NSS
Neutrosophic Sets and Systems, Vol. 47, 2021
University of New Mexico

Impacts of the adoption of teleworking by university professors during the COVID-19 health emergency

Eduardo Andrés Guzmán Barquet [1], María Belén Salazar Raymond [2], and Daniel Eduardo Guevara Sánchez [3]
[1]University of Guayaquil, Guayaquil - Ecuador. E-mail: eduardo.guzmanb@ug.edu.ec
[2]Catholic University of Santiago de Guayaquil - Ecuador. E-mail: maria.salazar02@cu.ucsg.edu.ec
[3]Pontifical Catholic University of Peru, CENTRUM. E-mail: dguevaras@pucp.pe

Abstract. The objective of this research was to identify the main impacts of the adoption of teleworking by university professors during the COVID-19 health emergency, as a mandatory work modality for the continuation of the teaching-learning process of higher education in Ecuador. With this objective, surveys were used as a primary information collection method, as well as multi-criteria decision methods to determine the elements with the greatest impact. The insights derived from neutrosophy were applied to eliminate the indeterminacies inherent in decision-making in real-world problems. Among the greatest dissatisfactions detected are poor time management, high personal economic investment to acquire the necessary means to carry out teleworking, high levels of work stress and the increase in unfavorable medical conditions associated with it, as well as the conflict between work life and family life for the teacher. Multi-criteria decision methods were applied to support the selection of solutions to complex problems. An action plan was elaborated in accordance with the main deficiencies found according to the methods as well as a system of priorities according to the causal relationships between the elements evaluated. Multi-criteria decision methods were applied to support the selection of solutions to complex problems.

Keywords*:* telework, impact, TOPSIS, DEMATEL, neutrosophic, professor, university.

Introduction

Until March 2019, in Ecuador, about 3.1 million people had adequate/full employment, that is, with an income equal to or greater than the minimum wage, according to the National Institute of Statistics and Censuses INEC (2019). As of the health emergency declared due to COVID-19, 253 247 workers began to work from home, which corresponds to 8% [2]. The servers that are performing the functions of teachers in educational institutions of the country under any work modality, must carry out the mandatory registration of activities in the teleworking system, through a virtual form that will allow the teacher to record their activities or products made during the COVID 19 health emergency. It must be filled out once the weekly workday is over.

One of the premises of the university teacher is that he must have the technological support to teach face-to-face classes in the new higher education and, in most of the research carried out, it is found that the use of information and communication technologies (ICTs) occurs to a high degree. Therefore, it can be assumed that teaching online or virtually should not affect the teacher when teaching classes in the new modality, since only the presence of the classroom is transferred to the video conference. However, the reality regarding the adaptation of the university teacher to the 'teleworking' modality was different, due to the very nature of teleworking and more related to teaching activities.

Important points at the socioeconomic level to consider in this abrupt change of adaptation to online education by university teachers are: (1) the availability of electronic devices of correct quality for the teaching-learning process in this new study modality ; (2) Internet access with an adequate range to avoid connection problems (minimize the risk of slowness or failures); and (3) the training required for the use of the various platforms and computer programs required for the aforementioned teaching-learning process.[3,4]. The aforementioned points depend on the level of demand of each higher education institution to which the university professors belong since their academic authorities will determine the resources selected for the training of their students. On the other hand, at the psychosocial level, aspects related to stress, work overload, problems related to health and rest, difficulties in reconciling work and family should be considered.

In accordance with Diaz et al. (2020), the confinement due to the COVID-19 health emergency has caused serious impacts on the academic performance of university students, as well as the impact on the performance of the teacher, their emotional state and social interaction, the reduction of their level of physical exercise, problems economic. These impacts have triggered an increase in sedentary lifestyle, stress and anxiety, symptoms of impatience and intolerance [6]. Due to the global pandemic, university professors have had to re-accommodate, reinvent and adapt to the management of ICT as a mandatory resource for teaching classes. [7]. These abrupt adjustments made by the higher education teacher have affected them physically, psychologically, economically, and socially. [6].

In this investigation, the problem described above is addressed, taking as a population the teachers of the Faculty of Administrative Sciences of the University of Guayaquil, during cycle I of the year 2020 to determine the main deficiencies perceived by teachers in terms of the activity of teleworking. To do this, surveys are used as a primary information collection method, as well as multi-criteria decision methods to determine the elements with the greatest impact. In correspondence with the elements to be treated, the elaboration of an action plan is foreseen that promotes an optimal experience of teleworking for the teacher of the analyzed center.

For the current study, the contributions made by neutrosophy and neutrosophic sets are applied. Neutrosophy is the branch of philosophy that studies the origin, nature, and scope of neutralities [8], so the incorporation of the neutrosophic sets guarantees that the uncertainty of decision-making, including indeterminacies, is taken into account during the analysis to be carried out [9].

Preliminaries

Definition 1. Let X be a space of points (objects) with generic elements in X denoted by x. A single-valued neutrosophic set (SVNS) A in X is characterized by truth-membership function TA (x), indeterminacy-membership function IA (x), and falsehood membership function FA (x). Then, an SVNS A can be denoted by A = {x, TA(x), IA(x), FA(x) x ∈ X}, where TA (x), IA (x), FA (x) ∈ [0.1] for each point x in X. Therefore, the sum of TA (x), IA (x) and FA (x) satisfies the condition $0 \leq TA(x) + IA(x) + FA(x) \leq 3$.[10]

For convenience, a SVN number is denoted by A = $(a\ b\ c)$, where a,b,c ∈ [0,1] and $a + b + c \leq 3$

Definition 2. Let A = (a,b,c) be an SVN number and an arbitrary positive real number, then:

$$\lambda A = \left(1 - (1 - a)^{\lambda}, b^{\lambda}, c^{\lambda}\right), \lambda > 0 \quad (1)$$

Definition 3. Let $A^* = \{A_1^*, A_2^*, \dots, A_n^*\}$ be a vector of n SVN numbers, such that Aj* = (aj*,bj*,cj*) (j= 1,2,…,n), and (i= 1,2,…,m), (j= 1,2,…,n). Then the separation measure between Bi and A^* based on Euclidian distance is defined as follows:

$$s_i = \left(\frac{1}{3}\sum_{j=1}^{n}\left(\left|a_{ij} - a_j^*\right|\right)^2 + \left(\left|b_{ij} - b_j^*\right|\right)^2 + \left(\left|c_{ij} - c_j^*\right|\right)^2\right)^{\frac{1}{2}} \quad (2)$$

(i= 1,2,…,m)

Definition 4. Let $A = \{A_1, A_2, \dots, A_n\}$ be a set of n SVN numbers, where Aj = (aj,bj,cj) (j= 1,2,…,n). The single value neutrosophic weighted average operator on them is defined by

$$\sum_{j=1}^{n}\lambda_j A_j = \left(1 - \prod_{j=1}^{n}\left(1 - a_j\right)^{\lambda_j}, \prod_{j=1}^{n} b_j^{\lambda_j}, \prod_{j=1}^{n} c_j^{\lambda_j}\right) \quad (3)$$

Where λ_j is the weight of A_j (j= 1,2,…,n), $\lambda_j \in [0,1]$ and $\sum_{j=1}^{n}\lambda_j = 1$

Next, we proposed a score function for ranking SVN numbers as follows:

Definition 5. Let A = (a,b,c) be a single-valued neutrosophic number, a score function S of a single-valued neutrosophic value, based on the truth-membership degree, indeterminacy-membership degree, and falsehood membership degree is defined by

$$S(A) = \frac{1+a-2b-c}{2} \quad (4)$$

where $S(A) \in [-1,1]$

The score function S is the reduced score function proposed by Li (2005) if b = 0 and $a + b \leq 1$.

The value of a linguistic variable is expressed as an element of its term set. The concept of a linguistic variable is very useful for solving decision-making problems with complex content. For example, we can express the performance ratings of alternatives on qualitative attributes by linguistic variables such as very important, important, medium, unimportant, very unimportant, etc. Such linguistic values can be represented using single-valued neutrosophic numbers.

In the method, there are k decision-makers, m-alternatives, and n-criteria. k decision-makers evaluate the importance of the m-alternatives under n-criteria and rank the performance of the n-criteria with respect to linguistic statements converted into single-valued neutrosophic numbers. Here, the decision-makers often use a set of weights such that W ={very important, important, medium, unimportant, very unimportant} and the importance weights based on single-valued neutrosophic values of the linguistic terms is given as Table 1.

Table 1: Linguistic variable and Single Valued Neutrosophic numbers

Integer	linguistic variable	svn numbers
0	No influence / Not important	(0.1,0.8,0.9)
1	Low influence/important	(0.35,0.6,0.7)
2	Medium influence/important	(0.5,0.4,0.45)
3	High influence/important	(0.8,0.2,0.15)
4	Very high influence/important	(0.9,0.1,0.1)

Note: Source:[12]

Definition 8 ([12], [13]) Deneutrosophication of SVNS Ñ can be defined as a process of mapping Ñ into a single crisp output for x f: Ñ $\rightarrow \psi^* \in$ X. If Ñ is discrete set then the vector of tetrads Ñ = {(x | TÑ(x), IÑ(x), FÑ(x)) | x ∈ X} is reduced to a single scalar quantity ψ∗∈X by deneutrosophication. The obtained scalar quantity ψ∗∈X best represents the aggregate distribution of three membership degrees of neutrosophic element TÑ (x), IÑ (x), FÑ (x). Therefore, the deneutrosophication can be obtained as follows.

$$\psi^* = 1 - \sqrt{[(1 - T_k(x))^2 + (I_k(x))^2 + (\mathrm{F}(x))^2]/3} \quad (5)$$

TOPSIS METHOD

The TOPSIS method for SVNS used consists of the following:
Assuming that is $\mathrm{A} = \{\rho_1, \rho_2, \dots, \rho_m\}$ a set of alternatives and $\mathrm{G} = \{\beta_1, \beta_2, \dots, \beta_n\}$ is a set of criteria, the following steps will be carried out:

Step 1: Determine the relative importance of the experts. For this, the specialists evaluate according to the linguistic scale that appears in Table 1, and the calculations are made with its associated single value neutrosophic number (SVNN), let's call $A_t = (a_t, b_t, c_t)$ bt the SVNS corresponding to the t-th decision-maker (t = 1, 2, …, k). The weight is calculated by the following formula:

$$\delta_t = \frac{a_t + b_t\left(\frac{a_t}{a_t + c_t}\right)}{\sum_{t=1}^{k} a_t + b_t\left(\frac{a_t}{a_t + c_t}\right)} \quad (6)$$

$$\delta_t \geq 0 \; and \; \sum_{t=1}^{k} \delta_t = 1$$

Step 2: Construction of the aggregate single value neutrosophic decision matrix. This matrix is defined by $D = \sum_{t=1}^{k} \lambda_t D^t$, where $d_{ij} = (u_{ij}, r_{ij}, v_{ij})$ and is used to aggregate all the individual evaluations; d_{ij} is calculated as the aggregation of the evaluations given by each expert $(u_{ij}^t, r_{ij}^t, v_{ij}^t)$, using the weights λ_t of each one with the help of Equation 1. In this way, a matrix $D = (d_{ij})_{ij}$ is obtained, where each d_{ij} is a SVNN (i = 1,2,..., m; j = 1,2,..., n).

Step 3: Determination of the Weight of the Criteria. Suppose that the weight of each criterion is given by W = $(w_1, w_2, \dots, w_n)$, where w_j denotes the relative importance of the criterion $\lambda_t w_j^t = (a_j^t, b_j^t, c_j^t)$. If it is the evaluation of the criterion by the t-th expert. Equation 2 is then used to add the $w_j^t$with the weights λ_t.

Step 4: Construction of the weighted mean of single values neutrosophic decision matrix regarding the criteria.

$$D^* = D * W, \quad (7)$$

$$where \; d_{ij} = (a_{ij}, b_{ij}, c_{ij})$$

Step 5: Calculation of the positive and negative SVNN ideal solutions.

The criteria can be classified as cost-type or benefit-type. Let G1 be the set of benefit-type criteria and G2 be the cost-type criteria. The ideal alternatives will be defined as follows:

The positive ideal solution, corresponding to G1.

$$\rho^+ = a_{\rho+w}(\beta_j), b_{\rho+w}(\beta_j), ac_{\rho+w}(\beta_j) \quad (8)$$

The negative ideal solution, corresponding to G2.

$$\rho^- = (a_{\rho-w}(\beta_j), b_{\rho-w}(\beta_j), ac_{\rho-w}(\beta_j)) \quad (9)$$

Where:

$$a_{\rho+w}(\beta_j) = \begin{cases} max_i a_{\rho iw}(\beta_j), si \; j \epsilon G_1 \\ min_i a_{\rho iw}(\beta_j), si \; j \epsilon G_2, \end{cases} \qquad a_{\rho-w}(\beta_j) = \begin{cases} min_i a_{\rho iw}(\beta_j), si \; j \epsilon G_1 \\ max_i a_{\rho iw}(\beta_j), si \; j \epsilon G_2, \end{cases}$$

$$b_{\rho+w}(\beta_j) = \begin{cases} max_i b_{\rho iw}(\beta_j), si \; j \epsilon G_1 \\ min_i b_{\rho iw}(\beta_j), si \; j \epsilon G_2, \end{cases} \qquad b_{\rho-w}(\beta_j) = \begin{cases} min_i b_{\rho iw}(\beta_j), si \; j \epsilon G_1 \\ max_i b_{\rho iw}(\beta_j), si \; j \epsilon G_2, \end{cases}$$

$$c_{\rho+w}(\beta_j) = \begin{cases} max_i c_{\rho iw}(\beta_j), si \; j \epsilon G_1 \\ min_i c_{\rho iw}(\beta_j), si \; j \epsilon G_2, \end{cases} \qquad c_{\rho-w}(\beta_j) = \begin{cases} min_i c_{\rho iw}(\beta_j), si \; j \epsilon G_1 \\ max_i c_{\rho iw}(\beta_j), si \; j \epsilon G_2, \end{cases}$$

Step 6: Calculation of the distances to the positive and negative SVNN ideal solutions.

With the help of Equation 3, the following Equations are calculated:

$$d_i^+ = \left(\frac{1}{3}\sum_{j=1}^{n}\left\{\left(a_{ij} - a_j^+\right)^2 + \left(b_{ij} - b_j^+\right)^2 + \left(c_{ij} - c_j^+\right)^2\right\}\right)^{\frac{1}{2}} \quad (10)$$

$$d_i^- = \left(\frac{1}{3}\sum_{j=1}^{n}\left\{\left(a_{ij} - a_j^-\right)^2 + \left(b_{ij} - b_j^-\right)^2 + \left(c_{ij} - c_j^-\right)^2\right\}\right)^{\frac{1}{2}} \quad (11)$$

Step 7: Calculation of the Proximity Coefficient (CP).

The CP of each alternative is calculated with respect to the positive and negative ideal solutions.

$$\widetilde{\rho_j} = \frac{s^-}{s^+ + s^-} \quad (12)$$

Where $0 \leq .\widetilde{\rho_j} \leq 1$

Step 8: Determining the order of the alternatives.

They are ordered according to what was achieved by $\widetilde{\rho_j}$ The alternatives are ordered from highest to lowest, with the condition that $\widetilde{\rho_j} \rightarrow 1$ is the optimal solution.

DEMATEL METHOD

To determine the causal relationships between the elements determined to have the greatest negative impact of teleworking, the use of the DEMATEL method in its neutrosophic variant is proposed through the steps set out below.[14]

1. *Identify the elements to evaluate*: The influential factors or elements are evaluated by the selected experts through paired comparisons, using the score shown in Table 1.
2. *Determine the relative importance of the experts:* Each of the selected experts has his importance value, based on their level of experience and knowledge of the decision problem. Therefore, the weight of each decider may be different from that of other deciders. The weight given to each of the t decision-makers are considered linguistic variables and are transmitted in SVNN Et = (Tt , It , Ft) to later be identified using equation 13.

$$\psi_t = \frac{1-\sqrt{[(1-T_t)^2+(I_t)^2+(\mathrm{F}_t)^2]/3}}{\sum_{t=1}^{p}\sqrt{[(1-T_t)^2+(I_t)^2+(\mathrm{F}_t)^2]/3}} \quad (13)$$

3. *Convert the linguistic evaluations given by the experts in SVNN:* From the individual sharp integer matrices obtained from the experts' evaluations, the individual neutrosophic matrices of the decision-makers are constructed according to what is indicated in Table 1.
4. *Obtain the initial direct relationship matrix:* To obtain the initial direct relationship matrix that is in the form of sharp numbers, the neutrosophic matrices of the individual decision-makers must be added using equation 3 and deneutrosophied using equation 5.
5. *Identify cause-effect relationships between factors using the DEMATEL method*: Based on the aggregate direct relationship matrix A obtained in step 4, the total relationship matrix T can be easily calculated using equations (14-16) as shown below:

   D=A*S (14)

   Where

$$S = \frac{1}{\max\limits_{l\leq i\leq \mathrm{n}} \sum_{j=1}^{n} a_{ij}} \quad (15)$$

   Y

   T= D*(ID)-1 (16)

   where I is the identity matrix. From this, the cause-effect relationship diagram (ri + ci, ri −ci) is constructed.
6. *Analyze the cause-effect relationship diagram.* The (ri −ci) indicates the importance of each factor while (ri −ci) is the net cause or effect group. The (ri+ci) is called "Prominence" and it measures the degree of the central role played by the factor or criterion within the system. While (ri −ci): it is called "Relationship" and means the effect produced by the factor or criterion in the system. If (ri −ci) >0, the factor or criterion is located in the group of causes. If (ri −ci) <0, the factor or criterion is located in the group of effects. The pairs (ri −ci) and (ri +ci) can be represented graphically to give decision-makers a graphic idea about the system.

METHODOLOGY

The segment under study was the university professors of the Faculty of Administrative Sciences of the University of Guayaquil, during the second semester of 2020. For the collection of primary information, a questionnaire of mostly multiple-choice questions was used, validated by experts in the specific area. A simple random sample was applied to finite populations, applying a confidence level of 95%, resulting in a sample of 60 teachers.

For the collection of information through the questionnaire, the survey was prepared digitally, and later it was distributed through electronic means so that the teachers of the Faculty of Administrative Sciences could answer it. The questionnaire consists of 31 questions that address demographic, psychographic, and socioeconomic areas of the impact of teleworking on the teachers analyzed.

RESULTS

Questionnaire applied to the sample population

A query was made about the place where they telecommute and 93% of those surveyed indicated that they do it from home, which implies that there is an interaction between their work and family life in carrying out their new

work modality. The difficulty in the adaptation process for teleworking was asked about, and 42% of those surveyed rated the process as difficult and very difficult, while 38% showed a neutral status in their response.
When asked about the number of hours they invest in this new work modality carried out from their homes, 47% responded that they spend more than 10 hours per day, which implies a work overload. 22% responded from 8 to 10 hours per day. Regarding the days for the dictation of the classes and the other management activities that university professors must carry out, answers indicate that 75% develop it in the night shift, 80% in the evening shift, and 88% during the daytime, which implies that the majority of teachers are immersed in more than one working day during this time of teleworking due to the COVID-19 health emergency.
Regarding the economic section for carrying out the activities in online and telematic mode, it was asked if they previously had the technological infrastructure to carry out the activities from their home, 65% answered yes while 35% did not. Next, they were asked if they had to invest in telematic tools and technological equipment to properly carry out activities from home, 67% answered yes and 33% no. Regarding the approximate amount that they invested to improve the infrastructure of their home for telematic activities, 45% responded in the range of $500 to $1,500 dollars, 28% less than $500 dollars and 27% chose a range greater than $1,500 up to $3000 dollars. It was also consulted about the equipment that teachers use the most to carry out their teaching activities in virtuality,

Analysis of the main deficiencies

The information obtained from the application of the questionnaire to the sampled teachers allowed obtaining an important basis to determine the impact of teleworking in this population. After obtaining and classifying the elements returned by the questionnaire, the working group agrees to carry out the analysis of those elements that negatively affect the implementation of teleworking in the center, based on the experiences of the teachers surveyed. For this, the following elements will be taken as analyses:

- Poor time management
- High personal financial investment to acquire the necessary means to carry out teleworking
- High levels of work stress and an increase in unfavorable medical conditions associated with it
- Conflict between work life and family life for the teacher
- Increased physical discomfort and muscle pain
- Decrease in teaching performance due to the digital gap between teacher and student
- Decrease in the quality of the learning process and educational teacher
- Decreased level of emotional intelligence of the individual due to social isolation
- Decreased cognitive level and concentration to perform tasks

The evaluation of the aforementioned aspects is carried out by a group of 5 teachers with extensive experience in teaching and teleworking, three of them with important publications on some of its effects in various professional areas; Therefore, it is assumed that the individual contribution of each one to the evaluations to be carried out for the execution of the method is of the highest importance according to the linguistic values shown in table 1.
To determine the most influential aspects according to the applied questionnaire, the levels of influence on the physical (C1), emotional (C2), economic C3, social C4, and professional (C5) health of the teacher will be taken as evaluation criteria.
In this sense, table 2 shows the aggregate decision matrix obtained after obtaining the evaluations of each of the aspects evaluated based on the selected criteria.

Table 2: *Aggregate decision matrix*

Aspects to evaluate	C1	C2	C3	C4	C5
Poor time management	(0.629,0.371,0.325)	(0.856,0.144,0.132)	(0.35,0.75,0.8)	(0.792,0.208,0.174)	(0.88,0.12,0.115)
High personal financial investment to acquire the necessary means to carry out teleworking	(0.856,0.144,0.132)	(0.621,0.379,0.347)	(0.35,0.75,0.8)	(0.67,0.33,0.289)	(0.827,0.173,0.152)
High levels of work stress and an increase in unfavorable medical conditions associated with it	(0.88,0.12,0.115)	(0.81,0.19,0.19)	(0.621,0.379,0.347)	(0.827,0.173,0.152)	(0.75,0.25,0.2)
Conflict between work life and family life for the teacher	(0.725,0.275,0.251)	(0.713,0.287,0.24)	(0.5,0.5,0.5)	(0.792,0.208,0.174)	(0.621,0.379,0.347)
Increased physical discomfort and muscle pain	(0.834,0.166,0.158)	(0.517,0.512,0.502)	(0.415,0.638,0.663)	(0.67,0.33,0.289)	(0.415,0.638,0.663)

Decrease in teaching performance due to the digital gap between teacher and student	(0.583,0.417,0.365)	(0.517,0.512,0.502)	(0.35,0.75,0.8)	(0.35,0.75,0.8)	(0.67,0.33,0.289)
Decrease in the quality of the learning process and educational teacher	(0.289,0.711,0.711)	(0.383,0.692,0.728)	(0.383,0.692,0.728)	(0.35,0.75,0.8)	(0.713,0.287,0.24)
Decreased level of emotional intelligence of the individual due to social isolation	(0.5,0.5,0.5)	(0.556,0.483,0.459)	(0.415,0.638,0.663)	(0.67,0.33,0.289)	(0.415,0.638,0.663)
Decreased cognitive level and concentration to perform tasks	(0.67,0.33,0.289)	(0.5,0.5,0.5)	(0.383,0.692,0.728)	(0.621,0.379,0.347)	(0.75,0.25,0.2)

Taking into account the vector of weights obtained through the evaluations of the experts, shown in table 3, the weighted aggregate decision matrix is calculated, remaining as seen in table 4.

Table 1: *Vector of criteria weights*

Criterion	Criterion weight
physical impact	(0.855;0.144;0.131)
emotional impact	(0.855;0.144;0.131)
Economic impact	(0.760;0.239;0.209)
Social impact	(0.712;0.287;0.240)
Teaching performance	(0.855;0.144;0.131)

Table 2: *Weighted Aggregate Decision Matrix*

Alternatives	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5
poor time management	(0.538;0.461;0.414)	(0.73;0.26;0.246)	(0.266;0.809;0.841)	(0.564;0.435;0.372)	(0.753;0.246;0.231)
High personal financial investment to acquire the necessary means to carry out teleworking	(0.732;0.267;0.246)	(0.531;0.468;0.433)	(0.266;0.809;0.841)	(0.477;0.524;0.45)	(0.707;0.292;0.263)
High levels of work stress and an increase in unfavorable medical conditions associated with it	(0.753;0.246;0.231)	(0.693;0.306;0.296)	(0.472;0.527;0.483)	(0.589;0.410;0.355)	(0.641;0.358;0.305)
Conflict between work life and family life for the teacher	(0.620;0.379;0.349)	(0.610;0.389;0.340)	(0.380;0.619;0.604)	(0.564;0.435;0.372)	(0.531;0.468;0.433)
Increased physical discomfort and muscle pain	(0.713;0.286;0.26)	(0.441;0.582;0.567)	(0.315;0.724;0.733)	(0.477;0.522;0.459)	(0.355;0.690;0.707)
Decrease in teaching performance due to the digital gap between teacher and student	(0.498;0.501;0.448)	(0.442;0.582;0.567)	(0.266;0.809;0.841)	(0.249;0.821;0.848)	(0.573;0.426;0.382)
Decrease in the quality of the learning process and educational teacher	(0.247;0.752;0.749)	(0.327;0.736;0.763)	(0.291;0.765;0.784)	(0.249;0.821;0.848)	(0.610;0.389;0.340)
Decreased level of emotional intelligence of the individual due to social isolation	(0.427;0.572;0.565)	(0.475;0.557;0.530)	(0.315;0.724;0.733)	(0.477;0.522;0.459)	(0.355;0.690;0.707)
Decreased cognitive level and concentration to perform tasks	(0.573;0.426;0.382)	(0.427;0.572;0.565)	(0.291;0.765;0.784)	(0.442;0.557;0.503)	(0.641;0.358;0.305)

Finally, the order of the analyzed elements is shown in table 5, according to the calculated proximity coefficient.

Table 3: *Positive and negative ideal distances and proximity coefficient*

Alternatives	d+	d-	$\widetilde{\rho_j}$
poor time management	0.43	0.64	0.598
High personal financial investment to acquire the necessary means to carry out teleworking	0.45	0.49	0.519
High levels of work stress and an increase in unfavorable medical conditions associated with it	0.31	0.7	0.695
Conflict between work life and family life for the teacher	0.45	0.58	0.565
Increased physical discomfort and muscle pain	0.7	0.49	0.412
Decrease in teaching performance due to the digital gap between teacher and student	0.74	0.16	0.178
Decrease in the quality of the learning process and educational teacher	0.91	0.27	0.229
Decreased level of emotional intelligence of the individual due to social isolation	0.76	0.47	0.383
Decreased cognitive level and concentration to perform tasks	0.55	0.33	0.376

The analysis carried out indicates that the high levels of work stress, poor time management, the conflict between work life and family life for the teacher and the high personal financial investment to acquire the necessary means to carry out teleworking are the deficiencies. of greater significance associated with it according to the evaluation of our experts. The results obtained are consistent with the opinion expressed by the teachers in the surveys carried out. In this sense, the proposed action plan to reduce the negative effects associated with teleworking in the sample studied should be focused on solving the aspects previously indicated by the method as the most significant. See Table 6.

Table 4: *Action Plan proposed to mitigate the negative effects associated with teleworking according to the elements analyzed*

Deficiencies detected	Proposed averages
Poor time management Work overload	Establish, at the center level, schedule proposals to guide teachers on optimizing time management during teleworking
High personal financial investment to acquire the necessary means to carry out teleworking	Establish institutional mechanisms that allow a better investment in technological infrastructure to guarantee the adequate quality of the teaching process through teleworking Facilitate information technologies to teachers for the dictation of online classes
High levels of work stress and an increase in unfavorable medical conditions associated with it	Prepare periodic plans to control work stress with the help of qualified personnel for such purposes Provide consultation spaces for training on methods and techniques for the control of work stress
Conflict between work life and family life for the teacher	Establish orientation plans aimed at facilitating mastery of work activity from the domestic space Involve the family and the community in general to raise awareness about teleworking

To evaluate the level of priority to be given to the proposed action plan, the analysis of the causal relationships between the deficiencies analyzed is carried out. In this way, it seeks to determine those deficiencies that have a greater impact within the system or are influential or causal to others. To carry out this analysis, each expert evaluates the degree of influence between the elements analyzed by applying the linguistic values in Table 1. By applying equations 3 and 5, the direct relationship matrix is obtained, as shown in Figure 1.

$$A = \begin{bmatrix} 0.0000 & 0.5000 & 0.8788 & 0.8558 & 0.7655 & 0.5000 & 0.6376 & 0.8788 & 0.7655 \\ 0.4370 & 0.0000 & 0.2853 & 0.1925 & 0.5000 & 0.7655 & 0.5000 & 0.3403 & 0.2853 \\ 0.3908 & 0.6833 & 0.0000 & 0.8558 & 0.8788 & 0.5376 & 0.8558 & 0.8788 & 0.8284 \\ 0.4371 & 0.1925 & 0.2853 & 0.0000 & 0.7655 & 0.5000 & 0.8284 & 0.4604 & 0.8558 \\ 0.8026 & 0.1925 & 0.8026 & 0.2853 & 0.0000 & 0.1925 & 0.5000 & 0.5000 & 0.5000 \\ 0.8558 & 0.7655 & 0.4604 & 0.1925 & 0.6092 & 0.0000 & 0.8558 & 0.1925 & 0.5710 \\ 0.2853 & 0.2293 & 0.3403 & 0.1925 & 0.1925 & 0.7746 & 0.0000 & 0.2853 & 0.6588 \\ 0.2853 & 0.1925 & 0.7655 & 0.6833 & 0.7373 & 0.2853 & 0.3706 & 0.0000 & 0.4174 \\ 0.8788 & 0.1925 & 0.2853 & 0.5000 & 0.6833 & 0.2853 & 0.5000 & 0.5710 & 0.0000 \end{bmatrix}$$

Figure 1: *Matrix of direct relationship of the factors*

From this, the normalized initial direct relationship matrix D is obtained by using equations (14) and (15), as well as the total direct relationship matrix T, which can be calculated by using equation (16) as it's shown in the following:

$$T = \begin{bmatrix} 0.290 & 0.271 & 0.410 & 0.387 & 0.452 & 0.326 & 0.425 & 0.411 & 0.441 \\ 0.244 & 0.120 & 0.212 & 0.178 & 0.272 & 0.267 & 0.272 & 0.214 & 0.236 \\ 0.351 & 0.293 & 0.272 & 0.377 & 0.459 & 0.330 & 0.450 & 0.402 & 0.443 \\ 0.290 & 0.174 & 0.253 & 0.186 & 0.361 & 0.262 & 0.367 & 0.276 & 0.370 \\ 0.324 & 0.171 & 0.321 & 0.235 & 0.238 & 0.208 & 0.308 & 0.281 & 0.309 \\ 0.360 & 0.274 & 0.291 & 0.230 & 0.351 & 0.203 & 0.385 & 0.252 & 0.341 \\ 0.209 & 0.148 & 0.201 & 0.167 & 0.212 & 0.253 & 0.178 & 0.192 & 0.274 \\ 0.244 & 0.164 & 0.305 & 0.280 & 0.341 & 0.213 & 0.283 & 0.191 & 0.289 \\ 0.338 & 0.168 & 0.249 & 0.262 & 0.340 & 0.220 & 0.306 & 0.287 & 0.230 \end{bmatrix}$$

Figure 2: *Total Direct Relationship Matrix*

After obtaining the total direct relationship matrix, the direct and indirect effects of the elements indicated are determined by analyzing the prominence and relationship axes for the cause and effect group, as shown in Table 7.

Table 5: *Calculation of effects*

Elements to be evaluated	Ri	Ci	Ri+Ci	Ri-Ci
poor time management	3,414	2.65	6,064	0.764
High personal financial investment to acquire the necessary means to carry out teleworking	2015	1,784	3,799	0.231
High levels of work stress and an increase in unfavorable medical conditions associated with it	3,377	2,514	5,891	0.863
Conflict between work life and family life for the teacher	2,539	2,302	4,841	0.237
Increased physical discomfort and muscle pain	2,395	3,026	5,421	-0.631
Decrease in teaching performance due to the digital gap between teacher and student	2,687	2,282	4,969	0.405
Decrease in the quality of the learning process and educational teacher	1,834	2,974	4,808	-1.14
Decreased level of emotional intelligence of the individual due to social isolation	2.31	2,506	4,816	-0.196
Decreased cognitive level and concentration to perform tasks	2.4	2,933	5,333	-0.533

As can be seen from the analysis carried out, time management is the deficiency that has the greatest prominence within the system, followed by high levels of work stress. On the other hand, precisely these two deficiencies are the ones with a higher level in the relationship indicator, which indicates that these two deficiencies are the two elements with the greatest causality over the rest of the deficiencies, followed by the existing digital gap between teacher and student and the existence of conflicts between work life and family life.

The analysis carried out reveals that the priorities regarding the execution of the proposed action plan, as well as for the elaboration or projection of other measures to alleviate the existing situation, should be focused mainly on these two deficiencies since they are found within the group of the direct causes of the rest of the deficiencies detected and analyzed in this study.

Conclusions

This work allows us to conclude that the university professors under study were not fully prepared to face the immediacy of the adoption of teleworking as a working modality due to the COVID-19 health emergency. This reality had economic, social, and psychological impacts on university professors that were collected through primary information in this study. Among the greatest dissatisfactions detected are poor time management, high personal financial investment to acquire the necessary means to carry out teleworking, high levels of work stress, and an increase in unfavorable medical conditions associated with it, as well as conflict between work life and family life for the teacher. Multi-criteria decision methods were applied to support the selection of solutions to complex problems. An action plan was elaborated in accordance with the main deficiencies found according to the methods, as well as a system of priorities according to the causal relationships between the elements evaluated.

References

[1] Instituto Nacional de Estadística y Censos INEC, "Encuesta Nacional de Empleo, Desempleo y Subempleo (ENEMDU). Indicadores Laborales Marzo 2019," 2019.

[2] Diario El Universo, "253 000 personas mantienen activos empleos desde sus casa en Ecuador," *El Universo*, 2020. https://www.eluniverso.com/noticias/2020/03/21/nota/7790568/teletrabajo-casa-coronavirus-trabajo-ecuatorianos-emergencia/.

[3] N. S. Monzón, "Formación docente universitaria y crisis sanitaria COVID-19," *CienciAmérica Rev. Divulg. científica la Univ. Tecnológica Indoamérica*, vol. 9, no. 2, pp. 109–114, 2020.

[4] M. del P. Quezada Castro, M. del P. Castro Arellano, J. M. Oliva Núñez, C. I. Gallo Aguila, and G. A. Quezada Castro, "Alfabetización digital como sustento del teletrabajo para docentes universitarios: hacia una sociedad inclusiva," *Conrado*, vol. 16, no. 77, pp. 332–337, 2020.

[5] A. L. Díaz, J. S. F. Prados, V. F. Canos, and A. M. M. Martínez, "Impactos del confinamiento por el COVID-19 entre universitarios: Satisfacción Vital, Resiliencia y Capital Social Online," *RISE*, vol. 9, no. 1, pp. 79–104, 2020.

[6] V. Burbano, M. Valdivieso, and A. Buerbano, "Teletrabajo académico afectado por el coronavirus: una mirada desde un grupo focal de profesores universitarios," *Espacios*, vol. 41, p. 42, 2020.

[7] C. S. Varguillas Carmona and P. C. Bravo Mancero, "Virtualidad como herramienta de apoyo a la presencialidad: Análisis desde la mirada estudiantil," *Rev. ciencias Soc. del Zulia*, vol. 26, no. 1, pp. 220–233, 2020.

[8] M. L. Vázquez and F. Smarandache, *Neutrosofía: Nuevos avances en el tratamiento de la incertidumbre.* Infinite Study, 2018.

[9] W. B. Vasantha, I. Kandasamy, and F. Smarandache, "Algebraic Structure of Neutrosophic Duplets in Neutrosophic Rings < Z U I>,< Q U I> and < R U I.>," *Neutrosophic Sets Syst.*, vol. 23, pp. 85–95, 2018.

[10] D. Xu, X. Wei, H. Ding, and H. Bin, "A new method based on PROMETHEE and TODIM for multi-attribute decision-making with single-valued neutrosophic sets.," *Mathematics*, vol. 8, no. 10, p. 1816, 2020.

[11] D. F. Li, "Multiattribute decision-making models and methods using intuitionistic fuzzy sets.," *J. Comput. Syst. Sci.*, vol. 70, no. 1, pp. 73–85, 2005.

[12] P. Biswas, S. Pramanik, and B. C. Giri, "TOPSIS method for multi-attribute group decision-making under single-valued neutrosophic environment.," *Neural Comput. Appl.*, vol. 27, no. 3, 2016.

[13] S. Pramanik, R. Mallick, and A. Dasgupta, "Contributions of selected Indian researchers to multi-attribute decision making in neutrosophic environment: an overview.," *Neutrosophic Sets Syst.*, vol. 20, pp. 109–130, 2018.

[14] L. M. Chávez, O. F. S. Montoya, and D. V. G. Mayorga, "DEMATEL NEUTROSÓFICO APLICADO AL ESTUDIO DE LOS FACTORES QUE INFLUYEN EN EL COMPROMISO EXTRACONTRACTUAL DEL ESTADO ECUATORIANO. Infinite Study.," *Investig. OPERACIONAL*, vol. 41, no. 5, pp. 622–628, 2020.

Received: Aug 2, 2021. Accepted: Dec 6, 2021