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Study of the relationship among economic variables in cattle production in a region of Peru, based on Plithogenic Statistics

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Abstract. This paper is an in-depth study that starts from a preliminary one, where we surveyed 141 ranchers from the town of Coto-Coto in Peru to obtain as much information as possible about the relationship between two economic variables, Activity Cost and Financial Management. Furthermore, we study the correlation of the first one of them with three other economic variables. To do this, we process the survey data using logical operators with the support of the plithogenic statistics theory. These results given in the form of plithogenic values are logically aggregated and were converted to crisp values and studied through the use of statistical tools, specifically Kendall's Tau b. The study of economic variables within the field of cattle farming is of great importance because it allows us to improve the productivity of this economic sector, which is also part of the most accepted human diet worldwide. A substantial advantage in the use of plithogeny is that linguistic values that are more natural for livestock farmers were processed, in addition, uncertainty and indeterminacy were taken into account by the use of neutrosophic numbers.

Keywords: Activity costs, financial management, profitability, resource optimization, plithogenic set, plithogenic statistics, Kendall's Tau b.

1 Introduction

Financial management, which is the process of decision-making and data analysis that seeks the optimal administration and use of the company's financial resources to achieve certain objectives, is relevant in the study that we present here because it allows us to contextualize the role of the producer, who is every cattle rancher in the planning, organization, direction, and control of economic activities that will generate effective flows as a result of the application of a cost system.

On the other hand, according to the Ministry of Agriculture and Irrigation, in 2020 he maintains that two investment programs have been started for the genetic improvement of cows. With a budget of 2.5 million soles, the National Institute of Agrarian Innovation (INIA) carries out the initiative to increase the availability of high-value bovine genetic material in seven areas of the country, benefiting 34,230 dairy farmers. This initiative will use genetic nuclei and will lead to the production of 1,800 embryos and 600,000 sperm straws.

The second project, which has a budget of 2.5 million soles and will serve 21,060 beef farmers, aims to increase the availability and access to the genetic material of cattle through the application of reproductive biotechnology. In this study, 2240 embryos and 110,000 sperm straws will be obtained. Both operations will mean a 20% increase in milk and beef production.

The livestock industry in the Junín Region has problems that could be solved. However, the lack of technical

guidance in raising livestock for the production and marketing of milk, as well as the lack of knowledge of the costs incurred in each of its production processes, is a factor that limits the optimal exploitation of the product. and, therefore, prevents achieving a reasonable standard of competitiveness.

Likewise, the cost of activities is broken down into different support tools to carry out the process of improving cattle, among them, there is labor, which also requires considering feeding, since it is the fundamental basis for improving milk and meat production is mainly based on fodder production; cultivated pastures; natural pastures; preserved forages (silage and hay), balanced feed, commercial concentrates, and mineral salts. On the other hand, it is important to establish the type of farm that is going to be built and the objective of our breeding. Additionally, there are economic limitations, such as the availability of equipment, labor costs, and transportation costs, both for supplies and food.

The animals (biological activities) are raised, fed, cultivated, and ultimately sold to a livestock farm, all while receiving care to obtain by-products. To create products that satisfy the needs of a market, a profitable company, like any other, has to account for a series of production costs derived from the purchase and use of inputs. Both operating costs, which appear in the operating income statement, and process costs, which arise throughout the manufacturing process.

The purpose of this study is to delve deeper into the relationship between the variables of Activity Cost and Financial Management. In a previous initial study, we determined that there is a positive relationship between both of them. Due to the importance of the topic, we are considering delving deeper into it and conducting a more detailed survey of the ranchers at the Coto-Coto Fair in Peru. To do this, we have 141 ranchers to whom we applied a survey with a series of questions, in addition to representing the data in the form of neutrosophic numbers within the plithogeny framework. In this case, we use statistical methods to avoid bias, which is why these farmers were selected randomly.

On this occasion, we once again use the tools offered by the theory of Neutrosophy to solve problems related to uncertainty and indeterminacy. We need to keep these components within the study because it guarantees greater accuracy. Additionally, we study other economic variables.

Plithogenic sets generalize the theory of neutrosophic sets since they deal with an appurtenance function that can be either fuzzy, intuitionistic fuzzy, or neutrosophic, in addition to allowing variables of different natures to be combined [1]. The fundamental idea is to model the dynamics of systems, where in addition to the interaction of the concept <A> with its opposite <AntiA> and the neutral <NeutA> , we also model its interactions with other concepts such as <B>, <C>, etc., or their opposites < AntiB >, < AntiC >, etc., or their neutrals < NeutB >, < NeutC >, etc.

Additionally, plithogenic statistics allow the combination of statistical methods with logical elements and operations [2]. Specifically, in this work, we propose to logically model the answers given by the respondents, aggregate them with logical plithogenic aggregators, and also process them with statistical methods.

In this study, in addition to the two economic variables mentioned above, we include others such as “Optimization of financial resources”, “achievement of objectives in beef cattle producers”, and “greater profitability in beef cattle producers”.

This paper has the following structure: we continue with a Materials and Methods section where we explain the fundamental concepts of the proposed financial variables, the plithogenic sets, and the plithogenic statistics. Next, the following section is dedicated to presenting the results of this study. The last section is dedicated to Conclusions.

2 Materials and Methods

This section is an approach to the main theories used in this study. We begin with an explanation of the economic variables used in this article. This is essential to be able to understand the economic essence with which we are dealing. The following subsection is a summary of the basic concepts within plithogeny theory and the concepts and methods used concerning the plithogenic statistics.

2.1. Main economic and financial indicators used in this study

Activity cost accounting is a system that accumulates the indirect costs of each of an organization's activities before allocating those costs to the products or services and other cost objectives that result from that activity.

Similarly, Ramos et al. ([3]) define activity costing as a tool to determine the costs and distribution of actual indirect costs incurred by each activity, which is a crucial step in the decision-making process.

The Activity cost is considered a methodology that assigns costs to the inputs necessary to execute the various activities of a production process, identified as those relevant to obtaining a certain cost object, calculating the cost of these inputs through cost absorption mechanisms of the activities.

Escobar et al. ([4]) consider activity costing as a method “to determine a real cost to produce a product or the

provision of a service that guarantees more reasonable and competitive market prices for the consumer."

Likewise, financial management is defined as a process that, through the use of financial tools and indicators, seeks to make decisions to improve the financial situation of the company. This is conceived as a form of strategic planning and management that implements certain parameters to evaluate and diagnose the financial system, and to make decisions in favor of the organization.

Also, financial management represents the underlying processes that give companies their competitive advantage, allowing them to effectively manage their resources to keep capital moving and increase their profits. Also, López et al. ([5]) mention that financial management is based "on the optimization of working capital and value creation that promotes improved profitability."

The term "resource optimization" refers to the process of finding methods to improve a company's resources to achieve greater efficiency and effectiveness. Due to the high volume of customer interactions, the quality of services provided by the industry requires continuous innovation in both, resources and management.

It is a means to talk about how to improve something. From this, we can deduce that the definition of resource optimization is the search for means that allow the resources of a company to be improved for the sake of greater performance.

As a consequence of the continuous connection with customers, companies in the service sector must constantly work to improve their management and infrastructure to maintain a high level of service. Given that the scope of services includes not only restaurants but also industrial and hospital canteens, in which the quality of service must be excellent so that this does not harm other aspects of those canteens, investing in high-quality resources is essential to offer excellent customer service.

Resource optimization can be defined as the way to profitably use resources to seek the best results, greater efficiency, and continuous improvement of the organization.

The achievement of an organization's objectives is related to financial planning since it plays an essential role in growth and sustainable development, implementing mechanisms to correct possible errors in the course of achieving objectives.

Profitability is the efficiency of an activity that can be measured by comparing the surplus generated for distribution to shareholders with the total resources invested in the activity.

Greater profitability is a term that refers to any economic activity in which material, human, and/or financial resources are mobilized to achieve an objective. It is any economic benefit derived from the use of certain resources. Accounting defines two forms of profitability: economic profitability and financial profitability. This is a percentage ratio that reflects the return on investment for each unit of resource invested over time. Also, Profitability can be defined as the percentage increase in value over the original investment plus possible cash distributions. This is the relationship between income and expenses.

Profitability ratios are indices that allow us to evaluate the ability of a company to generate profits, whether through its own or external resources so that they are significant to the extent that they allow evaluating the result of the efficiency of economic and financial resource management of the company. They are indicators that help determine the company's ability to obtain profits.

It is a term that refers to any economic activity in which material, human, and/or financial resources are mobilized to achieve an objective. It is any economic benefit derived from the use of certain resources. Accounting defines two forms of profitability: economic profitability and financial profitability.

2.2. Some notions on Plithogenic theory

According to F. Smarandache, "Plithogeny is the genesis or origination, creation, formation, development, and evolution of new entities from dynamics and organic fusions of contradictory and/or neutrals and/or non-contradictory multiple old entities. Plithogeny pleads for the connections and unification of theories and ideas in any field. As "entities" in this study, we take the "knowledge" in various fields, such as soft sciences, hard sciences, arts and letters theories, etc."([1,2,6,7]).

A *Plithogenic Set* is a non-empty set P whose elements within the domain of discourse $U(\ P \subseteq U)$ are characterized by one or more attributes $A_1,\ A_2, \cdots, A_m,\ m \geq 1$, where each attribute can have a set of possible values within the spectrum S of values (states), such that S can be a finite, infinite, discrete, continuous, open, or closed set.

Each element $x \in P$ is characterized by all possible values of the attributes that are within the set $V = \{v_1, v_2, \cdots, v_n\}$. The value of an attribute has a *degree of appurtenance* $d(x, v)$ of an element x, in the set P, about a certain given criterion. The degree of appurtenance can be fuzzy, intuitionistic fuzzy, or neutrosophic, among others.

Thus,

$\forall x \in P, d: P \times V \rightarrow \mathcal{P}([0,1]^z)$ (1)

Where $d(x,v) \subseteq [0,1]^z$ and $\mathcal{P}([0,1]^z)$ is the power set of $[0,1]^z$. $z = 1$ (for the fuzzy degree of appurtenance), $z = 2$ (for the intuitionistic fuzzy degree of appurtenance), or $z = 3$ (for the neutrosophic degree of appurtenance).

Whether the cardinality of V is greater than or equal to 1, $c: V \times V \rightarrow [0,1]$ is called *attributes value contradiction degree function* between any pair of attributes v_a, v_b, which satisfies the following axioms:

- $c(v_a, v_a) = 0$,
- $c(v_a, v_b) = c(v_b, v_a)$.

c defined as above, is denoted by c_F to indicate that this is a function called *fuzzy attributes value contradiction degree function*. It is generally defined $c_{IF}: V \times V \rightarrow [0,1]^2$ as an *intuitionistic attributes value contradiction function* and $c_N: V \times V \rightarrow [0,1]^3$ to indicate a *neutrosophic attributes value contradiction function*.

So, the Plithogenic Set is characterized by (P, a, V, d, c), consisting of the set P, the set a of attributes, the set V of values, d is the appurtenance function and c is the function attribute value contradiction degree function.

The contradiction function in practice is applied to compare the contradiction of all attributes concerning a dominant attribute if any, which is the most important compared to the others.

Definition 1. ([1, 8]) Given a plithogenic set (P, A, V, d, c), a *Plithogenic Neutrosophic Aggregation Operator* is defined as in Equation 2:

$$(\mathrm{a}_1, \mathrm{a}_2, \mathrm{a}_3)\mathrm{AND}_{\mathrm{p}}(\mathrm{b}_1, \mathrm{b}_2, \mathrm{b}_3) = \Big((1-\bar{c})(\mathrm{a}_1 \wedge_{\mathrm{F}} \mathrm{b}_1) + \bar{c}(\mathrm{a}_1 \vee_{\mathrm{F}} \mathrm{b}_1), \tfrac{1}{2}[\mathrm{a}_1 \wedge_{\mathrm{F}} \mathrm{b}_1 + \mathrm{a}_1 \vee_{\mathrm{F}} \mathrm{b}_1], (1-\bar{c})(\mathrm{a}_1 \vee_{\mathrm{F}} \mathrm{b}_1) + \bar{c}(\mathrm{a}_1 \wedge_{\mathrm{F}} \mathrm{b}_1)\Big) \quad (2)$$

Where $\bar{c} \in [0,1]$, $\wedge_{\mathrm{F}}$ is a t-norm and $\vee_{\mathrm{F}}$ is a t-conorm, see [9].

It is a *Plithogenic Neutrosophic Intersection* when $\bar{c} = 0$ and it is a *Plithogenic Neutrosophic Union* when $\bar{c} = 1$, [1, 2, 8]. This aggregator is more accurate than both the n-norms and n- conorms between neutrosophic sets ([1]),

A plithogenic neutrosophic set can be converted into a crisp value using the following formula, ([1]):

$$\mathcal{S}(\mathrm{T}, \mathrm{I}, \mathrm{F}) = \tfrac{1}{3}(2 + \mathrm{T} - \mathrm{I} - \mathrm{F}) \quad (3)$$

There are many applications of plithogeny in many sciences ([10-15]).

On the other hand, (U, a, V, d, c) is called *Plithogenic Probability*, where U is the event space of E. A Plithogenic Probability is the probability that an event will occur in all the random variables that determine it. Where each random variable can be classical, (T,I,F)-neutrosophic, I-neutrosophic, (T,F)-intuitionistic fuzzy, (T,N,F)-picture fuzzy, (T,N,F)-spherical fuzzy, or (another fuzzy extension) distribution function. In this way, the Plithogenic Probability generalizes the classical Multivariate Probability.

Additionally, Plithogenic Statistics comprises the analysis and observations obtained through Plithogenic methods of Probability. Plithogenic Probability generalizes the classical Multivariate Statistics.

The Refined Probabilities are decomposed into more than one element of truthfulness, more than one element of indeterminacy, or more than one element of falsity ([16]). That is, they are of the form $(T_1, T_2, \cdots, T_p, I_1, I_2, \cdots, I_q, F_1, F_2, \cdots, F_r)$, where at least one of the indices p, q, or r is strictly greater than 1.

3 Results

141 livestock farmers participating in the Coto-Coto Fair were selected at random, to apply the properties of plithogenic statistics.

We calculate the size and composition of the sample given the quantitative nature of the research population; the sample size is chosen using a statistical formula for the definition of the sample in finite populations ([17]).

$$n = \frac{N.Z^2.p.q}{e^2(N-1)+Z^2.p.q} \quad (4)$$

Where:

n= sample size

N= population size

Z: (critical coefficient depends on the confidence level) α = 95%; Z= 1.96,

P: (controlled N ratio) = 50%,

q = (1-p) = 50%,

e = (margin of error allowed) = 5%,

Applying the formula, we have:

N = 320, Z = 1.96, p = q = 0.5, e = 0.05, and n = 141.

The sample size is 141.

The selection of participants was carried out in proportion to the gender of the livestock farmers in the population, as shown in Table 1.

Gender	Amount	hi	hi*n subsamples
Men	180	0.6	84.6
Women	120	0.4	56.4
Total	300	1	141

Table 1. Livestock farmers participating in the Coto–Coto Sunday fair. Note: The table is prepared based on the information provided by the Huancayo charity.

For their convenience, they were asked to offer their opinion according to a linguistic scale, as shown in Table 2.

Linguistic Expression	Plithogenic number (T, I, F)
Strongly disagree	(0.10, 0.75, 0.85)
Disagree	(0.40, 0.70, 0.50)
Neutral	(0.50, 0.40, 0.60)
Agree	(0.65, 0.30, 0.45)
Strongly agree	(0.95, 0.05, 0.05)

Table 2: Linguistic values associated with plithogenic numbers for expert evaluation.

In Table 2 each linguistic value is associated with a plithogenic number, which is why each linguistic value is replaced by its plithogenic equivalent number when the calculations are performed. The surveys applied are detailed, as shown below.

PERUVIAN UNIVERSITY LOS ANDES
GRADUATE SCHOOL
QUESTIONNAIRE

"Cost for Activities and Financial Management in Beef Cattle Producers. Coto-Coto Livestock Fair - Chilca"

GENERAL DATA	
Survey location: …… **Survey date: ……** **Age: ……**	**Gender:** **Male** ☐ **Female** ☐

Instructions: Below, we present several propositions. We ask you to express your personal opinion in front of them, marking with an (X) the one that best expresses your point of view according to the following rating scale:				
1. Totally Disagree	**2. Disagree**	**3. Neutral**	**4. Agree**	**5. Totally agree**

PART I: COST PER ACTIVITY

DIMENSION/ITEMS	**QUALIFICATION**				
DIMENSION: ATTRIBUTION OF DIRECT COSTS	**1**	**2**	**3**	**4**	**5**
1. You consider that the farmers at the fair produce more than one product to improve their income.					

2. You consider that the farmers at the fair could take advantage of alternatives that allow them to produce more livestock products to improve their income.					
3. You consider that the farmers at the fair know what the indirect costs are, and that allows them to obtain greater income.					
4. You consider that ranchers would be able to identify indirect costs so that they can obtain greater income.					

DIMENSION: INDIRECT COST FOR EACH ACTIVITY	**1**	**2**	**3**	**4**	**5**
5. You consider that ranchers should know what commercial costs are, to improve their income.					
6. You consider allowing ranchers to have talks about managing commercial costs to improve their income.					
7. You consider that livestock farmers can organize themselves to improve their relations between the producers in the stable and the intermediaries who come to the fair.					

DIMENSION: COSTS PER ACTIVITY IN GLOBAL FORM	**1**	**2**	**3**	**4**	**5**
8. You consider that ranchers should know what the financial costs are, that allow them to improve their income.					
9. You consider that ranchers should work with financial entities so that they have capital that allows them to improve their production.					
10. You consider that ranchers should know the administrative costs that allow them to improve their income.					
11. You consider that ranchers identify their production costs that allow them to know how much they invest in raising their cattle to have real prices at the fair.					

PART II: FINANCIAL MANAGEMENT

DIMENSION: OPTIMIZATION OF FINANCIAL RESOURCES	**1**	**2**	**3**	**4**	**5**
12. You consider that ranchers should know the sources of financing that allow them to have capital to improve their production in raising their livestock.					
13. You consider that ranchers are capable of managing sources of financing from private companies that allow them to improve their income.					
14. You believe that ranchers should know the investment they make in raising their livestock so that their results improve.					
15. You consider that ranchers should have technical-financial support that allows them to improve their results in the different purchase and sale negotiations.					

DIMENSION: ACHIEVEMENT OF OBJECTIVES	**1**	**2**	**3**	**4**	**5**
16. You consider that ranchers set objectives to improve results in livestock raising.					
17. You consider that ranchers achieve their long-term objectives so that their results improve.					
18. You consider that ranchers achieve their short-term objectives to improve their results.					

DIMENSION: GREATER PROFITABILITY	**1**	**2**	**3**	**4**	**5**
19. You consider that ranchers should know better how to manage the profitability they have in the production of their cattle.					
20. You consider that ranchers determine the profitability of the investment they make in raising their livestock so that their results improve.					
21. You consider that ranchers should be well aware of the profitability that their assets offer about the amount of cattle they produce.					

22. You consider that ranchers determine the profitability of their assets, which is limited to the amount of livestock they count with for-profit that allows them to improve their results.					

Before administering the survey, its degree of reliability was measured using Cronbach's Alpha coefficient ([18]). This coefficient is used to ensure that there is no inconsistency within the survey questions. Once applied, it was equal to 0.858, which means that the reliability is high and the survey can be applied.

Data processing was carried out with the help of formula (1) of the plithogenic $\mathrm{AND_p}$, where we used $\wedge_{\mathrm{F}} = min$ and $\vee_{\mathrm{F}} = max$; in addition to that $\bar{c} = 0.5$ because it cannot be determined which of the two operators has more importance, either the conjunction or the disjunction.

This formula was applied repeatedly to each item answered by each respondent. For example, if $X = \{x_1, x_2, \dots, x_{141}\}$ is the set of the 141 respondents, let us denote by q_j the set of 22 items for $j \in \{1,2, \dots ,22\}$. If a_{ij} is the answer given by the farmer x_i to the question q_j, where a_{ij} is one of the plithogenic numbers that appear in Table 2 associated with the linguistic response answered by the ith interviewee.

To calculate the aggregate responses for each of the dimensions for the ith interviewee, the following logical identities are used:

$\mathrm{D}_{1i} = a_{i1}\mathrm{AND_p}a_{i2}\mathrm{AND_p}a_{i3}\mathrm{AND_p}a_{i4}$ (5)

It is the response of the ith interviewee on the dimension ATTRIBUTION OF DIRECT COSTS.

$\mathrm{D}_{2i} = a_{i5}\mathrm{AND_p}a_{i6}\mathrm{AND_p}a_{i7}$ (6)

It is the response of the ith interviewee on the dimension INDIRECT COST FOR EACH ACTIVITY.

$\mathrm{D}_{3i} = a_{i8}\mathrm{AND_p}a_{i9}\mathrm{AND_p}a_{i10}\mathrm{AND_p}a_{i11}$ (7)

It is the response of the ith interviewee on the dimension COSTS PER ACTIVITY IN GLOBAL FORM.

$\mathrm{D}_{4i} = a_{i12}\mathrm{AND_p}a_{i13}\mathrm{AND_p}a_{i14}\mathrm{AND_p}a_{i15}$ (8)

It is the response of the ith interviewee on the dimension OPTIMIZATION OF FINANCIAL RESOURCES.

$\mathrm{D}_{5i} = a_{i16}\mathrm{AND_p}a_{i17}\mathrm{AND_p}a_{i18}$ (9)

It is the response of the ith interviewee on the dimension ACHIEVEMENT OF OBJECTIVES.

$\mathrm{D}_{6i} = a_{i19}\mathrm{AND_p}a_{i20}\mathrm{AND_p}a_{i21}\mathrm{AND_p}a_{i22}$ (10)

It is the response of the ith interviewee on the dimension of GREATER PROFITABILITY.

$\mathrm{D}_1 = \mathrm{D}_{1,1}\mathrm{AND_p}\mathrm{D}_{1,2}\mathrm{AND_p} \dots \mathrm{AND_p}\mathrm{D}_{1,141}$ (11)

It is the total aggregated value on the dimension ATTRIBUTION OF DIRECT COSTS.

$\mathrm{D}_2 = \mathrm{D}_{2,1}\mathrm{AND_p}\mathrm{D}_{2,2}\mathrm{AND_p} \dots \mathrm{AND_p}\mathrm{D}_{2,141}$ (12)

It is the total aggregated value on the dimension INDIRECT COST FOR EACH ACTIVITY.

$\mathrm{D}_3 = \mathrm{D}_{3,1}\mathrm{AND_p}\mathrm{D}_{3,2}\mathrm{AND_p} \dots \mathrm{AND_p}\mathrm{D}_{3,141}$ (13)

It is the total aggregated value on the dimension COSTS PER ACTIVITY IN GLOBAL FORM.

$\mathrm{D}_4 = \mathrm{D}_{4,1}\mathrm{AND_p}\mathrm{D}_{4,2}\mathrm{AND_p} \dots \mathrm{AND_p}\mathrm{D}_{4,141}$ (14)

It is the total aggregated value on the dimension OPTIMIZATION OF FINANCIAL RESOURCES.

$\mathrm{D}_5 = \mathrm{D}_{5,1}\mathrm{AND_p}\mathrm{D}_{5,2}\mathrm{AND_p} \dots \mathrm{AND_p}\mathrm{D}_{5,141}$ (15)

It is the total aggregated value on the dimension ACHIEVEMENT OF OBJECTIVES.

$\mathrm{D}_6 = \mathrm{D}_{6,1}\mathrm{AND_p}\mathrm{D}_{6,2}\mathrm{AND_p} \dots \mathrm{AND_p}\mathrm{D}_{6,141}$ (16)

It is the total aggregated value on the dimension GREATEST PROFITABILITY.

$\mathrm{C} = \mathrm{D}_1\mathrm{AND_p}\mathrm{D}_2\mathrm{AND_p}\mathrm{D}_3$ (17)

It is the total aggregated value of “Activity cost”.

$\mathrm{M} = \mathrm{D}_4\mathrm{AND_p}\mathrm{D}_5\mathrm{AND_p}\mathrm{D}_6$ (18)

It is the total aggregated value of "Financial Management".

The values in Equations 11-18 are used to measure the behavior of these aspects in general. For the statistical processing, the results of Equations 5-10 are used for each of the dimensions in particular, and also the following two results for the variables “Activity cost” for each respondent (Equation 19) and “Financial Management” for each respondent (Equation 20).

$\mathrm{C}_i = \mathrm{D}_{1i}\mathrm{AND_p}\mathrm{D}_{2i}\mathrm{AND_p}\mathrm{D}_{3i}$ (19)

$\mathrm{M}_i = \mathrm{D}_{4i}\mathrm{AND_p}\mathrm{D}_{5i}\mathrm{AND_p}\mathrm{D}_{6i}$ (20)

For statistical processing, the crisp values are used to apply Equation 3 to the dimension or variable that we wish to study, which are Equations 5-10, 19, and 20.

For example, $\mathcal{S}\left(\mathrm{T}_{\mathrm{C}_i}, \mathrm{I}_{\mathrm{C}_i}, \mathrm{F}_{\mathrm{C}_i}\right) \in [0,1]$ is the crisp value of the ith interviewee's opinion on the variable “Activity cost”, where $i = 1,2, \dots ,141$. This is repeated for the other variables and dimensions.

The next step is to apply traditional statistical methods to these values converted from linguistic values for each item and each rancher, to crisp values for each dimension or variable for each interviewee.

The results are shown in the following Tables:

			Activity cost	Financial management
Kendall's tau_b	Activity cost	Correlation coefficient	1.000	.779 **
		Sig. (bilateral)	.	.000
		N	141	141
	Financial management	Correlation coefficient	.779 **	1.000
		Sig. (bilateral)	.000	.
		N	141	141

**. The correlation is significant at the 0.01 level (two-sided).

Table 3. The result of calculating Kendall's Tau_b on the correlation between "Activity cost" (C_i) and "Financial management" (M_i).

The result of the coefficient is $\tau = 0.779$ and $p = 0.000$, the p-value is less than the level of significance, $p < 0.05$, therefore the coefficient is significant, and consequently there is a high correlation; demonstrating a notable relationship between the variables for activity cost and financial management.

			Activity cost	Optimization of Financial Resources
Kendall's tau_b	Activity cost	Correlation coefficient	1.000	.655 **
		Sig. (bilateral)	.	.000
		N	141	141
	Optimization of Financial Resources	Correlation coefficient	.655 **	1.000
		Sig. (bilateral)	.000	.
		N	141	141

**. The correlation is significant at the 0.01 level (two-sided).

Table 4. The result of calculating Kendall's Tau_b on the correlation between "Activity cost" (C_i) and "Optimization of Financial Resources" (D_{4i}).

The result of the coefficient is $\tau = 0.655$ and $p = 0.000$, the p-value or $p < 0.05$, therefore the coefficient is significant, and thus there is a moderate correlation; demonstrating a considerable relationship between the cost variables for activities and optimization of financial resources.

			Activity cost	Goal Achievement
Kendall's Tau_b	Activity cost	Correlation coefficient	1.000	.480 **
		Sig. (bilateral)	.	.000
		N	141	141
	Goal Achievement	Correlation coefficient	.480 **	1.000
		Sig. (bilateral)	.000	.
		N	141	141

**. The correlation is significant at the 0.01 level (two-sided).

Table 5. The result of calculating Kendall's Tau_b on the correlation between "Activity cost" (C_i) and "Goal achievement" (D_{5i}).

The result of the coefficient is $\tau = 0.480$ and $p = 0.000$, the p-value is less than the level of significance, $p < 0.05$, therefore the coefficient is significant, so there is a moderate correlation; demonstrating a considerable relationship between the variables activity cost and achievement of objectives.

			Activity cost	Greater Profitability
Kendall's tau_b	Activity cost	Correlation coefficient	1.000	.462 **
		Sig. (bilateral)	.	.000
		N	141	141
	Greater Profitability	Correlation coefficient	.462 **	1.000
		Sig. (bilateral)	.000	.
		N	141	141

**. The correlation is significant at the 0.01 level (two-sided).

Table 6. The result of calculating Kendall's Tau_b on the correlation between "Activity cost" (C_i) and "Greater profitability" (D_{6i}).

The result of the coefficient is $\tau = 0.462$ and $p = 0.000$, the p-value is less than the level of significance, $p < 0.01$, therefore the coefficient is significant, and consequently there is a moderate correlation; demonstrating a considerable relationship between the variables activity cost and greater profitability.

Additionally, it was obtained from Equations 17 and 18 that the Activity Cost $\mathcal{S}(T_C, I_C, F_C) = 0.5063$, and $\mathcal{S}(T_M, I_M, F_M) = 0.5749$.

Conclusion

Plithogenic statistics is a new generalization of statistical theory since it generalizes both, Neutrosophic statistics and Interval statistics. In this work, we use the benefits of this new mathematical tool in the study of the statistical relationships between pairs of variables that are important to measure because they have to do with the behavior of profitability in the production and marketing of beef and milk in the town of Junín in Peru. For this purpose, a survey was applied to 141 randomly selected ranchers to study the relationship between the pairs Activity cost-Financial management, Activity cost-Optimization of financial resources, Activity cost-Goal achievement, Activity cost-Greater profitability. The advantage of using this tool is that respondents, who are not mathematics specialists, only had to respond on an easy-to-understand linguistic scale. In turn, the association of these values with neutrosophic numbers allowed us to capture the indeterminacy and uncertainty intrinsic to each opinion that is expressed. The results were that between each pair of variables studied above, there is a significant positive correlation from moderate to strong. Therefore, it is necessary to improve each of them to improve the others. Furthermore, the different values of the variables studied were shown to be in a situation of "more or less" to "slightly favorable", therefore, all of them are feasible to be improved.

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