University of New Mexico

Neutrosophic Statistical Analysis of E-commerce

Lysbeth Kruscthalia Álvarez Gómez[1], Mireya Silvana Cuarán Guerrero[2], Jimena Elizabeth Montes de Oca Sánchez[3], Mónica Elizabeth Benalcázar Paladines[4] and Asnioby Hernandez Lopez[5]

[1] Directora. Universidad Regional Autónoma de los Andes (UNIANDES). Transversal Central, Quevedo. Los Ríos. Ecuador Email: uq.lysbethalvarez@uniandes.edu.ec
[2] Docente de la carrera de Administración de Empresas. Universidad Regional Autónoma de los Andes (UNIANDES). Juan de Salinas 612-500, Ibarra. Imbabura. Ecuador Email: ui.mireyacuaran@uniandes.edu.ec
[3] Docente de la carrera de Administración de Empresas. Universidad Regional Autónoma de los Andes (UNIANDES). Km 5 ½ vía a Baños. Ambato. Tungurahua. Ecuador Email: ua.jimenamontesdeoca@uniandes.edu.ec
[4] Docente de la carrera de Administración de Empresas. Universidad Regional Autónoma de los Andes (UNIANDES). Avenida La Lorena, Santo Domingo. Ecuador Email: us.monicabenalcazar@uniandes.edu.ec
[5] Mercado Libre, Montevideo, Uruguay. Email: asnioby.hernandez@mercadolibre.com

Abstract. E-commerce consists of the purchase, sale, distribution, marketing, and supply of information about products or services through the internet so that any client can access the products or services from anywhere and at any time. It constitutes a negotiation model that acquires more and more followers, generating great economic benefits for those who use it. To make e-commerce successful, it is necessary to be present in large marketplaces, by increasing visibility. A marketplace has a very large flow of users who already trust the brand. Therefore every detail of the consumer's shopping experience must be taken care of, the customer service system perfected, and business promoted with the practice of marketing. In this paper, the main effects that influence the pillars and the success of e-commerce were determined and it is identified that customer service constitutes the factor with the greatest incidence in the growth of e-commerce, based on the analysis of the neutrosophic statistics.

Keywords: E-commerce, business, neutrosophic statistics.

1 Introduction

Electronic commerce or e-commerce is the economic activity that allows the trade of products and services from digital media [1-3], and it is a trend that moves a large part of the world economy. It is present in governments and large companies. The globalized world, its dizzying competitiveness and the speed to do business have driven the development of electronic commerce by modifying the way of selling and buying products or services on the internet in a local, national and international market [4], either through web pages, mobile applications, or social networks.
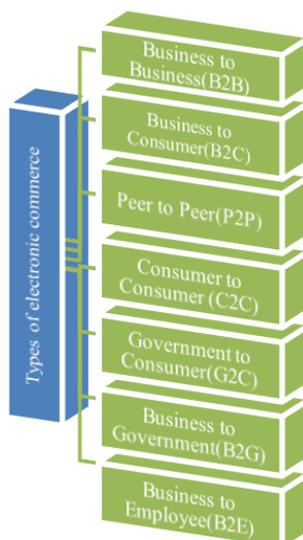

Figure 1. Types of e-commerce

Nowadays, various types of e-commerce can be done: (see Figure 1) [5]. These allow anyone to start an online business. Among the most used are B2B and B2C (see Figure 2). In 2015, B2B accounted for 89% of global e-commerce. The rest (11%) to B2C [6], the latter grew annually by 31% on average between 2014 and 2017, leading the United States with sales of $ 7.1 trillion, corresponding to 28% of global e-commerce [7]. Thus, the amount of global e-commerce would increase in total from 1.3 to 4.9 trillion dollars.

The use of e-commerce generates millionaire profits; during 2015 the global e-commerce market exceeded 25 trillion dollars [8] and contributed in 2016 to the increase of 2.92% of GDP worldwide, verifying that the use of online stores by companies increases their exports and productivity, with a growth in the use of broadband in the countries, thus increasing the trading relationship [9].
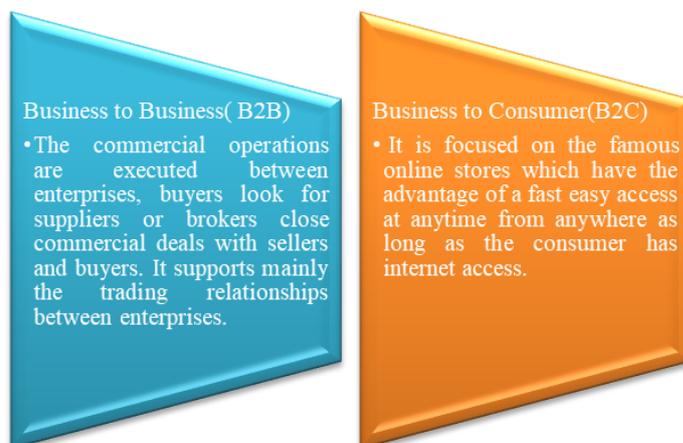

Figure 2. Types of electronic commerce that are most used in the world.

For the proliferation of e-commerce, technologies play an essential role in the exchange, promotion and sales of products and services today and their use is increasing. Among the most important electronic commerce sites in 2019 are Amazon, JD.com, Alibaba, eBay, Rakuten, Zalando, and Otto [10-13].
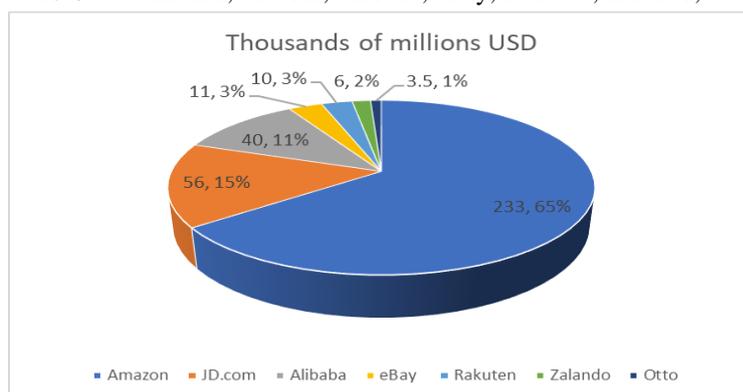

Figure 3. Incomings of the main e-commerce companies in 2019.

This new form of business undoubtedly represents a driving force for the economic development of the business sector, as well as for developed and developing nations [14]. As organizations grow in size, e-commerce becomes more complex and challenging and to maintain customer attention, it is necessary to create a strong relationship with the customer and offer services that attract them to visit the website frequently, buy products and services and carry out successful digital marketing activities [15], which are essential to the success of an e-commerce business today [1-3].

All the effort invested in creating and marketing a product will be wasted if the logistics involved in delivery are not robust. In addition, a negative experience will leave a bad impression on the customer, reducing the probability that they will return to the online store [16]. Another important impact is to guarantee security in financial transactions between customers and suppliers, combat fraud and unwanted emails [17], and prioritize authentication and controls over access to data.

For the analysis of the factors that affect electronic commerce, it is defined:

- ▪ Problem situation: effects on the development of e-commerce
- ▪ Main objective: define the main effects that influence the success of e-commerce
- ▪ Specific objectives:
  - ➢ Determine the factors that affect the variable analyzed
  - ➢ Carry out the measurement and modeling of the variable
  - ➢ Define the potential alternatives to mitigate the effects that influence the success of the e-commerce
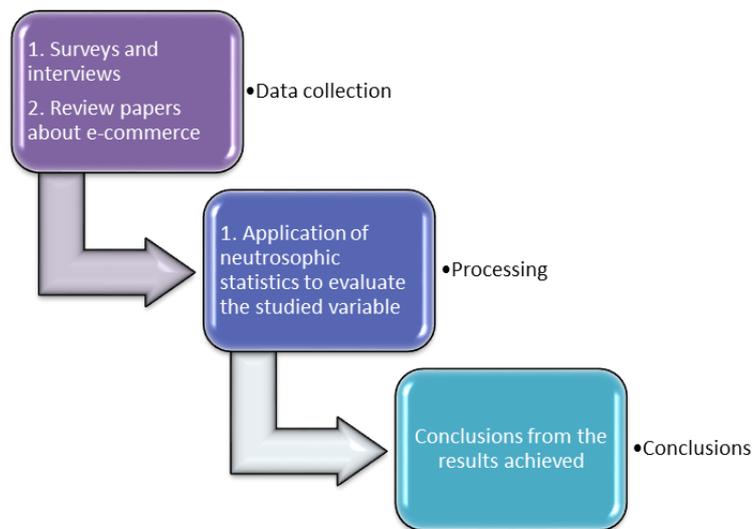

Figure 4. Development of the study

2 Materials and methods

[18-40] Neutrosophic probabilities and statistics are a generalization of classical and imprecise probabilities and statistics. For example, the Neutrosophic Probability of an event E is the probability that event E will occur [41], the probability that event E does not occur, and the probability of indeterminacy (not knowing whether event E occurs or not). In classical probability nsup ≤1, while in neutrosophic probability nsup ≤3+. The function that models the neutrosophic probability of a random variable x is called the neutrosophic distribution:

$$NP(x) = (T(x), I(x), F(x)),$$

Where T(x) represents the probability that the value x occurs, F(x) represents the probability that the value x does not occur, and I(x) represents the indeterminate or unknown probability of the value x. Neutrosophic Statistics is the analysis of neutrosophic events and deals with neutrosophic numbers, the neutrosophic probability distribution [42], neutrosophic estimation, neutrosophic regression, etc. It refers to a set of data formed totally or partially by data with some degree of indeterminacy and the methods to analyze them.

Neutrosophic statistical methods allow the interpretation and organization of neutrosophic data (data that can be ambiguous, vague, imprecise, incomplete, or even unknown) to reveal the underlying patterns [43].

In short, the Neutrosophic Logic [44, 45], Neutrosophic Sets and Neutrosophic Probabilities and Statistics have a wide application in various research fields and constitute a new reference of study in full development.

The Neutrosophic Descriptive Statistics includes all the techniques to summarize and describe the characteristics of the neutrosophic numerical data [46].

Neutrosophic Numbers are numbers of the form where a and b are real or complex numbers [47], while "I" is the indeterminacy part of the neutrosophic number N.

$$N = a + bI.$$

The study of neutrosophic statistics refers to a neutrosophic random variable where X_l and $X_u I_N$ represent the corresponding lower and upper level that the studied variable can reach, in an indeterminate interval $[I_l, I_u]$. Following the neutrosophic mean of the variable $(\bar{x}_N)$ when formulating:

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$$X_N = X_l + X_u I_N; \ I_N \in [I_l, I_u] \tag{1}$$

$$\text{Where } \bar{x}_a = \frac{1}{n_N} \sum_{i=1}^{n_N}, X_{il} \ \bar{x}_b = \frac{1}{n_N} \sum_{i=1}^{n_N}, X_{iu} \ n_N \in [n_l, n_u] \tag{2}$$

is a neutrosophic random sample. However, for the calculation of neutral squares (NNS), it can be calculated as follows.

$$\sum_{i=1}^{n_N}(X_i - \bar{X}_{iN})^2 = \sum_{i=1}^{n_N} \begin{bmatrix} \min \begin{pmatrix} (a_i + b_i I_L)(\bar{a} + \bar{b} I_L), (a_i + b_i I_L)(\bar{a} + \bar{b} I_U) \\ (a_i + b_i I_U)(\bar{a} + \bar{b} I_L), (a_i + b_i I_U)(\bar{a} + \bar{b} I_U) \end{pmatrix} \\ \max \begin{pmatrix} (a_i + b_i I_L)(\bar{a} + \bar{b} I_L), (a_i + b_i I_L)(\bar{a} + \bar{b} I_U) \\ (a_i + b_i I_U)(\bar{a} + \bar{b} I_L), (a_i + b_i I_U)(\bar{a} + \bar{b} I_U) \end{pmatrix} \end{bmatrix}, I \epsilon [I_L, I_U] \tag{3}$$

Where $a_i = X_l b_i = X_u$. The variance of the neutrosophic sample can be calculated through

$$S_N^2 = \frac{\sum_{i=1}^{n_N}(X_i - \bar{X}_{iN})^2}{n_N}; \ S_N^2 \epsilon [S_L^2, S_U^2] \tag{4}$$

The neutrosophic coefficient (NCV) measures the consistency of the variable. The lower the NCV value, the more consistent the factor's performance is than the other factors. NCV can be calculated as follows [48].

$$CV_N = \frac{\sqrt{S_N^2}}{\bar{X}_N} \times 100; \ CV_N \epsilon [CV_L, CV_U] \tag{5}$$

3 Results

Data collection

After analyzing the different approaches in the introduction of this paper, the techniques described above are applied as follows: for the growth of e-commerce and due to the complexity and indeterminacy of the data, we decided to apply the neutrosophic statistics for modeling the analyzed variable.

From the information processing and the consensus of the experts, the factors that most affect e-commerce and the variable to be modeled were determined (Table 1).

Variable analyzed: e-commerce growth, for a sample of n = 120 for each factor (f)

Resources needed to create or maintain e-commerce	Initials	Factors that affect business success (e-commerce)	Scale	Occurrence of the incident
Security in financial transactions	V	Digital security breaches	[0; 3]	From 0 to 3 people per day, report a violation of their data
Market	M	Marketing does not guarantee trust in the website	[0; 3]	0 to 3 people do not recommend the website due to the low level of publicity and promotion
Positioning of the business in web search engines	D	Difficulty accessing the platform	[0; 3]	From 0 to 3 people per day comment that they had some difficulty accessing the website
Customer Support	B	Low interaction with customers	[0; 3]	0-3 people per day complain about customer service delays

Logistics	A	Delays in delivery times	[0; 3]	0 to 3 people have problems with the delivery of the purchased product

Table 1. Incidence range for each factor.

To model the neutrosophic statistics, it was decided to code the factors to make the results viable (Table 2).

Code	Initials	Factors that affect business success
A	V	Digital security breaches
B	M	Marketing does not guarantee trust in the website
C	D	Difficulty accessing the platform
D	B	Low interaction with customers
E	A	Delays in delivery times

Table 2. Determinant factors for the business success.

For the development of the statistical study, the neutrosophic frequencies of the determining factors in the success of an electronic commerce business are analyzed. For each factor, an incidence is analyzed in an interval of days for each factor, which makes up the set of affectations for e-commerce to become a sales success.

Days	Neutrosophic frequencies				
	V	M	D	B	A
1	[1 ; 2]	[1 ; 4]	[2 ; 5]	[0; 1]	[0; 1]
2	[0; 1]	[3 ; 5]	[2 ; 4]	[2 ; 4]	[3 ; 6]
3	[0; 0]	[0; 1]	[0; 3]	[0; 3]	[3 ; 6]
4	[1 ; 2]	[0; 1]	[0; 1]	[3 ; 6]	[1 ; 4]
5	[0; 0]	[3 ; 6]	[1 ; 2]	[0; 2]	[0; 1]
6	[1 ; 2]	[3 ; 6]	[1 ; 3]	[0; 3]	[1 ; 4]
7	[1 ; 1]	[2 ; 5]	[1 ; 1]	[0; 2]	[0; 3]
8	[1 ; 1]	[1 ; 1]	[3 ; 3]	[0; 3]	[0; 1]
9	[0; 1]	[1 ; 3]	[0; 0]	[0; 0]	[1 ; 1]
10	[1 ; 1]	[0; 0]	[0; 0]	[2 ; 2]	[2 ; 2]
11	[0; 1]	[3 ; 4]	[3 ; 3]	[3 ; 5]	[1 ; 2]
12	[0; 1]	[2 ; 4]	[3 ; 6]	[2 ; 5]	[0; 0]
13	[0; 1]	[1 ; 1]	[1 ; 1]	[1 ; 4]	[2 ; 5]
14	[1 ; 1]	[2 ; 2]	[0; 3]	[3 ; 3]	[1 ; 3]
15	[0; 1]	[0; 0]	[0; 2]	[0; 1]	[3 ; 6]
16	[0; 0]	[2 ; 5]	[1 ; 1]	[1 ; 1]	[3 ; 3]
17	[1 ; 1]	[3 ; 6]	[1 ; 2]	[2 ; 2]	[1 ; 4]
18	[0; 0]	[0; 0]	[1 ; 3]	[1 ; 3]	[1 ; 1]
19	[1 ; 1]	[2 ; 5]	[1 ; 3]	[1 ; 1]	[2 ; 3]
20	[1 ; 1]	[1 ; 3]	[2 ; 3]	[3 ; 6]	[3 ; 4]
0-120	[60; 125]	[186; 359]	[175; 353]	[177; 358]	[173; 353]

Table 3. Neutrosophic frequencies of factors

Table 3 analyzed the neutrosophic frequency of occurrence of the determining factors in the development of e-commerce, for 120 days, with an occurrence level of [0; 6] for each factor per day with a total indeterminacy level of a = 65, b = 173, c = 178, d = 181, e = 180, and a level of representativeness of [48.19%; 52.00%], on the days that 6 impacts per factor were recorded, with an incidence of 52% in terms of digital security violations.

Neutrosophic statistical analysis

From the data on the effects that affect the business (table 4), it will be possible to understand which factor implies a representative mean $\bar{x} = \in [\bar{x}_L; \bar{x}_U]$, the values of the neutrosophic means are calculated and for the study of the variations in the effects, the values of the neutrosophic standard deviation $S_N \in [S_L; S_U]$. To determine which impact requires a greater impact on business growth, the $CV_N \in [CV_L ; CV_U]$values are calculated.

Factors	$\bar{x}_N$	YN	CVN
Digital security breaches	[0.5; 1,042]	[0.112; 0.934]	[0.224; 0.896]
Marketing does not guarantee trust in the website	[1.55; 2,992]	[0.707; 2.39]	[0.456; 0.799]
Difficulty accessing the platform	[1,458; 2,942]	[0.695; 2.24]	[0.477; 0.761]
Low interaction with customers	[1,475; 2,983]	[0.721; 2,106]	[0.489; 0.706]
Delays in delivery times	[1,442; 2,942]	[0.681; 2,237]	[0.472; 0.76]

Table 4. Neutrosophic statistical analysis of incidents in online business

In table 4, we determined that the factors. *Marketing does not guarantee trust in the website* and *low interaction with customers* have higher mean values that affect the other factors. This means that the M and B factors are, on average, the ones that most affect an online commerce business to be successful and evolve, while the value of CV_{Nb} in the low interaction with customers is lower than the rest. This means that the result of factor B has a more consistent, coherent, and precise impact when evaluating indeterminacy than the other factors in e-commerce (Figure 5).
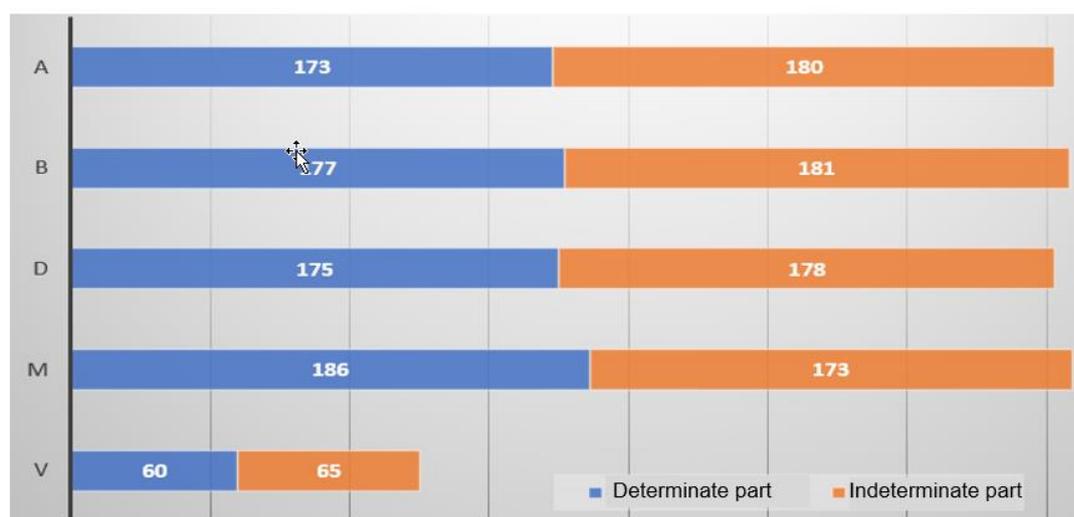

Figure 5: Neutrosophic bar chart of incidents for the development of the online business

Comparative analysis

To calculate the associated referent indeterminacy measure $\bar{x} = \in [\bar{x}_L; \bar{x}_U]$, $S_N \in [S_L; S_U]$ and $CV_N \in [CV_L; CV_U]$ for the form of neutrosophic numbers (Table 5), in the results, we observe that the values range from 0.489 to 0.706 with indeterminacy measure 30.7 generating a negative impact on poor communication with customers.

Factors	$\bar{x}_N$	YN	CVN
V	0.5 + 1.042 I;I $\in$ [0; 0.52]	0.112 + 0.934 I;I $\in$ [0; 0.88]	0.224 + 0.896 I;I $\in$ [0; 0.75]
M	1.55 + 2,992 I;I $\in$ [0; 0.48]	0.707 + 2.39 I;I $\in$ [0; 0.70]	0.456 + 0.799 I;I $\in$ [0; 0.42]
D	1,458 + 2,942 I;I $\in$ [0; 0.50]	0.695 + 2.24 I;I $\in$ [0; 0.69]	0.477 + 0.761 I;I $\in$ [0; 0.37]
B	1,475 + 2,983 I;I $\in$ [0; 0.50]	0.721 + 2.106 I;I $\in$ [0; 0.65]	0.489 + 0.706 I;I $\in$ [0; 0.30]
A	1,442 + 2,942 I;I $\in$ [0; 0.51]	0.681 + 2.237 I;I $\in$ [0; 0.69]	0.472 + 0.76 I;I $\in$ [0; 0.37]

Table 5. Neutrosophic statistical analysis

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Alternatives to mitigate negative effects on e-commerce

With this study, it was determined that one of the main priorities of electronic commerce is to enhance the Customer Service System. Online chats are a very easy-to-use tool that will improve customer service in two fundamental aspects, quality and speed. It is a strategy that manages to reach the recipients more quickly. Several reasons lead the client to contact your company: defects, doubts, claims, suggestions, delivery time, among others, and the use of various communication channels to offer solutions at all times and raise the prestige of the company's online store is the point of reference for anyone who wants to start an online business. So, it is necessary to train professionals, they must have the ability to serve clients with patience, cordiality, efficiency, and clarify all doubts. There is no better customer service than offering you quick answers to your client's problems.

Figure 6. Alternatives to enhance communication channels

Conclusions

E-commerce needs to overcome various obstacles and public policy challenges. For example, limited and deficient connectivity and inadequate technological infrastructure, postal services with unsatisfactory performance, legal and regulatory frameworks that restrict the degree to which people trust and carry out online transactions, in addition to creating promotions and enhancing the communication channel with the consumer, are some of the main reasons for the growth and success of electronic commerce.

The analysis of the neutrosophic statistics found that the e-commerce growth variable is affected by the low interaction with customers with an indeterminacy level of 30.7% by influencing inversely proportional with respect to the other factors, so that, if the factor B, increases the other factors and the instability of the business.

The neutrosophic statistical analysis shows a lower CV value for low interaction with customers as a determining factor to start an online business. Based on this result, it was concluded that with the use of several communication channels, quick responses could be offered to the consumer and guarantee satisfactory buying experiences.

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