangle & \langle 0.30, 0.40, 0.12\rangle & \langle 0.33, 0.37, 0.07\rangle & \langle 0.20, 0.32, 0.12\rangle \end{bmatrix} \end{array}$$

$$(N_3^*)_1 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array}\begin{array}{c} \begin{array}{cccc} \quad p_1 \quad & \quad p_2 \quad & \quad p_3 \quad & \quad p_4 \quad \end{array} \\ \begin{bmatrix} \langle 0.28, 0.32, 0.17\rangle & \langle 0.40, 0.42, 0.12\rangle & \langle 0.32, 0.42, 0.14\rangle & \langle 0.40, 0.42, 0.10\rangle \\ \langle 0.21, 0.31, 0.10\rangle & \langle 0.35, 0.38, 0.10\rangle & \langle 0.28, 0.32, 0.15\rangle & \langle 0.37, 0.40, 0.15\rangle \\ \langle 0.30, 0.34, 0.16\rangle & \langle 0.42, 0.45, 0.15\rangle & \langle 0.25, 0.30, 0.16\rangle & \langle 0.20, 0.25, 0.17\rangle \\ \langle 0.27, 0.32, 0.20\rangle & \langle 0.30, 0.35, 0.25\rangle & \langle 0.21, 0.31, 0.15\rangle & \langle 0.30, 0.35, 0.25\rangle \end{bmatrix} \end{array}$$

$$(N_4^*)_1 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.23, 0.32, 0.15\rangle & \langle 0.25, 0.30, 0.19\rangle & \langle 0.30, 0.32, 0.21\rangle & \langle 0.34, 0.38, 0.43\rangle \\ \langle 0.33, 0.35, 0.45\rangle & \langle 0.26, 0.34, 0.55\rangle & \langle 0.40, 0.42, 0.45\rangle & \langle 0.35, 0.38, 0.44\rangle \\ \langle 0.31, 0.35, 0.20\rangle & \langle 0.29, 0.32, 0.17\rangle & \langle 0.35, 0.40, 0.20\rangle & \langle 0.40, 0.43, 0.13\rangle \\ \langle 0.25, 0.28, 0.65\rangle & \langle 0.30, 0.34, 0.55\rangle & \langle 0.32, 0.35, 0.50\rangle & \langle 0.32, 0.33, 0.24\rangle \end{bmatrix} \end{array}$$

$$(N_5^*)_1 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.40, 0.45, 0.15\rangle & \langle 0.30, 0.34, 0.20\rangle & \langle 0.34, 0.40, 0.30\rangle & \langle 0.25, 0.28, 0.15\rangle \\ \langle 0.34, 0.35, 0.25\rangle & \langle 0.32, 0.35, 0.30\rangle & \langle 0.32, 0.35, 0.45\rangle & \langle 0.35, 0.38, 0.25\rangle \\ \langle 0.20, 0.25, 0.12\rangle & \langle 0.20, 0.30, 0.13\rangle & \langle 0.20, 0.25, 0.20\rangle & \langle 0.45, 0.48, 0.05\rangle \\ \langle 0.23, 0.24, 0.25\rangle & \langle 0.30, 0.40, 0.23\rangle & \langle 0.25, 0.30, 0.24\rangle & \langle 0.50, 0.52, 0.34\rangle \end{bmatrix} \end{array}$$

Now, compute the risk level analysis Table for session 1 using Algorithm 6.2 and with the help of norms (Table 14) understand the risk level associated with the students as in Table 15.

TABLE 15. Shows students' mental health scores and levels for session 1

s_i	p_1		p_2		p_3		p_4		$Total$	
	score	**level**	**score**	**level**	**score**	**level**	**score**	**level**	**score**	**level**
s_1	19	high	18	high	19	high	18	high	74	high
s_2	20	high	19	high	19	high	19	high	77	high
s_3	20	high	18	high	19	high	17	high	74	high
s_4	21	vh	20	high	19	high	19	high	79	high

Likewise, form $(N_1^*)_2$, $(N_2^*)_2$, $(N_3^*)_2$, $(N_4^*)_2$ and $(N_5^*)_2$ $SVNSMs$ for the second lockdown session.

$$(N_1^*)_2 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.90, 0.85, 0.15\rangle & \langle 0.55, 0.45, 0.20\rangle & \langle 0.40, 0.60, 0.20\rangle & \langle 0.88, 0.78, 0.20\rangle \\ \langle 0.35, 0.40, 0.15\rangle & \langle 0.55, 0.45, 0.15\rangle & \langle 0.45, 0.40, 0.15\rangle & \langle 0.35, 0.20, 0.15\rangle \\ \langle 0.82, 0.78, 0.25\rangle & \langle 0.82, 0.77, 0.25\rangle & \langle 0.82, 0.75, 0.25\rangle & \langle 0.82, 0.30, 0.25\rangle \\ \langle 0.85, 0.35, 0.18\rangle & \langle 0.85, 0.35, 0.18\rangle & \langle 0.85, 0.35, 0.18\rangle & \langle 0.85, 0.35, 0.18\rangle \end{bmatrix} \end{array}$$

$$(N_2^*)_2 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.79, 0.69, 0.20\rangle & \langle 0.58, 0.48, 0.17\rangle & \langle 0.55, 0.33, 0.24\rangle & \langle 0.65, 0.32, 0.24\rangle \\ \langle 0.64, 0.60, 0.13\rangle & \langle 0.23, 0.16, 0.16\rangle & \langle 0.66, 0.22, 0.21\rangle & \langle 0.77, 0.24, 0.20\rangle \\ \langle 0.80, 0.55, 0.20\rangle & \langle 0.81, 0.76, 0.23\rangle & \langle 0.77, 0.87, 0.24\rangle & \langle 0.80, 0.66, 0.24\rangle \\ \langle 0.82, 0.34, 0.20\rangle & \langle 0.82, 0.33, 0.15\rangle & \langle 0.83, 0.31, 0.19\rangle & \langle 0.82, 0.36, 0.25\rangle \end{bmatrix} \end{array}$$

$$(N_3^*)_2 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.83, 0.54, 0.22\rangle & \langle 0.56, 0.32, 0.20\rangle & \langle 0.68, 0.54, 0.33\rangle & \langle 0.70, 0.65, 0.24\rangle \\ \langle 0.68, 0.23, 0.18\rangle & \langle 0.64, 0.19, 0.15\rangle & \langle 0.77, 0.20, 0.24\rangle & \langle 0.80, 0.30, 0.18\rangle \\ \langle 0.85, 0.69, 0.22\rangle & \langle 0.84, 0.79, 0.25\rangle & \langle 0.72, 0.88, 0.18\rangle & \langle 0.75, 0.65, 0.24\rangle \\ \langle 0.87, 0.31, 0.19\rangle & \langle 0.85, 0.30, 0.18\rangle & \langle 0.82, 0.35, 0.25\rangle & \langle 0.81, 0.31, 0.19\rangle \end{bmatrix} \end{array}$$

$$(N_4^*)_2 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.55, 0.45, 0.25\rangle & \langle 0.65, 0.55, 0.15\rangle & \langle 0.58, 0.48, 0.22\rangle & \langle 0.77, 0.67, 0.22\rangle \\ \langle 0.60, 0.25, 0.20\rangle & \langle 0.75, 0.15, 0.20\rangle & \langle 0.86, 0.22, 0.18\rangle & \langle 0.68, 0.22, 0.16\rangle \\ \langle 0.45, 0.40, 0.15\rangle & \langle 0.85, 0.54, 0.30\rangle & \langle 0.88, 0.66, 0.24\rangle & \langle 0.88, 0.58, 0.24\rangle \\ \langle 0.45, 0.52, 0.20\rangle & \langle 0.80, 0.30, 0.25\rangle & \langle 0.82, 0.34, 0.20\rangle & \langle 0.84, 0.34, 0.20\rangle \end{bmatrix} \end{array}$$

$$(N_5^*)_2 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.88, 0.30, 0.20\rangle & \langle 0.77, 0.30, 0.28\rangle & \langle 0.55, 0.30, 0.22\rangle & \langle 0.60, 0.34, 0.26\rangle \\ \langle 0.68, 0.40, 0.26\rangle & \langle 0.67, 0.28, 0.15\rangle & \langle 0.60, 0.20, 0.18\rangle & \langle 0.54, 0.67, 0.28\rangle \\ \langle 0.88, 0.78, 0.25\rangle & \langle 0.87, 0.89, 0.25\rangle & \langle 0.77, 0.68, 0.30\rangle & \langle 0.84, 0.76, 0.25\rangle \\ \langle 0.84, 0.38, 0.24\rangle & \langle 0.46, 0.35, 0.12\rangle & \langle 0.87, 0.35, 0.28\rangle & \langle 0.85, 0.38, 0.18\rangle \end{bmatrix} \end{array}$$

Similarly, form $(N_1^*)_3$, $(N_2^*)_3$, $(N_3^*)_3$, $(N_4^*)_3$ and $(N_5^*)_3$ $SVNSMs$ for the third lockdown session.

$$(N_1^*)_3 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.70, 0.80, 0.25\rangle & \langle 0.92, 0.89, 0.25\rangle & \langle 0.90, 0.85, 0.40\rangle & \langle 0.90, 0.80, 0.20\rangle \\ \langle 0.80, 0.70, 0.20\rangle & \langle 0.88, 0.90, 0.25\rangle & \langle 0.91, 0.88, 0.05\rangle & \langle 0.69, 0.59, 0.40\rangle \\ \langle 0.82, 0.75, 0.21\rangle & \langle 0.84, 0.88, 0.10\rangle & \langle 0.75, 0.72, 0.14\rangle & \langle 0.85, 0.75, 0.10\rangle \\ \langle 0.90, 0.88, 0.10\rangle & \langle 0.88, 0.84, 0.12\rangle & \langle 0.77, 0.72, 0.10\rangle & \langle 0.76, 0.78, 0.25\rangle \end{bmatrix} \end{array}$$

$$(N_2^*)_3 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.71, 0.81, 0.20\rangle & \langle 0.88, 0.87, 0.22\rangle & \langle 0.77, 0.87, 0.10\rangle & \langle 0.88, 0.85, 0.10\rangle \\ \langle 0.55, 0.50, 0.25\rangle & \langle 0.50, 0.60, 0.26\rangle & \langle 0.57, 0.57, 0.21\rangle & \langle 0.91, 0.80, 0.15\rangle \\ \langle 0.80, 0.85, 0.21\rangle & \langle 0.95, 0.88, 0.32\rangle & \langle 0.67, 0.65, 0.05\rangle & \langle 0.88, 0.98, 0.05\rangle \\ \langle 0.85, 0.88, 0.22\rangle & \langle 0.72, 0.75, 0.42\rangle & \langle 0.77, 0.71, 0.10\rangle & \langle 0.90, 0.88, 0.15\rangle \end{bmatrix} \end{array}$$

$$(N_3^*)_3 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.67, 0.72, 0.29\rangle & \langle 0.82, 0.88, 0.30\rangle & \langle 0.84, 0.90, 0.25\rangle & \langle 0.85, 0.82, 0.20\rangle \\ \langle 0.85, 0.75, 0.30\rangle & \langle 0.86, 0.77, 0.32\rangle & \langle 0.88, 0.81, 0.30\rangle & \langle 0.90, 0.85, 0.31\rangle \\ \langle 0.70, 0.80, 0.25\rangle & \langle 0.72, 0.82, 0.28\rangle & \langle 0.77, 0.80, 0.24\rangle & \langle 0.85, 0.72, 0.21\rangle \\ \langle 0.88, 0.91, 0.21\rangle & \langle 0.77, 0.88, 0.38\rangle & \langle 0.79, 0.85, 0.34\rangle & \langle 0.84, 0.81, 0.30\rangle \end{bmatrix} \end{array}$$

$$(N_4^*)_3 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.72, 0.75, 0.25\rangle & \langle 0.91, 0.73, 0.21\rangle & \langle 0.94, 0.75, 0.28\rangle & \langle 0.93, 0.77, 0.20\rangle \\ \langle 0.95, 0.82, 0.31\rangle & \langle 0.92, 0.84, 0.30\rangle & \langle 0.92, 0.85, 0.21\rangle & \langle 0.89, 0.88, 0.15\rangle \\ \langle 0.82, 0.78, 0.21\rangle & \langle 0.88, 0.79, 0.23\rangle & \langle 0.90, 0.79, 0.19\rangle & \langle 0.72, 0.82, 0.10\rangle \\ \langle 0.72, 0.68, 0.24\rangle & \langle 0.78, 0.69, 0.22\rangle & \langle 0.75, 0.70, 0.22\rangle & \langle 0.79, 0.77, 0.09\rangle \end{bmatrix} \end{array}$$

$$(N_5^*)_3 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 0.73, 0.76, 0.10\rangle & \langle 0.93, 0.83, 0.25\rangle & \langle 0.89, 0.80, 0.10\rangle & \langle 0.85, 0.80, 0.25\rangle \\ \langle 0.95, 0.90, 0.15\rangle & \langle 0.94, 0.92, 0.44\rangle & \langle 0.88, 0.82, 0.17\rangle & \langle 0.89, 0.85, 0.20\rangle \\ \langle 0.85, 0.80, 0.20\rangle & \langle 0.88, 0.82, 0.21\rangle & \langle 0.92, 0.55, 0.19\rangle & \langle 0.79, 0.89, 0.15\rangle \\ \langle 0.80, 0.75, 0.25\rangle & \langle 0.89, 0.72, 0.19\rangle & \langle 0.94, 0.88, 0.25\rangle & \langle 0.90, 0.85, 0.25\rangle \end{bmatrix} \end{array}$$

Step 4: Apply SF Definition 3.1, to get the values in matrices form for session 1.

$$S(N_1^*)_1 = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.215 & 0.235 & 0.190 & 0.385 \\ s_2 & 0.265 & 0.250 & 0.260 & 0.275 \\ s_3 & 0.260 & 0.325 & 0.355 & 0.200 \\ s_4 & 0.160 & 0.275 & 0.225 & 0.295 \end{array} \quad S(N_2^*)_1 = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.125 & 0.335 & 0.255 & 0.270 \\ s_2 & 0.200 & 0.270 & 0.345 & 0.285 \\ s_3 & 0.155 & 0.210 & 0.235 & 0.335 \\ s_4 & 0.210 & 0.290 & 0.315 & 0.200 \end{array}$$

$$S(N_3^*)_1 = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.215 & 0.350 & 0.300 & 0.360 \\ s_2 & 0.210 & 0.315 & 0.225 & 0.310 \\ s_3 & 0.240 & 0.360 & 0.195 & 0.140 \\ s_4 & 0.195 & 0.200 & 0.185 & 0.200 \end{array} \quad S(N_4^*)_1 = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.200 & 0.180 & 0.205 & 0.145 \\ s_2 & 0.115 & 0.025 & 0.185 & 0.145 \\ s_3 & 0.230 & 0.220 & 0.275 & 0.350 \\ s_4 & -0.060 & 0.045 & 0.085 & 0.205 \end{array}$$

$$S(N_5^*)_1 = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.350 & 0.220 & 0.220 & 0.190 \\ s_2 & 0.220 & 0.185 & 0.110 & 0.240 \\ s_3 & 0.165 & 0.185 & 0.125 & 0.440 \\ s_4 & 0.110 & 0.238 & 0.155 & 0.340 \end{array}$$

Apply SF Definition 3.1, for session 2.

$$S(N_1^*)_2 = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.800 & 0.400 & 0.400 & 0.730 \\ s_2 & 0.300 & 0.425 & 0.350 & 0.200 \\ s_3 & 0.675 & 0.670 & 0.660 & 0.435 \\ s_4 & 0.510 & 0.510 & 0.510 & 0.510 \end{array} \quad S(N_2^*)_2 = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.640 & 0.445 & 0.320 & 0.365 \\ s_2 & 0.555 & 0.115 & 0.335 & 0.405 \\ s_3 & 0.575 & 0.670 & 0.700 & 0.610 \\ s_4 & 0.480 & 0.500 & 0.475 & 0.465 \end{array}$$

$$S(N_3^*)_2 = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.575 & 0.340 & 0.445 & 0.555 \\ s_2 & 0.365 & 0.340 & 0.366 & 0.460 \\ s_3 & 0.660 & 0.690 & 0.710 & 0.580 \\ s_4 & 0.495 & 0.485 & 0.460 & 0.465 \end{array} \quad S(N_4^*)_2 = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.375 & 0.525 & 0.420 & 0.610 \\ s_2 & 0.325 & 0.350 & 0.450 & 0.370 \\ s_3 & 0.350 & 0.545 & 0.650 & 0.610 \\ s_4 & 0.385 & 0.425 & 0.480 & 0.490 \end{array}$$

$$S(N_5^*)_2 = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.490 & 0.395 & 0.315 & 0.340 \\ s_2 & 0.410 & 0.400 & 0.310 & 0.465 \\ s_3 & 0.705 & 0.755 & 0.575 & 0.675 \\ s_4 & 0.490 & 0.345 & 0.470 & 0.525 \end{array}$$

Similarly, apply SF Definition 3.1, for session 3.

$$S(N_1^*)_3 = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.625 & 0.780 & 0.675 & 0.750 \\ s_2 & 0.650 & 0.765 & 0.870 & 0.440 \\ s_3 & 0.680 & 0.810 & 0.665 & 0.750 \\ s_4 & 0.840 & 0.800 & 0.695 & 0.645 \end{array} \quad S(N_2^*)_3 = \begin{array}{c|cccc} & p_1 & p_2 & p_3 & p_4 \\ \hline s_1 & 0.660 & 0.765 & 0.770 & 0.815 \\ s_2 & 0.400 & 0.420 & 0.465 & 0.780 \\ s_3 & 0.720 & 0.755 & 0.635 & 0.905 \\ s_4 & 0.755 & 0.525 & 0.690 & 0.815 \end{array}$$

$$S(N_3^*)_3 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} 0.550 & 0.700 & 0.745 & 0.735 \\ 0.650 & 0.655 & 0.695 & 0.720 \\ 0.625 & 0.630 & 0.665 & 0.680 \\ 0.790 & 0.635 & 0.650 & 0.675 \end{bmatrix} \end{array} S(N_4^*)_3 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} 0.610 & 0.715 & 0.705 & 0.750 \\ 0.730 & 0.730 & 0.780 & 0.810 \\ 0.695 & 0.720 & 0.750 & 0.720 \\ 0.580 & 0.625 & 0.615 & 0.735 \end{bmatrix} \end{array}$$

$$S(N_5^*)_3 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} 0.695 & 0.755 & 0.795 & 0.700 \\ 0.850 & 0.710 & 0.765 & 0.770 \\ 0.725 & 0.745 & 0.640 & 0.765 \\ 0.650 & 0.710 & 0.785 & 0.750 \end{bmatrix} \end{array}$$

Step 5: Let's consider the information from sessions 1 to 3 to pre-assess the mental illness of the students before the next lock-down session begins. By applying Definition 8.3, we get the following matrices. The $QHDISVN\mathcal{N}SM$ at the beginning of session 1 is computed by

$$N_r^*(5)_1 = \left\langle g_{p_{ij}}, \frac{1}{3}\left[(s_{ij})_1 + 0.5\Big(\sum_{t=1}^{2} 0.9^t.(s_{ij})_{1+t}\Big)\right]\right\rangle,$$

$r = 1, 2, ..., 5$, $i = 1, 2, 3, 4$ and $j = 1, 2, 3, 4$.

$$N_1^*(5)_1 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 4, 0.276\rangle & \langle 4, 0.244\rangle & \langle 4, 0.214\rangle & \langle 3, 0.339\rangle \\ \langle 4, 0.221\rangle & \langle 4, 0.250\rangle & \langle 4, 0.257\rangle & \langle 4, 0.181\rangle \\ \langle 4, 0.280\rangle & \langle 3, 0.318\rangle & \langle 3, 0.307\rangle & \langle 4, 0.233\rangle \\ \langle 4, 0.243\rangle & \langle 4, 0.276\rangle & \langle 4, 0.245\rangle & \langle 4, 0.262\rangle \end{bmatrix} \end{array}$$

$$N_2^*(5)_1 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 4, 0.227\rangle & \langle 4, 0.282\rangle & \langle 4, 0.237\rangle & \langle 4, 0.255\rangle \\ \langle 4, 0.204\rangle & \langle 4, 0.164\rangle & \langle 4, 0.228\rangle & \langle 4, 0.261\rangle \\ \langle 4, 0.235\rangle & \langle 4, 0.272\rangle & \langle 4, 0.269\rangle & \langle 3, 0.325\rangle \\ \langle 4, 0.244\rangle & \langle 4, 0.243\rangle & \langle 4, 0.269\rangle & \langle 4, 0.246\rangle \end{bmatrix} \end{array}$$

$$N_3^*(5)_1 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 4, 0.232\rangle & \langle 4, 0.262\rangle & \langle 4, 0.267\rangle & \langle 3, 0.302\rangle \\ \langle 4, 0.213\rangle & \langle 4, 0.244\rangle & \langle 4, 0.224\rangle & \langle 4, 0.270\rangle \\ \langle 4, 0.263\rangle & \langle 3, 0.309\rangle & \langle 4, 0.261\rangle & \langle 4, 0.225\rangle \\ \langle 4, 0.246\rangle & \langle 4, 0.225\rangle & \langle 4, 0.218\rangle & \langle 4, 0.228\rangle \end{bmatrix} \end{array}$$

$$N_4^*(5)_1 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} \langle 4, 0.205\rangle & \langle 4, 0.235\rangle & \langle 4, 0.227\rangle & \langle 4, 0.241\rangle \\ \langle 4, 0.186\rangle & \langle 4, 0.159\rangle & \langle 4, 0.234\rangle & \langle 4, 0.213\rangle \\ \langle 4, 0.223\rangle & \langle 4, 0.252\rangle & \langle 4, 0.290\rangle & \langle 3, 0.305\rangle \\ \langle 4, 0.116\rangle & \langle 4, 0.163\rangle & \langle 4, 0.183\rangle & \langle 4, 0.241\rangle \end{bmatrix} \end{array}$$

$$N_5^*(5)_1 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 4, 0.284\rangle & \langle 4, 0.235\rangle & \langle 4, 0.228\rangle & \langle 4, 0.209\rangle \\ \langle 4, 0.250\rangle & \langle 4, 0.218\rangle & \langle 4, 0.186\rangle & \langle 4, 0.254\rangle \\ \langle 4, 0.259\rangle & \langle 4, 0.275\rangle & \langle 4, 0.214\rangle & \langle 3, 0.351\rangle \\ \langle 4, 0.198\rangle & \langle 4, 0.227\rangle & \langle 4, 0.228\rangle & \langle 4, 0.293\rangle \end{bmatrix} \end{array}$$

By applying Definition 8.3, we get the following matrices for sessions 2 to 3. The $QHDISVN\mathcal{N}SM$ at the beginning of session 2 is computed by

$$N_r^*(5)_2 = \left\langle g_{p_{ij}}, \frac{1}{2}\left[(s_{ij})_2 + 0.5\big(0.9^1\big).(s_{ij})_3\big)\right] \right\rangle,$$

$r = 1, 2, ..., 5,\ i = 1, 2, 3, 4$ and $j = 1, 2, 3, 4$.

$$N_1^*(5)_2 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 3, 0.541\rangle & \langle 3, 0.376\rangle & \langle 3, 0.352\rangle & \langle 3, 0.534\rangle \\ \langle 4, 0.296\rangle & \langle 3, 0.385\rangle & \langle 3, 0.371\rangle & \langle 4, 0.199\rangle \\ \langle 3, 0.491\rangle & \langle 3, 0.517\rangle & \langle 3, 0.480\rangle & \langle 3, 0.386\rangle \\ \langle 3, 0.444\rangle & \langle 3, 0.435\rangle & \langle 3, 0.411\rangle & \langle 3, 0.400\rangle \end{bmatrix} \end{array}$$

$$N_2^*(5)_2 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 3, 0.469\rangle & \langle 3, 0.395\rangle & \langle 3, 0.333\rangle & \langle 3, 0.366\rangle \\ \langle 3, 0.368\rangle & \langle 4, 0.152\rangle & \langle 4, 0.272\rangle & \langle 3, 0.378\rangle \\ \langle 3, 0.450\rangle & \langle 3, 0.505\rangle & \langle 3, 0.493\rangle & \langle 3, 0.509\rangle \\ \langle 3, 0.410\rangle & \langle 3, 0.368\rangle & \langle 3, 0.393\rangle & \langle 3, 0.416\rangle \end{bmatrix} \end{array}$$

$$N_3^*(5)_2 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 3, 0.411\rangle & \langle 3, 0.328\rangle & \langle 3, 0.390\rangle & \langle 3, 0.443\rangle \\ \langle 3, 0.329\rangle & \langle 3, 0.317\rangle & \langle 3, 0.339\rangle & \langle 3, 0.392\rangle \\ \langle 3, 0.471\rangle & \langle 3, 0.487\rangle & \langle 3, 0.505\rangle & \langle 3, 0.443\rangle \\ \langle 3, 0.425\rangle & \langle 3, 0.385\rangle & \langle 3, 0.376\rangle & \langle 3, 0.384\rangle \end{bmatrix} \end{array}$$

$$N_4^*(5)_2 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 3, 0.325\rangle & \langle 3, 0.423\rangle & \langle 3, 0.369\rangle & \langle 3, 0.474\rangle \\ \langle 3, 0.327\rangle & \langle 3, 0.339\rangle & \langle 3, 0.401\rangle & \langle 3, 0.367\rangle \\ \langle 3, 0.331\rangle & \langle 3, 0.435\rangle & \langle 3, 0.494\rangle & \langle 3, 0.467\rangle \\ \langle 3, 0.323\rangle & \langle 3, 0.353\rangle & \langle 3, 0.378\rangle & \langle 3, 0.410\rangle \end{bmatrix} \end{array}$$

$$N_5^*(5)_2 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 3, 0.401\rangle & \langle 3, 0.367\rangle & \langle 3, 0.336\rangle & \langle 3, 0.328\rangle \\ \langle 3, 0.396\rangle & \langle 3, 0.360\rangle & \langle 3, 0.327\rangle & \langle 3, 0.406\rangle \\ \langle 3, 0.516\rangle & \langle 3, 0.545\rangle & \langle 3, 0.432\rangle & \langle 3, 0.510\rangle \\ \langle 3, 0.391\rangle & \langle 3, 0.332\rangle & \langle 3, 0.412\rangle & \langle 3, 0.431\rangle \end{bmatrix} \end{array}$$

By applying Definition 8.3, we get the following matrices for session 3. The $QHDISVN\mathcal{N}SM$ at the beginning of session 3 is computed by

$$N_r^*(5)_3 = \left\langle g_{p_{ij}}, (s_{ij})_3 \right\rangle,$$

$r = 1, 2, ..., 5,\ i = 1, 2, 3, 4$ and $j = 1, 2, 3, 4$.

$$N_1^*(5)_3 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 2, 0.625\rangle & \langle 2, 0.780\rangle & \langle 2, 0.675\rangle & \langle 2, 0.750\rangle \\ \langle 2, 0.650\rangle & \langle 2, 0.765\rangle & \langle 1, 0.870\rangle & \langle 3, 0.440\rangle \\ \langle 2, 0.680\rangle & \langle 1, 0.810\rangle & \langle 2, 0.665\rangle & \langle 2, 0.750\rangle \\ \langle 1, 0.840\rangle & \langle 1, 0.800\rangle & \langle 2, 0.695\rangle & \langle 2, 0.645\rangle \end{bmatrix} \end{array}$$

$$N_2^*(5)_3 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 2, 0.660\rangle & \langle 2, 0.765\rangle & \langle 2, 0.770\rangle & \langle 1, 0.815\rangle \\ \langle 3, 0.400\rangle & \langle 3, 0.420\rangle & \langle 3, 0.465\rangle & \langle 2, 0.780\rangle \\ \langle 2, 0.720\rangle & \langle 2, 0.755\rangle & \langle 2, 0.635\rangle & \langle 1, 0.905\rangle \\ \langle 2, 0.755\rangle & \langle 3, 0.525\rangle & \langle 2, 0.690\rangle & \langle 1, 0.815\rangle \end{bmatrix} \end{array}$$

$$N_3^*(5)_3 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 3, 0.550\rangle & \langle 2, 0.700\rangle & \langle 2, 0.745\rangle & \langle 2, 0.735\rangle \\ \langle 2, 0.650\rangle & \langle 2, 0.655\rangle & \langle 2, 0.695\rangle & \langle 2, 0.720\rangle \\ \langle 2, 0.625\rangle & \langle 2, 0.630\rangle & \langle 2, 0.665\rangle & \langle 2, 0.680\rangle \\ \langle 2, 0.790\rangle & \langle 2, 0.635\rangle & \langle 2, 0.650\rangle & \langle 2, 0.675\rangle \end{bmatrix} \end{array}$$

$$N_4^*(5)_3 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 2, 0.610\rangle & \langle 2, 0.715\rangle & \langle 2, 0.705\rangle & \langle 2, 0.750\rangle \\ \langle 2, 0.730\rangle & \langle 2, 0.730\rangle & \langle 2, 0.780\rangle & \langle 1, 0.810\rangle \\ \langle 2, 0.695\rangle & \langle 2, 0.720\rangle & \langle 2, 0.750\rangle & \langle 2, 0.720\rangle \\ \langle 3, 0.580\rangle & \langle 2, 0.625\rangle & \langle 2, 0.615\rangle & \langle 2, 0.735\rangle \end{bmatrix} \end{array}$$

$$N_5^*(5)_3 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} \langle 2, 0.695\rangle & \langle 2, 0.755\rangle & \langle 2, 0.795\rangle & \langle 2, 0.700\rangle \\ \langle 1, 0.850\rangle & \langle 2, 0.710\rangle & \langle 2, 0.765\rangle & \langle 2, 0.770\rangle \\ \langle 2, 0.725\rangle & \langle 2, 0.745\rangle & \langle 2, 0.640\rangle & \langle 2, 0.765\rangle \\ \langle 2, 0.650\rangle & \langle 2, 0.710\rangle & \langle 2, 0.785\rangle & \langle 2, 0.750\rangle \end{bmatrix} \end{array}$$

Step 6: Determine $N_+^*(5)_1$ matrix by summing the corresponding entries of $N_1^*(5)_1, N_2^*(5)_1, ..., N_5^*(5)_1$ matrices.

$$N_+^*(5)_1 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} \begin{array}{c} \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{bmatrix} 20 & 20 & 20 & 18 \\ 20 & 20 & 20 & 20 \\ 20 & 18 & 19 & 17 \\ 20 & 20 & 20 & 20 \end{bmatrix} \end{array} \begin{array}{c} \\ 78 \\ 80 \\ 74 \\ 80 \end{array}$$

For $N_+^*(5)_2$ matrix by summing the corresponding entries of $N_1^*(5)_2, N_2^*(5)_2, ..., N_5^*(5)_2$ matrices.

$$N^*_+(5)_2 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} 15 & 15 & 15 & 15 \\ 16 & 16 & 16 & 16 \\ 15 & 15 & 15 & 15 \\ 15 & 15 & 15 & 15 \end{bmatrix} \begin{array}{c} 60 \\ 64 \\ 60 \\ 60 \end{array} \end{array}$$

Similarly, form $N^*_+(5)_3$ matrix by summing the corresponding entries of $N^*_1(5)_3, N^*_2(5)_3, ..., N^*_5(5)_3$ matrices.

$$N^*_+(5)_3 = \begin{array}{c c} & \begin{array}{cccc} p_1 & p_2 & p_3 & p_4 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \\ s_3 \\ s_4 \end{array} & \begin{bmatrix} 11 & 10 & 10 & 9 \\ 10 & 11 & 10 & 10 \\ 10 & 9 & 10 & 9 \\ 10 & 10 & 10 & 9 \end{bmatrix} \begin{array}{c} 40 \\ 41 \\ 38 \\ 39 \end{array} \end{array}$$

Step 7: Tabulate the details as in Table 16 and pre-assess the risk level of the students during the lockdown sessions 1 to 3 .

TABLE 16. Pre-assessing students' mental illness from sessions 1 to 3

s_i	p_1		p_2		p_3		p_4		$Total$	
	score	**level**	**score**	**level**	**score**	**level**	**score**	**level**	**score**	**level**
s_1	20	high	20	high	20	high	18	high	78	high
s_2	20	high	20	high	20	high	20	high	80	high
s_3	20	high	18	high	19	high	17	high	74	high
s_4	20	high	20	high	20	high	20	high	80	high

Tabulate as in Table 17 and pre-assess the risk level of the students during the lock-down sessions 2 to 3.

TABLE 17. Pre-assessing students' mental health illness from sessions 2 and 3

s_i	p_1		p_2		p_3		p_4		$Total$	
	score	**level**	**score**	**level**	**score**	**level**	**score**	**level**	**score**	**level**
s_1	15	bor	15	bor	15	bor	15	bor	60	bor
s_2	16	high	16	high	16	high	16	high	64	high
s_3	15	bor	15	bor	15	bor	15	bor	60	bor
s_4	15	bor	15	bor	15	bor	15	bor	60	bor

Similarly, tabulate the details as in Table 18 and pre-assess the risk level of the students for the lock-down session 3.

Analysis: When we examine the total (last column) in Table 15, we understand that everyone in the group establishes a high risk-level towards mental health. Similarly, when we analyze the total data in Table 16, the students show a high risk-level in sessions 1 to 3. The reason is that $QHDF$ enhances the effect of value in the first session and decreases the

TABLE 18. Pre-assessing students' mental health illness for session 3

s_i	p_1		p_2		p_3		p_4		$Total$	
	score	**level**	**score**	**level**	**score**	**level**	**score**	**level**	**score**	**level**
s_1	11	bor	10	mod	10	mod	9	mod	40	mod
s_2	10	mod	11	bor	10	mod	10	mod	41	bor
s_3	10	mod	9	mod	10	mod	9	mod	38	mod
s_4	10	mod	10	mod	10	mod	9	mod	39	mod

influence of value in the second and third sessions. Likewise, when we analyze the total data in Table 17, except s_2, all others show a borderline risk of mental illness in sessions 2 and 3. The student s_2 is yet to subdue from high risk-level. The reason is the same as before. $QHDF$ enhances the effect of value in the second session and decreases the influence of value in the third session. Hence, from the above observation, we conclude that in session 2, except for the student s_2, all other students are in the borderline stage, and s_2 still shows a high-risk level towards mental health illness. Also, we state that the students s_1, s_3, and s_4 have reached the borderline stage from high-level mental health illness. On a similar note, when we analyze the total data in Table 18, except s_2, all others show a moderate risk of mental illness in session 3. We infer from the data that students s_1, s_3, and s_4 have reached the borderline stage (session 3) from high-level mental health illness (session 1). This method helps the psychiatrist to understand the risk level during a longitudinal study when there are n counseling sessions. Also, this result provokes to follow an alternative remedy process to lower the risk level from the forthcoming session for the student s_2.

11. Comparison and Significance of $QHDISVNNSM$

This section will focus on the significance of $QHDISVN\mathcal{N}SM$. Since, this method is new and cannot be compared with existing methods, we choose a simple average method to show the superiority of $QHDISVN\mathcal{N}SM$.

Consider a scenario where the students have to undergo a total of four counseling sessions. Let's assume that MHC would like to pre-assess the mental health of the students before the completion of the last session. Here, the MHC wishes to pre-assess the students after the completion of the third session. The rating scale distribution and norms be as in Tables 19 and 20.

Step 1: Suppose that $\mathcal{U} = \{s_1, s_2\}$ be the set of students who suffer from mental illness and $\mathcal{P} = \{p_1, p_2, p_3, p_4, p_5\}$ be the set of parameters. Let MHC observes the behavior of each student based on a framed positive statement and provide the values in $SVNSMs$ form, $(N_1^*)_1$ for the first session.

TABLE 19. Shows the rating scale distribution

Positive statement	**Negative statement**	**Score values**
5	1	$0.8 \leq s_{ij} \leq 1.0$
4	2	$0.6 \leq s_{ij} < 0.8$
3	3	$0.3 \leq s_{ij} < 0.6$
2	4	$0.0 \leq s_{ij} < 0.3$
1	5	$-0.5 \leq s_{ij} < 0.0$

TABLE 20. Shows the qualitative norm details

Parameter	**Scores**	**Norms**
	1	low
p_1, p_2, p_3, p_4, p_5	2-3	average (avg)
	4-5	high
	1-15	low
Total	16-20	avg
	21-25	high

$$(N_1^*)_1 = \begin{array}{c c} & \begin{array}{ccccc} p_1 & p_2 & p_3 & p_4 & p_5 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \end{array} & \begin{bmatrix} \langle 0.98, 0.76, 0.05\rangle & \langle 0.88, 0.77, 0.06\rangle & \langle 0.83, 0.69, 0.10\rangle & \langle 0.78, 0.88, 0.43\rangle & \langle 0.78, 0.83, 0.15\rangle \\ \langle 0.92, 0.95, 0.17\rangle & \langle 0.80, 0.95, 0.12\rangle & \langle 0.90, 0.95, 0.25\rangle & \langle 0.87, 0.83, 0.24\rangle & \langle 0.88, 0.86, 0.34\rangle \end{bmatrix} \end{array}$$

The MHC provides the value in $SVNSMs$ form, $(N_1^*)_2$ for the second session.

$$(N_1^*)_2 = \begin{array}{c c} & \begin{array}{ccccc} p_1 & p_2 & p_3 & p_4 & p_5 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \end{array} & \begin{bmatrix} \langle 0.90, 0.80, 0.20\rangle & \langle 0.88, 0.85, 0.10\rangle & \langle 0.85, 0.82, 0.20\rangle & \langle 0.93, 0.77, 0.20\rangle & \langle 0.85, 0.80, 0.25\rangle \\ \langle 0.76, 0.78, 0.25\rangle & \langle 0.90, 0.88, 0.15\rangle & \langle 0.84, 0.81, 0.30\rangle & \langle 0.79, 0.77, 0.09\rangle & \langle 0.90, 0.85, 0.25\rangle \end{bmatrix} \end{array}$$

The MHC provides the value in $SVNSMs$ form, $(N_1^*)_3$ for the third session.

$$(N_1^*)_3 = \begin{array}{c c} & \begin{array}{ccccc} p_1 & p_2 & p_3 & p_4 & p_5 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \end{array} & \begin{bmatrix} \langle 0.88, 0.78, 0.20\rangle & \langle 0.65, 0.32, 0.24\rangle & \langle 0.70, 0.65, 0.24\rangle & \langle 0.77, 0.67, 0.22\rangle & \langle 0.60, 0.34, 0.26\rangle \\ \langle 0.85, 0.35, 0.18\rangle & \langle 0.82, 0.36, 0.25\rangle & \langle 0.81, 0.31, 0.19\rangle & \langle 0.84, 0.34, 0.20\rangle & \langle 0.85, 0.38, 0.18\rangle \end{bmatrix} \end{array}$$

Step 2: Apply SF Definition 3.1, to get $S(N_1^*)_1$, $S(N_1^*)_2$ and $S(N_1^*)_3$ in matrices form for sessions 1, 2 and 3.

$$S(N_1^*)_1 = \begin{array}{c c} & \begin{array}{ccccc} p_1 & p_2 & p_3 & p_4 & p_5 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \end{array} & \begin{bmatrix} 0.845 & 0.795 & 0.710 & 0.615 & 0.730 \\ 0.850 & 0.815 & 0.800 & 0.730 & 0.700 \end{bmatrix} \end{array}$$

$$S(N_1^*)_2 = \begin{array}{c c} & \begin{array}{ccccc} p_1 & p_2 & p_3 & p_4 & p_5 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \end{array} & \begin{bmatrix} 0.750 & 0.815 & 0.735 & 0.750 & 0.700 \\ 0.645 & 0.815 & 0.675 & 0.735 & 0.750 \end{bmatrix} \end{array}$$

$$S(N_1^*)_3 = \begin{array}{c c} & \begin{array}{ccccc} p_1 & p_2 & p_3 & p_4 & p_5 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \end{array} & \begin{bmatrix} 0.730 & 0.365 & 0.555 & 0.610 & 0.340 \\ 0.510 & 0.465 & 0.465 & 0.490 & 0.525 \end{bmatrix} \end{array}$$

Step 3: Now, let's construct the $\mathcal{A}N_1^*$ matrices by computing the average of each corresponding entries in $S(N_1^*)_1$, $S(N_1^*)_2$ and $S(N_1^*)_3$ matrices.

$$\mathcal{A}N_1^* = \begin{array}{c c} & \begin{array}{ccccc} p_1 & p_2 & p_3 & p_4 & p_5 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \end{array} & \begin{bmatrix} 0.775 & 0.658 & 0.667 & 0.658 & 0.590 \\ 0.668 & 0.698 & 0.647 & 4, 0.652 & 0.658 \end{bmatrix} \end{array}$$

Step 4: Apply Definition 5.3, to determine the rating scale for each entry and represent the resultant matrix as $\mathcal{A}N_1^*(5)$.

$$\mathcal{A}N_1^*(5) = \begin{array}{c c} & \begin{array}{ccccc} p_1 & p_2 & p_3 & p_4 & p_5 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \end{array} & \begin{bmatrix} \langle 4, 0.775\rangle & \langle 4, 0.658\rangle & \langle 4, 0.667\rangle & \langle 4, 0.658\rangle & \langle 3, 0.590\rangle \\ \langle 4, 0.668\rangle & \langle 4, 0.698\rangle & \langle 4, 0.647\rangle & \langle 4, 0.652\rangle & \langle 4, 0.658\rangle \end{bmatrix} \end{array}$$

Step 5: Tabulate the details as in Table 21 and pre-assess the risk level of the students during the sessions 1 to 3 by using the norms (Table 20).

Table 21. Pre-assesing students' mental health scores and levels by taking average of sessions 1 to 3

s_i	p_1		p_2		p_3		p_4		p_5		$Total$	
	score	**level**	**score**	**level**	**score**	**level**	**score**	**level**	**score**	**level**	**score**	**level**
s_1	4	high	4	high	4	high	4	high	3	avg	19	avg
s_2	4	high	4	high	4	high	4	high	4	high	20	avg

Now, let's compute the $QHDISVN\mathcal{N}SM$ at the beginning of session 1. Steps 1 and 2 remain the same as above.

Step 3: By applying $QHDISVN\mathcal{N}SM$ Definition 8.3, for the corresponding entries in $S(N_1^*)_1$, $S(N_1^*)_2$ and $S(N_1^*)_3$ matrices, we get $N_1^*(5)_1$ matrix for sessions 1 to 3.

$$N_1^*(5)_1 = \begin{array}{c c} & \begin{array}{ccccc} p_1 & p_2 & p_3 & p_4 & p_5 \end{array} \\ \begin{array}{c} s_1 \\ s_2 \end{array} & \begin{bmatrix} \langle 3, 0.493\rangle & \langle 3, 0.437\rangle & \langle 3, 0.422\rangle & \langle 3, 0.400\rangle & \langle 3, 0.394\rangle \\ \langle 3, 0.449\rangle & \langle 3, 0.457\rangle & \langle 3, 0.431\rangle & \langle 3, 0.420\rangle & \langle 3, 0.417\rangle \end{bmatrix} \end{array}$$

Step 4: Tabulate the details as in Table 22 and pre-assess the risk level of the students during the sessions 1 to 3 .

TABLE 22. Pre-assessing students' mental health scores and levels by using $QHDISVN\mathcal{N}SM$ from sessions 1 to 3

s_i	p_1		p_2		p_3		p_4		p_5		$Total$	
	score	**level**	**score**	**level**	**score**	**level**	**score**	**level**	**score**	**level**	**score**	**level**
s_1	3	avg	3	avg	3	avg	3	avg	3	avg	15	low
s_2	3	avg	3	avg	3	avg	3	avg	3	avg	15	low

Analysis: From Tables 21 and 22, we infer that the risk levels are different for the same values. When we use a simple average approach, the overall risk levels for the students are high. Similarly, when we implement the $QHDISVN\mathcal{N}SM$, the risk levels are low for the students. The reason being, in the former approach, we derive the average of the SF values, whereas, in the latter method, the computation approach is intermittent. Hence, the risk levels are different in each of the discussed methods. The MHC may take a discussion based on the results of immediate effect. Thus the $QHDISVN\mathcal{N}SM$ proves to be significant than the simple average approach.

12. **Limitations, Conclusion and Future works**

The following are the limitations of the proposed research work: i) May require a qualified mental health counselor, therapist,psychiatrist to execute the case studies. ii) When we involve over one psychiatrist in examining the students, the risk of understanding the uncertainty information may lead to different remedy process. iii) Negative preferences for psychological applications. iv) There may be areas of ambiguity that test results do not reflect, even after comprehensive research because of students cautiousness.

Smarandache [71] presented the concept of neutrosophic to determine the vagueness associated with actions, memory, and temperaments of humans. Christianto and Smarandache [72] analyzed cultural psychology as one of the seven philosophical aspects by using neutrosophic theory. To find the hidden patterns in psychological models, Farahani et al. [73] developed a case study on mental health disorders. They compared the combined overlap block of fuzzy cognitive maps and neutrosophic cognitive maps to find out the hidden patterns. In most of the current psychological applications, we come across only a limited range of neutrosophic theoretical principles and methods. Most of such applications merely use membership classes, usually in combination with prototypes and product similarity measures. We have a scarcity of neutrosophic theories in the psychology field but may soon find a wide range of ways to make use of neutrosophic constructs in their pursuits. There are situations where psychologists appeal to vagueness have not progressed far beyond the theoretical level. In this study, we provide a suitable workaround to two critical issues, which represent a barrier for the domination of neutrosophic theory in psychology. i) Most of the psychological studies deal with questionnaires, and psychiatrists would like to follow the traditional method of handling scale construction and classical test-theory to access the conditions. But, considering the ambiguity conditions, it is not advisable to capture the information with raw data to analyze the vagueness associated with psychological aspects. ii) Also, psychiatrists would like to record the data and analyze the change in behavior based on the treatment given for each session. We present solutions to these arguments by using a blend of $SVNSS$, $\mathcal{N}SS$, and $QHDF$. By applying the concept of $SVN\mathcal{N}SS$ and $QHDISVN\mathcal{N}SS$, we can easily relate these theoretical theories to the neutrosophic group. These concepts support the psychiatrists to capture the information using neutrosophic and follow the rating method. $SVN\mathcal{N}SS$ helps the psychiatrists to use their traditional scoring method (positive and negative scoring keys). During the decision-making process, we consider the immediate influence of human action to decide on the consequences more accurately.

We may extend these notions to other fuzzy hybrid sets and determine the importance of the same with a real-life case study. Also, we may prepare a questionnaire with the support of a pilot study and try to pre-assess or assess the students psychosocial behavior during the pandemic.

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