

Study of the Pampay Mass (burial of offering) at the summit of the Andean snow-capped mountain as an example of (t,i,f) -Neutrosophic social structure

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Abstract. The purpose of this research is to analyze the characteristics of the Mass Pampay ritual (burying an offering with special objects) of the peasants on the summit of the snow-capped Apu Razuhuilca located in the Andes of Peru at 4,800 meters above sea level as (t,i,f) -Neutrosophic social structure. The essence is to explain the syncretic relationship between the Catholic religion and the ancestral Andean philosophy that has survived over time for generations. The method of study is a survey of the natives and tourists, believer or not in the sacred power of the Apu (Andean God) that provides spiritual security to the pilgrims on special dates of the Andean calendar, which is July 31 of each year, the ceremony on the eve of the Andean custom to the branding of cattle in honor of the feast of "Taita Santiago". We measure approximately the degree of certainty, ignorance, and contradiction which are present in this tradition as a social phenomenon, which is a pillar in the local culture. For processing the data we used Neutrosophic Statistics.

Keywords: Peruvian Cultural traditions, (t,i,f) -structure, (t,i,f) - Neutrosophic social structure, Refined I-Neutrosophic Structure, Neutrosophic Statistics.

1 Introduction

The present research is related to the syncretic relationship between the Catholic religion and the ancestral Andean philosophy called Pampay Mass (burial of blessed offering) in the province of Huanta, Ayacucho region of the Peruvian highlands. This activity has positive effects on the pilgrims, granting good health, work, economy, social welfare, and multiplication of their livestock: "Similarly, rituals are approached primarily as expressions of thoughts and feelings of those who participate in them" [1]. The Apu (hill, Andean god) of Razuhuilca (the name of the snow-capped mountain) has an altitude of 4,800 meters above sea level. The peculiar characteristic that makes it different from other mountains of similar altitude, is its particularity of being an enchanted hill (bewitched) considered the Andean God of the Huantina population.

Independently of the ancestral activity of Mass Pampay, the Andean ceremony of the pilgrims that climb the summit of the snowy Razuhuilca; there are other similar activities about the Andean calendar in Peru. The activity of Samikuy (offering to the Apu with agricultural species) is registered and explained: "Samikuy of Quechua root, means an Andean ritual with natural products produced with the blessing of the Apu that is deposited in the hills, in this case in the apu Razuhuilca" [2]. This activity is in addition to the Pampay Mass that is celebrated every

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July 31st with the participation of pilgrims from different parts of the Peruvian highlands. The pilgrims who climb every year to the summit of Razuhuillca, have the same common interests in getting a reward for the effort made in climbing and carrying the ancestral offering as an interpretation of their Andean conception of: "exchange of offerings with the apus is the essence of the Andean ritual. Colonization fused Samikuy rituals with European products, the mixture of Quechua and Spanish in their prayers" [2].

The veneration of the highest snow-capped mountains in the Peruvian highlands is a common denominator of the rituals that syncretize the conception of Western philosophy that merged with the Christian religion and the survival in time of the ancestral knowledge interpreted in the Andean philosophy that survives to the present day.

According to information gathered at the site of the activity on the summit of Razuhuillca at 4,800 meters above sea level, the Pampay Mass ritual has a positive effect on all pilgrims and their families that keeps them in economic prosperity, social, family, health, work, vigilance of the Apu against rustling, multiplication of their livestock throughout the year.

Our hypothesis is that the ritual is an example of the existence of Neutrosophic Social Structures [3-6]. According to F. Smarandache, this is defined as a (t,i,f) -structure, where there is a component of truth, another of indeterminacy, and a third one of falsehood [7-12]. This is a ritual practice that involves all members of the community and tourists from inside and outside the country, so there is an epistemological contradiction between the objective and the subjective meanings of the ritual. Some individuals from other cultures or who come from other realities of the country perceive this ritual as an exotic folkloric manifestation, which has an attractive cultural value, but they do not feel spiritually connected with them. Certain families within the community prepare throughout the year to perform the ritual, therefore this is part of their social and cultural achievement.

On the other hand, it is a syncretic festivity, that is, the religious symbol has a double meaning, representing one or another religious significance depending on the person who consumes it [6]. A Catholic image is revered by Catholics according to the Christian Catholic tradition, however for the indigenous, it can have a meaning according to their polytheistic traditions in the representation of their gods, and this is the way that the conquered and colonized peoples used to maintain their traditions without disturbing to its conquerors.

This phenomenon becomes more complex when ethnic and cultural miscegenation appears, where the mestizo may have a degree of belief in the Catholic God and another degree of belief in the pre-Hispanic God. This is added to the historical perception of the ritual, young people may feel alien to this activity because they have influences from other modern cultures consumed by social networks, by tourist visits, among others. However, older people, who were raised in love with their traditions, may feel much more tied to this type of ceremony.

This article aims to measure approximately the degree of certainty, ignorance, and contradiction that the ritual called Pampay Mass presents, as a social phenomenon among the visitors and the inhabitants of the community in Huanta dedicated to this ceremonial. To do this, the researchers surveyed community members and visitors, on the days before, during, and after the ceremony [13]. The collected data was processed with the help of Neutrosophic Statistics and refined neutrosophic numbers [14]. Neutrosophic Statistics uses the methods of classical statistics applied to data in the form of intervals, or where the size of the sample or that of the population is indeterminate [15-18]. Additionally, there was the opinion of 3 anthropologists who studied the subject, their opinions were aggregated to the results obtained from the survey of the participants.

The article is divided into a section on Materials and Methods where the basic notions of neutrosophy, (t,i,f) -structures, their refined variant, and neutrosophic statistics are explained. The section called Results summarizes the results obtained from this research. In the last section, the Conclusions are given.

2 Materials and Methods

A (t,i,f) -structure is composed of one space S endowed with a set of axioms (or laws) acting (governing) on it, such that the space or at least one of its axioms has an indeterminacy. t represents the degree of truthfulness, i represents the degree of indeterminacy, and f represents the degree of falseness [7].

Originally, this theory was designed for applications in Algebra, Geometry, etc. However, later F. Smarandache recognized its applicability in other sciences like sociology. Thus, he said that the different points of view of all the individuals in society have as a consequence complex social relationships, which causes indeterminacy. One example is syncretism in religion, many people can believe in a Christian God, and however, they practice this "pagan" ritual. Maybe they cannot explain why, so contradiction is part of this phenomenon. Additionally, some persons who are part of the ceremony could not explain their motivation to participate in this mass, thus there is an indeterminacy due to ignorance or lack of information.

Specifically, we are dealing with Refined I- Neutrosophic Structures, as we explain further.

In the following, there are some important concepts to develop this study:

Definition 1: ([8]) A *neutrosophic number* N is defined as a number as follows:

$$N = a + bI \quad (1)$$

Where a is called the *determined part* and bI is called the *indeterminate part*.

Given $N_1 = a_1 + b_1I$ and $N_2 = a_2 + b_2I$ are two neutrosophic numbers, some operations between them are defined as follows:

$$N_1 + N_2 = a_1 + a_2 + (b_1 + b_2)I \text{ (Addition);}$$

$$N_1 - N_2 = a_1 - a_2 + (b_1 - b_2)I \text{ (Difference),}$$

$$N_1 \times N_2 = a_1a_2 + (a_1b_2 + b_1a_2 + b_1b_2)I \text{ (Product),}$$

$$\frac{N_1}{N_2} = \frac{a_1 + b_1I}{a_2 + b_2I} = \frac{a_1}{a_2} + \frac{a_2b_1 - a_1b_2}{a_2(a_2 + b_2)}I \text{ (Division).}$$

Professor Smarandache also defined types of truthfulness, indeterminacy, and falsity symbolically beyond T , I , and F , respectively. This is what he called refinement, where T is split into T_1, T_2, \dots, T_p ; I into I_1, I_2, \dots, I_q ; and F into F_1, F_2, \dots, F_r , which depend on the problem we are treating [19]. Specifically, he generalized the neutrosophic numbers in Equation 1 to represent the Refined Neutrosophic Numbers like in Definition 2 [14].

Definition 2: ([8]) Given I_1, I_2, \dots, I_q , with $q \geq 1$, a *Refined Neutrosophic Number* is obtained as $N_q = a + b_1I_1 + b_2I_2 + \dots + b_qI_q$, where a is the *determined part* and b_jI_j ($j = 1, 2, \dots, q$) are the *indeterminate parts*, such that a, b_1, b_2, \dots, b_q are real or complex numbers.

Some of the properties that hold are the following:

- $mI_k + nI_k = (m + n)I_k$,
- $0I_k = 0$,
- $I_k^n = I_k$,
- $I_k/I_k = \text{undefined}$,
- $I_j \cdot I_k$ with $j \neq k$ is defined depending on the problem being addressed.

Specifically, we will use the following type of Refined Neutrosophic numbers [14, 19]:

$N_q = a + b_1I_1 + b_2I_2$, where I_1 denotes contradiction (simultaneously true and false proposition), while I_2 denotes ignorance (true or false proposition without being able to determine which of the two it is) [8].

Neutrosophic statistics refers to a set of data, such that the data or a part of it is indeterminate to some degree, and to the methods used for analyzing them [15-17, 20].

In classical statistics, all data is determined. This is the distinction between neutrosophic statistics and classical statistics. In many cases, when the indeterminacy is zero, the neutrosophic statistics coincide with the classical statistics. *Neutrosophic measurement* can be used to measure indeterminate data. *Neutrosophic statistical methods* will allow us to interpret and organize neutrosophic data (data that may have some indeterminacies) to reveal underlying patterns. Many approaches can be used in neutrosophic statistics.

In *neutrosophic probability*, indeterminacy is different from randomness. While classical statistics is concerned solely with randomness, neutrosophic statistics is concerned with both randomness and especially indeterminacy.

Neutrosophic descriptive statistics consists of all the techniques for summarizing and describing the characteristics of neutrosophic numerical data. Since neutrosophic numerical data contain indeterminacies, *neutrosophic line plots*, and *neutrosophic histograms* are plotted in 3D space, rather than 2D space as in classical statistics. The third dimension, in addition to the Cartesian XOY system, is that of indeterminacy (I). From unclear graphical data, we can extract (unclear) neutrosophic information.

Neutrosophic data are data containing some indeterminacy. In a similar way to classical statistics, it can be classified as:

- *Discrete neutrosophic data*, if the values are isolated points; for example $3 + I_1$, where $I_1 \in [0,1]$, $27 + I_2$, where $I_2 \in [2.3, 5.5]$;

- and *Continuous neutrosophic data*, if the values form one or more intervals, for example $[0.01, 0.9]$ or $[0.12, 1.0]$ (i.e., not sure which).

Other classification:

- *Quantitative (numerical) neutrosophic data*;

For example a number in the interval $[1, 4]$ (we don't know exactly), or; 60, 62, 67, or 70 (we don't know exactly);

- and *Qualitative (categorical) neutrosophic data*; for example: black or blue (we don't know exactly), white, orange or green or gray (we don't know exactly). Also, we can have:

- *Univariate neutrosophic data*, that is, neutrosophic data consisting of observations on a single neutrosophic attribute;

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- and *Multivariate neutrosophic data*, that is neutrosophic data consisting of observations on two or more attributes. In particular cases, we mention *bivariate neutrosophic data* and *trivariate neutrosophic data*.

A *neutrosophic sample* is a chosen subset of a population, a subset that contains some indeterminacy: either concerning several of its individuals (who may not belong to the population we are studying or may only partially belong to it) or for the subset as a whole.

While classical samples provide precise information, neutrosophic samples provide vague or incomplete information. By abuse of language, it can be said that any sample is a neutrosophic sample since it can be considered that its indeterminacy is equal to zero.

Neutrosophic survey results are survey results containing some indeterminacy. A *neutrosophic population* is a population not well determined at the membership level (i.e., it is not sure whether some individuals do or do not belong to the population). For example, as in the neutrosophic set, a generic element x belongs to the neutrosophic population M as follows, $x(t, i, f) \in M$ which means: x is $t\%$ in the population M , $f\%$ of x is not in the population M , while $i\%$ membership of x in M is indeterminate (unknown, unclear, neutral: neither in the population nor outside).

3 Results

A survey was prepared for the participants of the Mass Pampay. Sampling was non-probabilistic for convenience, that is, we interviewed all the participants in this ritual who appeared on the way to mass and who were willing to give their opinion. The questions were simple and recorded on a tape to avoid the use of pencil and paper or the investment of inconvenient time to give the answers. Interviews were practically carried out with the participants with questions that had short answers, with the idea of not disturbing the celebration of the participants.

On the other hand, the interviewers kept in mind to identify the broadest possible variety of types of participants, whether they are national or foreign tourists or natives. Thus, the survey questions were as follows:

Survey on the Pampay Mass
<ol style="list-style-type: none"> 1. Please say your name: 2. Are you a tourist or a native? 3. You participate in the Pampay Mass for these reasons: <ol style="list-style-type: none"> a) Religious b) Cultural c) Economic d) By family tradition 4. What religion or religions do you practice? <ol style="list-style-type: none"> a) Catholic b) Protestant Christian c) Peruvian indigenous native d) From other origins 5. Do you know what the meaning of the Pampay Mass is? <ol style="list-style-type: none"> a) Yes b) No c) I don't know 6. Do you believe that Pampay Mass will bring you economic prosperity, health, family happiness, etc.? <ol style="list-style-type: none"> a) Yes b) No c) I don't know

For each respondent, let us call him/her s_k in $S = \{s_1, s_2, \dots, s_n\}$, a value $a_k + b_k I_1 + c_k I_2$ is associated, where I_1 denotes the indeterminacy due to contradiction, and I_2 is the indeterminacy due to ignorance [8].

The following variables were used to process the responses:

The variable $T = \{Tourist, Native\}$ is defined as an answer to Question 2.

The variable $M = \{Religion, Cultural, Economic, Family tradition\}$ is defined as responses to Question 3.

The variable $R = \{Catholic, Protestant, Native, Others\}$ is defined as an answer to Question 4.

The variable $m = \{Yes, No, I don't know\}$, is defined as an answer to Question 5.

The variable $P = \{Yes, No, I don't know\}$, is defined as an answer to Question 6.

Let us start with $a_k = b_k = c_k = 0$

The following IF-THEN rules below are used for processing the data:

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- R1:** IF $T = \textit{Tourist}$ AND $M = \textit{Cultural, Economic}$ THEN add 1 to a_k .
R2: IF $T = \textit{Tourist}$ AND $m = \textit{No}$ THEN add 1 to c_k .
R3: IF $T = \textit{Tourist}$ AND $M = \textit{Religion, Tradition}$ THEN add 1 to b_k .
R4: IF $T = \textit{Native}$ AND $M = \textit{Cultural, Economic}$ THEN add 1 to b_k .
R5: IF $T = \textit{Native}$ AND $M = \textit{Religion, Family tradition}$ THEN add 1 to a_k .
R6: IF There is more than one answer of R THEN add 1 to b_k .
R7: IF $R = \textit{Catholic, Protestant}$ AND $P = \textit{Yes}$ THEN add 1 to b_k .
R8: IF $m = \textit{I don't know}$ THEN add 1 to c_k .
R9: IF $P = \textit{I don't know}$ THEN add 1 to c_k .
R10: IF $M \neq \textit{Religion}$ AND $P = \textit{Yes}$ THEN add 1 to b_k .

The explanation of the rules above is as follows:

R1: It makes sense that tourists go to the Pampay Mass for cultural or economic reasons.

R2: The tourist who goes to the ritual and does not know its meaning denotes ignorance.

R3: Complementing R1, the tourist who goes to the Pampay Mass for religious or traditional reasons contradicts himself/herself because this is a local ceremony, which the tourist would not appreciate beyond the cultural motivation.

R4: This is the rule that complements R1.

R5: This is the rule that complements R3.

R6: The religions that are shown as an answer are contradictory to each other in their foundations, if more than one of them is marked it denotes a contradiction.

R7: If the person professes a Christian religion (Catholic or Protestant) and thinks that this pre-Hispanic rite will bring prosperity thanks to a non-Christian God, then this is contradictory.

In the case of the natives, we do not consider it contradictory because these are syncretized gods for them.

R8 and **R9:** Obviously a response of I don't know denotes ignorance.

R10: If the person claims to have come for reasons unrelated to religion and thinks that the ritual will have welfare effects on his/her life due to the powers of the god of the mountain, then this contradicts that he/her did not come for religious reasons.

These values were calculated for all respondents in S and aggregated. In practice, we obtained 184 opinions from those surveyed [13]. The following Refined Neutrosophic Numbers were obtained for each of them:

$$\bar{N}_k = \bar{a}_k + \bar{b}_k I_1 + \bar{c}_k I_2, \text{ where } \bar{a}_k = \frac{a_k}{2}, \bar{b}_k = \frac{b_k}{5}, \text{ and } \bar{c}_k = \frac{c_k}{3}, \text{ this guarantees that } \bar{a}_k, \bar{b}_k, \bar{c}_k \in [0, 1].$$

Neutrosophic Numbers were obtained with the help of the following formula:

$$\bar{N} = \bar{a} + \bar{b} I_1 + \bar{c} I_2, \text{ where } \bar{a} \text{ is the mean of the } \bar{a}_k\text{s, } \bar{b} \text{ is the mean of the } \bar{b}_k\text{s, and } \bar{c} \text{ is the mean of the } \bar{c}_k\text{s.}$$

The result was $\bar{N} = 0.64809 + 0.29428I_1 + 0.082376I_2$.

See Figure 1, where this result is graphically represented [18].

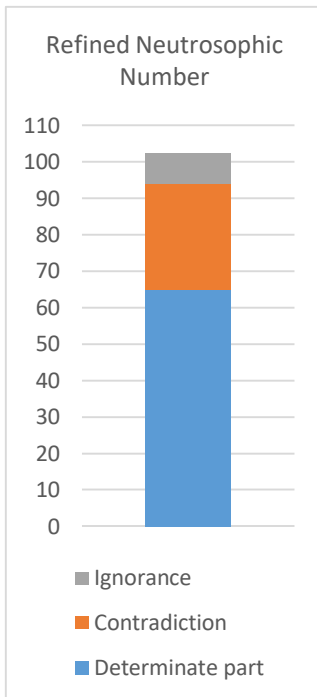


Figure 1: Neutrosophic Chart Graph representing the Refined Neutrosophic Number obtained from the survey in percent. The determined part is represented in blue, in orange it is the indeterminate part due to contradiction, and in gray it is the indeterminate part due to ignorance.

Let us note that in Figure 1 it was considered $I_1 = I_2 = [0, 1]$ for the graphic representation.

Additionally, three anthropologists, familiar with this ceremony and with scientific knowledge of its meanings, were surveyed. This guarantees having expert opinions on the subject to complement the results obtained previously. We believe that the results will be more indeterminate, but more accurate.

They were asked on a scale of 0 to 100 the following three questions:

1. In what percentage do you consider that the people who participate in the Pampay Mass are coherent with their philosophy of life?
2. In what percentage do you consider that the people who participate in the Pampay Mass contradict their own religious beliefs above all?
3. In what percentage do you consider that the people who participate in the Pampay Mass do not know at all the characteristics and history of this ritual?

The results obtained were the following, after dividing the Refined Neutrosophic Numbers by 100:

$$\text{Expert 1: } N_1 = 0.75 + 0.24I_1 + 0.1I_2,$$

$$\text{Expert 2: } N_2 = 0.7 + 0.2I_1 + 0.1I_2,$$

$$\text{Expert 3: } N_3 = 0.7 + 0.25I_1 + 0.05I_2,$$

We find the average of the results of the 3 experts with the results of the interviews and we have the following Refined Neutrosophic Number:

$$N_m = 0.71667 + 0.21333I_1 + 0.083333I_2$$

This Refined Neutrosophic Number is graphed with a Neutrosophic Chart Graphic in Figure 2 [18].

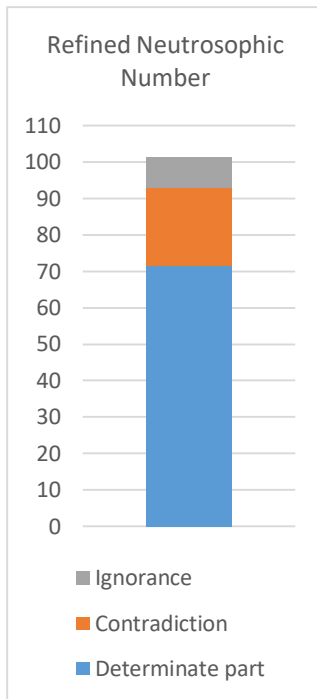


Figure 2: Neutrosophic Chart Graphic of the Refined Neutrosophic Number N_m in percent. The determined part is represented in blue, the indeterminate part due to contradiction is represented in orange, and in gray it is the indeterminate part due to ignorance.

Conclusion

Pampay Mass is a traditional religious ritual on the top of the Snow-Capped Mountain in Peru. This receives national and foreign tourists, as well as the natives of the region who wait all a year to celebrate this important event. In this anthropological article, we show that from a sociological point of view, this is an example that reflects the existence of (t,i,f) -Neutrosophic social structures in real-life. Specifically, we use the concept of Refined I-Neutrosophic Structures with the structure $N = a + bI_1 + cI_2$, where a is the determined part, bI_1 is the indeterminate part that means contradiction, and cI_2 is the indeterminate part that means ignorance or unknowing. To calculate the values of a, b, c we used a survey based on a non-probabilistic convenience sampling having 184 participants in the ritual, we designed rules to determine the coherence, contradiction, and ignorance of the respondents about the ritual. The results were that 64.809% are coherent, 29.428% have had contradictory beliefs, whereas 8.2376% are ignorant about the ritual. We also surveyed 3 expert anthropologists familiar with this ceremony. We calculated the mean of all the Refined Neutrosophic Numbers and we arrived at that approximately up to 69.952% of the participants in the Pampay Mass are consistent about their beliefs and this rite, up to 24.607% are not consistent, while up to 8.3094% participate without knowing anything about this ritual. This is a type of data processing with the help of Neutrosophic Statistics.

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