Neutrosophic Sets and Systems
{Special Issue:Impact of neutrosophic scientific publication in Latin American context}, Vol. 44, 2021

University of New Mexico

Neutrosophic Statistics for Project Management. Application to a Computer System Project

Ariel Romero Fernández[1], Lourdes Viviana Moreira Rosales[2], Olga Germania Arciniegas Paspuel[3] , Walter Bolívar Jarrín López[4] and Anthony Rafael Sotolongo León[5]

[1] Director de Investigación. Universidad Regional Autónoma de los Andes (UNIANDES). Km 5 ½ vía a Baños. Ambato. Tungurahua. Ecuador. Email: dir.investigacion@uniandes.edu.ec
[2] Docente de la carrera de Administración de Empresas. Universidad Regional Autónoma de los Andes (UNIANDES). Avenida La Lorena, Santo Domingo. Ecuador Email: us.lourdesmoreira@uniandes.edu.ec
[3] 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.olgaarciniegas@uniandes.edu.ec
[4] Docente de la carrera de Contabilidad y Auditoría. Universidad Regional Autónoma de los Andes (UNIANDES). Calle Teniente Hugo Ortiz, Puyo. Pastaza. Ecuador Email: up.walterjarrin@uniandes.edu.ec
[5]Ongres, Santiago de Chile, Chile. Email: asotolongo@ongres.com

Abstract. This research aims to apply a mathematical procedure of the project evaluation and review technique (PERT) in a neutrosophic environment. For such purpose, the elements of the three PERT estimates are considered neutrosophic elements, more specifically, trapezoidal neutrosophic numbers. The technique used is novel and attractive since it allows to overcome the limitations of the different Fuzzy PERT methods and handle indeterminacy mathematically. On this occasion, the neutrosophic PERT method is applied to managing a computer system development project. The PERT method made it possible to estimate the minimum duration of the project, the beta parameters of the duration of each activity, and the identification and calculation of the critical path, with the help of specialized software.

Keywords: Neutrosophic trapezoidal number, Neutrosophic PERT, IT project, Critical path.

1 Introduction

The complexity, uncertainty, and extreme competition in the economic and industrial environment in which companies of all kinds operate today, and the difficulties in managing their projects are the cause of new challenges and growing problems. Therefore, it is not weird to see projects end up in severe and costly failures, deterioration or questioning of their main objectives (costs, deadlines, and technical performance) and sometimes in their immediate abandonment. For these reasons, project management has become one of the most important topics for many companies in recent years.

The word project comes from the Latin *projectum* of *projacere*, "to launch something forward." The prefix pro means "precedent in time" (by analogy with the Greek) and the root jacere means "to launch". Thus, the word "project" originally meant what is done before the launch (development, manufacture, construction) of something.

According to [2], a project can be defined as a series of works related to achieving a goal or the development of a product and for which time is required. Therefore, project management seeks the planning, direction, and control of resources that are subject to critical activities, dependent activities, slack, and lead time.

In their simplest form, projects are unique in that they have a single goal and a set of individual, definable and measurable objectives. They have a finite shelf life and are generally intended to improve or create some process. On the other hand, they are usually relatively complex and (because they involve the generation of change), they are often relatively risky. Hence the importance of its correct administration.

It can be stated that project management is the planning, direction, and control of resources (people, equipment, materials) to ensure the budget control of the project, the efficient management of available resources and compliance with the agreed deadlines and thus guarantee an execution effective, comprehensive project.

Project management developed from its founding phases in the 1940s and became one of the most important international and interdisciplinary applications. The related professional associations are active throughout the world and in most areas of industry and commerce. Project management practices and procedures are used in various applications, from agricultural projects to complex engineering projects.

Project management is based on the following objectives. The functional performance objective and technical specifications for (reliability, maintainability, ease of use). The respect of a project execution deadline is an important component of the expression of needs since a delay can reduce the interest of the project and, in most cases, lead to additional costs, in the form of a delayed penalty, in particular.

Depending on the project's scope, the economic objective can take different forms (cost, profitability). Among the limitations or restrictions that must be controlled in the project, time limitations must be highlighted. These are the expression of the periods within which the project must be completed.

The increasing complexity of projects worldwide has driven the growth of project management as an international discipline. To structure the implementation of a project, different techniques have been designed that allow addressing some calculations related to the management of its costs, quality, and delivery times, within these techniques the network planning models stand out, one of the best known is the Program Evaluation and Review Technique (PERT).

From a network analysis perspective, project planning methods require the identification of data and the organization and typification of reciprocal relationships between activities to estimate the project execution time and thus carry out planning [2].

These methods have also been used to manage IT projects, which are designed based on a set of tasks that have their associated costs and delivery times. Mainly, the PERT method offers certain advantages when considering probable scenarios for the development of the tasks and, therefore, for fulfilling the deadlines. In addition, some authors consider the usefulness of the PERT method for the management of computer projects for the development of multipurpose software systems [5].

PERT method was developed to include the uncertainty in the estimates of the duration and assumes that the time to carry out each of the activities is a random variable described by a probability distribution.

The original version of PERT takes into account uncertainty by using three different types of estimates of the duration of an activity, to obtain basic information about its probability distribution (Beta). These are the *most probable estimate* (m); *optimistic estimate* (o) and *pessimistic estimate* (p). These estimates can be identified as the estimate of the most probable value of the duration; the estimated duration under the most favorable conditions and the estimated duration under the most unfavorable conditions, respectively [9].

Some authors identified certain limitations in the classic PERT method. This is evidenced by the statements made by [6]:

The common method of analyzing projects, classical PERT, has numerous problems such as the beta distribution and stochastic variables and the estimation of parameters (expected duration and variance). This has led researchers to seek new solutions, eg to integrate fuzzy sets with PERT and created a new approach, namely Fuzzy PERT or FPERT. (p.185)

Likewise, these authors believe that the planning of the project should be carried out with greater precision and the results should be obtained more realistically with the help of fuzzy sets and the inclusion of opinions and experiences of experts [3] [6] [7] [14].

However, other authors believe that the theory of neutrosophic sets is more appropriate than fuzzy sets to model the uncertainty associated with parameters such as the duration of the activity and the availability of resources in PERT. This is mainly because the project manager, to determine the optimistic and pessimistic values of the duration of the activities, often faces uncertain, inconsistent, and incomplete information about the real world [11].

Following the above, a Neutrosophic version of the PERT method was used that allows the treatment of indeterminacy in the possible scenarios, to estimate the duration of the project of a computer system for the control of production in an Ecuadorian company. The following section addresses the theoretical elements of the classical and neutrosophic PERT method applied to the management of a computer project.

For the PERT method, it is assumed that the shape of the probability distribution obtained is a beta distribution with mean [9] [10]:

$$\mu = \frac{o+4m+p}{6} \tag{1}$$

and variance:

$$\sigma^2 = \left(\frac{p-o}{6}\right)^2 \tag{2}$$

In recent years, according to fuzzy set theory for project management, there were different PERT methods. However, the existing fuzzy PERT methods have some drawbacks [2]:

- A critical path cannot be found in a fuzzy project network.
- Increase possible critical paths, which is the riskiest path.
- Indeterminacy, which exists in real-life situations, cannot be determined.

In the case of PERT, time estimates vary considerably. Three-time estimates are used here, which are optimistic (a), pessimists (b), and most likely (m). In practice, the question often arises as to how to obtain good optimistic or pessimistic estimates. Neutrosophic set theory is more appropriate than fuzzy sets, for modeling the uncertainty associated with parameters, such as activity duration and resource availability in PERT. By using neutrosophic set theory in the PERT technique, we can also overcome the drawbacks of fuzzy PERT methods [11].

Due to those above, we propose applying the neutrosophic sets to the project management of a computer system. The neutrosophic PERT method based on trapezoidal neutrosophic sets, proposed by [12], will be applied. This method will be implemented based on the plan of activities planned to develop a computer system proposed by [5].

2 Materials and methods

In this section, some theoretical elements, formulas, and calculation procedures of the neutrosophic statistics are systematized [15-18], which will be used to estimate the project's duration using the neutrosophic PERT method.

Definition 1. [1] Let X be a space of points (objects) and $x \in X$. A neutrosophic set A in X is defined by a truth-membership function (x), an indeterminacy-membership function $I_A(x)$ and a falsity-membership function $F_A(x)$. (x), (x) and (x), are real standard or real nonstandard subsets of]- 0, 1+[. That is (x): $X \to$]-0,1+[, $I_A(x)$: $X \to$]-0, 1+[and $F_A(x)$:$X \to$]-0, 1+[. There is no restriction on the sum of $T_A(x)$, $I_A(x)$ and $F_A(x)$, so $0- \leq \sup T_A(x) + \sup I_A(x) + \sup F_A(x) \leq 3+$.

Definition 2. [1] Let X be a universe of discourse. A single valued neutrosophic set A over X is an object having the form $A=\{\langle x, T_A(x), I_A(x), F_A(x)\rangle : x \in X\}$, where $T_A(x)$:$X \to [0,1]$, $I_A(x)$:$X \to [0,1]$ and $F_A(x)$: $X \to [0,1]$ with $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$ for all $x \in X$. The intervals (x), (x) and (x) denote the truth-membership degree, the indeterminacy-membership degree, and the falsity membership degree of x to A, respectively. For convenience, an SVN number is denoted by A= (a, b, c), where a, , $c \in [0, 1]$ and $a + b + c \leq 3$.

Definition 3. [6] Let $\boldsymbol{\alpha_{\tilde{a}}, \theta_{\tilde{a}}, \beta_{\tilde{a}} \epsilon [0,1]}$ and $\boldsymbol{a_1, a_2, a_3, a_4 \epsilon R}$ such that $\boldsymbol{a_1 \leq a_2 \leq a_3 \leq a_4}$. Then a single-valued trapezoidal neutrosophic number, $\boldsymbol{\tilde{a} = \langle (a_1, a_2, a_3, a_4); \alpha_{\tilde{a}}, \theta_{\tilde{a}}, \beta_{\tilde{a}} \rangle}$ is a special neutrosophic set on the real line set R. The truth-membership, indeterminacy-membership, and falsity- membership functions of $\boldsymbol{\tilde{a}}$, are given by [12]:

$$T_{\tilde{a}}(x) = \begin{cases} \alpha_{\tilde{a}}\left(\frac{x-a_1}{a_2-a_1}\right) & if\ \ a_1 \leq x \leq a_2 \\ \alpha_{\tilde{a}} & if\ \ a_2 \leq x \leq a_3 \\ \alpha_{\tilde{a}}\left(\frac{a_4-x}{a_4-a_3}\right) & if\ \ a_3 \leq x \leq a_4 \\ 0 & otherwise \end{cases} \tag{3}$$

$$I_{\tilde{a}}(x) = \begin{cases} \frac{(a_2-x+\theta_{\tilde{a}}(x-a_1))}{(a_2-a_1)} & if\ \ a_1 \leq \mathrm{x} \leq a_2 \\ \theta_{\tilde{a}} & if\ \ a_2 \leq \mathrm{x} \leq a_3 \\ \frac{(x-a_3+\theta_{\tilde{a}}(a_4-x))}{a_4-a_3} & if\ \ a_3 \leq \mathrm{x} \leq a_4 \\ 1 & otherwise \end{cases} \tag{4}$$

$$\boldsymbol{F_{\tilde{a}}(x)} = \begin{cases} \frac{(\boldsymbol{a_2-x+\beta_{\tilde{a}}(x-a_1)})}{(\boldsymbol{a_2-a_1})} & \boldsymbol{if\ \ a_1 \leq \mathrm{x} \leq a_2} \\ \boldsymbol{\beta_{\tilde{a}}} & \boldsymbol{if\ \ a_2 \leq \mathrm{x} \leq a_3} \\ \frac{(\boldsymbol{x-a_3+\beta_{\tilde{a}}(a_4-x)})}{\boldsymbol{a_4-a_3}} & \boldsymbol{if\ \ a_3 \leq \mathrm{x} \leq a_4} \\ \boldsymbol{1} & \boldsymbol{otherwise} \end{cases} \tag{5}$$

where $\boldsymbol{\alpha_{\tilde{a}}}, \boldsymbol{\theta_{\tilde{a}}}$ **and** $\boldsymbol{\beta_{\tilde{a}}}$ denote the maximum truth-membership degree, minimum indeterminacy-membership degree, and minimum falsity-membership degree, respectively. A single-valued trapezoidal neutrosophic number $\boldsymbol{\tilde{a} = \langle (a_1, a_2, a_3, a_4); \alpha_{\tilde{a}}, \theta_{\tilde{a}}, \beta_{\tilde{a}} \rangle}$, according to [11], may express an ill-defined quantity about a, which is approximately equal to [a_2, a_3].

From the theory about the single-valued trapezoidal neutrosophic numbers, [12], they propose the theory of the neutrosophic PERT method, in which, they define the three-time estimates for activity duration as *Optimistic time* ($\tilde{a}$); *Pessimistic time* ($\tilde{b}$) and *Most likely* time, ie Mode ($\tilde{m}$). Where$\tilde{a}$,, $\tilde{m}$ are trapezoidal neutrosophic numbers. Then, based on three-time estimates ($\tilde{a}$, $\tilde{b}$,$\tilde{}$), expected time and standard deviation of each activity should be calculated, and to do this, we should first obtain crisp values of the three-time estimates.

To obtain the crisp values of each estimated time, we use the score function $\left(S(\tilde{a})\right)$ and accuracy function $\left(A(\tilde{a})\right)$, as follows [11]:

$$Score\ function\ \ S(\tilde{a}) = \left(\frac{1}{16}\right)[a_1 + a_2 + \ a_3 + a_4]x[\alpha_{\tilde{a}} + (1 - \theta_{\tilde{a}}) + (1 - \beta_{\tilde{a}})] \tag{6}$$

$$\boldsymbol{Accuracy\ function\ \ A(\tilde{a}) = \left(\frac{1}{16}\right)[a_1 + a_2 + \ a_3 + a_4]x[\alpha_{\tilde{a}} + (1 - \theta_{\tilde{a}}) + (1 + \beta_{\tilde{a}})]} \tag{7}$$

With the crisp values for each time estimated (a, m, and b), by using the score function, the expected time and standard deviation of each activity can be calculated by using (1) and (2), respectively.

For the management of the computer system project, the activities proposed by [5] are shown in table 1.

N.	Task title
1	Beginning of the project implementation
2	Meeting with a customer
3	Investigating the subject area
4	Designing class models and basic algorithms
5	Developing the modules of the software system
6	Module Testing
7	Interface design and development
8	Testing and Debugging
9	Presenting software to a customer
10	Writing software documentation
11	Project Completion

Table 1. Tasks defined for the IT system project

The temporal relationship between the activities in Table 1, represented by the project network, is illustrated in Figure 1.

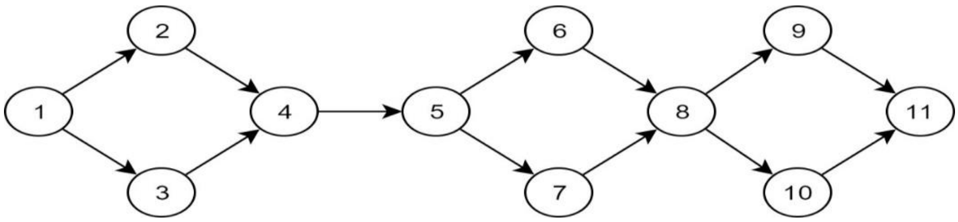

Figure 1. Project network. Source: [5]

On the other hand, the trapezoidal neutrosophic numbers proposed by [12] and which are listed below will be applied.:

$\tilde{1} = \langle (0,2,4,5));\ 0.8,0.6,0.4\rangle;\ \tilde{2} = \langle (1,3,5,6));\ 0.2,0.3,0.5\rangle; \tilde{3} = \langle (1,2,5,6));\ 0.2,0.5,0.6\rangle$
$\tilde{4} = \langle (1,2,5,7));\ 0.5,0.4,0.9\rangle; \tilde{5} = \langle (2,4,7,10));\ 0.8,0.2,0.4\rangle; \tilde{6} = \langle (3,7,9,12));\ 0.7,0.2,0.5\rangle$
$\tilde{7} = \langle (5,8,9,13));\ 0.4,0.6,0.8\rangle; \tilde{8} = \langle (1,6,10,13));\ 0.9,0.1,0.3\rangle; \tilde{9} = \langle (6,8,10,15));\ 0.6,0.4,0.7\rangle$
$\widetilde{10} = \langle (1,6,11,15));\ 0.7,0.6,0.3\rangle; \widetilde{11} = \langle (5,8,15,20));\ 0.8,0.2,0.5\rangle; \widetilde{12} = \langle (4,8,17,25));\ 0.3,0.6,0.4\rangle$

The elements exposed up to here were applied in correspondence with the working algorithm proposed by [12]:

- We considered three-time estimates of the PERT technique as a single-valued trapezoidal neutrosophic number to deal with uncertain, inconsistent, and incomplete information about activity time.
- Calculate membership functions of each single-valued trapezoidal neutrosophic number, using equations 1, 2, and 3.
- Obtain the crisp model of PERT three-time estimates using the score function equation as we illustrated previously.
- Use crisp values of three-time estimates to calculate the expected time and standard deviation of each activity.
- Draw a PERT network diagram.
- Determine floats and critical path, which is the longest path in the network, as we illustrated previously with details.
- Calculate the expected time and variance of the critical path.
- Determine expected project completion time.

2 Results

From the application of the trapezoidal neutrosophic numbers listed at the end of the previous section, the duration of the computer system project activities was determined, which are shown in Table 2.

N	Task title	Duration (days) $\tilde{a}$	$\tilde{m}$	$\tilde{b}$
1	Beginning of the project implementation	0	0	0
2	Meeting with a customer	$\langle(0,2,4,5); 0.8,0.6,0.4\rangle$	$\langle(1,3,5,6); 0.2,0.3,0.5\rangle$	$\langle(1,2,5,6); 0.2,0.5,0.6\rangle$
3	Investigating the subject area	$\langle(1,2,5,6); 0.2,0.5,0.6\rangle$	$\langle(1,2,5,7)); 0.5,0.4,0.9\rangle$	$\langle(2,4,7,10); 0.8,0.2,0.4\rangle$
4	Designing class models and basic algorithms	$\langle(1,2,5,6); 0.2,0.5,0.6\rangle$	$\langle(2,4,7,10); 0.8,0.2,0.4\rangle$	$\langle(3,7,9,12); 0.7,0.2,0.5\rangle$
5	Developing the modules of the software system	$\langle(1,6,10,13); 0.9,0.1,0.3\rangle$	$\langle(6,8,10,15)); 0.6,0.4,0.7\rangle$	$\langle(4,8,17,25)\ 0.3,0.6,0.4\rangle$
6	Module Testing	$\langle(2,4,7,10); 0.8,0.2,0.4\rangle$	$\langle(5,8,9,13); 0.4,0.6,0.8\rangle$	$\langle(6,8,10,15); 0.6,0.4,0.7\rangle$
7	Interface design and development	$\langle(1,3,5,6); 0.2,0.3,0.5\rangle$	$\langle(1,2,5,7); 0.5,0.4,0.9\rangle$	$\langle(2,4,7,10); 0.8,0.2,0.4\rangle$
8	Testing and Debugging	$\langle(1,2,5,6); 0.2,0.5,0.6\rangle$	$\langle(1,2,5,7)); 0.5,0.4,0.9\rangle$	$\langle(3,7,9,12); 0.7,0.2,0.5\rangle$
9	Presenting software to a customer	$\langle(0,2,4,5); 0.8,0.6,0.4\rangle$	$\langle(1,3,5,6); 0.2,0.3,0.5\rangle$	$\langle(1,2,5,6); 0.2,0.5,0.6\rangle$
10	Writing software documentation	$\langle(1,3,5,6); 0.2,0.3,0.5\rangle$	$\langle(1,2,5,6); 0.2,0.5,0.6\rangle$	$\langle(2,4,7,10); 0.8,0.2,0.4\rangle$
11	Project Completion	0	0	0

Table 2. Input data for neutrosophic PERT

Using the scoring function (6), the estimated times for each activity were obtained, shown in Table 3, together with the immediate predecessors of each activity.

N.	Task title	Immediate Predecessors (Activity number)	Duration (days) a	m	b
1	Beginning of the project implementation	-	0	0	0
2	Meeting with a customer	1	1.31	0.96	1.31
3	Investigating the subject area	1	1.12	3.16	1.12

4	Designing class models and basic algorithms	2.3	3.16	3.87	3.16
5	Developing the modules of the software system	4	3.66	4.39	3.66
6	Module Testing	5	2.19	3.66	2.19
7	Interface design and development	5	1.12	3.16	1.12
8	Testing and Debugging	6.7	1.12	3.87	1.12
9	Presenting software to a customer	8	1.31	0.96	1.31
10	Writing software documentation	8	0.96	3.16	0.96
11	Project Completion	9.10	0	0	0

Table 3. Three-time estimated crisp numbers for activities

By applying (1) and (2), the meantime and the variance of the duration of the activities were obtained. In figure 2, the project network is shown with the estimated average times of each activity.

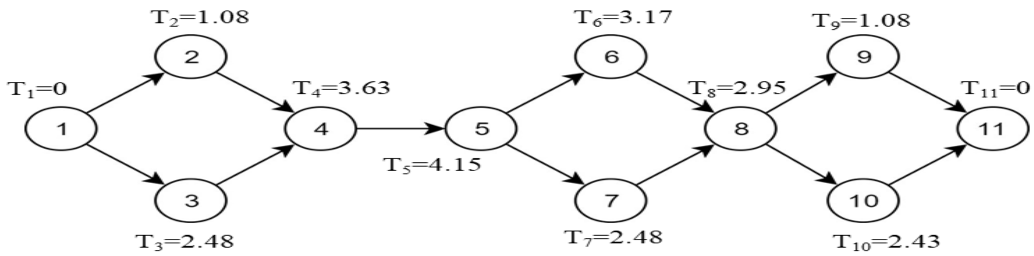

Figure 2. Estimated time network

Applying specialized software for project management, it was possible to estimate a minimum duration for the computer system development project of 19.86 days. Likewise, the critical path shown in figure 3 could be obtained.

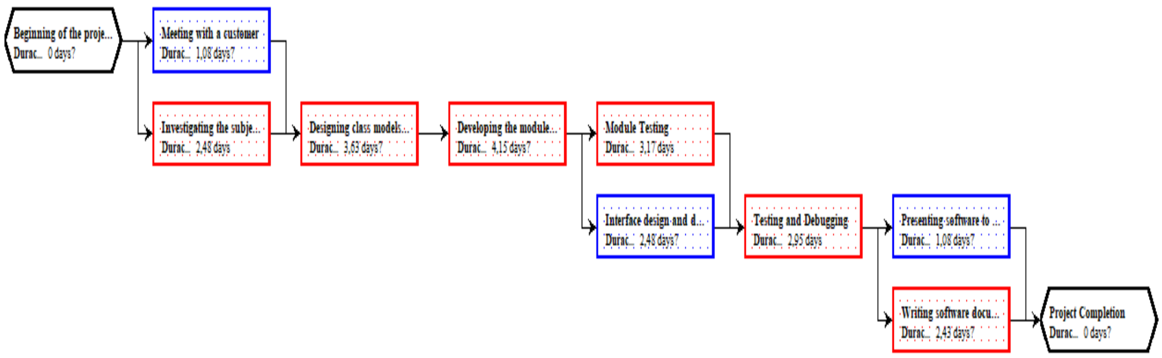

Figure 3. Project Critical path

As can be seen in Figure 3, the critical activities of the project, ie those that significantly affect the completion of this project, are the following: Investigating the subject area; Designing class models and basic algorithms; Developing the modules of the software system; Module Testing; Testing and Debugging and Writing software documentation.

Conclusions

With the application of the neutrosophic PERT method, it was possible to calculate the estimated time of completion of the project (19.81 days), from indeterminate values of the three classical times of the PERT method. This was made possible by applying for trapezoidal neutrosophic numbers. This type of number allows handling 4 components for each time and their respective functions of belonging to the specified sets. Hence it is important for project management, in inconsistent or ambiguous information environments.

The neutrosophic PERT method is a very useful tool, which can be generalized to any type of project that you want to manage or undertake, although it can be stated that it has proven efficiency in the management of computer projects, in which vagueness tends to abound. When estimating the completion of a task, due to the complexities inherent in the art of programming.

Although the problem of software development is widely discussed in academic articles, some specific issues related to the management of software development projects may be of interest for future research.

5 References

[1] Abdel-Basset, M., Mohamed, M. & Sangaiah, AKJ (2017). Ambient Intell Human Comput. DOI: https://doi.org/10.1007/s12652-017-0548-7.

[2] Chaves Castelblanco, LF, & Espitia Poveda, JC (2017). Automation of reports for PERT-CPM project management. Retrieved from:http://alejandria.poligran.edu.co/handle/10823/1605

[3] Chanas, S., & Zieliński, P. (2001). Critical path analysis in the network with fuzzy activity times. Fuzzy sets and systems, 122 (2), 195-204.

[4] El-Hefenawy, N., Metwally, MA, Ahmed, ZM, & El-Henawy, IM (2016). A Review on the Applications of Neutrosophic Sets. Journal of Computational and Theoretical Nanoscience, 13 (1), 936-944.

[5] Evdokimov, IV, Tsarev, RY, Yamskikh, TN, & Pupkov, AN (2018). Using PERT and Gantt charts for planning software projects on the basis of distributed digital ecosystems. In Journal of Physics: Conference Series (Vol. 1074, No. 1, p. 012127). IOP Publishing.

[6] Habibi, F., Birgani, O., Koppelaar, H., & Radenović, S. (2018). Using fuzzy logic to improve the project time and cost estimation based on Project Evaluation and Review Technique (PERT). Journal of Project Management, 3 (4), 183-196.

[7] Hapke, Maciej, Jaszkiewicz, Andrzej, & Slowinski, Roman. (1994). Fuzzy project scheduling system for software development. Fuzzy sets and systems, 67 (1), 101-117.

[8] Hezam, IM, Abdel-Baset, M., Smarandache, F. (2015). Taylor Series Approximation to Solve Neutrosophic Multiobjective Programming Problem. In: Neutrosophic Sets and Systems. An International Journal in Information Science and Engineering, Vol. 10, pp. 39-45.

[9] Hillier, F., & Lieberman, G. (2015). Introduction to Operations Research (Internatio).

[10] Kemamine, N., & Bousalmi, SEI (2017). Project management for the method of PERT probabiliste Cas d'étude: cover du doublement d'une route nationale par l'entreprise STARR (Doctoral dissertation). Retrieved from:http://dspace.univ-tlemcen.dz/handle/112/11540

[11] Mohamed, Mai, et al. (2017). Neutrosophic Integer Programming Problem. Neutrosophic Sets & Systems 15

[12] Mohamed, M., Abdel-Basset, M., Hussien, AN, & Smarandache, F. (2017). Using neutrosophic sets to obtain PERT three-times estimates in project management. Infinite Study.

[13] Leyva-Vázquez, M. (2018) Neutrosophy: New advances in the treatment of the uncertainty (In Spanish), Pons, Brussels.

[14] C. E. Herrera Cucaita and J. R. Noreña Angel, "Implementación de un módulo de gestión de proyectos para el sistema AS/400," 2016.

[15] A. D. M. Manzano, J. Y. V. Villegas, L. M. O. Escobar, and L. T. Jiménez, "Neutrosophic Analysis of the Facultative Vote in the Electoral Process of Ecuador," Neutrosophic Sets and Systems, vol. 37, pp. 355-360, 2020.

[16] P. A. Mena Silva, A. Romero Fernández, and L. A. Granda Macías, "Neutrosophic Statistics to Analyze Prevalence of Dental Fluorosis," Neutrosophic Sets and Systems, vol. 37, pp. 160-168, 2020.

[17] I. Pimienta Concepción, E. Mayorga Aldaz, L. Gabriel Flores, and E. González Caballero, "Neutrosophic Scale to Measure Psychopathic Personalities Based on Triple Refined Indeterminate Neutrosophic Sets," Neutrosophic Sets and Systems, vol. 37, pp. 61-70, 2020.

[18] P. A. M. Silva, A. R. Fernández, and L. A. G. Macías, "Neutrosophic Statistics to Analyze Prevalence of Dental Fluorosis," Neutrosophic Sets and Systems, vol. 37, pp. 160-168, 2020.

Received: March 13, 2021. Accepted: May 8, 2021