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Plithogenic Logic for Determination of Strategic Solutions for Ergonomic Occupational Health Risks

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Abstract. This research aims to evaluate the knowledge about the incidence of ergonomic risks in the occupational health of the teachers of the UNIANDES University. Our starting point was the problem related to many physical affectations suffered by teachers and registered in the Institution's medical department system. Then they were scientifically based on topics such as occupational health, occupational risks, ergonomics, and technological elements. Methodologically, we worked with a population of 478 teachers from which a sample of 218 people was selected. Digital survey through the Forms application and the AHP Saaty method were the investigative techniques we used. Among the main findings, it can be noted that the vast majority of those investigated spend an average of 10 hours in front of the computer and are unaware of aspects related to ergonomics and its impact on occupational health. Finally, we make a proposal related to the use of technological elements to generate knowledge about the occupational risks generated by ergonomic aspects.

Keywords: Ergonomics, occupational health, teachers, AHP Saaty, plithogenic.

1. Introduction

The technological advance achieved in the 21st century has transformed the work aspect of all people. Today almost all people do their work supported by computer technology. In a preliminary investigation before this research, we found some other projects that serve as antecedent; among them, we would like to highlight the one developed by Magister Llamo Corrales Yzela Marelin with the title "Ergonomic risk in nursing graduates of the Emergency service of Las Mercedes Regional Teaching Hospital 2016", presented in 2017, which analyzes the existing problems at Las Mercedes Regional Teaching Hospital in the city of Pimentel, Peru.

In this health center, most of the nursing staff are exposed to ergonomic risks due to the various functions they perform; they are also exposed to occupational diseases, whose onset is slow and overlapping. These arise as a result of repeated occupational exposures or even just being in the workplace, but they can have a long latency period. Many of these diseases are progressive, irreversible, and severe, yet many are predictable [1].

The project initially develops bibliographic research on occupational hazards with ergonomic aspects. Then field research is carried out among 31 nurses. The results of this research are: the data obtained in the survey applied to the nursing staff yielded that 80% of the personnel knows ergonomic risks to which they are exposed; 77.42% do not take breaks during their shift; 83.87% of nurses maintain postures or movements that last more than one hour during their shift; and a 70.97% work uninterruptedly for more than 36 hours.

The Regional Autonomous University of the Andes "UNIANDES" is a Higher Education Center, a private and secular law entity, with legal status and administrative and financial autonomy, which offers integral training to its students, without distinction of sex, race, religion, or politics; therefore, the registration of the students depends only on their intellectual abilities. The presence of UNIANDES is based on the experience of more than 20 years in Ecuadorian private education. It was created on February 20, 1997, by Law of the Republic. The University "UNIANDES" has its headquarters in the city of Ambato; its extensions operate in the cities of: Tulcán, Ibarra, Santo Domingo, Quevedo, Babahoyo, Riobamba and Puyo. It currently has 10,000 students and approximately 500 teachers, both undergraduate and graduate [2].

Based on visits made to the Institution's medical department, we obtained information confirming that many teachers declare that they have back pain due to poor position during work, it is also stated that there are eye discomfort and ailments at the level of their hands. All this leads to thinking that UNIANDES teachers are doomed to occupational health problems due to ergonomic difficulties [3]. Based on this criterion, the problem can be formulated in the following terms: how to reduce the ergonomic risks that affect teachers' occupational health at the

Autonomous Regional University of the Andes?

To solve the formulated problem, we proceed to define a research project whose general objective is "to structure a set of strategies that allow reducing the ergonomic risks that affect the occupational health of teachers of the Autonomous Regional University of the Andes."

The multi-criteria decision method Analytic Hierarchy Process will be applied to achieve this objective, as exposed by Tomás Saaty (hereinafter AHP Saaty) in its version of plithogenic logic. The reason why this technique and its fusion to plithogenic logic are chosen is the nature of the phenomenon to be analyzed. Plithogeny is the genesis or origin, creation, formation, development, and evolution of new entities from dynamics and mergers of multiple contradictory and/or neutral and/or non-contradictory previous entities. Plithogeny advocates the connections and the unification of theories and ideas in varied fields of science such as social and technical sciences, theories of arts and letters, etc.[4, 5].

Plithogeny is the dynamics of various types of opposites, and/or their neutrals, and/or non-opposites and their organic fusion. Plithogeny is a generalization of dialectics (dynamics of a type of opposites, Plithogeny studies the dynamics of many types of opposites and their neutrals and non-opposites. The plithogenic set extends the classical set, fuzzy set, fuzzy intuitionist set, and neutrosophic set, and has multiple scientific applications[4].

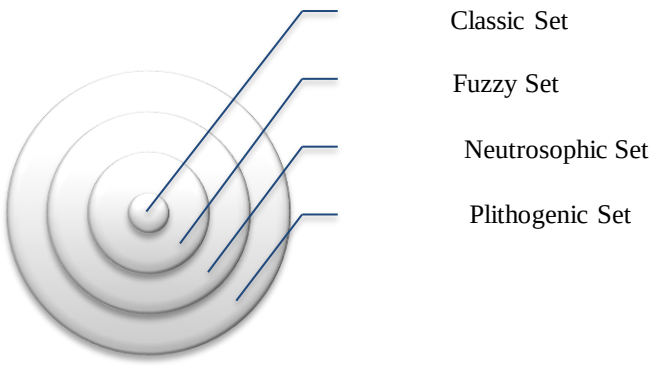

Figure 1. Logic of the plithogenic set.

To achieve the proposed general objective, the following specific objectives are required:

1. Scientifically substantiate the theoretical aspects related to occupational health, ergonomics, occupational hazards and technology.
2. Diagnose the different occupational risks currently suffered by teachers of the Autonomous Regional University of The Andes.
3. Expose solution strategies:
    a. Identify solution pathways
    b. Determine the order of preference in the application of these solutions.

Hereinafter it is structured as follows:

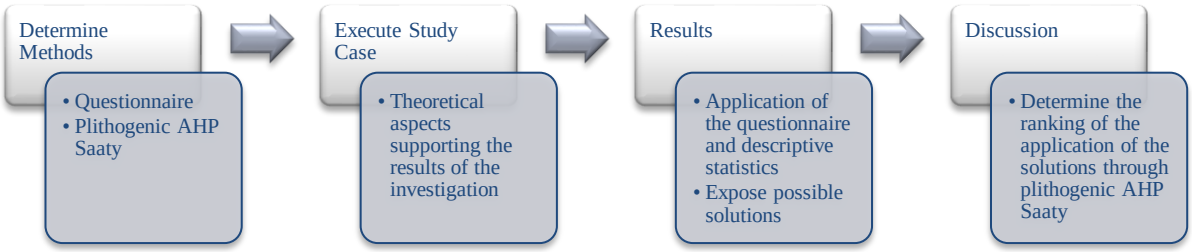

Figure 2. Sequence of the investigation.

In this work, we formulated and defend the idea that: "With the hierarchical ranking of the solutions determined according to their possibility of implementation in the short term, the ergonomic risks of UNIANDES teachers can be reduced and thus achieve the improvement of their occupational health in a short period".

2 Methods

The research was developed based on the following methods:

- Applied research methodology: qualitative-quantitative.

  The qualitative aspects of occupational hazards were related to ergonomic aspects obtained through observation.

  The quantitative was achieved based on the numerical tabulation of the surveys.

- Type of investigation:

  Bibliographic: to elaborate the theoretical foundation,

  Field: developed in situ where the manifestations of the problem took place.

- Theoretical research methods:

  Analytical-synthetic that served for the elaboration of the theoretical foundation.

  Inductive-deductive is used to induce a particular answer and deduce it for a general scope.

- Empirical research methods:

  Brainstorming, Direct observation, Interviews

  Questionnaires: A population of 478 teachers was stipulated for this research, from which a random sample of 218 people was selected. The survey was carried out electronically. The questionnaire generated in Microsoft's Forms application was shared with the institutional emails of the teachers. The instrument designed was the following:

  1. About how many hours a day do you spend in front of the computer?
  2. Do you know if your working position in front of the computer is adequate?
  3. Do you know if the distance from the screen is ideal?
  4. Do you know if your work chair, your keyboard, and your mouse have a good ergonomic design?
  5. Is your current work environment comfortable?
  6. In your current work environment, are the electrical installations adequate and safe (there are no loose or crossed cables)?
  7. In the work environment at the University, were the circulation corridors spacious?
  8. Have you received training in ergonomics aspects within an occupational health improvement process?
  9. Are all the elements necessary for your work very close to your workplace (printers, computers, copiers, documents, files)?

Saaty's AHP: Multicriteria analysis is used to make a comparative judgment between projects or heterogeneous measures and in the field of evaluation [6]. The multi-criteria analysis, the selection and adaptation of the tools used to achieve the proposed objectives is substantial. Professor Saaty, a doctorate in mathematics from Yale University, created a mathematical model called the Analytic Hierarchy Process as an effective way to define measures for such elements and use them in decision-making processes [7-23]. The AHP is a theory oriented towards the decision-maker and serves to identify the best alternative according to the resources allocated. This method can be applied to situations that involve technical, economic, political, social, and cultural factors [24]. It is a scientific tool to address those aspects that are difficult to quantify, but that sometimes requires a unit of measurement and structuring of complexity [20].

The AHP approach is systemic, although it analyzes the decisions based on the hierarchical decomposition and the existing interdependencies between the sets of factors, criteria and alternatives. Saaty's AHP Methodology:

1. Prioritization of the elements of the hierarchical model (table 1)

2. Pairwise comparison of elements
3. Evaluation of the elements by assigning weights
4. Ranking of the alternatives according to the given weights
5. Synthesis
6. Sensitivity analysis

Scale	
9 Extremely most preferred	3 Moderately more preferred
7 Very powerfully preferred	1 Equally preferred
5 Powerfully most preferred	

Table 1. Saaty assessment scale (Verbal judgment rate). Source: [5]

Number of alternatives for decision n	Random Index	Number of alternatives for decision n	Random Index
3	0.58	7	1.32
4	0.9	8	1.41
5	1.12	10	1/49
6	1.24		

Table 2: Random index for the calculation of the consistency coefficient Source: [5]

In the plithogenic extension of Saaty's AHP, the basic notions of plithogenic sets will be applied as follows [4, 5, 8, 10, 12-14, 16, 17, 24-35]:

Let U be a universe of discourse, and P a non-empty set of elements, $P \subseteq U$. Let A be a non-empty set of *uni-dimensional* attributes $A = (\alpha_1, \alpha_2, \dots, \alpha_m)$, $m \geq 1$, and $\alpha \in A$ is a given attribute whose spectrum of all the possible values (or states) is the non-empty set S, where S can be a set of finite discrete, $S = (s_1, s_2, \dots, s_l)$, $1 \leq l < \infty$, or infinitely numerable set $S = \{(, s_2, \dots, s_\infty)$, or an infinitely uncountable set (continuous), $S =]a, b[$, $a < b$, where] ... [is any open, semi-open, or a closed interval set of real numbers or another set.

Let V be a non-empty subset of S, where V is the range of all attribute values needed by experts for the application. Each element $x \in P$ is characterized by the values of all attributes in $V = (v_1, v_2, \dots, v_n)$, for $n \geq 1$.

In the set of attribute values, V in general, there is a dominant attribute value determined by experts in its application. Calling an attribute value *dominant* means that it is the most important attribute value that experts are interested in.

Each attribute value $v \in V$ has a corresponding *degree of membership* $d(x, v)$ of the element x, to the set P, concerning some given criteria.

The degree of membership can be a fuzzy degree of membership, a fuzzy intuitionist degree of membership, or a neutrosophic degree of membership to the plithogenic set.

Therefore, the membership degree function of the attribute value is:

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

Such that $d(x, v)$ is a subset of $[0,1]^z$, where $\mathcal{P}([0,1]^z)$ is the power set of $[0,1]^z$, where z = 1 (fuzzy degree of membership), z = 2 (intuitionistic fuzzy degree of membership), or z = 3 (neutrosophic degree of membership).

Let $|V| \geq 1$ be the cardinality. Let $c: V \times V \to [0,1]$ be the *attribute value contradiction degree function* between any two attribute values v_1 and v_2, denoted by $c(v_1, v_2)$, and satisfying the following axioms:

$c(v_1, v_1) = 0$, the degree of contradiction between the same attribute values is zero;

$c(v_1, v_2) = c(v_2, v_1)$, commutativity.

We can define a fuzzy attribute value contradiction degree function (c as before, we denote by c_F to distinguish it from the following two), an intuitionistic fuzzy attribute value contradiction degree function ($c_{IF} : V \times V \to [0,1]^2$), or more generally, a neutrosophic attribute value contradiction degree function ($c_N : V \times V \to [0,1]^3$), the latter one can be used to increase the complexity of the calculation, but also to increase the accuracy.

The degree of contradiction between the values of the one-dimensional attributes is mainly calculated. For multidimensional attribute values, we can divide them into their corresponding one-dimensional attribute values.

The attribute value contradiction degree function helps the plithogenic aggregation and plithogenic inclusion (partial order) operators to obtain a more accurate result.

The attribute value contradiction degree function is designed in each field where a plithogenic set is used according to the application to be solved. If ignored, the aggregations still work, but the result may lose precision.

So, (P, a, V, d, c) is called a plithogenic set

1. Where "P" is a set, "a" is an attribute (multi-dimensional in general), "V" is the range of values of the attribute, "d" is the degree of appurtenance of the attribute value of each element x to the set P for some given criteria ($x \in P$), and "d" means "d_F" or "d_{IF}" or "d_N", when it is a degree of fuzzy appurtenance, an intuitionistic fuzzy appurtenance, or a degree of neutrosophic appurtenance, respectively, of an element x to the plithogenic set P;
2. "c" means "c_F" or "c_{IF}" or "c_N", when it is a fuzzy attribute value contradiction degree function, intuitionistic fuzzy attribute value contradiction degree function, or neutrosophic attribute value contradiction degree function, respectively.

Functions $d(\cdot,\cdot)$ and $c(\cdot,\cdot)$ are defined according to the applications that experts need to solve.

Then, the following notation is used:

$x(d(x,V))$, where $.d(x,V) = \{d(x,v), \text{for every } v \in V\}, \forall x \in P$

The attribute value contradiction degree function is calculated between each attribute value concerning the dominant attribute value (denoted by v_D) in particular, and for other attribute values as well.

The attribute value contradiction degree function c evaluated between the values of two attributes is used in the definition of plithogenic aggregation operators (intersection (AND), union (OR), implication ($\Longrightarrow$), equivalence ($\Leftrightarrow$), inclusion (partial order), and other plithogenic aggregation operators that combine two or more degrees of attribute values based on a t-norm and a t-conorm.

Most plithogenic aggregation operators are linear combinations of one fuzzy t-norm (denoted by $\wedge_F$) with one fuzzy t-conorm (denoted by $\vee_F$), but nonlinear combinations can also be constructed.

If the t-norm is applied over the dominant attribute value denoted by v_D, and the contradiction between v_D and v_2 is $c(v_D, v_2)$, then v_2 is applied over the attribute value as follows:

$$[1 - c(v_D, v_2)] \cdot t_{norm}(v_D, v_2) + c(v_D, v_2) \cdot t_{conorm}(v_D, v_2), \quad (2)$$

Or, by using symbols:

$$[1 - c(v_D, v_2)] \cdot (v_D \wedge_F v_2) + c(v_D, v_2) \cdot (v_D \vee_F v_2), \quad (3)$$

Similarly, if the t-conorm is applied on the dominant attribute value denoted by v_D, and the contradiction between v_D and v_2 is $c(v_D, v_2)$, then on the attribute value v_2 it is applied:

$$[1 - c(v_D, v_2)] \cdot t_{conorm}(v_D, v_2) + c(v_D, v_2) \cdot t_{norm}(v_D, v_2), \quad (4)$$

Or, by using symbols:

$$[1 - c(v_D, v_2)] \cdot (v_D \vee_F v_2) + c(v_D, v_2) \cdot (v_D \wedge_F v_2), \quad (5)$$

The plithogenic neutrosophic intersection is defined as:

$$(a_1, a_2, a_3) \wedge_P (b_1, b_2, b_3) = \left(a_1 \wedge_F b_1, \frac{1}{2}[(a_2 \wedge_F b_2) + (a_2 \vee_F b_2)], a_3 \vee_F b_3\right), \quad (6)$$

The plithogenic neutrosophic junction is defined as:

$$(a_1, a_2, a_3) \vee_P (b_1, b_2, b_3) = \left(a_1 \vee_F b_1, \frac{1}{2}[(a_2 \wedge_F b_2) + (a_2 \vee_F b_2)], a_3 \wedge_F b_3\right), \quad (7)$$

In other words, regarding what applies to membership, the opposite applies to non-membership, while in indeterminacy, the average between them is what applies.

Plithogenic neutrosophic inclusion is defined as follows:

Since the degrees of contradiction are $c(a_1, a_2) = c(a_2, a_3) = c(b_1, b_2) = c(b_2, b_3) = 0.5$, it applies $a_2 \geq [1 - c(a_1, a_2)]b_2$ or $a_2 \geq (1 - 0.5)b_2$ or $a_2 \geq 0.5b_2$, while $c(a_1, a_3) = c(b_1, b_3) = 1$.

Having $a_1 \leq b_1$ the opposite is fulfilled for $a_3 \geq b_3$, hence $(a_1, a_2, a_3) \leq_P (b_1, b_2, b_3)$ if and only if $a_1 \leq b_1$, $a_2 \geq 0.5b_2$, and $a_3 \geq b_3$.

Next, an algorithm for the resolution of this research is presented where Plithogeny will be merged with Saaty's AHP algorithm:

- Evaluate each of the criteria (solutions) by the experts, substituting the value given in the classic Saaty AHP shown in table 1 with those in table 3:

Language expression	Plithogenic number
Low significance	(0.10, 0.70, 0.80)
Equal importance	(0.30, 0.40, 0.80)

Language expression	Plithogenic number
Robust importance	(0.50, 0.40, 0.60)
Very robust significance	(0.70, 0.30, 0.10)
Absolutely significant	(0.90, 0.10, 0.10)

Table 3. Linguistic values associated with plithogenic numbers for evaluating the weight of the criteria

- Make paired decision matrix

From this moment on, expressions 2 to 8 must be applied to execute the operations of the classical algorithm with plithogenic numbers.

For the elaboration of a single decision matrix, the median of the plithogenic numbers is calculated for each combination, for all specialists. The median is calculated using the following formula:

$$\text{median}_{i=1}^{m}\{PN_i\} = (\text{median}_{i=1}^{m}\{T(PN_i)\}, \text{median}_{i=1}^{m}\{I(PN_i)\}, \text{median}_{i=1}^{m}\{F(PN_i)\}), \quad (8)$$

Where, PN_i are plithogenic numbers, $T(PN_i)$ are the true components, $I(PN_i)$are the indeterminate components and $F(PN_i)$ are the false components. In other words, Equation 8 means that the median of a set of plithogenic numbers is defined as the plithogenic number of the medians of its components:

To compare the relationships between the quadrants, we use the following formula to fuzzy a neutrosophic number [36]:

$$\mathcal{S}([T, I, F]) = \frac{2+T-I-F}{3}, \quad (9)$$

- Determine for each line of the pairwise comparison matrix, a weighted sum based on the sum of the product of each cell by the priority of each alternative or corresponding criterion.
- For each line, divide its weighted sum by the priority of its corresponding alternative or criterion
- Determine the mean ʎmax of the result of the previous stage.
- Calculate the consistency index (CI) for each alternative or criterion

$$CI = \frac{\lambda_{max}-m}{m-1} \quad (10)$$

Where m is the number of alternatives

- Determine the Random Index (AI) from table 2
- Determine the consistency ratio index (the ratio between the consistency index and the random index)

3 Case study

To comply with the first specific objective, we proceed to state the theoretical aspects that support the present investigation [37]:

- Ergonomics is a discipline that tries to adjust the conditions of the task and the environment to people's capacities, considered scientific-technical and design since it studies the relationship between the workplace and workers [38].
- Ergonomics is responsible for the study of the physical workspace, thermal environment, noise, vibrations, work postures, energy wear, mental load, nervous fatigue, and workload, taking care of preventing dangers that affect the health, balance, emotional and nervous condition of the worker [39].
- Ergonomics is intended to: adapt products, tasks, tools, spaces and in general, the environment to the capacities and needs of people, and thereby improve the efficiency of workers, safety and well-being [40].
- The benefits of ergonomics can be reflected in many ways: in productivity and quality, in safety and health, in reliability, in job satisfaction, and in personal development. This wide field of action is because the basic objective of ergonomics is to achieve efficiency in any activity carried out with a purpose, efficiency in the

broadest sense, to achieve the desired result without wasting resources, without errors and damage to the person involved or others. It is inefficient to waste energy or time due to poor design of work, workspace, environment, or working conditions [41].

- Nor is it to obtain the desired results despite the bad design of the position, instead of obtaining them with the support of a good design. The goal of ergonomics is to ensure that the work environment is in harmony with the activities carried out by the worker. This goal is valid in itself, but its achievement is not easy for several reasons. The human operator is flexible and adaptable and continually learns, but individual differences can be very great. Some differences, such as those in build and strength, are obvious, but others, such as differences in culture, style, or skills, are more difficult to identify [42].

Given the complexity of the situation, it might seem that the solution is to provide a flexible environment in which the human operator can optimize a specifically suitable way of doing things. Unfortunately, this approach cannot always be practiced, as the most efficient way is not always obvious and consequently the worker may continue to do something for years in an inappropriate way or under unacceptable conditions. Therefore, it is necessary to adopt a systematic approach: start from a grounded theory, establish quantifiable objectives and contrast the results with the objectives. The different possible objectives are detailed below [43]:

- Ergonomic risks, particularly overexertion, produce musculoskeletal disorders or injuries in workers, for example; inflammatory or degenerative pain and lesions in the back and upper extremities. Today musculoskeletal disorders are among the most frequent injuries suffered by workers in developed countries [44].

- Ergonomic risks apart from generating injuries to workers, also raise the economic costs of companies since they disrupt work activity, leading to sick leave and incapacity for work. The main ergonomic risks are generally produced by the adoption of forced postures, the realization of repetitive movements, the manual handling of loads, and the application of forces during the working day [44].

- Forced postures can be defined as "Positions that a worker adopts when performing the tasks of the position, where one or more anatomical regions are no longer in a natural position to move to a position that generates hypertensions, hyper-flexion, and hyper-rotations in different parts of the body [44].

- Repetitive work is considered to be any movement that is repeated in cycles of less than 30 seconds or when more than 50% of the cycle is used to carry out the same movement. In addition, when a repetitive task is carried out for at least 2 hours during the day, it is necessary to assess its level of risk [44].

Ergonomics is a discipline concerned with the adaptation of work to man. Although, its development is recent in our environment, there is a great need for health professionals to incorporate ergonomic criteria in their activities since in the modern world there is a set of pathologies that can be triggered or aggravated by work. In these cases, the treatments are not effective if the causes that generate them are not corrected. Health professionals treat workers who, in many cases, have pathologies derived from their working conditions. For example, in the modern world, work stress, musculoskeletal symptoms associated with repetitive work, inappropriate postures and manual handling of materials, obesity associated with sedentary work, chronic fatigue, etc., [45].

Modern societies are increasingly based on information and knowledge. For this reason, they need to constitute productive forces endowed with ICT skills, which allow them to handle information and provide them with the ability to reflect, create and solve problems, to generate knowledge. To promote that its citizens are educated and capable so that each one can effectively guide their own life and develop a full and satisfactory existence. Encourage all citizens to participate fully in society and influence the decisions that affect their lives. Promote intercultural understanding and peaceful conflict resolution [46].

E-learning makes it possible to create student-centered learning environments. They are characterized by being interactive, efficient, easily accessible, and distributed. An E-learning scenario must consider aspects such as institutional, pedagogical, technological, interface design, evaluation, management, support, and ethics of use. In this way, E-learning tries to be a combination of interactive resources that generate support and structured learning activities [46, 47].

The Massive Open Online Courses (MOOC) are classes taught through technological platforms linked through the Internet, these enable the teaching-learning process to thousands of students. MOOCs appeared as a response to the challenges faced by educational institutions and organizations in times of information overload: there is a need for training a population that seeks quality education at low cost and, in turn, hoping to achieve short-term results and without having to wait for a traditional school period to take the course [48].

4 Results

The questionnaire and the respective tabulation were applied through the descriptive statistics resulting from the data processing. The results are presented below by questions:

Question No 1: Approximately how many hours a day do you spend in front of the computer?

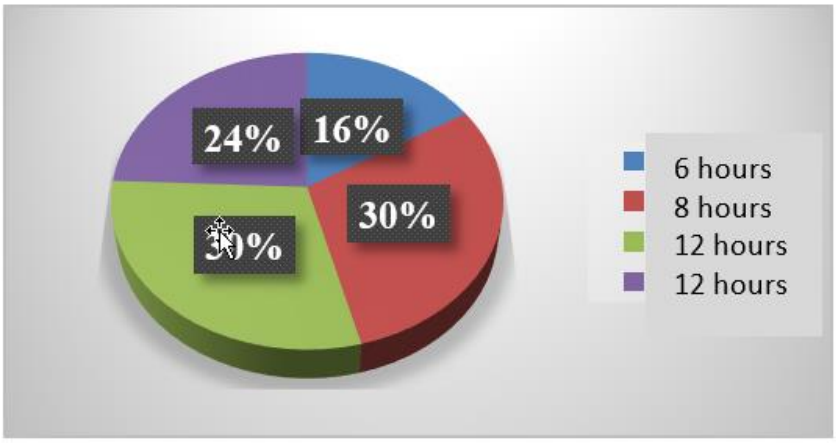

Figure 3. Results of question 1. **Source**: Own elaboration.

Question No 2. Do you know if your work position in front of the computer is adequate?

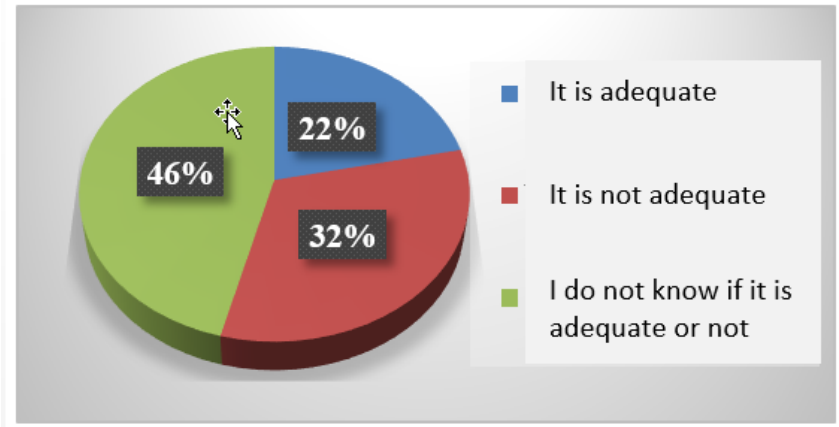

Figure 4. Results of question 2. **Source**: Own elaboration.

Question No 3. Do you know if the distance from the screen is the ideal one?

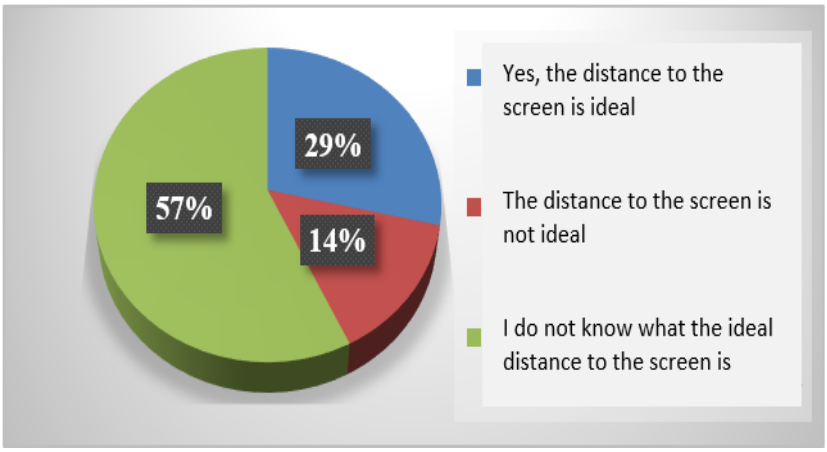

Figure 5. Results of question 3. **Source**: Own elaboration.

Question No 4. Do you know if your work chair, your keyboard and your mouse have a good ergonomic design?

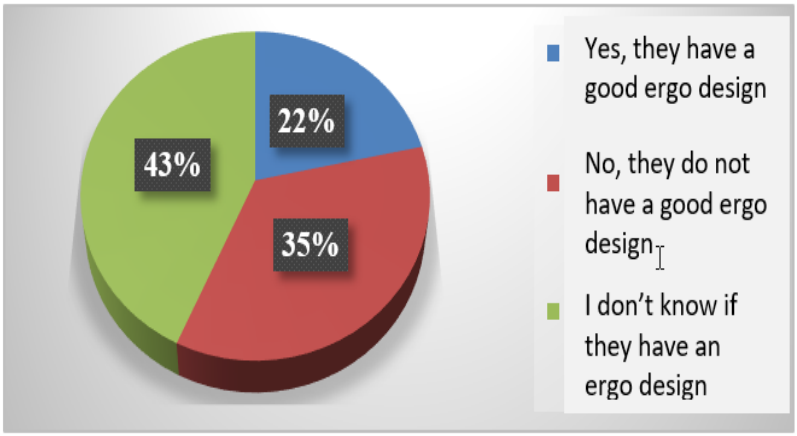

Figure 6. Results of question 4. **Source**: Own elaboration.

Question No 5 Is your current work environment comfortable?

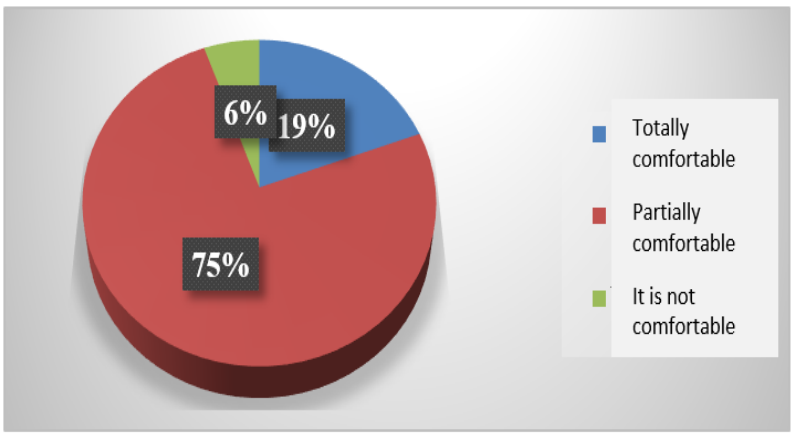

Figure 7. Results of question 1. **Source**: Own elaboration.

Question No 6. In your current work environment, are the electrical installations adequate and safe (There are no loose or crossed cables)?

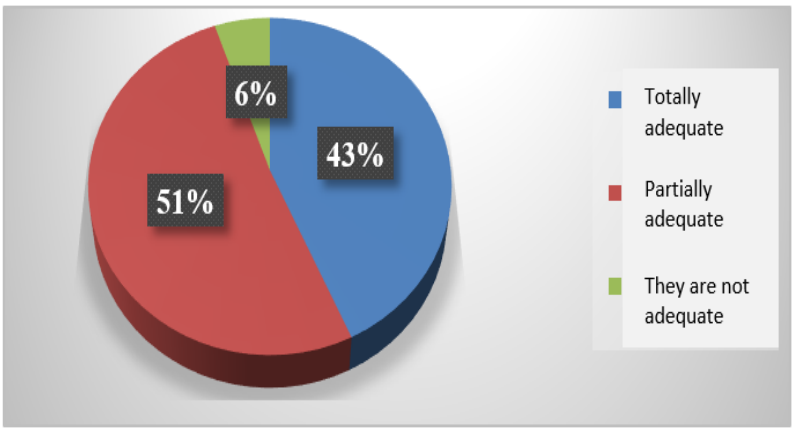

Figure 8. Results of question 6. **Source**: Own elaboration.

Question No 7. In the work environment at the University, were the corridors spacious?

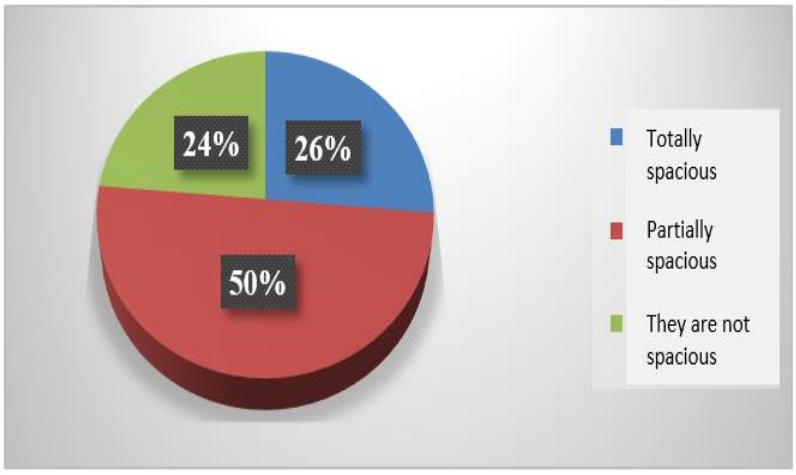

Figure 9. Results of question 7. **Source**: Own elaboration.

Question No 8. Have you received training in ergonomics aspects within an occupational health improvement process?

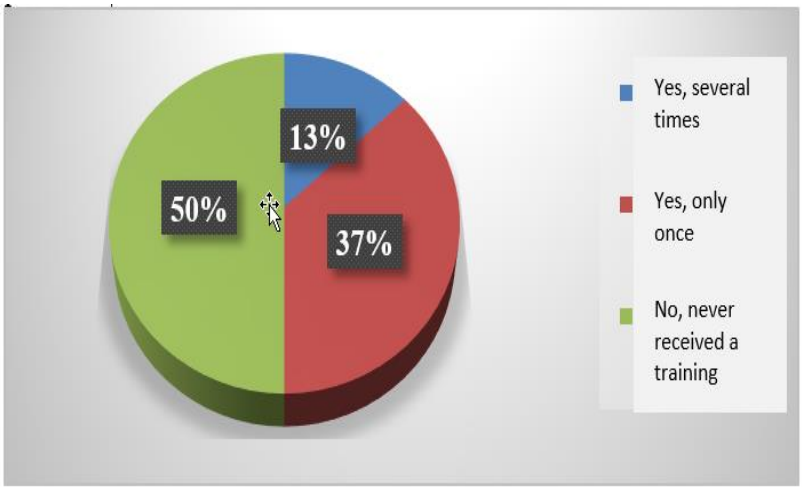

Figure 10. Results of question 8. **Source**: Own elaboration**.**

Question No 9. Are all the elements necessary for your work very close to your workplace (printers, computers, copiers, documents, files)?

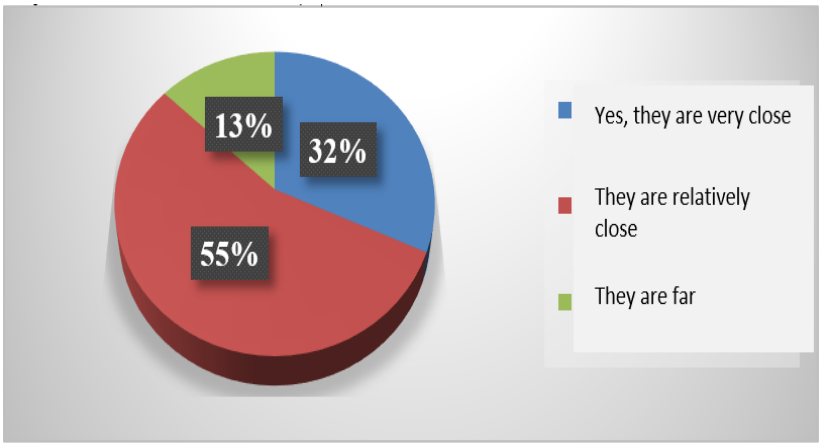

Figure 11. Results of question 9**. Source:** Own elaboration**.**

As can be seen, from the results obtained in the research on teachers, the situation behaves as follows:

- 60% work an average of 11 hours a day on the computer.

- 46% say they do not know if their position in front of the computer is adequate, and 32% say it is inadequate.
- 57% do not know what the ideal distance a person should sit to look at their computer screen is.
- 43% do not know if the chair, keyboard, and mouse elements have an ergonomic design, and 34% say that they do not have a good ergonomic design.
- Due to the pandemic, all teachers are developing telework, which is why 71% of those investigated say that their workplace is partially comfortable and 51% say that the electrical installations are partially adequate.
- It is also stated that the circulation corridors at the University are partially spacious.
- On the other hand, 50% state that they have never received a training process on ergonomic aspects related to occupational health. 35% declare that they received training only once.
- 55% indicate that the elements they use frequently in their work are relatively close, which means that they should not make additional efforts to reach them.

5 Discussion

To establish a discussion of the results from the comparative point of view, it is decided to take as a reference the results obtained in the research developed by [49] on ergonomic risks within the Paulo Emilio Macías Superior Technological Institute of Portoviejo. In this investigation, it is stated that:

- In 95% of the ergonomic risks that occur most frequently happen in the workplace regarding postures and the workspace itself.
- 90% of the teachers and administrative staff do not have ergonomic furniture for the development of their activities.
- According to the results obtained, 85% of the personnel studied show that they do not know the correct posture to adopt when working in front of a computer for more than two continuous hours during a working day.
- Because of the anti-ergonomic design of the 65 evaluated jobs, we found that the most persistent health problems that require periodic medical attention are those related to incorrect postures.
- Comparing the two research works, we may point out that there is a total similarity in them, the main ergonomic risk lies in the postures during the work time, also in the two investigations it is stated:
- Not knowing about ergonomic aspects,
- Most of those investigated are unaware of an ideal ergonomic posture.
- It is agreed that both the equipment and the furniture are not properly ergonomically designed.

As can be seen, the research results are very similar, which implies that this phenomenon has a general nature. Therefore, any proposed solution can be ideal for both institutions.

We then proceed to determine possible solutions to be implemented in the short term by brainstorming techniques, which are listed below:

1. Carry out an ergonomic study of the lighting and colors of the work and study rooms within the center.
2. Implement a web application to assess the level of ergonomic risks of each employee and occupation.
3. Training on ergonomics and occupational health through virtual classes complemented with synchronous classes. Encourage the dissemination of materials through different platforms and social networks, YouTube channels, blogs, SlideShare, among others.
4. Acquisition of furniture, such as desks, chairs and shelves with ergonomic designs.
5. Develop and implement a physical exercise program within the working day called "Active breaks" of 10

minutes in the morning session and 10 minutes in the afternoon, where teachers and administrators frequently perform physical exercises aimed at correcting certain postures.

6. Generate a digital campaign with tips related to ergonomics and occupational health in general.

Since it works with the idea that with the establishment of an order of priority in the implementation of short-term solutions, the ergonomic risks of UNIANDES teachers can be reduced and thus achieve the improvement of their occupational health in a short period. These solutions are subjected to the Saaty AHP technique in its plithogenic extension. For this topic, we chose administrative experts who intervene in the decision-making process. Their implementation will focus on two parts, one for teachers and administrators and a second for students. Therefore, two AHPs of Saaty will be executed for both parties as explained:

For the data processing and the construction of the binary comparison matrix, the median of the experts' evaluations is taken using equation 8, as shown below:

Strategies	Ergo study.	Web Application	Ergo furniture.	Active breaks	Digital campaign	Training
Ergo study.	(0.30, 0.40, 0.80)	(0.50, 0.40, 0.60)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.30, 0.40, 0.80)
Web Application	1 / (0.50,0.40,0.60	(0.30, 0.40, 0.80)	(0.80, 0.10, 0.30)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)
Ergo furniture.	1 / (0.80,0.10,0.30	1 / (0.80,0.10,0.30	(0.30, 0.40, 0.80)	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)
Active breaks	1 / (0.65, 0.30, 0.45	1 / (0.80,0.10,0.30	1 / (0.65, 0.30, 0.45	(0.30, 0.40, 0.80)	(0.50, 0.40, 0.60)	(0.50, 0.40, 0.60)
Digital campaign	1 / (0.80,0.10,0.30	1 / (0.65, 0.30, 0.45	1 / (0.65, 0.30, 0.45	1 / (0.50,0.40,0.60	(0.30, 0.40, 0.80)	(0.50, 0.40, 0.60)
Training	1 / (0.30,0.40,0.80	1 / (0.80,0.10,0.30	1 / (0.80,0.10,0.30	1 / (0.50,0.40,0.60	1 / (0.50,0.40,0.60)	(0.30, 0.40, 0.80)

Strategies	Ergo study.	Web Application	Ergo furniture.	Active breaks	Digital campaign	Training
Ergo study.	0.04	0.08	0.13	0.10	0.16	0.11
Web Application	0.22	0.06	0.13	0.12	0.13	0.24
Ergo furniture.	0.14	0.20	0.06	0.10	0.13	0.24
Active breaks	0.17	0.20	0.25	0.06	0.10	0.15
Digital campaign	0.14	0.25	0.25	0.31	0.07	0.15
Training	0.30	0.20	0.20	0.31	0.41	0.11

Strategies	Pesos	Order of importance for its implementation
Ergo study.	0.10	5
Web Application	0.15	3
Ergo furniture.	0.14	4
Active breaks	0.15	3
Digital campaign	0.20	two
Training	0.25	1

Table 4. Saaty's AHP application in its plithogenic extension for teachers

It is said that this study is validated because the CR index = 0.07 ≤ 0.10; therefore the application of the method is accepted.

Strategies	Ergo study.	Web Application	Ergo furniture.	Active breaks	Digital campaign	Training
Ergo study.	(0.30, 0.40, 0.80)	(0.50, 0.40, 0.60)	(0.70, 0.30, 0.10)	(0.70, 0.30, 0.10)	(0.70, 0.30, 0.10)	(0.50, 0.40, 0.60)
Web Application	1 / (0.50,0.40,0.60)	(0.30, 0.40, 0.80)	(0.90, 0.10, 0.10)	(0.90, 0.10, 0.10)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)
Ergo furniture.	1 / (0.70,0.30,0.10)	1 / (0.90,0.10,0.10)	(0.30, 0.40, 0.80)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.90, 0.10, 0.10)
Active breaks	1 / (0.70,0.30,0.10)	1 / (0.90,0.10,0.10)	1 / (0.65,0.30,0.45)	(0.30, 0.40, 0.80)	(0.90, 0.10, 0.10)	(0.50, 0.40, 0.60)
Digital campaign	1 / (0.70,0.30,0.10)	1 / (0.65,0.30,0.45)	1 / (0.50,0.40,0.60)	1 / (0.90,0.10,0.10)	(0.30, 0.40, 0.80)	(0.90, 0.10, 0.10)
Training	1 / (0.50,0.40,0.60)	1 / (0.80,0.10,0.30)	1 / (0.90,0.10,0.10)	1 / (0.50,0.40,0.60)	1 / (0.90,0.10,0.10)	(0.30, 0.40, 0.80)

Strategies	Ergonomic study	App	Ergo furniture.	Pauses	Bell	Training

		Web		active	digital	
Ergo study.	0.04	0.08	0.11	0.12	0.17	0.13
Web Application	0.23	0.06	0.14	0.16	0.15	0.20
Ergo furniture.	0.17	0.19	0.06	0.11	0.12	0.23
Active breaks	0.17	0.19	0.24	0.06	0.21	0.13
Digital campaign	0.17	0.27	0.30	0.19	0.09	0.23
Training	0.23	0.21	0.17	0.35	0.26	0.09

Strategies	Pesos	Order of importance for its implementation
Ergo study.	0.11	6
Web Application	0.16	4
Ergo furniture.	0.14	5
Active breaks	0.17	3
Digital campaign	0.21	2
Training	0.22	1

Table 5. Saaty's AHP application in its plithogenic extension for students

Strategies	Teachers and administrative	Students
Ergo study.	5	6
Web Application	3	4
Ergo furniture.	4	5
Active breaks	3	3
Digital campaign	2	2
Training	1	1

Table 6. Comparison of the order of priority for administrators, teachers and students

Conclusions

Ergonomic risks may cause physical problems for teachers and thus affect their academic performance. The vast majority of the studied teachers work an average of 11 hours on the computer; they also affirm that they do not know about the correct postures during the daily work process. However, we found that they are unaware of the fundamental concepts of ergonomics and therefore, no initiatives can be taken to prevent ergonomic risks since the vast majority of teachers have not received a training process on ergonomics and occupational health. Similarly, it was determined that the furniture does not have an adequate ergonomic design.

The study revealed the need to find quick solutions to avoid sick leave. Therefore, once Saaty's AHP was applied in its plithogenic version, the appropriate ranking could be determined based on the criteria of the administrative decision-makers consulted, and we obtained the following results:

1. Training on ergonomics and occupational health through virtual classes complemented with synchronous classes. Encourage the dissemination of materials through different platforms and social networks, YouTube channels, blogs, SlideShare, among others.

2. Generate a digital campaign with tips related to ergonomics and occupational health in general.

3. Develop and implement a physical exercise program within the working day called "Active breaks" of 10 minutes in the morning session and 10 minutes in the afternoon session, where teachers and administrators frequently perform physical exercises aimed at correcting certain postures.

The implementation of a web application to evaluate the level of ergonomic risks of each employee and work position, the ergonomic studies of the lighting and colors of the work and study rooms within the center, and the acquisition of furniture and shelves with ergonomic designs have a different order for each group. This shows that it is preferred to start a corrective and preventive protocol at the same time.

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