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A NEUTROSOPHIC DECISION-MAKING MODEL FOR DETERMINING YOUNG PEOPLE'S ACTIVE ENGAGEMENT

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Young people's skills and attitudes must be observed, studied and evaluated in order to create appropriate models that would serve an educational purpose. In this paper, we propose a decision-making model with the aim to detect certain attitudinal and behavioural patterns of actively engaged young people. The data used in this research resulted from a questionnaire drawn up by a group of researchers from 6 European countries with the aim to investigate the youth's awareness about the *Sustainable Development Goals* and their engagement as active agents of development and change at regional level. For the purpose of this study, we selected the regional results obtained from administering this questionnaire in Dolj County (Romania) and La Rioja (Spain). We developed a neutrosophic model that determines the *Mindchanger profile* of the respondents based on a minimal set of questions, which is dependent on the inclusion or exclusion of the nationality-specific traits. The resulting decisions were then compared with the respondents' self-evaluations, yielding high precisions (more than 0.83) for all the investigated evaluation scenarios. Our results were significantly better than the ones provided by several machine learning models applied on the same set of data. A direct impact of our model is that it can be applied to questionnaires which include linguistic responses that express, among others, unclear or vague thoughts. Additionally, it offers the possibility to identify the minimal set of questions that impact the respondent's answer choice to a target question.

Keywords: neutrosophic representation, decision-making model, attribute selection, uncertainty reasoning, questionnaire analysis, youth engagement

1. Introduction

Current realities of the globalised communities have pointed to the stringent need for a world of greater justice, equality and human rights for all its citizens, a world in which all actors of society are responsible for reaching the *Sustainable Development Goals* (SDGs) included in the 2030 Agenda for Sustainable Development.

Young citizens play a key role in addressing issues of global concern at local and regional level and in improving the critical understanding of the communities and the wider public opinion about these issues. They are crucial in promoting awareness messages, changes of behaviour and active engagement due to their ability to innovate, communicate and influence their peers by using specific tools that overcome geographical distances. Moreover, the EU Consensus recognised youths as agents of development and change and, as such, as essential contributors to the 2030 Agenda. In this context, youths can be considered as actual "Mindchangers" that can actively support the Decade of Action announced in 2019 by the United Nations.

In order to identify the elements that foster the active engagement of young people in six European regions, the questionnaire "Youth engagement in climate change and migration issues" (henceforth YECCM) was drawn up within the DEAR-funded project "Mindchangers: Regions and Youth for Planet and People" and was administered to young people aged 15-35 from Wallonie-Bruxelles (Belgium), Auvergne-Rhône-Alpes (France), Baden-Wurttemberg (Germany), Piemonte (Italy), Dolj County (Romania) and La Rioja (Spain).

According to recent Eurobarometers (*Special Eurobarometer 441*[1] and *Special Eurobarometer 476*[2]), EU citizens are hardly aware about the exact dimensions of poverty and global environmental emergencies, and even less willing to engage themselves and change their behaviour and attitudes to contribute to the reaching of SDGs. 63% of EU citizens have never heard about the SDGs (*Special Eurobarometer 441*) and just over half of all respondents agree that, as individuals, they can play a role in tackling poverty in developing countries (53%), whereas four in ten disagree (43%) and only 44% claim to be personally involved in helping developing countries (*Special Eurobarometer 476*). The YECCM questionnaire complements these data, collected at national level, with references about the local and regional context. Moreover, it complements the investigation of the engagement and commitment of local and regional governments to SDGs, carried out in 2021 by the European Committee of the Regions (CoR) and the Organisation for Economic Co-operation and Development (OECD), with an analysis of young people's engagement and commitment in the above-mentioned six European regions.

In order to obtain an overview of the current situation at the regional level, the questionnaire was drawn up with the objective to examine the youths' awareness about SDGs and their engagement as active agents of development and change, in the field of global challenges, specifically on two topics: *climate change* and *migration.* Similarly to the Eurobarometers, about which it was emphasized that *"it is not a tool to collect statistics, it rather provides a snapshot of public opinion perceptions at a given time"*, this questionnaire offers a snapshot of young people's attitudes, perspectives, motivations, preferences and reflections on active engagement in the 6 European regions, partners in the Mindchangers project. It additionally provides a general profile of a Mindchanger, i.e. of a young person willing to get actively engaged in civic activities. However, if a local authority or a civil society organisation needs to analyse the likelihood to become a Mindchanger, the YECCM presents the disadvantage of being time consuming because of the large number of questions, resulting from its wide range of objectives. Therefore, despite its complexity, when taken in its entirety, the YECCM may not be considered an effective tool for local authorities and civil society organisations interested in working with young people who already have or are willing to reach a high level of engagement.

Considering all the above, our study addresses the following research questions:

(1) *Is there a minimal set of questions in the YECCM questionnaire that allow us to determine, irrespective of the national context, the young people's self-evaluation of the likelihood to become Mindchangers?*
(2) *Are there any nationality-based characteristics that can influence this self-evaluation?*

To answer these questions, we created a decision-making model that can accurately process the respondents' answers to a set of questions selected from the YECCM questionnaire and, based on these answers, to determine for each respondent his/her self-evaluation of the likelihood to become a Mindchanger or shortly, his/her *Mindchanger profile.*

There are decision situations in which the information cannot be assessed precisely in a quantitative form, but it may be qualitatively evaluated using labels such as *"rather agree"*, *"rather disagree"*, etc. As a consequence, Fuzzy Sets (FS)[3] are widely used in decision making problems due to their ability to represent uncertainty or vagueness. Fuzzy Sets were extended to Intuitionistic fuzzy sets (IFS)[4,5] which provide a better way to manage the inaccuracy, dubiousness, and vulnerabilities that are usually found in human information. Designed especially to deal with imprecision and uncertainty in decision making, Neutrosophic sets (NS)[6] generalize the concepts of classical sets, FS and IFS by adding three grades of truth, falsehood and indeterminacy, being thus more indeterminacy tolerant as compared to the fuzzy counterparts. The significant level of uncertainty corresponding to the answers in the questionnaire led us to design and implement a neutrosophic model for the questionnaire data representation and processing. Our neutrosophic model responds to the need to investigate the impact of the uncertainty degrees of the respondents' answer choices to a target question.

The model we propose selects a minimal set of questions from the YECCM questionnaire, based on which the young people's *Mindchanger profile* can be determined with maximum precision. Feature selection is a dimension-reduction method that diminishes dataset size while maintaining model performance.[7] The obtained precision is quite significant (0.83) and stable in the sense that it is not altered by different training sets with the same distribution,[8] in our case by national or regional characteristics. Still, in order to select only those nationality-based characteristics that could result in a higher precision, we explored, for each of the two countries' datasets, additional questions from the questionnaire. Our efforts paid off as we increased the model precision for both datasets considered separately. The whole study has been implemented and run with the Python environment.

Subsequently, the model presented in this paper can be applied to questionnaires which include linguistic responses that express, among others, unclear or vague thoughts, with the aim to predict the respondents' answers to a specific question, named in our study the target question.

The paper is organized as follows: Section 2 provides a short overview of similar studies existing in the literature, Section 3 presents the structure and the administration of the YECCM questionnaire, Section 4 is dedicated to the proposed decision-making model, Section 5 presents the conducted experiments for our model on different scenarios and the obtained results, while Section 6 summarizes the main conclusions of the study and opens future research directions.

2. Related Works

The use of questionnaires to collect data about people's opinions, behaviours or preferences is a common practice in behavioural and social science research. Even if there are some disadvantages, such as potential social desirability biases and excessively rationalized responses,[9] there are also advantages, such as the easiness to administer them, the ability to obtain data from different places with distinct characteristics (wide coverage) and the low cost, among others.[10] The questions included in a questionnaire can be: dichotomous, nominal, or ordinal, the well-known Likert scales. Many studies were carried out on the number of predefined answers on Likert scale in order to discuss its influence on their reliability and validity.[11,12] To facilitate the analysis of the collected responses, questions are usually designed in closed-response format involving linguistic variable representations.[11]

For the data analysis stage, statistical methods, such as descriptive statistics, correlations, multivariate analysis of variance,[13] linear and logistic regression[14,15] and structural equation modelling,[16] are the most prominent approaches to draw inferences and reach conclusions from the data sets. Recently, machine learning techniques, such as random forests,[17,18] ARIMA,[19] decision trees and SVM,[20] have also been applied to survey analysis in social sciences.

In contrast to the statistical techniques, these data-driven approaches do not require prior knowledge about the relationship under study. Furthermore, they are able to identify complex relationships in data. Thus, the application of machine learning in survey research can help to tackle research problems that usually involve specifying parametric regression models.[21]

Despite the advantages that machine learning techniques can bring to the analysis of survey data, we must keep in mind that the rating scales typically used in survey questions are linguistic variables,[22] which are naturally vague.[23] As a direct consequence, the techniques to analyse Likert-type data for statistical purposes are quite limited.[10,24] Indeed, representing these responses as crisp variables and calculating statistics or training models with them may result in unreasonable bias due to the ambiguity and uncertainty in the respondent's mind.[25]

Regarding the decision processes, it is obvious that questionnaire data could not represent the unique source for the decision making, as this data is usually full of noise, incompleteness and inconsistency.[26] These problems can be overcome by the use of fuzzy sets,[27,28,29] as they provide ways to deal with uncertainty in information and to minimize the uncertainty in the decision-making problems.[30] In a fuzzy-based approach, responses are encoded by means of appropriate linguistic descriptors which are assumed to be identified with fuzzy numbers/intervals:[34] T represents the truth, while $F = 1 - T$ is the nonmembership (or the falsehood). Intuitionistic fuzzy sets (IFS)[4] extend fuzzy sets concept by modelling the vagueness or incomplete data and, thus, are more effective in representing the essence of responses in this type of questionnaires.[31,32] In IFS, besides the membership (T) and nonmembership (F), the indeterminacy called hesitancy is also represented: $H = 1 - T - F$.[33]

Neutrosophic sets (NS) are even more suitable than IFS to represent the responses to questionnaires, allowing for more accurate representations of the respondents' true feelings or thoughts. In neutrosophy, we also consider Indeterminacy membership function (I)[35,36,37] along with the membership and nonmembership, all three components being totally independent from one another, as their sum is $0 \leq T + I + F \leq 3$. If compared with IFS, NS allow the uncertainty measurement, apart from the truth and falsity degrees.[38] NS can be restrained to IFS, but the independence of components is lost and the results of the aggregation operators are totally different in the neutrosophic environment as compared to the intuitionistic fuzzy environment, since Indeterminacy is ignored by IFS operators (indeterminacy is ignored by the intuitionistic fuzzy aggregation operators). Even if $T + I + F = 1$, there is still a distinction between IFS and NS: in IFS the operators (union, intersection, complement/negation, difference, etc.) are defined for T and F only, not for I, while in NS the operators (union, intersection, complement/negation, difference, etc.) are defined with respect to all components T, I, F.

In 2019, a new research direction was proposed in the literature under the name of *Neutrosophic sociology* or *Neutrosociology*,[39] addressing the studies of sociology by means of neutrosophic methods. In this case, due to the membership function of indeterminacy,[35] the use of NS is suitable for modelling the lack of knowledge, doubts or contradictions that can be found in the answers of a survey.[40]

3. Youth Engagement in Climate Change and Migration Issues Questionnaire

The design of the YECCM questionnaire was made according to the stages of survey design defined by Lavrakas.[41] The formulation of the objectives and of the research questions was followed by the definition of a set of key concepts related to engagement and the development of a conceptual framework, including the issues to be addressed in the questionnaire.[42,43] Three main organising concepts were identified for youth engagement: *affective*, *cognitive* and *behavioural*.[44,45] The concepts included in the conceptual framework were operationalized into questionnaire items. The conceptual framework was refined leading to the creation of 64 items that cover the most important issues regarding youth engagement. Two types of variables were used: nominal and ordinal, in the form of Likert type questions with 4 and 5-point rating scales.

3.1. *Structure of the questionnaire*

The structure of the questionnaire consists of a short introduction to the project and the research objectives, and the five sections detailed below:

- Section 1. Socio-demographic data (10 questions)
- Section 2. Sustainable Development Goals (6 questions)
- Section 3. Climate change (23 questions)
- Section 4. Migration (23 questions)
- Section 5. Mindchangers (2 questions)

Each question has a unique ID of the form:

$$Q. < \#\ of\ section > . < \#\ of\ question > . < \#\ of\ option >^*$$

where $< \#\ of\ option >^*$, when applicable, corresponds to the structure of the question and represents the number of the items targeted by the question.

The questions included in Section 1 collected demographic data about the surveyed group: age, gender, nationality, residence, education, employment a.o. Moreover, in question $Q.1.9$, young people were asked to describe themselves by self-evaluating a list of personal characteristics based on a 1 to 5 rating scale (1 being the lowest and 5, the highest). The 24 characteristics corresponding to questions $Q.1.9.1$ - $Q.1.9.24$ were established by the researchers and considered key characteristics for an actively engaged young person. As detailed in Section 5, the self-assessment of these characteristics will contribute to the improvement of the precision rate for determining the *Mindchanger profile*.

Section 2 included a question evaluating the general awareness regarding the SDGs (question $Q.2.1$), alongside questions aimed at offering a perspective on regional circumstances, capacities and levels of responsibility with regard to the implementation of the $SGDs$.

Sections 3 and 4 were divided in three scenarios, A, B and C. In Scenario A entered young people engaged in actions on several occasions (more than twice), whereas Scenario B included young people engaged in actions at least once or twice. In Scenario C entered only the young people who have never been engaged in actions addressing climate change/migration. Sections 3 and 4 were randomly sequenced, in the sense that some respondents got Section 3 first, others got Section 4, and, at the end of each section, they were asked if they wanted to continue with the other section.

Section 5 referred to the characteristics of a Mindchanger and to the participants' self-evaluation of the likelihood to achieve a high level of engagement in actions addressing climate change and migration.

3.2. *Questionnaire administration*

To facilitate its administration at the regional level, the YECCM questionnaire was translated into five languages and made available online using the LimeSurvey tool.[46] Data cleaning was done in accordance with the decision reached by the regional researchers that only the answers that exceeded 20 minutes were taken into consideration (at least 10 minutes per section).

The recommended number of respondents at regional level was approx. 100 young people. The research was organised in compliance with the EU's 2016 General Data Protection Regulation (EU Reg. 2016/679). Prior to their participation, the respondents were informed that the data collected would be processed and disclosed exclusively in aggregated form, that is without examining or describing in any way characteristics and opinions individually; the results obtained would be used only for research purposes; the data collected would be kept in a protected place, and would not be disseminated in any way outside the research group. Moreover, this research got the ethical approval from the Bioethical Committee of the University of Torino (Decision no. 0438557/13.07.2021).

Table 1: Demographics of Romanian and Spanish respondents participating in the survey

Country	N	Gender			Age			
		Female	Male	Other	15-20	21-25	26-30	31-35
Romania	100	71	29	0	33	44	11	12
Spain	102	74	27	1	5	61	18	18

In this study, we refer to the answers provided by the respondents from Dolj

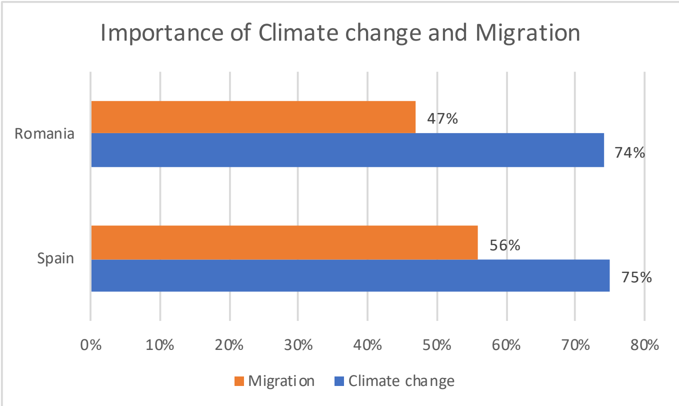


Fig. 1: Importance of climate change and migration, based on YECCM data

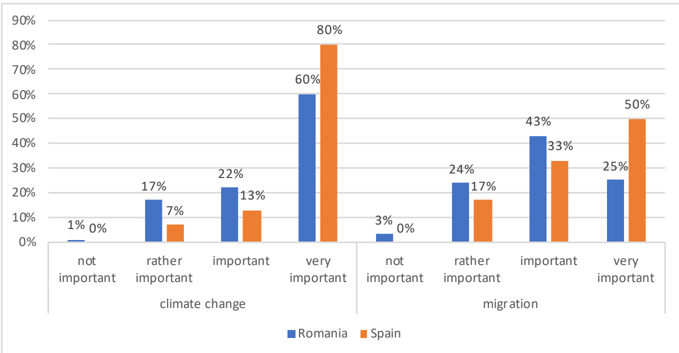
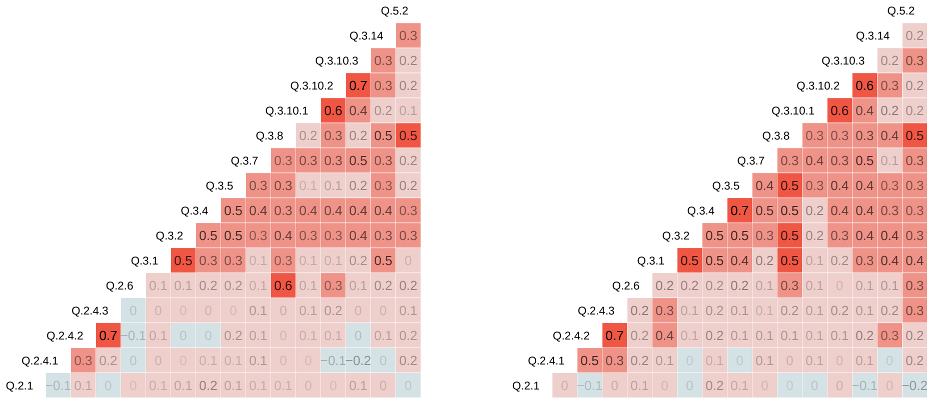


Fig. 2: Importance of young people's engagement on climate change and migration, based on YECCM data

County (Romania) and La Rioja (Spain). Table 1 shows demographic information about the respondents. The average age of the Romanian respondents was 24 years and of the Spanish ones 25-26 years.

The questionnaire data showed that young people paid a greater importance to the issues of climate change as opposed to migration and even the level of their personal concern about climate action is higher (see Figure 1).

Moreover, when asked to rate the importance of young people's engagement in addressing climate change (Q.3.14) or migration (Q.4.14) issues by using a 4-level Likert scale (1:*not at all*, 2:*not important*, 3:*important*, 4:*very important*), a great majority of the respondents admitted that their engagement is important, with more importance attributed to climate change issues than to migration. Both Romanian and Spanish respondents consider that young people's actions have a higher impact on climate change issues than on migration (Figure 2).



(a) Romanian data (b) Spanish data

Fig. 3: Correlations between questions from Section 2 and 3 and Mindchanger options for each dataset.

Considering the above, the study presented in this paper and detailed in the following sections refers to young people's engagement in climate change actions. We create our model taking into consideration the questions related to this topic which are included in Section 3 of the questionnaire, as well as those included in Section 2, referring to the SDGs.

We built the correlation matrix (see Figure 3) for the questions of Sections 2 and 3 of the questionnaire in terms of responses' correlation with the target question $Q.5.2$, which asks the respondents to evaluate their *Mindchanger profile*. In this case, Spearman's correlation (r) was used because we dealt with Likert-scale items. Overall, as illustrated in Fig. 3, the relationship between questions on the SDGs ($Q.2.x$) and on climate change ($Q.3.x$) with $Q.5.2$ is weak. There is only a moderate positive relationship between the attractiveness to participate in climate change-related actions in the future ($Q.3.8$) and the *Mindchanger profile* of the respondents ($Q.5.2$) ($r = .51, p < .001$ for both data sets).

Regarding the questions in Section 2, respondents from both countries agree on the role that both national and regional authorities should play in the fight against global inequalities and poverty ($Q.2.4.2$ and $Q.2.4.3$): $r = .72, p < .001$ for Romanian respondents and $r = .68, p < .001$ for Spanish respondents. On the other hand, there is a moderate positive relationship between the importance of climate change for the respondents ($Q.3.1$) and their concern about this issue ($Q.3.2$) ($r = .51, p < .001$ and $r = .54, p < .001$ for Romanian and Spanish data, respectively). Finally, for both Romanian and Spanish respondents, there is a moderate positive relationship between their awareness of measures/projects addressing climate change at the three levels considered: local ($Q.3.10.1$), national ($Q.3.10.2$) and international ($Q.3.10.3$).

To sum up, the correlation values are poor for both Romanian and Spanish data. Nevertheless, with the neutrosophic approach detailed in the next section we achieve more than 0.8 precision in determining the respondents' *Mindchanger profile* based on their responses to a set of selected questions from Sections 2 and 3.

4. A neutrosophic decision-making model to determine the *Mindchanger profiles*

Neutrosophic Set theory focuses on the importance of indeterminacy, while in other set theories this is completely or partially ignored. This theory is considered the right tool to handle and represent data with a high degree of indeterminacy, such as the answers to Likert scale questions[40] because we can define not only membership functions of truthfulness and falseness, but also indeterminacy, independently of the membership function of falseness.[40,37]

We construct a neutrosophic decision-making model by means of the following two algorithms:

- **Algorithm 1.** to determine the *Mindchager profile* of a specific respondent by computing an overall score based on his/her answers to a set of selected questions. For each respondent, this overall score will be used to decide one of the four possible values (alternatives) of the *Mindchager profiles* using a Ranking algorithm for Single-Valued Neutrosophic Triplets. The alternatives of the decision are as follows: *unlikely / rather likely / likely / most likely to become a Mindchanger.*
- **Algorithm 2**. to identify the minimal set of questions from Sections 2 and 3 of the YECCM questionnaire which lead to the best precision rate for determining the *Mindchanger profile*. The answers to these questions will represent the attributes under consideration in the proposed decision-making model.

We test the proposed model on several datasets: two datasets specific to a certain country (in our case Spain and Romania), but also one combined dataset, which includes the previous two. The results show that the proposed model achieves its highest precision (more than 80%) on the combined dataset but also maintains the precision on the Romanian and Spanish datasets taken separately, which means that the model's precision is stable regardless of the nationality of the respondents.

In what follows, we describe the proposed model in detail.

4.1. *Questionnaire answers as single-valued neutrosophic triplets*

For a specific question $Q.x$ of the YECCM questionnaire, we can have multiple answer options, written as: $Ans^i_{Q.x}$, $i \geq 2$.

In the YECCM questionnaire, the user's choices when answering the questions are expressed in natural language using linguistic terms. The linguistic approach is the solution to qualify the user's perception, which, in natural language, is often expressed with words instead of numerical values.

For example, let us consider a question $Q.x$ from the questionnaire with the following set of possible answers: *Not at all, Not much, Much, Very much.* As shown below, this combination of answers is frequently encountered in the questionnaire. In our approach, each answer is represented as a *neutrosophic fuzzy set* commonly named *single-valued neutrosophic triplet number* because the components are single-valued numbers. Thus, each alternative for the $Q.x$ answers is represented as $Ans^i_{Q.x} = (T^i_{Q.x}, I^i_{Q.x}, F^i_{Q.x})$, $i = \overline{1,4}$, such that $T^i_{Q.x}, I^i_{Q.x}, F^i_{Q.x} \in [0,1]$, where:

- $T^i_{Q.x}$ is the truth (or membership) component, quantifying the positive quality of the answer;
- $I^i_{Q.x}$ is the degree of indeterminacy (neutrality), more precisely the unclear or confused aspect of the answer, which is neither true nor false;
- $F^i_{Q.x}$ is the degree of falsehood (or nonmembership) of the i-th answer of question $Q.x$, which is opposed to the truth degree $T^i_{Q.x}$.

This representation follows the neutrosophy's triad $(< A >, < neutA >, < antiA >)$, where $< A >$ is an item (concept, idea, proposition, etc.), $< antiA >$ is its opposite, while $< neutA >$ is the neutrality (indeterminacy) between these opposites. There are many such neutrosophic triads (triplets) in our everyday life, such as: (positive, neutral, negative), (win, draw, loose), (accept, undecided, reject), (membership, indeterminacy, nonmembership), (truth, indeterminacy, falsehood), etc.[47]

We must point out that if a question $Q.x$ has only two dual opposite answers, such as *Yes* and *No*, the model can also be applied on this crisp data, but no indeterminacy will be represented, because the answer *Yes* determines the $(1,0,0)$ neutrosophic number representation, where $T^1_{Q.x} = 1$ and $I^1_{Q.x} = F^1_{Q.x} = 0$, while *No* determines the $(0,0,1)$ representation, $F^2_{Q.x} = 1$ and $I^2_{Q.x} = T^2_{Q.x} = 0$, so in both cases the indeterminacy is 0.

In the Neutrosophic Set (NS) literature, there are several cases that can be encountered for the sum of the components T, I and F as NS is an extension of Intuitionistic Fuzzy Set (IFS), even if the sum of single-valued neutrosophic components is < 1, or > 1, or $= 1$:[48]

- when T, I, F are independent from one another, their sum is $0 \leq T + I + F \leq 3$,
- when T, I, F are totally dependent, as in IFS, the sum is $0 \leq T + I + F \leq 1$,
- when T, I, F are partially independent and partially dependent, then $1 \leq T + I + F \leq 3$.

As presented in Tables 2 and 3 below, the neutrosophic representations we propose consider that all the questionnaire answers are in the totally dependent case in which $T^i_{Q.x} + I^i_{Q.x} + F^i_{Q.x} = 1$ where $Ans^i_{Q.x} = (T^i_{Q.x}, I^i_{Q.x}, F^i_{Q.x})$, $i \geq 2$, is the representation for the i-th answer to the question $Q.x$. In this way, the answers of all considered questions have equal importance in the study, even the crisp ones.

But even when the components are totally dependent and their sum is 1, as in our case when $T^i_{Q.x} + I^i_{Q.x} + F^i_{Q.x} = 1$ for any i-th answer to any question $Q.x$ from the questionnaire, we can apply the neutrosophic operators and get different results than in the case of applying the intuitionistic fuzzy operators.[49,50] This is due to the fact that in NS the indeterminacy is included in the operators' formulas, but in IFS the indeterminacy (hesitancy) is not present in the IF operators (hesitancy is completely ignored).

All neutrosophic-triplet numbers that represent the questionnaire answers take into account the level of truthfulness, indeterminacy and falsity corresponding to the semantics of the answers' linguistic descriptors. The existing literature suggests taking the elements of a linguistic term set as primary ones and distributing them on a scale on which a total order is defined.[51] For example, a set of seven terms S:

$S = \{s_0 = none; s_1 = very\ low; s_2 = low; s_3 = medium; s_4 = high; s_5 = very\ high; s_6 = perfect\}$, $s_a < s_b$ iff $a < b$
is often required to satisfy the following:[51]

(1) There is a negation operator, e.g., $Neg(s_i) = s_j$; $j = T - i$ ($T + 1$ is the cardinality);
(2) There is a maximization operator: $Max(s_i; s_j) = s_i$ if $s_i \geq s_j$;
(3) There is a minimization operator: $Min(s_i; s_j) = s_i$ if $s_i \leq s_j$.

For each question $Q.x$, the set of the linguistic terms of $Q.x$ answers form an n-terms set noted as $S_{Q.x}$,$n \geq 2$. In line with the existing literature, we consider the neutrosophic representation of the $Q.x$ answers based on the cardinality of the term set, that is $\mid S_{Q.x} \mid$, and according to the semantics of its elements as shown below.

The set of single-valued neutrosophic triplet numbers corresponding to a respondent's answers to a selected set of questions $Q_1, \ldots, Q_n$, $n \geq 1$ are aggregated into a single-valued neutrosophic triplet. When applying a neutrosophic aggregation operator we can obtain a different result from that obtained when applying intuitionistic fuzzy operators, since the intuitionistic fuzzy operators ignore the indeterminacy, while the neutrosophic aggregation operators take into consideration the indeterminacy at the same level as truth-membership and falsehood-nonmembership are taken.[36]

Most of the aggregation operators are linear combinations of the fuzzy t-norm (denoted by $\wedge_F$) and fuzzy t-conorm (denoted by $\vee_F$), but non-linear combinations may as well be constructed. In this study, we use the arithmetic average aggregation operator.

Let us consider a specific respondent $\mathcal{U}$ and its answers to a set of selected questions extracted from the questionnaire: $Q_1, \ldots, Q_n$ represented as:

$$Ans^{\mathcal{U}}_{Q_1}, \ldots, Ans^{\mathcal{U}}_{Q_n}$$

where the superscript denotes the answer option selected by the user $\mathcal{U}$ to each of the questions Q_i.

We consider the answers of the user $\mathcal{U}$ represented as a set of n single-valued neutrosophic triplet numbers. We obtain:

$$Answers_{\mathcal{U}} = \bigcup_{i=1}^{n}\{Ans^{\mathcal{U}}_{Q_i} \mid Ans^{\mathcal{U}}_{Q_i} = (T^{\mathcal{U}}_{Q_i}, I^{\mathcal{U}}_{Q_i}, F^{\mathcal{U}}_{Q_i})\}$$

We aggregate these answers representations into a single-valued neutrosophic-triplet number and we note this operation by means of Agg function defined on the set of n tuples of $Answers_{\mathcal{U}}$:

$$Agg(Answers_{\mathcal{U}}) = (\frac{\sum_{i=1}^{n} T^{\mathcal{U}}_{Q_i}}{n}, \frac{\sum_{i=1}^{n} I^{\mathcal{U}}_{Q_i}}{n}, \frac{\sum_{i=1}^{n} F^{\mathcal{U}}_{Q_i}}{n})$$

Based on the resulted single-valued neutrosophic-triplet number $Agg(Answers_{\mathcal{U}})$ the model decides the best choice of the *Mindchanger profile* value for the user $\mathcal{U}$.

Let us use the following notations for the possible answer options of the target question QT: *How likely are you to become a Mindchanger?*:

- Ans^1_{QT} corresponding to the answer "*unlikely to become a Mindchanger*";
- Ans^2_{QT} corresponding to the answer "*rather likely to become a Mindchanger*";
- Ans^3_{QT} corresponding to the answer "*likely to become a Mindchanger*";
- Ans^4_{QT} corresponding to the answer "*most likely to become a Mindchanger*".

As previously pointed out, these answers represent the four possible values of the *Mindchager profile* and also the four alternatives of the proposed decision-making model.

The neutrosophic representation corresponding to the questionnaire answers is defined based on their level of truthfulness, indeterminacy and falsity. In order to identify a proper representation for the QT answers, we mapped the linguistic terms of S_{QT} =*unlikely*, *rather likely*, *likely*, *most likely* on an ordered structure of 7 linguistic terms: $S_{7-terms}$ = s_0=*not at all*, s_1=*very unlikely*, s_2=*unlikely*, s_3=*rather likely*, s_4=*likely*, s_5=*most likely*, s_6=*definite*[51] in which $s_i < s_j$ if $i < j$. We obtain:

$s_0 < s_1 < s_2$=*unlikely* $< s_3$=*rather likely* $< s_4$=*likely* $< s_5$=*most likely* $< s_6$

in which the terms of S_{QT} are put mostly in the positive half-part of $S_{7-terms}$ structure.

To ensure a proper granularity among the neutrosophic representations of the QT answers we considered the following triplet numbers: $Ans^1_{QT} = (0.35, 0.3, 0.35)$, $Ans^2_{QT} = (0.7, 0.2, 0.1)$, $Ans^3_{QT} = (0.85, 0.1, 0.05)$, $Ans^4_{QT} = (1, 0, 0)$ (see Figure 4). Because of the high level of positiveness for the QT answers, we cannot define the negation operator on these neutrosophic representations as suggested in[51] but we can define the Max and Min operators using the neutrosophic intersection and union:

(1) Min($Ans^i_{QT} = (T^i_{QT}, I^i_{QT}, F^i_{QT})$, $Ans^j_{QT} = (T^j_{QT}, I^j_{QT}, F^j_{QT})$) $= \wedge_N$ $(Ans^i_{QT}, Ans^j_{QT}) = (min\{T^i_{QT}, T^j_{QT}\}, max\{I^i_{QT}, I^j_{QT}\}, max\{F^i_{QT}, F^j_{QT}\}) = Ans^i_{QT}$ for $i < j$, $i, j \in \{1, \ldots, 4\}$ where $\wedge_N$ denotes the neutrosophic intersection

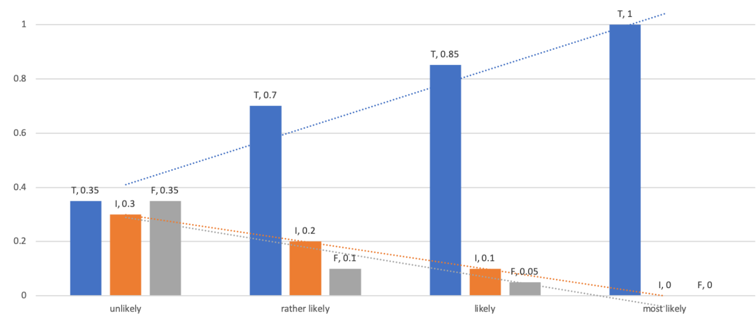


Fig. 4: The single-valued neutrosophic-triplet numbers corresponding to the linguistic variables *unlikely*, *rather likely*, *likely*, *most likely*

(2) Max($Ans^i_{QT} = (T^i_{QT}, I^i_{QT}, F^i_{QT})$, $Ans^j_{QT} = (T^j_{QT}, I^j_{QT}, F^j_{QT})$) $= \vee_N (Ans^i_{QT}, Ans^j_{QT}) = (max\{T^i_{QT}, T^j_{QT}\}, min\{I^i_{QT}, I^j_{QT}\}, min\{F^i_{QT}, F^j_{QT}\}) = Ans^j_{QT}$ for $i < j$, $i, j \in \{1, \ldots, 4\}$ where $\vee_N$ denotes the neutrosophic union.

By making use of the Single-Valued Score, Accuracy, and Certainty Functions introduced by Smarandache,[36] we can determine a total order on the set of neutrosophic triplets (T, I, F). This total order is used in our study to determine, for a specific user, the *Mindchanger profile* value corresponding to his/her answers to a set of selected questions from the YECCM questionnaire.

4.2. *Decision-making model using Ranking algorithm for Single-Valued Neutrosophic Triplets*

In our model, the possible answers to the target question QT represent the four *Mindchanger profile* values (linguistic descriptions) that the proposed model must determine, denoted by $Profile_i$, for $i = \overline{1,4}$. Table 2 summarises these profiles together with their neutrosophic representations in our study.

Table 2: The four *Mindchanger profiles* and their representations

Profile	Neutrosophic representation	Linguistic value
$Profile_1$	$(0.35, 0.3, 0.35)$	*unlikely to become a Mindchanger*
$Profile_2$	$(0.7, 0.2, 0.1)$	*rather likely to become a Mindchanger*
$Profile_3$	$(0.85, 0.1, 0.05)$	*likely to become a Mindchanger*
$Profile_4$	$(1, 0, 0)$	*most likely to become a Mindchanger*

In order to determine the *Mindchanger profile* for a specific user $\mathcal{U}$ we apply a total order relation for the value of $Agg(Answers_{\mathcal{U}})$ and for the values corresponding to the neutrosophic representations of the four profiles: $Profile_1, \ldots, Profile_4$.

To this aim, we make use of single-valued score, accuracy, and certainty functions defined for single-valued neutrosophic triplet numbers that provide a total order on the set of these numbers.[36] All these functions are used by the Ranking algorithm for Single-Valued Neutrosophic Triplets introduced by Smarandache.[36] We apply this algorithm to determine the respondents' Mindchanger profiles.

If M is a set of single-valued neutrosophic triplet numbers, $M = \{(T, I, F) \mid T, I, F \in [0,1], 0 \leq T+I+F \leq 3\}$, the *Single-Valued Neutrosophic Score Function*[36] was defined as $s : M \to [0,1]$ such that:

$$s(T, I, F) = \frac{T + (1-I) + (1-F)}{3} = \frac{2 + T - I - F}{3}$$

The minimum possible value of the score function is 0 (zero), which occurs when $(T, I, F) = (0, 1, 1)$ - the maximum neutrosophic falsehood value, which is opposite of $(1, 0, 0)$ - the maximum neutrosophic truth value.

If M is a set of single-valued neutrosophic triplet numbers, $M = \{(T, I, F) \mid T, I, F \in [0,1], 0 \leq T + I + F \leq 3\}$, the *Single-Valued Neutrosophic Accuracy Function*[36] was defined as $a : M \to [-1, 1]$, such that:

$$a(T, I, F) = T - F$$

If M is a set of single-valued neutrosophic triplet numbers, $M = \{(T, I, F) \mid T, I, F \in [0,1], 0 \leq T + I + F \leq 3\}$, the *Single-Valued Neutrosophic Certainty Function*[36] $c : M \to [0,1]$ was defined such that:

$$c(T, I, F) = T$$

If we consider (T_1, I_1, F_1) and (T_2, I_2, F_2) two single-valued neutrosophic triplets from M, i.e. $T_1, I_1, F_1, T_2, I_2, F_2 \in [0,1]$, the *Ranking algorithm for Single-Valued Neutrosophic Triplets*[36] was defined as follows:

Apply the Neutrosophic Score Function.

1. If $s(T_1, I_1, F_1) > s(T_2, I_2, F_2)$, then $(T_1, I_1, F_1) > (T_2, I_2, F_2)$.
2. If $s(T_1, I_1, F_1) < s(T_2, I_2, F_2)$, then $(T_1, I_1, F_1) < (T_2, I_2, F_2)$.
3. If $s(T_1, I_1, F_1) = s(T_2, I_2, F_2)$ apply the Neutrosophic Accuracy Function:

    3.1 If $a(T_1, I_1, F_1) > a(T_2, I_2, F_2)$, then $(T_1, I_1, F_1) > (T_2, I_2, F_2)$.
    3.2 If $a(T_1, I_1, F_1) < a(T_2, I_2, F_2)$, then $(T_1, I_1, F_1) < (T_2, I_2, F_2)$.
    3.3 If $a(T_1, I_1, F_1) = a(T_2, I_2, F_2)$ apply the Neutrosophic Certainty Function.

        3.3.1 If $c(T_1, I_1, F_1) > c(T_2, I_2, F_2)$, then $(T_1, I_1, F_1) > (T_2, I_2, F_2)$.

        3.3.2 If $c(T_1, I_1, F_1) < c(T_2, I_2, F_2)$, then $(T_1, I_1, F_1) < (T_2, I_2, F_2)$.
        3.3.1 If $c(T_1, I_1, F_1) = c(T_2, I_2, F_2)$, then $(T_1, I_1, F_1) = (T_2, I_2, F_2)$, i.e. $T_1 = T_2$, $I_1 = I_2$, $F_1 = F_2$.

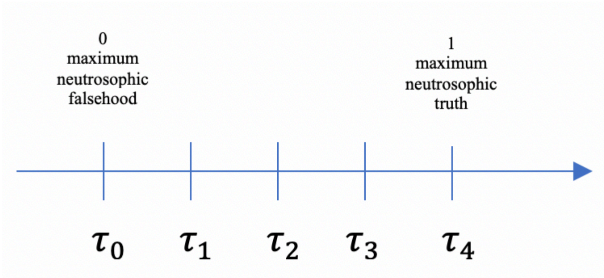


Fig. 5: The five threshold values used for the *Mindchanger profiles* scale

By using the Ranking algorithm defined by means of the single-valued neutrosophic score, accuracy, and certainty functions, we can locate the value corresponding to the scores of a respondent's answers on the *Mindchanger profiles* scale (see Figure 5). We note that the YECCM questionnaire does not provide a possible profile for the maximum neutrosophic falsehood value. Nevertheless, we consider the threshold τ_0 in order to obtain a complete scale for all the possible Score function values.

Algoritm 1. Algorithm for determining the *Mindchanger profile* value of a user $\mathcal{U}$ using his/her answers to $Q_1, \ldots, Q_n$ questions:

function getMindchangerProfile($\mathcal{U}$, $\{Q_1, \ldots, Q_n\}, QT$)

1. Take $Answers_{\mathcal{U}}$: $\{(T^{\mathcal{U}}_{Q_i}, I^{\mathcal{U}}_{Q_i}, F^{\mathcal{U}}_{Q_i}) \mid Ans^{\mathcal{U}}_{Q_i} = (T^{\mathcal{U}}_{Q_i}, I^{\mathcal{U}}_{Q_i}, F^{\mathcal{U}}_{Q_i}), i = \overline{1,n}\}$
2. Take $Profile_1, \ldots, Profile_4$: $Profile_i = (T^i_{QT}, I^i_{QT}, F^i_{QT}), i = \overline{1,4}$
3. Aggregate the answers of user $\mathcal{U}$: $Agg(Answers_{\mathcal{U}}) = (T^{\mathcal{U}}, I^{\mathcal{U}}, F^{\mathcal{U}})$ where $T^{\mathcal{U}} = \frac{\sum_{i=1}^n T^{\mathcal{U}}_{Q_i}}{n}$, $I^{\mathcal{U}} = \frac{\sum_{i=1}^n I^{\mathcal{U}}_{Q_i}}{n}$, $F^{\mathcal{U}} = \frac{\sum_{i=1}^n F^{\mathcal{U}}_{Q_i}}{n}$
4. Compute the Score function of user $\mathcal{U}$:

$$S_{\mathcal{U}} = S(T^{\mathcal{U}}, I^{\mathcal{U}}, F^{\mathcal{U}}) = \frac{T^{\mathcal{U}} + (1 - I^{\mathcal{U}}) + (1 - F^{\mathcal{U}})}{3}$$

5. Locate the value of $S_{\mathcal{U}}$ among the five thresholds values defined as follows: $\tau_0 = S(0, 1, 1)$, $\tau_1 = S(Profile_1)$, $\tau_2 = S(Profile_2)$, $\tau_3 = S(Profile_3)$, $\tau_4 = S(Profile_4)$:
6. Identify the pair of consecutive thresholds $(\tau_i, \tau_{i+1}), i = \overline{0,3}$ such that $\tau_i \leq S(T^{\mathcal{U}}, I^{\mathcal{U}}, F^{\mathcal{U}}) \leq \tau_{i+1}$ and then compute the percentage distances between $S(T^{\mathcal{U}}, I^{\mathcal{U}}, F^{\mathcal{U}})$ and τ_i and τ_{i+1} respectively:

   $\overline{S_{\mathcal{U}} Profile_i} = \frac{S(T^{\mathcal{U}}, I^{\mathcal{U}}, F^{\mathcal{U}}) - \tau_i}{\tau_{i+1} - \tau_i}$ represents the percentage distance of $S(T^{\mathcal{U}}, I^{\mathcal{U}}, F^{\mathcal{U}})$ from τ_i, $i > 0$ and

   $\overline{S_{\mathcal{U}} Profile_{i+1}} = \frac{\tau_{i+1} - S(T^{\mathcal{U}}, I^{\mathcal{U}}, F^{\mathcal{U}})}{\tau_{i+1} - \tau_i}$ represents the percentage distance of $S(T^{\mathcal{U}}, I^{\mathcal{U}}, F^{\mathcal{U}})$ from τ_{i+1}

7. **return** $Profile_i$, iff $\overline{S_{\mathcal{U}} Profile_i}$ is minimal, with $i > 0$.

endfunction

Therefore, at Step 5 of **Algorithm 1** we consider as thresholds the values of the score functions corresponding to the neutrosophic representations of *Mindchanger profiles*. For a specific user $\mathcal{U}$, the values $T^{\mathcal{U}}$, $I^{\mathcal{U}}$ and $F^{\mathcal{U}}$ corresponding to the aggregated triplet $Agg(Answers_{\mathcal{U}})$ (Step 3) can be different from the resulted threshold values, but we got four intervals: $[\tau_0, \tau_1]$, $[\tau_1, \tau_2]$, $[\tau_2, \tau_3]$, $[\tau_3, \tau_4]$ and we compute the score function of the triplet $S_{\mathcal{U}} = S(T^{\mathcal{U}}, I^{\mathcal{U}}, F^{\mathcal{U}})$ we get from the user' questionnaire answers (Step 4) and place it into the interval in which it fits and then we test if the resulted score function $S_{\mathcal{U}}$ is closer to the left or right side of the interval it belongs to (Step 6). As a direct consequence, we approximate the result corresponding to a user $\mathcal{U}$ with its closer threshold, and thus we determine our prediction for the user's *Mindchanger profile*.

For example, if we get the following aggregated values for a user $\mathcal{U}$: $Agg(Answers_{\mathcal{U}}) = (0.6, 0.3, 0.1)$, its score function is $S_{\mathcal{U}} = S(T^{\mathcal{U}}, I^{\mathcal{U}}, F^{\mathcal{U}}) = (0.6 + 0.7 + 0.9)/3 = 0.733$. But 0.733 belongs to the interval $[\tau_1, \tau_2] = [0.57, 0.8]$ and it is closer to 0.8, since 0.733 is above the average of the interval. So, we approximate the result to $0.8 = \tau_2 = S(Profile_2)$ and the algorithm returns $Profile_2$ = *rather likely to become a Mindchanger* for the user $\mathcal{U}$.

4.3. *Selection of the relevant questions from the YECCM questionnaire*

To select the minimal set of attributes that maximizes the decision rate of the *Mindchanger profile* value, we run **Algorithm 1** in a question selection mechanism described in **Algorithm 2**. The scope of the subsequent steps of **Algorithm 2** is to identify the minimal set of relevant questions from the YECCM questionnaire that influence the *Mindchanger profile* decision of the respondents. The resulted set of such questions is represented as $Core\_Set$.

Algorithm 2. Algorithm for attribute selection by considering a set of questions from the YECCM questionnaire and a target question QT.

function CoreSetSelection($Set\ of\ YECCM\ questions$**,** $Dataset$**,** QT**)**

1. Generate all subsets of the $Set\ of\ YECCM\ questions$.
1.1. For each subset S:
1.1.1. For each respondent $\mathcal{U}$ from $Dataset$:
1.1.2. Take $Profile^{\mathcal{U}}$ = **getMindchangerProfile(**$\mathcal{U}$**,** S**,** QT**)**
1.1.3 If $Profile^{\mathcal{U}}$ equates to $Ans^{\mathcal{U}}_{QT}$ then increase the number of correct decisions
1.2. Take $Precision_S = \frac{\#\ of\ correct\ decisions}{\#\ of\ respondents}$
2. Take $Core\_Set$ = the minimal set S with a maximal $Precision_S$ value
3. **return** $Core\_Set$, $Precision_{Core\_Set}$

endfunction

As already specified in the previous section, in order to obtain a good decision rate, the questions upon which our model is built are selected according to a specific topic and according to their correlation values with the target question QT. The statistics performed on the overall data of the questionnaire guided us through the questions included in Sections 2 and 3 (see Figure 3).

By applying **Algorithm 2** on this data, we obtained a set of five questions that, taken together, determine the maximum decision score, more precisely:

$$Core\_Set, Precision = \textbf{CoreSetSelection}(Questions\ of\ Sect.\ 2\ and\ 3,\ RO\ and\ SP\ Datasets, Q.5.2)$$

where $Core\_Set = \{Q.2.6, Q.3.2, Q.3.5, Q.3.8, Q.3.14\}$ and $Precision = 0.8366$.

Table 3: Neutrosophic representations for the answer options of the $Core\_Set$ questions

Question	Options	Neutrosophic triplet number		
		Truth	Indeterminacy	Falsehood
Q.2.6	Not at all	0	0	1
	Not much	0,25	0.5	0.25
	Much	0.75	0.25	0
	Very much	1	0	0
Q.3.2	Not at all	0	0	1
	Not much	0.25	0.5	0.25
	Much	0.75	0.25	0
	Very much	1	0	0
Q.3.5	Never	0	0	1
	Rarely	0.25	0.5	0.25
	Often	0.75	0.25	0
	Always	1	0	0
Q.3.8	Not at all	0	0	1
	Not enough	0.25	0.5	0.25
	Enough	0.75	0.25	0
	A lot	1	0	0
Q.3.14	Not important	0	0	1
	Rather important	0.25	0.5	0.25
	Important	0.75	0.25	0
	Very important	1	0	0

The questions of the $Core\_Set$ are as follows:

- **Q.2.6** *How much are you willing to change your personal behaviour to reduce the impact of global issues?* (with possible answers *Not at all/ Not much/ Much/ Very much*)

- **Q.3.2** *How much do you feel concerned about climate change?* (with possible answers *Not at all/ Not much/ Much/ Very much*)
- **Q.3.5** *Do you keep up with the news about climate change?* (with possible answers *Never/ Rarely/ Often/ Always*)
- **Q.3.8** *How attractive is the idea of participating in actions addressing climate change in the future?* (with possible answers *Not at all/ Not enough/ Enough/ A lot*)
- **Q.3.14** *How much do you think young people's engagement on climate change is important to address the issue?* (with possible answers *Not important/ Rather important/ Important/ Very important*)

In Table 3, we present the questions of the $Core\_Set$ together with their possible answers and the corresponding neutrosophic representations. Because all the questions of the $Core\_Set$ have dual answers, $Ans^1_{Q.x}$ is the negation of $Ans^4_{Q.x}$ and $Ans^2_{Q.x}$ is the negation of $Ans^3_{Q.x}$. The neutrosophic-triplet numbers are defined using the scale [0, 0.25, 0.5, 0.75, 1] and cover all the operators suggested for linguistic terms set:[51]
(1) $Neg(Ans^i_{QT}) = Ans^j_{QT}$ with $j = 5 - i$,
(2) $Min(Ans^i_{QT}, Ans^j_{QT}) = Ans^i_{QT}$ for $i < j$, $i, j \in \{1, \ldots, 4\}$
(3) $Max(Ans^i_{QT}, Ans^j_{QT}) = Ans^j_{QT}$ for $i < j$, $i, j \in \{1, \ldots, 4\}$

As a direct consequence, for a specific respondent, the entire set of selected questions from the YECCM questionnaire generates, in our internal representation, a set of single-valued neutrosophic triplet numbers (Step 1 of **Algorithm 1**) which characterizes the respondent's knowledge about the investigated questions targeting global problems (hunger, poverty, etc.) or climate change.

5. Experiments and Results

The evaluation process of the proposed decision-making model was designed in two phases. The main purpose of *Phase 1* was to find the minimal set of questions based on which the model decision rate for the whole dataset (including both Romanian and Spanish datasets) is maximum. As already specified, the best precision was obtained for the questions of the $Core\_Set$:

$$Core\_Set = \{Q.2.6, Q.3.2, Q.3.5, Q.3.8, Q.3.14\}$$

As can be seen in Table 4, for the whole dataset (in short ALL Dataset), the obtained precision is 0.8366. We have also evaluated the precision obtained with the $Core\_Set$ questions by considering each dataset separately (Romanian and Spanish datasets). We found out that the precision score is stable as it is preserved when the Romanian and Spanish datasets are evaluated separately.

Phase 1 led to a successful result since it provided the minimal set of questions based on which the precision of the model reached its maximum value, without being altered by the nationality-specifics traits of the respondents.

The $Core\_Set$ questions are consistent with the three main components that are the base of youth engagement, which *"consists of a behavioural component (such as spending time doing the activity), an affective component (for example, deriving pleasure from participating), and a cognitive component (for example, knowing about the activity)".*[44] It includes the minimal set of questions that need to be addressed in order to determine the *Mindchanger profile* of the respondents. In other words, this selection emphasises that it is necessary to interrogate young people about all three components of engagement in order to determine their *Mindchanger profiles* with maximum accuracy:

- the affective component ($Q.2.6$ and $Q.3.2$),
- the cognitive component ($Q.3.5$) and
- the behavioural component ($Q.3.8$ and $Q.3.14$).

This interplay between the three components also confirms that engagement is a multidimensional construct[52] and an ongoing process.

In *Phase 2* of the evaluation, we considered each dataset separately. We aimed at identifying other questions that, added to the $Core\_Set$ questions, increase the precision of the model by considering the particularities of each national group.

Table 4: Neutrosophic model evaluation results

Evaluation Phase	**Set of Questions**	**RO Dataset**	**SP Dataset**	**ALL Dataset**
Phase 1	$Core\_Set$	0.84	0.8333	0.8366
Phase 2	$Core\_Set \cup \{Q.1.9.07, Q.1.9.10, Q.1.9.11, Q.1.9.19, Q.2.1\}$	0.87	0.67	0.73
	$Core\_Set \cup \{Q.1.9.07, Q.1.9.14, Q.1.9.19, Q.1.9.20, Q.3.1\}$	0.78	0.8725	0.8267

We ran **Algorithm 2** for the Romanian dataset (in short RO Dataset) and we obtained the following results:

$Core\_Set_{RO}, Precision_{RO} =$
CoreSetSelection$(Q.1.9.x \cup Questions\ of\ Sect.\ 2\ and\ 3, RO\ Dataset, Q.5.2)$
where $Core\_Set_{RO} = Core\_Set \cup \{Q.1.9.07, Q.1.9.19, Q.1.9.10, Q.1.9.11, Q.2.1\}$ and $Precision_{RO} = 0.87$.

$Q.1.9.x$ denotes the set of questions $Q.1.9.1, \ldots, Q.1.9.24$ targeting the 24 characteristics that the respondents were asked to self-evaluate. As can be seen, we obtained 0.87 precision for the Romanian Dataset adding supplementary questions to the $Core\_Set$.

For the Spanish dataset (in short SP Dataset) the maximum precision of 0.8725 was obtained for the following set of questions:

$Core\_Set_{SP}, Precision_{SP} =$
CoreSetSelection$(Q.1.9.x \cup Questions\ of\ Sect.\ 2\ and\ 3, SP\ Dataset, Q.5.2)$
where $Core\_Set_{SP} = Core\_Set \cup \{Q.1.9.07, Q.1.9.19,\ Q.1.9.14, Q.1.9.20, Q.3.1\}$ and $Precision_{SP} = 0.8725$.

The maximum precision scores are represented in Table 4 in green rectangles, while minimal precision scores are represented in red rectangles.

It is worth highlighting the two important variables that may largely explain these results, as well as some of the differences found between the two analyzed datasets.

Table 5: The additional questions resulted from Phase 2 of the model evaluation

	Romania (Dolj county)	**Spain (La Rioja)**
Personal characteristics	Responsible (Q.1.9.07)	
	Open to international solidarity (Q.1.9.19)	
	Good communicator with young people from my own culture (Q.1.9.10)	Extroverted (Q.1.9.14)
	Good communicator with young people from other cultures (Q.1.9.11)	Interested in global issues (Q.1.9.20)
Awareness level	Have you ever heard or read about the Sustainable Development Goals agreed by the international community? (Q.2.1)	How important do you consider the issue of climate change? (Q.3.1)

The model determines with a precision score of 0.87 the *Mindchanger profile* for a young person about whom we know, besides the answers to the $Core\_Set$, the level of awareness about the SDGSs (RO Dataset) or the importance of climate change (SP Dataset), and the self-attributed rate for the characteristics considered in *Phase 2* of our evaluation (Table 5). The characteristics resulting from *Phase 2* are targeted by the following questions:

- for Romania: questions $Q.1.9.x \cap Core\_Set_{RO}$,
- for Spain: questions $Q.1.9.x \cap Core\_Set_{SP}$.

The table 5 shows the self-attributed characteristics of the young people from Dolj County (RO Dataset) and La Rioja (SP Dataset) considered in *Phase 2* of the evaluation. In this analysis, there are two common personality traits that influence the decision rate (i.e. responsible and open to international solidarity), and also two different ones, which can be explained by looking into the regional/cultural context.

5.1. *A Comparison between the neutrosophic model and different machine learning models*

In this section, we compare the results of the neutrosophic model with several machine learning (ML) models, such as decision trees, random forests and support vector machines (SVM). The performance of the ML models was evaluated using 5-fold cross-validation. In addition, to avoid overfitting, we performed hyperparameter tuning for each model via grid search using 5-fold cross-validation with five repetitions. The procedure for each ML model and dataset is as follows:

(1) The grid search is created.
(2) The data set is split into five subsets or folds.
(3) The previously created grid and 4-folds from step 2 (training data) are used to find the optimal hyperparameters:
   (a) The training data is again split into five folds.
   (b) For each possible combination of parameters, a model is trained with 4-folds from step 3.a.
   (c) Each model is evaluated on the remaining part of the data, i.e., the fold that was not used in step 3.b.
   (d) Steps 3.b and 3.c are repeated five times (each time using a different fold for evaluation). This process is repeated five times. Thus, in total, 25 models are trained and evaluated for each combination of parameters.
(4) The model trained with the optimal hyperparameters is used to predict the target question QT for the fifth fold (test data), which was not used in Step 3.
(5) Steps 3 and 4 are repeated five times (each time using a different fold for evaluation) and the performance measure is calculated by averaging the values obtained in the loop.

Table 6: Machine learning models evaluation results

Set of Questions	**Trained Model**	**RO Dataset**	**SP Dataset**	**ALL Dataset**
$Core\_Set$	Decision Tree	0.6784	0.7553	0.773
	Random Forest	0.6669	0.7858	0.7472
	SVM	0.6659	0.8358	0.7679
$Core\_Set \cup \{Q.1.9.07, Q.1.9.10, Q.1.9.11, Q.1.9.19, Q.2.1\}$	Decision Tree	0.6157	0.7337	0.7267
	Random Forest	0.6268	0.7232	0.701
	SVM	0.6449	0.7126	0.6806
$Core\_Set \cup \{Q.1.9.07, Q.1.9.14, Q.1.9.19, Q.1.9.20, Q.3.1\}$	Decision Tree	0.6479	0.7958	0.7004
	Random Forest	0.6359	0.8047	0.7370
	SVM	0.6750	0.7942	0.7112

The results presented in Table 6 show that the ML models are not able to reach the precision scores obtained with the neutrosophic model. For the whole dataset, the best precision is 0.773, while for the Romanian dataset, the precision is even lower, with a value equal to 0.6784. Finally, for the Spanish dataset, the best precision is 0.8358, which is not bad, but also lower than the best score obtained with the neutrosophic approach. It should be noted that the best results were obtained with the $Core\_Set$, i.e., with the fewest number of questions.

6. Conclusions and Future Work

Communication, a transversal skill of sustainable education,[53] is fundamental for any kind of human interaction or interpersonal exchange of information, ideas and emotions. Being a key competence included in the Romanian core curriculum (as part of the Language and communication area of learning), it lays at the foundation of the entire educational system. Thus, the Romanian young people are encouraged to develop communication-associated skills from a very early age. Moreover, further emphasis is placed on intercultural communication, which has become a priority for the Romanian educational system and is aimed at helping to integrate young Romanians in the present world.[54,55] Recent migration phenomena have brought along the need to interact and adapt, especially since half of the young Romanian respondents reported to have experienced migration stories in their families. Additionally, the Romanian society is characterized by cultural diversity, so intercultural communication has always been a prerequisite in mediating relationships in diverse social and cultural environments. On the other hand, the fact that more than half of the sample are graduates of higher education and one in three is employed may impact their concern for their future and their conscientiousness about the world they live in, especially with regard to sustainable solidarity goals in general, and climate change in particular. Moreover, recent international events confirmed the level of responsibility and solidarity of young people from Dolj, since in the particular case of the unfortunate events in Ukraine, which brought massive waves of refugees to Romania, numerous young volunteers and young representatives of the civil society organizations initiated local actions and offered their support. All these characteristics may lead to a good precision rate for the Romanian group if they are investigated in correlation not only with the $Core\_set$, but also with the level of awareness about the SDGs.

In the specific case of La Rioja (Spain), where almost nine out of ten respondents are employed and about 73% of the participants have a Bachelor's or Master's degree, we refer to the possible influences of the socio-economic context and the personal characteristics associated with the young respondents. In terms of context, the social and economic development of the region is oriented towards agriculture, the food industry and the service sector. In this sense, the perceived negative effects for this socio-economic development as a consequence of global phenomena, such as climate change, may determine the high impact of some questions on climate change in predicting the young people's Mindchanger profile. On the other hand, some personal characteristics related to the age, employment status and university education of most of the young people surveyed (e.g. responsibility), seem to be determinant in the transition from awareness to active participation that will enable their personal and professional development, as well as the common welfare within a framework of sustainable development. Finally, and closely related to the idiosyncrasies of La Rioja, some distinctive personality traits, such as extroversion, seem to have an impact on the self-estimated likelihood to become a Mindchanger.

The statistical analysis of the 24 characteristics from questions $Q.1.9.x$ depicted in Figure 6 shows the mean score and standard deviation of all the characteristics analysed, ordered from the highest to the lowest overall score (represented by the red line). In addition, the mean scores per country are represented. Although there are no significant differences between the responses of the two countries, Romanian participants scored higher than Spanish participants in almost 63% of the characteristics analysed. The highest consensus (lower standard deviation) and the highest scores (around 4.5 points out of 5) in the self-assessments made by all participants correspond to the personal traits open-minded and responsible. In contrast, the lowest overall scores correspond to actively engaged in community life and well-informed on local and international issues. Moreover, in the Spanish data, the lowest mean score is given to leadership skilled.

The $Q.1.9.x$ characteristics selected by **Algorithm 2** in Phase 2 of the evaluation, namely $Q.1.9.x \cap Core\_Set_{RO}$ and $Q.1.9.x \cap Core\_Set_{SP}$, only partially coincide with the ones statistically-determined to have the highest consensus and the highest scores. This means that the highest scored characteristics are not the most relevant for determining the *Mindchanger profile* and confirms the fact that the proposed decision-making model complements the statistical analysis, providing a specific tool for obtaining a high precision rate.

Therefore, this study was aimed at increasing the understanding of what makes young people actively engaged with SDGs and of what determines them to develop a pro-environmental behaviour.

Based on the data collected through the YECCM questionnaire, we explored the likelihood of young people to act as Mindchangers, that is to reach a high level of civic engagement. By means of a neutrosophic approach we determined the minimal set of questions that allows for a high decision rate of the respondents' *Mindchanger profile*. We demonstrated that the neutrosophic model offers a quite significant and stable precision rate (0.83), in the sense that it is not altered by national or regional characteristics. In order to improve the decision rate, we further explored, for each of the two countries' datasets, additional questions targeting specific national features. This decision-making model proved to be successful for both datasets, considered separately.

In conclusion, we highlight several advantages of using the proposed model on questionnaire data. Firstly, this model can be applied to questionnaires which involve linguistic responses that express, among others, unclear or vague thoughts.

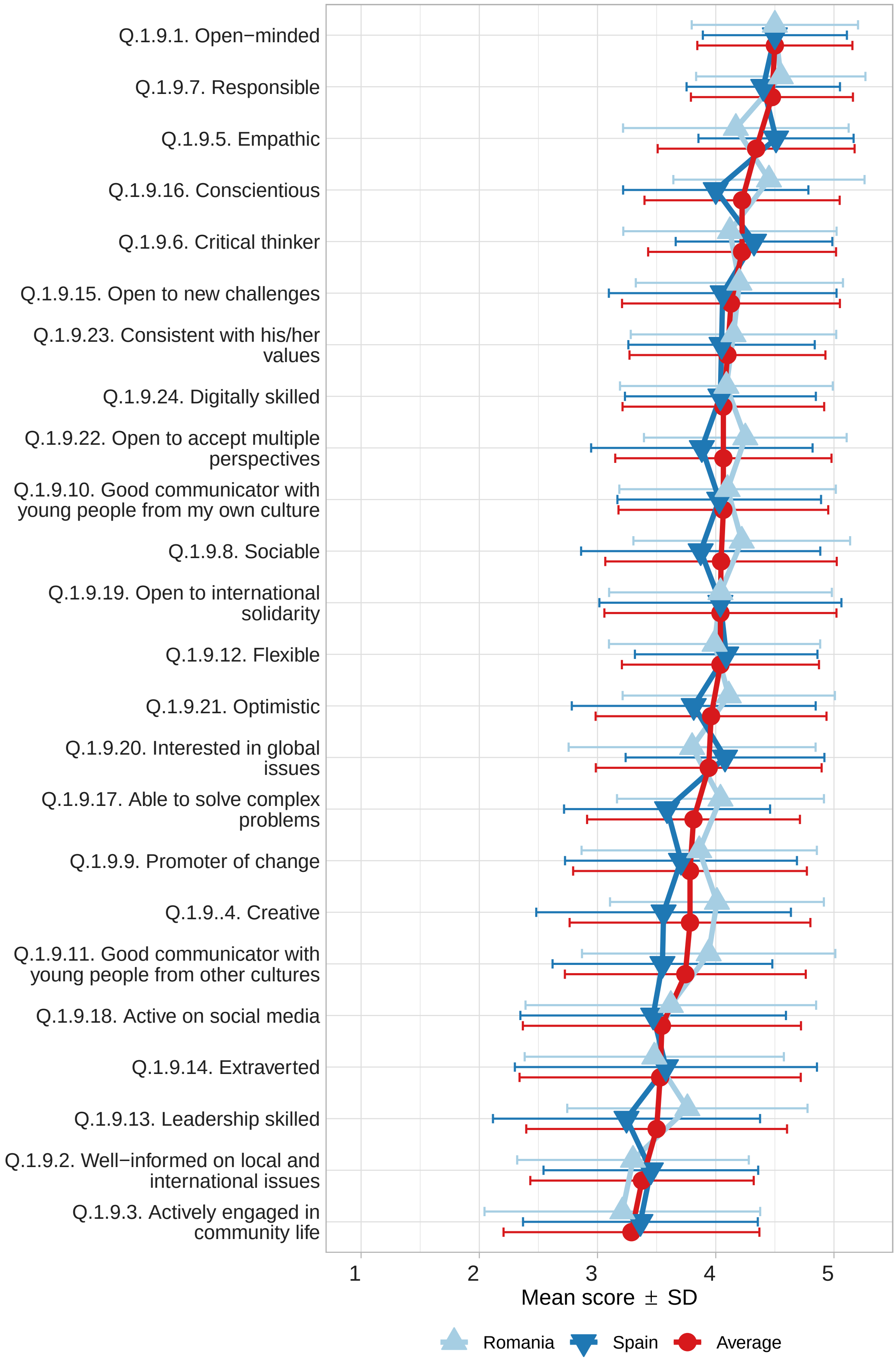


Fig. 6: Mean values of the respondents' self-evaluated characteristics (questions $Q.1.9.x$)

The model can be configured to work on any combinations of questions, for each combination the precision being calculated by considering the sum of correct decisions versus the number of respondents. In this manner, one could easily identify the minimum set of characteristics based on which the decision of the target choice (in this study denoted as *Mindchanger profile*) can be done with a maximum precision. Also, the model can be configured to work on different datasets in order to identity the particular combination of questions which maintains its precision on the considered data.

A direct impact of our approach is the possibility to identify the minimal set of questions that influence the respondent's answer choice to a target question. More precisely, the proposed decision-making model allows the identification of a minimal set of attributes (e.g. attitudes, beliefs, behaviour) that can generate a high rate of precision. In the context of youth engagement, the obtained $Core_Set$s correspond to the conceptual framework of engagement (affective, cognitive, behavioural) and can be used by a trainer or a teacher to enrich young people's attitudes and beliefs that impact their choices to become Mindchangers.

Our study was performed on a set of specific topic questions which included only 4-point Likert scale. Further investigation can be made to generalise the decision-making model and consequently develop it in order to process other types of questions, such as open-ended questions, whose answers are natural language texts, or 5 and 7-point Likert scale questions, which give a better reflection of the respondents' opinions.

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References

1. Special Eurobarometer 441: The European Year for Development - Citizens' views on development, cooperation and aid, Directorate-General for Communication, Brussels, 2016, `https://data.europa.eu/data/datasets/s2069_84_4_441_eng?locale=en`.
2. Special Eurobarometer 476: EU citizens and development cooperation, Directorate-General for Communication, Brussels, 2018, `https://data.europa.eu/data/datasets/s2202_89_3_476_eng?locale=en`.
3. L. A. Zadeh, "Fuzzy sets", *Inf. Control*, vol. 8, 1965, pp. 338–353.
4. K. T. Atanassov, "Intuitionistic fuzzy sets", *Fuzzy Sets Syst*, vol. 20, no. 1, 1986, pp. 87 – 96.

5. K.T. Atanassov, "Intuitionistic fuzzy sets", *Intuitionistic Fuzzy Sets*; Springer: Berlin/Heidelberg, Germany, 1999, pp. 1 – 137.
6. F. Smarandache, "Definition of Neutrosophic Logic - A Generalization of the Intuitionistic Fuzzy Logic", *3rd Conf. European Society for Fuzzy Logic and Technology*, 2003, pp. 141–146.
7. G. Kou, Y. Xu, Y. Peng, F. Shen, Y. Chen, K. Chang, S. Kou, "Bankruptcy prediction for SMEs using transactional data and two-stage multiobjective feature selection", *Decis. Support Syst.*, vol. 140, 113429, 2021, 10.1016/j.dss.2020.113429
8. G. Kou, P. Yang, Y. Peng, F. Xiao, Y. Chen, F. E. Alsaadi, Evaluation of feature selection methods for text classification with small datasets using multiple criteria decision-making methods, *Appl. Soft Comput.*, vol. 86, 105836, 2019, j.asoc.2019.105836
9. P.M. Podsakoff and S.B. MacKenzie and J.-Y. Lee and N.P. Podsakoff, "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies", *J. Appl. Psychol.*, vol 88, no. 5, pp. 879–903, 2003, 10.1037/0021-9010.88.5.879.
10. S. Laaksonen, *Survey Methodology and Missing Data. Tools and Techniques for Practitioners*, Springer Cham, Springer International Publishing AG, 2018.
11. S. de la Rosa de Sáa, M. Á. Gil, G. González-Rodríguez, M. T. López and M. A. Lubiano, "Fuzzy rating scale-based questionnaires and their statistical analysis", *IEEE Trans Fuzzy Syst*, vol. 23, no. 1, pp. 111 – 126, 2015, 10.1109TFUZZ.2014.2307895.
12. A. T. Jebb, V. Ng and L. Tay, "A Review of Key Likert Scale Development Advances: 1995?2019", *Front. Psychol.*, vol. 12, 2021, 10.3389/fpsyg.2021.637547.
13. R. Yusuf and I. Fajri, "Differences in behavior, engagement and environmental knowledge on waste management for science and social students through the campus program", *Heliyon*, vol. 2, e08912, 2022, 10.1016/J.HELIYON.2022.E08912.
14. K. Mädamürk, H. Tuominen, L. Hietajärvi and K. Salmela-Aro, "Adolescent students? digital engagement and achievement goal orientation profiles", *Computers & Education*, vol. 161, 104058, 2021, 10.1016/j.compedu.2020.104058.
15. E. Ariyo, M. Amurtiya, O. Y. Lydia, A. Oludare, O. Ololade, A. P. Taiwo, L. A. Olukemi and D. Ogunniyi, "Socio-demographic determinants of children home learning experiences during COVID 19 school closure", *IJEDRO*, vol. 3, pp. 100 – 111, 2022, 10.1016/j.ijedro.2021.100111.
16. A. O. Ojo and M. A. Fauzi, "Environmental awareness and leadership commitment as determinants of IT professionals engagement in Green IT practices for environmental performance", *Sustain. Prod. Consum.*, Elsevier, vol. 24, pp. 298 – 307, 2020, 10.1016/J.SPC.2020.07.017.
17. L. Cheng, X. Chen, J. De Vos, X. Lai and F. Witlox, "Applying a random forest method approach to model travel mode choice behavior", *Travel Behav Soc*, vol. 14, pp. 1 –10, 2019, 10.1016/j.tbs.2018.09.002.
18. X. Deng, G. Thurston, W. Zhang, I. Ryan, C. Jiang, H. Khwaja, X. Romeiko, T. Marks, B. Ye, Y. Qu and S. Lin, "Application of data science methods to identify school and home risk factors for asthma and allergy-related symptoms among children in New York", *Sci. Total Environ.*, vol. 770, 144746, 2021, 10.1016/j.scitotenv.2020.144746.
19. C.-I. Popîrlan, I.-V. Tudor, C.-C. Dinu, G. Stoian, C. Popîrlan and D. Dănciulescu, "Hybrid Model for Unemployment Impact on Social Life", *Mathematics*, vol. 9, no. 18, 2278, 2021, 10.3390/math9182278.
20. K. B. Best, J. M. Gilligan, H. Baroud, A. R. Carrico, K. M. Donato, B. A. Ackerly and B. Mallick, "Random forest analysis of two household surveys can identify important predictors of migration in Bangladesh", *J. Comput. Soc. Sci.*, vol. 4, pp. 77 – 100,

2021, 10.1007/s42001-020-00066-9.
21. C. Kern, T. Klausch and F. Kreuter, "Tree-based Machine Learning Methods for Survey Research", *Surv. Res. Methods*, vol. 13, no. 1, pp. 73 – 93, 2019, 10.18148/srm/2019.v1i1.7395.
22. L.A. Zadeh, "The concept of a linguistic variable and its application to approximate reasoning?I", *Inf. Sci.*, vol. 8, no. 3, pp. 199 – 249, 1975, 10.1016/0020-0255(75)90036-5.
23. E. Di Nardo and R. Simone, "A Model-Based Fuzzy Analysis of Questionnaires", *Stat. Methods Appl.*, vol. 28, no. 2, pp. 187 – 215, 2019, 10.1007/s10260-018-00443-9.
24. M. A. Lubiano, S. la Rosa de Sáa, M. Montenegro, B. Sinova and M. Á. Gil, "Descriptive analysis of responses to items in questionnaires. Why not using a fuzzy rating scale?", *Inf. Sci.*, vol. 360, pp. 131 – 148, 2016, 10.1016/j.ins.2016.04.029.
25. L. Lin and H. M. Lee, "Fuzzy assessment method on sampling survey analysis", *Expert Syst. Appl.*, Elsevier Ltd., vol. 36, no. 3, pp. 5955 – 5961, 2009, 10.1016/j.eswa.2008.07.087.
26. H. Guan, Z. Dai, S. Guan and A. Zhao, "A neutrosophic forecasting model for time series based on first-order state and information entropy of high-order fluctuation", *Entropy*, vol. 21, no. 5, 455, 2019, 10.3390/e21050455.
27. M. Smithson, *Fuzzy Set Analysis for Behavioral and Social Science*, Springer-Verlag, New York, 1987.
28. Y.N. Blagoveschensky and G.A. Satarov, "A New Approach to Building Fuzzy Classifications in Sociological Research with Survey Data", *Classification and Clustering for Knowledge Discovery*, Springer, Berlin, pp. 349 – 356, 2005, 10.1007/11011620_22.
29. Y.N. Blagoveschensky and G.A. Satarov, "Ambiguity and Social Judgment: Fuzzy Set Model and Data Analysis", *Fuzzy Logic - Algorithms, Techniques and Implementations*, E. Dadios, Ed. InTech, Rijeka, 2012, pp. 3–24.
30. G. Kou, Ö. O. Akdeniz, H. Dincer, S. Yüksel, "Fintech investments in European banks: a hybrid IT2 fuzzy multidimensional decision-making approach", *Financ Innov*, vol. 7, 39, 2021, s40854-021-00256-y
31. D. Marasini, P. Quatto, E. Ripamonti, "Intuitionistic fuzzy sets in questionnaire analysis", emphQual Quant, vol. 50, 2016, pp. 767 – 790.
32. B. Jefmański, E. Roszkowska, M. Kusterka-Jefmańska, "Intuitionistic Fuzzy Synthetic Measure on the Basis of Survey Responses and Aggregated Ordinal Data", *Entropy*, 2021, vol. 23(12), 1636.
33. P. A. Ejegwa, S. O. Akowe, P. M. Otene, J. M. Lkyule, "An overview on Intuitionistic fuzzy sets", *Int. Journal of Scientific & Technology Research*, vol. 3, 2014, pp. 142 – 145.
34. J. Zou, Y. Deng, Y. Hu and G. Lin, "Measure distance between neutrosophic sets: An evidential approach", *J. Ambient Intell. Smart Environ.* , 2018, pp. 1 – 8.
35. M. Leyva-Vazquez and F. Smarandache, *Neutrosofa: Nuevos avances en el tratamiento de la incertidumbre*, Pons Publishing House, Bruselas, 2018.
36. F. Smarandache, "The Score, Accuracy, and Certainty Functions determine a Total Order on the Set of Neutrosophic Triplets (T, I, F)", *Neutrosophic Sets Syst.*, vol.38, pp. 1 – 8, 2020.
37. V. Duran, S. Topal, F. Smarandache and S. Broumi, "Using Sieve Eratosthenes for the factor analysis of neutrosophic form of the five facet mindfulness questionnaire as an alternative confirmatory factor analysis", *CMES-Comput Model Eng Sci*, vol. 129, no. 2, pp. 953 – 971, 2021, 10.32604/cmes.2021.016696.
38. C. Fan, S. Feng and K. Hu, "Linguistic Neutrosophic Numbers Einstein Operator and Its Application in Decision Making", *Mathematics*, vol. 7, no. 5, 389, 2019,

10.3390/math7050389.
39. F. Smarandache, *Introduction to Neutrosophic Sociology (Neutrosociology)*, Pons Publishing House, Bruxelles, 2019.
40. C. R. Martnez, G. A. Hidalgo, M. A. Matos and F. Smarandache, "Neutrosophy for Survey Analysis in Social Sciences", *Neutrosophic Sets Syst.*, vol.37, no. 1, pp. 409 – 416, 2020.
41. P. J. Lavrakas, *Encyclopedia of Survey Research Methods*, Thousand Oaks, CA: SAGE Publications Inc., 2008.
42. L. Cohen, L. L. Manion and K. Morrison, *Research Methods in Education (8th ed.)*, London: Routledge, 2018.
43. P. C. Beatty, D. Collins, L. Kaye, J.-L. Padilla, G. B. Willis and A. Wilmot, *Advances in questionnaire design, development, evaluation and testing*, John Wiley & Sons, Inc, 2019.
44. S. M. Pancer, L. Rose-Krasnor and L. D. Loiselle, "Youth conferences as a context for engagement", *New Directions for Youth Development*, Wiley Periodicals, vol. 96, pp. 47 – 64, 2003, 10.1002/yd.26.
45. S. M. Kelders, E. van Zyl Llewellyn and G. D. S. Ludden, "The Concept and Components of Engagement in Different Domains Applied to eHealth: A Systematic Scoping Review", *Front. Psychol.*, vol. 11, pp. 1 – 14, 2020, 10.3389/fpsyg.2020.00926.
46. LimeSurvey - online survey tool: `https://www.limesurvey.org`.
47. F. Smarandache, "Indeterminacy in Neutrosophic Theories and their Applications", *IJNS*, vol. 15(2), 2021, pp. 89 – 97.
48. F. Smarandache, *Advances of Standard and Nonstandard Neutrosophic Theories*, Brussels: Pons Editions, 2019.
49. Z.S. Xu, "Intuitionistic fuzzy aggregation operators", *IEEE Transactions on Fuzzy Systems*, vol. 15, 2007, pp. 1179 – 1187.
50. Y.J. Xu, and H.M. Wang, "The induced generalized aggregation operators for intuitionistic fuzzy sets and their application in group decision making", *Appl. Soft Comput.*, 2012, pp. 1168 – 1179.
51. F. Herrera, E. Herrera-Viedma, "Linguistic decision analysis: steps for solving decision problems under linguistic information", *Fuzzy Sets Syst.*, vol. 115(1), 2000, pp. 67 – 82.
52. L. Wray-Lake, A. Metzger and A. K. Syvertsen, "Testing multidimensional models of youth civic engagement: Model comparisons, measurement invariance, and age differences", *Appl. Dev. Sci.*, vol. 21, no. 4, pp. 266–284, 2017, 10.1080/10888691.2016.1205495.
53. M. Tilea, O.-A. Duţă and A. Reşceanu, *Sustainable and Solidary Education. Reflections and Practices*, Berlin: Peter Lang Verlag, 2017.
54. C. M. Bunăiaşu, A. C. Strungă, A. C. Stoian and M. Tilea, "Psychosocial and Curricular Determinations of Intercultural Education Programs", *Revista Românească Pentru Educaţie Multidimensională (The Romanian Review for Multidimensional Education)*, vol. 13, no. 2, pp. 304 – 322, 2021, 10.18662/rrem/13.2/423.
55. A. Reşceanu and M. Tilea, "Training Foreign Language Students to Be Mindchangers: A Local Perspective on a Global Issue", *Proceedings of the 13th International Conference of Education, Research and Innovation (ICERI2020)*, pp. 6156-6165, 2020, 10.21125/iceri.2020.1325.