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# **Journal of Urban and Sustainable Development**

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In the first article we present, *Sustainable carpet: attitudinal strategy with emphasis on sustainable development*, by MUÑOZ-ROSALES, Alberto Francisco, PÉREZ-JUÁREZ, Gisela, PORTILLO-ECHAVARRÍA, Susana and GARCÍA-ORTEGA, Rosa María, with adscription in the Universidad Tecnológica de Huejotzingo, as next article we present, *Analysis of the thermal sensation in cold period outdoor spaces, in the dry climate of the metropolitan area of Tijuana, Baja California, Mexico*, by GONZÁLEZ-TRINIDAD, Julián, VEYNA-GÓMEZ, Ana Isabel, JÚNEZ-FERREIRA, Hugo Enrique, BAUTISTA-CAPETILLO, Carlos Francisco and ROBLES-ROVELO, Cruz Octavio, with adscription in the Universidad Autónoma de Zacatecas “Francisco García Salinas”, as next article we present, *Evaluation of luminance levels. digital tool or traditional device? case study: Alameda Park in Saltillo, Mexico*, by MERY-RUIZ, Miriam E., LOPEZ-MONTELONGO, Areli, MOLAR-OROZCO, María Eugenia and CARMONA-OCHOA, Gabriela, with adscription in the Universidad Autónoma de Coahuila, as next article we present, *Export of vegetables in the rural development district of Tecamachalco, Puebla, within the framework of the USMCA*, by XIMITL-ISLAS, Iván, RODRÍGUEZ-DE LA VEGA, Marisol, CABILDO-OREA, Alejandra and MACHORRO-DÍAZ, Rafael, with adscription in the Universidad Tecnológica de Tecamachalco.

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**Sustainable carpet: attitudinal strategy with emphasis on sustainable development****Alfombra sostenible: estrategia actitudinal con énfasis en el desarrollo sostenible**

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**Abstract**

The generation of attitudinal strategies in students is fundamental for their integral development and the construction of a balanced quality of life. These strategies allow activating skills that go beyond technical and academic knowledge, as they promote social, environmental and economic awareness. The objective of the research is to identify the perception of the students of the administration career of the attitudinal strategy "Sustainable Carpet" with an active participation. The methodology is based on a qualitative paradigm; interviews were conducted with thirty-two people using a non-probability sample. The main contribution is the creation of an attitudinal strategy with fifteen simple and easy steps with a high feasibility for the case studies belonging to the administration career. Therefore, to generate a degree of awareness it is useful to start from the breach of a human right and this will help to take a personal position in this regard, if it is accompanied by collaborative and cooperative activities, as well as active learning, we are in the presence of learning meaningful and experiential.

**Attitudinal strategies, Perception, Active learning**

**Resumen**

La generación de estrategias actitudinales en los estudiantes es fundamental para su desarrollo integral y la construcción de una calidad de vida equilibrada. Estas estrategias permiten activar competencias que van más allá de los conocimientos técnicos y académicos, ya que promueven la conciencia social, ambiental y económica. El objetivo de la investigación es identificar la percepción de los estudiantes de la carrera de administración de la estrategia actitudinal "Alfombra Sostenible" con una participación activa. La metodología es a partir de un paradigma cualitativo, se realizaron entrevistas a treinta y dos personas utilizando una muestra no probabilística. La contribución principal es la creación de una estrategia actitudinal con quince pasos sencillos y fáciles con una alta viabilidad para los casos de estudios pertenecientes a la carrera de administración. Por ello, para generar un grado de conciencia es útil partir del incumplimiento de un derecho humano y esto ayudará a tomar una posición personal al respecto, si se acompaña de actividades colaborativas, cooperativas, de forma activa estaremos en presencia de un aprendizaje significativo y vivencial.

**Estrategias actitudinales, Percepción, Aprendizaje activo**

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## Introduction

In many countries there is a social decomposition due to the lack of values and attitudes on the part of its citizens. In view of this, higher education must provide scenarios to modify this situation and contribute to its transformation with planned, systematic actions, clear objectives and competencies.

The generation of attitudinal strategies provides students with the opportunity to activate competencies to generate a quality of life balancing the social, environmental and economic part with their professional activity, the proposal presented here has an added value by using few monetary resources, generating a dialogue, activating a reflection and taking a degree of awareness to a particular situation.

The problem to be solved is to contribute to the definition of an awareness of a social problem which affects and transcends our country, therefore, the generation of an educational process with purposes and actions linked to the decision making of university students is vital for their integral formation.

In line with the above, Baron et al. (2020) ratify the Higher Education Institutions - IES- as the space for the acquisition of values, knowledge and competencies through the participation of all in the generation of solutions that impact the political, social and economic, thus allowing the expected social transformations.

The objective of the research is to identify the perception of the students of the administration career of the attitudinal strategy called "Sustainable Carpet", which is framed within sustainable development and at the same time promotes an active participation inside and outside the classroom during the four-month period from January to April 2023. The research question of this work is how to apply an attitudinal strategy in higher education, which will strengthen the graduate profile of the students of the administration career of the Technological University of Huejotzingo.

Higher education students must make decisions based on their area of knowledge and at the same time follow values and attitudes in accordance with human rights because they work with people.

It is here, where the creation and evaluation of the strategy presented here is justified, because it will help the healthy coexistence among the members of a society and will contribute to solve a current challenge.

Consequently, for the General Directorate of Technological and Polytechnic Universities of Mexico (2010), teaching practice should be focused on learning and on the student, these elements give relevance to the present research, therefore, innovating in attitudinal strategies is required and shapes the university teaching task. Likewise, the SEP (1991) seeks to promote values and attitudes which will be present in the professional, personal and contextual activity, well, this is one more justification to carry out a new way of activating the knowledge to be.

One of the consequences will be a methodology, which will have a series of academic and ludic steps to contribute to the awareness of a particular social problem. The feasibility is high because the human, material, technological and financial resources are available, given that they are a series of actions which do not require large expenditures, on the contrary, existing resources are used.

The realization of the sustainable carpet, is to make students aware of the importance of caring for the environment, as well as to develop their skills, knowledge, dispositions and motives of co-responsibility for the care of society with the economic situation.

It is important to recognize that we are facing a generational crisis, since little has been done for the conservation and care of the environment, which is why students are encouraged to reflect on the subject and make proposals to expose their knowledge with materials that do not affect.

The proposal of the sustainable outdoor carpet allows students to express their feelings on a common theme by capturing phrases with colored chalk, sharing them among them; this allows to know the position that each one has on the subject and reflect on the values and beliefs, each participant represents acting responsibly, the participation of human beings and their development is weighted.

A theoretical framework is presented where the main concepts that allow the construction of the proposal are approached, then the methodology to be followed for the qualitative research is defined, in results the inductive codes found are visualized and from this some conclusions are built.

### **Theoretical framework**

Within higher education it is urgent to take up social issues, which coexist with the business and environmental context, that is, teachers are called to generate new scenarios where the university student is able to build awareness about a particular situation, with Irina Bokova has premises of great value in the educational field, UNESCO (2015) "individuals are called to contribute increasingly more positively to their communities through the promotion of peace, solidarity and respect for others and the environment" (p.3 ), therefore, teachers can and should generate new attitudinal strategies that allow reflection, analysis and dialogue in a playful framework with the intervention of other members of the educational community.

The aforementioned author refers to give students the capabilities to be creative and responsible with which it is necessary to generate new educational strategies that contribute to mobilize the aforementioned premises, "Education can empower children, youth and adults to actively participate at local, national and global levels, and contribute to overcome the current and emerging challenges of an increasingly interconnected world"(UNESCO, 2015, p.52 ), this quote, makes it possible to create actions inside and outside the classroom, to change the paradigm of action, but above all to build alternatives having students at the center.

On the other hand, some authors refer to a situation which can be reverted from dialogue and reflection, as long as there is an active participation of the members of society, that is, if we have students today educated with attitudinal strategies and join the knowledge of their own disciplinary area then their integration and application with the other members of society will be perceived, in our "current era, it seems that there is a tendency to crisis, especially of values; part of this crisis may be due to the excessive use of scientific and technological advances, without considering the impacts on humanity and the environment" (Partidas et al. ,2016, p.17).

In addition, attitudinal strategies should go from the simple to the complex, with this the student will have the opportunity to clearly understand knowing how to be, but always moving forward relating it to what happens to him in his environment or in his person, that is, the experience and explanation from his past or present, will enable him in the future to make a clear decision of right or wrong "for an attitude to be consolidated and expressed clearly it is necessary that it is accompanied by the necessary conceptual progressions. And on the other hand, re-signifying one's own experience allows a change in attitudes and value criteria" (Pineda- Alfonso, 2017, p.371).

Likewise, to understand education for sustainable development is to balance their personal, academic, professional, social, international or global performance, or other with a performance attached to values and attitudes valid in a society, that is, "competence that empowers students to make informed decisions conducive to environmental integrity, economic viability and the construction of a just society for current and future generations, respecting cultural diversity". (UNESCO, 2020, p. 30), and it is here, where a student member of a society must see the now without losing sight of the negative effects caused by making a decision.

At the same time, with Estrella and González (2017) manifest a change within society, before the search for economic indicators in a positive way, such as the gross domestic product at whatever cost, today the change is to generate actions to generate a welfare in the population and the environment, that is, productivity taking care of people to acquire better standards of living without permanent damage to ecosystems.

At the same time, a great variety of teaching and learning strategies are used in classrooms, which seek to promote meaningful and solid learning, in certain educational institutions "with older students there is a tendency to suspend high levels of active learning" (Silberman, 2006, p. 8), this causes low student participation, however, it is possible to create attitudinal strategies with an approach focused on activity, collaboration and constructivist participation, which generates an approach that takes into account the other members of the educational community.

Simultaneously, in the teaching role, sometimes certain traditions are followed and consequently, "another reason why learning is not active enough among older students is that teachers feel constrained by their subject, and are also pressured by the limited time they have to teach it" (Silberman, 2006, p. 8). 8), the variables mentioned above are present in some institutions, however, when a student is motivated, enthusiastic and with clarity in the objectives to build within a collaborative, cooperative and open dialogue environment there will be an active and constructivist participation because the student feels to be the center of the attitudinal strategy.

Renowned authors consider of great importance learning accompanied by active actions, where the student takes a participatory and constructivist role, this obliges the university institution to encourage and allow scenarios with playful activity, with which "the importance of promoting interaction between teachers and students, as well as among students themselves, with the management of the group through the use of cooperative learning strategies" (Díaz-Barriga and Hernández, 2010, p.27 ),

which is vital to transform and at the same time contribute to obtaining favorable results and elements that will allow students to make decisions in their future performance.

Similarly, attitudinal learning or values should follow certain parameters, because they go to the performance of the human being and should be treated differently from the conceptual, Díaz-Barriga and Hernandez (2010):

Teaching cannot be focused on the repetitive reception of factual or declarative information, but requires meaningful learning experiences that allow not only to acquire valuable information, but that really affect the behavior of students, in the manifestation of affection or moral emotion, in their ability to critically understand the reality around them, in the development of specific skills for dialogue, self-direction, active participation, cooperation or tolerance. (p.60).

Thus, an attitudinal strategy must innovate in the resources to be used, in the participation of the students, the results to be generated, the actions with the other students, the personal activities, in the place to be used, the experiences to be generated, but above all in the capacity and acquisition of new competences that will allow the healthy coexistence in society, the environment and in their private, public or social organizations.

Thus, it is proposed the existence of an ethical commitment of the teacher in his teaching practice, that is to say, he must promote values and make human rights the solid base to generate good living, with which we agree. Given this, it is necessary to have enough strategies to achieve this goal, being relevant to innovate and create academic alternatives to achieve these social competencies, Terigi (2013).

For further clarification, Gutiérrez (2020) expresses the new role of the teacher, from identifying a problem, new solutions are provided to improve classroom intervention, but it is important to start from a reflective and proactive process where the objectives are clear and the academic products contribute to educational training because the competencies must be well defined.

## Methodology

The research is developed in a qualitative approach, because it seeks to identify the perception of students and from this to build its evaluation, within the premises to be taken up from this type of studies, "it is oriented to learn from experiences and views of individuals, to value processes" (Hernández et al., 2018, p.361), with which it seeks to understand the experiences of the environment generated by the attitudinal strategy "sustainable carpet". The case studies are students of the Management career, which are in an age of 20 to 24 years old, enrolled at the Technological University of Huejotzingo in the state of Puebla of Mexico. Thirty-two people were interviewed out of a total of 40 students. The place where the strategy was developed is the municipality of Huejotzingo, which is considered according to data from Data Mexico (2023), with 19.2% of its graduates coming from the aforementioned higher education institution, which reflects its importance in this region.

The interview was conducted with open-ended questions, which were applied during the four-month period from January to April 2023. A non-probabilistic convenience sample was used. As a processing technique, lists of terms and words in context were used, that is, the data were analyzed based on the use of inductive codes.

To achieve rigor in the present investigation, the researchers reviewed the data alternately, with the aim of achieving congruence of the results and avoiding biases.

The attitudinal strategy of the sustained rug was carried out with the following steps:

1. Selection of an attitudinal theme, in our case we chose human rights.
2. Sending educational material to their personal mobile devices.
3. Analysis with positive and negative examples contrasting with human rights in a round table format.
4. Selection of a human right that is not being fulfilled according to the student's perspective.
5. Construction of a personal sentence.
6. Group discussion on the student's sentence.

7. Reflection of personal sentence in collaborative work teams.
8. Teacher mediation and sentence revision.
9. Personal sentence adjustment by the student.
10. Simulation of sentence writing in the schoolyard using a square of 3 meters x 3 meters.
11. Writing of all students in the school yard with chalk and decoration according to their drawing skills, leaving a corridor or hallway for other students to pass through.
12. Students from other groups walk through the corridor created.
13. Constructive dialogue based on explaining the phrase placed in the schoolyard to other students of the administration career where the selected human right, the situation of the context and the personal phrase are expressed, with an emphasis on cooperative work.
14. Closing strategy of positive and negative elements in the classroom. And its application of phrase in their daily life, professional and with their environment, looking for scenarios transformer new scenarios.
15. Dissemination of results in institutional media for an impact to the entire university community.

This methodology can be followed by selecting an attitudinal theme, in our case human rights was the central theme and at the same time it was within the framework of the UN Women's Day, thus linking a knowledge of being with a current problem of the region, but with an active participation of students and teachers in order to learn to transform oneself and the present and future society, being premises of sustainable development.

At the same time, the strategy can be seen with the three dimensions of sustainable development from indicators:

### Social:

- Forty students reflected on human rights in a constructive way.- Eighty students dialogued on a phrase created by their fellow students.

## Environmental:

- Each student used three chalkboards which are biodegradable.
- No use of paper for the strategy, zero sheets of paper.

## Economic:

- Students bought chalk at stationery stores in the region, spending approximately 9 pesos or half a dollar, i.e., encouraging local consumption.

## Results

When we hear the word strategy, our brain automatically takes us back to scenarios of war, economy, sports and even video games, understanding that by developing and applying it we are doing something different, unique and disruptive to what we are commonly used to.

As far as educational strategy is concerned, far from talking about a meaningless adaptation, we should understand it as focusing all the means to achieve a common competence, in other words, directing all activities to achieve an identifiable, measurable and achievable objective that helps to meet the goals set at the beginning.

According to Alvarez, (2003), the strategy is the project or program that is developed on a certain basis to achieve the proposed objective. In order for this study to be successful, the structure and internal processes of the case study were defined with the expectation that they would produce positive effects on its performance and results.

In general terms, the general result of this test is different from what is commonly worked in the classroom, since a topic that has a direct impact on human rights is being addressed, specifically with the female and male groups, resulting in a high participation of the subjects of the study, considering in turn a positive scenario and acceptance of this analysis strategy.

The majority opinion of this case study was to perceive this technique as innovative because the knowledge was acquired outside the classroom, identifying the competence achieved immediately when the phrase was captured as the final result in the sustainable carpet, which in turn encouraged teamwork, obtaining a reflection from two areas.

The first approach was a group criterion where empathy was practiced, the identification of roles in a team and active listening to be able to generate the group opinion being exposed to the rest of the working groups; the second approach allowed to identify and expose ideas in a personal way, while respecting the opinion of the rest, improving and providing new knowledge on issues that are latent in society.

The students immersed in the activity allowed the creation of a space for reflection given that the dialogue was achieved in a binary and even group manner since they were able to adopt new ideas and even managed to strengthen their own. This was achieved because the activity was carried out in an environment of equality.



**Graphic 1** Strengths of the strategy

Source: Prepared by the authors based on interviews conducted from January to April 2023.

In response to the question, "What do you think are the personal benefits of the sustainable carpet?", the answers are very broad, see Graph 2, the code identified with the greatest predominance is "reflection", with which the students confirm the existence of a reading, the construction of sentences and a personal awareness of a problem. Secondly, they expressed, it contributed to learn the concept of "non-discrimination", thirdly, a benefit perceived by the students was generated a "respect" and the time allowed to reflect on the "value of women" with which are positive indications of the actions taken, fourthly, they learned of "human rights" and generated a "conscience", these findings confirm the role of the teacher in teaching values and human rights, Terigi (2013).

Fifthly, of importance from what was done with the interviewees, the strategy helped to obtain "other perspectives", there being a "learning" and at the same time, "actions against violence" are necessary, thus complying with what is expressed by UNESCO (2020) in relation to the construction of just societies.



**Graphic 2** Benefits of the strategy

Source: Prepared by the authors based on interviews conducted from January to April 2023

A question asked to the students, what is your perception of violence against women, the data is presented in Graph 3, the code with the highest predominance is "unacceptable", in second place "do not allow it anymore".

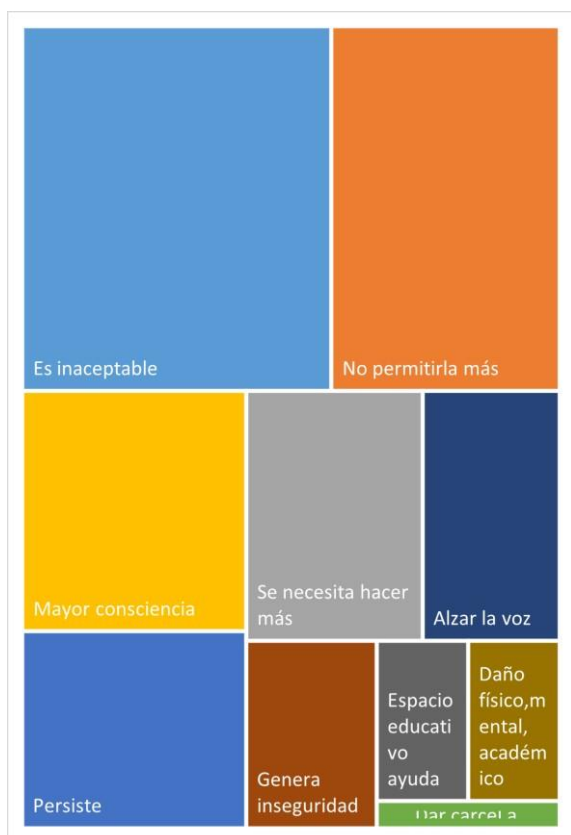
These elements are responses that should and can be addressed by education and it is necessary to carry out planned, systematic and experiential actions to achieve attitudinal and meaningful learning.

Clearly in this problem it is necessary to generate a "greater awareness" and in the region "it persists" and "more needs to be done", with which students ratify the idea of UNESCO (2015), where it is necessary to have an active participation before this situation and the idea of improving in our environments it is possible to reverse the situation, but it depends on each one, therefore, the role of the teacher is, not to separate the knowledge proper to the career with the topics of human rights.

The question makes visible the need to "raise our voices", this is a perception of great importance due to the fact that the participants consider the need to not remain silent and ask for support in these situations.

The attitudinal strategy contributes to give strength to all those involved in this problem when applying human rights.

The interviewees consider the existence of "a generation of insecurity" with which it manifests itself in a personal, professional, social or other way, this code forces a vital action, channeling students who have this problem to other areas of the university institution, such as the psycho-pedagogical department for being the experts or medical area, the strategy contributed to clarify the purpose of these.



**Graphic 3** Perception of violence

Source: Prepared by the authors based on interviews conducted from January to April 2023

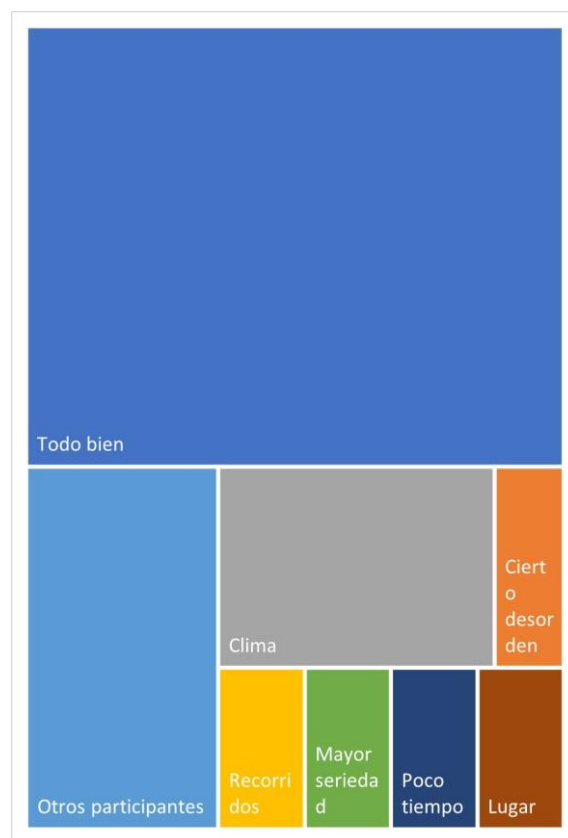
In response to the question "What did you not like about the sustainable carpet?", the results are shown in Graph 4. Firstly, the answer "everything is fine", thus the planning and development of the strategy is satisfactory and at the same time the premise of Silberman (2006) on active learning is fulfilled, because the purpose is to have the student as the center and the construction of activities is done individually, in collaborative teams and cooperatively with other students in classrooms different from their own.

But there are areas of opportunity, the "other participants" are identified, that is, some students of the career did not take it with the required seriousness, they did not give the value of what was being done and that forces to improve in the following editions of the strategy.

Thirdly, "the weather" is a factor to be reviewed, since it is done outdoors, there are weather conditions typical of the region, which affect and impact, undoubtedly it is necessary to take care of this situation, in subsequent occasions it will be done earlier to take care of the integrity of the students.

When working with human beings it is always necessary to continuously improve, within the suggestions are "some disorder", this because at the beginning the students did not know the corridor to go through, undoubtedly it is necessary a team of teachers with more training and a global vision of the activity, "routes" it is necessary to place some kind of signage for the progress of the educational community, "more seriousness" some students did not express this concept and empathy with the students who wrote their sentences, "little time", the activity was developed in one hour for writing and another for dialogue in an intensive way. The "place", as it was a school yard, had some discomfort, being elements to be taken care of in the next editions.

It is worth clarifying that 40 students wrote their sentences, each one took a square of 9 square meters, the extension of the whole strategy was 360 square meters and the other students who dialogued in the school yard about the sentences were about eighty people.



**Graphic 4** Things to improve in the strategy

Source: own elaboration based on interviews conducted from January to April 2023



As a process of methodological triangulation, we present some of the phrases constructed during the strategy, Mercedes, "Perseverance is the key to success, therefore, women should not forget it", Ana Karen, "I deserve dignified treatment without abuse", Anahi, "I woman, I am free to choose who to marry", Marlene, "We should never give up, much less lose hope", Lupita, "Women are born free and remain free", Elena, "The art of teaching human rights is the art of helping to discover", Xóchitl, "We are an example for other women, we must show that we are capable of achieving everything", Fabiola, "If we do not advance the world stops, human rights are the path to follow today and always", Anahí, "You do not select your family but your partner, yes, his way of being, yes, the way he treats you, yes, good luck! "Esmeralda, "I am a woman, I have the right to security in all its forms", Juan, "Knowledge does not depend on gender, nothing should stop it". With the contributions it is possible to infer in that the social problem is very present in this region and as teachers we must build scenarios to reverse this situation, that is, learn to transform oneself and the environments, thus responding to the call of education for sustainable development for educators and educational institutions.

Pablo, "Pay attention: No one should be silenced, everyone should be listened to", Karen, "Every free woman leaves fear behind and faces her destiny with human rights", Ivonne, "I am free to have my own opinion and to be able to express it", Gaby, "Something clear, women are free and nothing should change it, today and always", Kevin, "Staying silent is the worst torture", Uriel, "Enough, I want to live, not to think that I must survive", Salome, "Not one more woman humiliated, neither by her gender, nor by men", Dulce, " Women are free, we want to live without fears or fears", these ideas agree with Pineda-Alfonso (2017), because the author seeks to give a new meaning to an attitude from his experience. The contributions are diverse and strengthen values and attitudes in the foreground, it is necessary to continue with academic work to consolidate this meaningful learning.

In the image of Figure 1, the participation of a group of students around the constructed phrase is appreciated, clearly a feeling of liking in the realization of the sustainable carpet is visualized.



**Figure 1** Participating group

*Source: Own elaboration April 2023.*

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To the group leaders of the 5 C and 5 D of the generation 2021-2023 because their support was total to carry out this activity, without their collaboration and cooperation it would not have been possible. Morales Torres Mercedes and Juárez Cirne Juan Pablo, thank you, as well as to each of the members of these groups.

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## Conclusion

The objective of the research was fulfilled by identifying the perception of the student community, as well as their active participation, these elements are fundamental for the strategy because they are evidence of the actions carried out, but above all they are evidence of learning. There is an acceptance of the "Sustainable Carpet" strategy because most of them managed to follow the steps and contribute with their contributions at different times, but all of them concluded with the innovative strategy.

These steps are considered fundamental, but the student must apply them in their daily and professional life and within their society, that is, it has an immediate utility, this happened for men and women without distinction, with this there was a personal construction from what happens in the environment, being a success factor for the development of the proposed strategy. In conclusion, the strategy is viable for this group of students because the steps followed contribute to their attitudinal learning.

The strategy generated can be adapted to a specific topic, in our case we took human rights, but it is possible to take another gender or attitudinal topic, likewise, the steps followed have an active learning and the teacher at all times is in the background, building his proposal with the student, but the student makes his decisions at all times, that said, the fifteen steps followed make up a useful methodology for this generation of students.

The value of the strategy is to make use of existing resources such as mobile devices, internet of the institution, active participation of students, dialogue with other students of the career, school playground, university dissemination system, all of them aligned to the profile of graduation of the career because critical thinking, leadership, empathy, decision making was used and at the same time, it was an activity within the action plan to reduce school dropout, this because it helps integration between different school groups, therefore, there was a high degree of feasibility in its implementation and deployment of playful activities.

By developing these competencies, students acquire skills to interact effectively with their environment, understanding the importance of their professional activity in relation to society, the environment and the economy. This implies a proactive and responsible attitude, oriented towards the search for sustainable and equitable solutions.

By balancing the social, environmental and economic aspects, students not only prepare themselves to perform efficiently in the workplace, but also contribute to the construction of a more just and sustainable society. Awareness of the interdependence between these aspects allows them to make informed and ethical decisions, considering the impact their actions have on their environment.

In summary, the generation of attitudinal strategies provides students with the opportunity to develop integral competencies and promote a balanced quality of life. By fostering a conscious and responsible attitude, they are prepared to face the challenges of today's world and contribute positively to their community and the environment in general.

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## Rainwater harvest, an alternative for water supply for human consumption

### Cosecha de agua de lluvia, una alternativa para el abastecimiento de agua para consumo humano

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#### Abstract

One of the millennium development goals is to have the world population without sustainable access to safe drinking water and basic sanitation. Another challenge of the millennium also states that every human being has the right to clean water, which implies access to minimum quantity and quality values to meet their basic needs; however, rapid urbanization, industrialization and population growth, have reduced the availability of drinking water. In this sense, several alternatives have been practiced in order to solve this problem. Recent studies have demonstrated the economic, social and environmental benefits of harvesting rainwater in different regions, water harvesting systems provide flexible solutions that can properly meet the needs of existing and future demands. The overall objective of this research was to monitor the quality of water stored in rainwater harvesting systems installed in the state of Zacatecas, Mexico this technology was developed by a group of researchers CA-177 of the Autonomous University of Zacatecas. The determination of cations Na<sup>+</sup>, K<sup>+</sup>, Mg<sup>2+</sup>, Ca<sup>2+</sup> and trace elements was performed by atomic absorption (AA Team ThermoScientific ICE 3300) under the NMX-AA-012-200-SCFI APHA standard. Results indicate that quality of water stored in tanks receiving rainwater meets the Mexican Standard NOM-127-SSA1-1994 and WHO for human consumption. It is concluded that physico-chemical and biological characteristics of harvested water is suitable for all purpose, demonstrating that this technology is inexpensive and represents a sustainable alternative to supply water in marginal areas of Zacatecas and Mexico.

**Rainwater, Tank reservoir, Acceptable quality**

#### Resumen

Uno de los retos del milenio es que la constante población en crecimiento tenga un acceso sustentable al agua limpia con una calidad adecuada para consumo. Este reto implica valores de calidad y cantidad para conocer las necesidades básicas; sin embargo, la pronta urbanización, industrialización y crecimiento poblacional han reducido la disponibilidad del agua potable. En este sentido, diversas alternativas se han llevado a la práctica para la solución de este problema. Estudios recientes han demostrado beneficios económicos, sociales y medio ambientales al cosechar el agua de lluvia de diferentes regiones alrededor del planeta. Los sistemas de cosecha de agua de lluvia proporcionan soluciones flexibles que pueden cumplir ampliamente las necesidades de las demandas de agua actuales y futuras. El objetivo general de este trabajo fue monitorear la calidad de agua almacenada en los sistemas de cosecha de agua de lluvia instalados en diferentes puntos de Zacatecas, México, tecnologías que fueron diseñadas por investigadores del CA-UAZ-177 “Uso y conservación de los recursos hídricos”, de la Universidad Autónoma de Zacatecas “Francisco García Salinas”. Se determinaron diversos cationes como: Na<sup>+</sup>, K<sup>+</sup>, Mg<sup>2+</sup>, Ca<sup>2+</sup> y elementos traza mediante la adsorción atómica (AA Team ThermoScientific ICE 3300) regulados por la norma estándar NMX-AA-012-200-SCFI APHA. Los resultados indican que el agua almacenada en estos sistemas cumple con las normas oficiales (nacionales e internacionales) para consumo humano. Se concluye que las características físico-químicas del agua cosechada es adecuada para tal propósito, demostrando que esta tecnología es económicamente factible y representa una alternativa sustentable para el abastecimiento de agua en zonas marginadas de esta región semiárida de México.

**Cosecha de agua de lluvia, Región semiárida mexicana, Calidad del agua de cosecha**

**Citation:** GONZÁLEZ-TRINIDAD, Julián, VEYNA-GÓMEZ, Ana Isabel, JÚNEZ-FERREIRA, Hugo Enrique, BAUTISTA-CAPETILLO, Carlos Francisco and ROBLES-ROVELO, Cruz Octavio. Rainwater harvest, an alternative for water supply for human consumption. Journal of Urban and Sustainable Development. 2023. 9-24:12-17.

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## Introduction

One of the developing sustainable objectives by UNO, is to reduce the half of population without access to clean water and basic services of disinfection. In this sense, an increase of 3.3 million of low-cost housing is estimated at 2007 to 6.4 million of housing by 2050 without access. Climate change worsen the situation mainly with the rainfall events (increasingly prolonged periods or devastating events) (UNO, 2008).

Since the whole population, by human rights, have right to access to clean water, the previous will imply to supply water in quantity and quality in order to satisfy the basic needs that in the worst case it will be 60 liters/person/day (WHO, 201720). In order to achieve a good service this will imply in good benefits to health worldwide. A highest water consume produces two improvements to the system: the modernization of the integrated system to supply to more population and health improvements.

In other sense, the rapid urbanization, industrialization, and constant growth population, affects the water availability and water degradation as one of the biggest problems. Against this, government institutions are looking for sustainable alternatives helping to solve this issue. Recent studies have shown benefits in these aspects: economics, social and environmental, at collecting/harvesting water for housing roofs in order to satisfy a low-medium proportion of the water demand in individual vulnerable housing or rural communities (Young, et al. 2010).

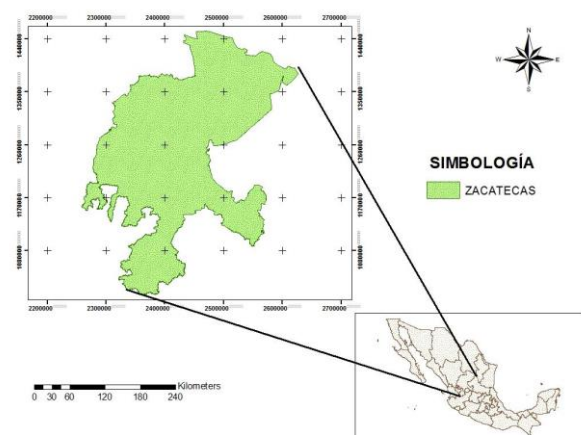
Harvesting water systems proportionate flexible solution that could proper satisfy the current and future water demands (Preti, P. and Ataur R. 2021). One of the main advantages of adopting these technologies is the low maintenance costs, accessibility and building easiness in common houses, besides being a sustainable alternative of water supply (Fayez, et al., 2009; Méndez et al., 2011).

Rain water quality remains inside the storage deposit properly designed, operated and maintained, water must be protected against solar radiation and external agents must be avoided to enter to the tank, sediments also must be controlled through filters. These technologies guaranty water supply for vegetable gardens and human consumption (Al-Salaymeh, et al., 2011).

Based on the previous, this research work consisted on measuring the water quality of harvesting water in reservoirs in order to satisfy the water demands in vulnerable family houses and low-income communities in a central-north Mexican arid region. As specific objectives the physical, chemical, biological, metals characterization will be performance to harvesting water in order to compare these parameters with the ones reported by the Mexican Official Norms that regulates these values for use and human consumption.

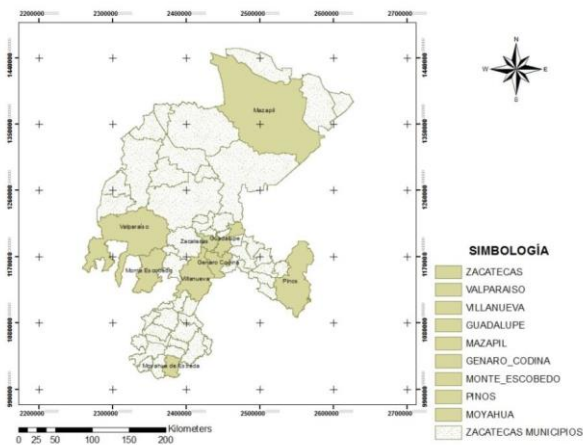
## Materials and methods

Zacatecas state is located in Mexico north, between high mountains and plain terrain, in the coordinate's  $100^{\circ} 43'$  y  $104^{\circ} 22'$  west and  $25^{\circ} 7'$  y  $21^{\circ} 1'$  north and at 2400 m.a.s.l. At the north Zacatecas is adjacent to Durango and Coahuila and at the east with Nuevo Leon and San Luis Potosi, in the south with Guanajuato, Jalisco and Aguascalientes, meanwhile at the west in next to Nayarit. Zacatecas has 73 103 km<sup>2</sup> (INEGI, 2010). It is the number eight of the states in Mexico and represents 3.8% the total country surface (Figure 1).



**Figure 1** Zacatecas state location

The weather is semiarid with a W classification and rains in summer and winter with an annual average of 492 mm and a mean annual temperature of 18°C and 1990 mm mean evaporation (CONAGUA, 2010). Harvest systems have been installed in Zacatecas state mainly in the municipalities of Valparaíso, Monte Escobedo, Guadalupe, Genaro Codina, Pinos, Mazapil, Villanueva, Moyahua, among others, in order to supply drinking water and backyard irrigation (Figure 2).



**Figure 2** Water harvesting systems location

#### *Water sampling from the storage reservoirs*

The illness related with water pollution for human consumption have a great repercussion on human health. Official norms worldwide establish the maximum standards for each element depending on the country. In Mexico, the current norm NOM-127-SSA1-1994 (DOF, 2022) established these limits for water quality.

In order to evaluate the water quality collected in the storage tanks, it is recommended to analyze the following elements Ca<sup>2+</sup>, Mg<sup>2+</sup>, Na<sup>+</sup>, K<sup>+</sup>, Fe, SO<sub>4</sub><sup>2-</sup>, Cl<sup>-</sup> (main ions), besides the field measurements of pH, electric conductivity and temperature (Al-Salaymeh et al., 2011). All measurements were performed with specific equipment and work team at the Autonomous University of Zacatecas in the hydro-geochemical laboratory.

The samples were taken according to APHA-SMWW 2006 and the NMX-AA-005-SCFI-2013, the bottles used were washed the day before and left in a cleaning solution for at least 12 hours, then they were rinsed under running water and a second rinse with distilled water was applied (Figure 3).



**Figure 3** Water samples

#### *Determination of laboratory parameters*

Na<sup>+</sup>, K<sup>+</sup>, Mg<sup>2+</sup>, Ca<sup>2+</sup> cations and trace elements were performed by atomic absorption spectrometry, which is based on the amount of energy absorbed by an element atomized in a flame at a characteristic wavelength that is proportional to the element's concentration. In the sample, in a limited range of concentrations, determined in a ThermoScientific ICE AA 3300 Equipment under the NMX-AA-012-SCFI-2001 standard. Chlorides, Cl<sup>-</sup>, Sulfates and Bicarbonates.

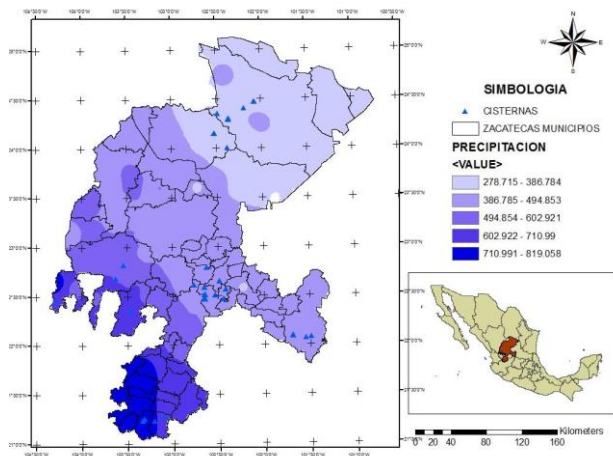
Fecal coliforms, which is determined by a selective and differential enrichment test for the detection of microorganisms from the coliform group in various products and to investigate the presence of E. Coli by fluorescence (Preti, P et al., 2022). The DBC reagent contains the chromogenic substrate of the enzyme 5-bromo-4-chloro-3-indolyl-B-D-Galactopyranoside (X-GAL) for the detection of β-galactosidase (an enzyme indicative of the coliform group). In the hydrolysis of β-Dgalactosidase. X-GAL releases a chromogenic compound (indigo-blue) that turns the medium from light yellow to a blue-green color. It also contains the fluorogenic substrate of the enzyme 4-methyl-umbelliferyl-b-d-glucuronide (MUG) for the detection of β-glucuronidase (a specific enzyme for E. Coli). On β-glucuronidase hydrolysis, MUG releases 4-methylumbelliferone which fluoresces when exposed to ultraviolet light. Fluorescence distinguishes the presence of E. coli from the coliform group.

Heavy Metals: The Thermo ICE 3300 Spectrometer is an efficient atomic absorption device engineered for elemental analysis of major, minor and toxic elements. This ergonomic design features improved software, an integrated oven vision system, an improved burner design, and an extensive self-optimization procedure.

**Results**

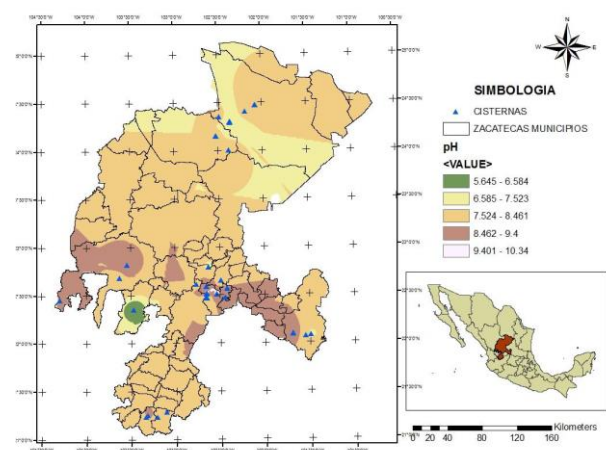
*Geographical information systems*

The locations of the water samples present a large variability in rainfall: 200 mm per year in the north region, 450 mm per year in the central region and 800 mm per year in the south (CONAGUA, 2010). Figure 4 shows the potential points where sample water were taken.



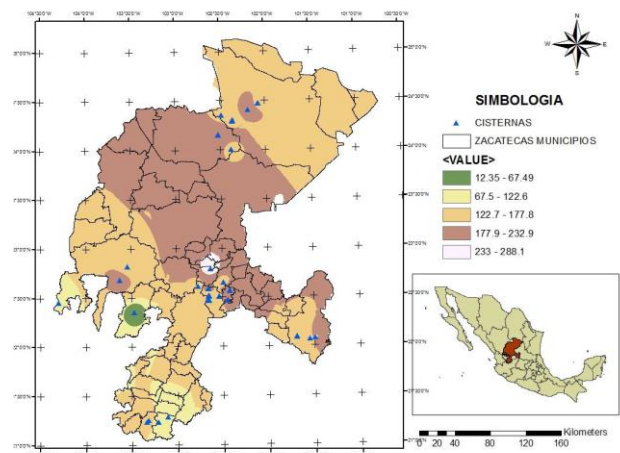
**Figure 4** Spatial rainfall patterns in Zacatecas state

Results of water quality shows that the water could widely be used for human consumption with an acceptable value excepting for some pH values that were larger in some specific regions as it is shown in Figure 5.



**Figure 5** pH values spatial variation in storage tanks

Electric conductivity values in rainwater were between 12 y 312  $\mu\text{s/cm}$  (Figure 6), concluding that the different materials in the roof affects the conductivity, there values were compared with the reported by Farreny et al., 2011; Mendez et al., 2011 and Gikas, et. al., 2012 and Baby et al. 2019 with similar values to the ones of this research.



**Figure 6** Electric conductivity spatial variability

The nitrates analysis shows concentrations between 0.6 – 5.4 mg/l which are acceptable according to the norm NOM-127-SSA1-1994 (DOF, 2022) and OMS with a maximum value of 10 mg/l, obtaining in this research a mean value of 2.6 mg/l, these could be probably due the organic sediments form animals in the regions that were similar to Young Lee et. al., (2012) in south corea.

Values of 2.8 and 2.4 mg/l have been found for metal and concrete roofs, respectively. In other sense, Al-Salaymeh et al., (2011) reports values between 1.5-7.0 mg/l according to values measured in Palestina in previous research works. Abaynew et al. (2022) and Mendez et al., (2011) indicate that the nitrates concentration of the first season rain is significantly larger than in previous rains, they reported that nitrates come from organic sediments in the capitation area. Gikas et al. (2012), also found similar results previously discussed. In this research, the animals stay too close to the tanks where the water was measured justifying the presence of nitrates (Figure 7).



**Figure 7** Storage tank type

High iron concentrations were found (0.0491 mg/l) with high values were obtained when iron sheets in roof were installed or also because of the high concentrations in concrete, none of the results indicate upper values compared with the maximum established in the norm NOM-127-SSA1-1994 (DOF, 2022).

Mean lead concentration was 0.0043 mg/l, just the 15 % showed presence of lead in low quantities. Zinc was found in a rank of (0.0024 – 0.7054 mg/l) with a mean value of 0.0914 mg/l with acceptable values according to the norm. The 51% of the samples indicate the presence of this metal. Mendez et al. (2011) showed that in iron roofs is common also found zinc. Physical, chemical and biological characterization in laboratory. The physical, chemical and biological parameters were analyzed in the reservoirs showed in Figure 4 and the results are shown in Table 1 and the results were compared with two official norms.

| Parameter                     | Rank               | Average       | NOM-127-SSA1-1994 (2000) | WHO (2020) |
|-------------------------------|--------------------|---------------|--------------------------|------------|
| Color (Pt-Co)                 | 1 - 95             | 28.208        | 20                       | 20         |
| Cloudiness (UTN)              | 0 -15              | 3.15          | 5                        | 5          |
| Total Solids suspended (mg/l) | 0 - 25             | 3.7           | 500                      | 500        |
| Alcalinity (mg/l)             | 9 - 253            | 97.98         | -                        | 250        |
| Total hardness (mg/l)         | 10 - 210           | 100.72        | 500                      | 500        |
| Chloride(mg/l)                | 2.75 – 16.79       | 8.43          | 250                      | 250        |
| Nitrate (mg/l)                | 0.6 - 5.4          | 2.6           | 10                       | 10         |
| Sulphate (mg/l)               | 0 - 69             | 8.93          | 400                      | 250        |
| Total coliform                | absence - presence | 74 % presence | absence                  | absence    |
| E-coli                        | absence - presence | 58% presence  | absence                  | absence    |

**Table 1** Water comparison between standards of NOM-127 (2000) and WHO (2020)

## Acknowledgments

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## Conclusions

The reservoir tanks built in the Zacatecas state are a sustainable alternative in order to storage high quality water and according to the precipitation data these could satisfy the water demand that lives in this arid region.

The tanks capacity is up to the collection area of each house, the rainfall and the water demand. These parameters could vary in volume of water, making necessary the simulation and the variables analysis will determinate the water supply during the year.

Water variables measured were suitable and recommended for human consumption, nevertheless the biological variables require much more careful and analysis. Chlorinating the water in the filtering phase could be a suitable alternative without compromise the quality avoiding illness such as typhoid and cholera.

The water color overpass the maximum values reported in NOM-127-SSA1-1994 that generally is due the organic matter, this problem could be solved by filtering the water. The metals concentration of Fe, Pb y Zn were obtained as low, not representing a risk for health in humans.

Physical, chemical and biological variables measured in water tanks shows the same rank that in geomembranes, showing that these technologies implemented by the academic group CA-177 from the Autonomus University of Zacatecas is a low-cost alternative that could be implemented in low-cost housing.

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## Evaluation of luminance levels. digital tool or traditional device? case study: Alameda Park in Saltillo, Mexico

## Evaluación de niveles lumínicos ¿herramienta digital o dispositivo tradicional? caso de estudio: la Alameda en Saltillo, México

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### Abstract

Assessing luminance levels in outdoor public spaces is relevant for the lighting design of architectural and urban environments. This article compares a digital tool and a traditional device for measuring luminance levels in outdoor settings, aiming to explore the pros and cons of each method and offer guidance to public space designers. The study involves a literature review of luminance measurement techniques and a comparative analysis of the results obtained using Fusion Optix software and a lux meter. Both methods exhibit benefits and drawbacks, with the choice of method hinging on the specific context and evaluation objectives. Generally, digital tools provide a more efficient and precise measurement of luminance levels, while traditional devices contribute to a broader understanding of the lighting environment. It is recommended that a combination of digital tools and traditional devices be employed in luminance assessments to achieve the most accurate and comprehensive results.

### Resumen

Evaluar los niveles de luminancia en espacios públicos exteriores es de gran importancia para el diseño de iluminación de entornos arquitectónicos y urbanos. Este artículo presenta una comparación entre una herramienta digital y un dispositivo tradicional para medir los niveles de luminancia en entornos exteriores, con el objetivo de explorar los pros y los contras de cada método y ofrecer orientación a los diseñadores de espacios públicos. El estudio implica una revisión de la literatura sobre técnicas de medición de luminancia y un análisis comparativo de los resultados obtenidos utilizando el software Fusion Optix y un luxómetro. Ambos métodos exhiben ventajas e inconvenientes, y la elección del método depende del contexto específico y los objetivos de la evaluación. En general, las herramientas digitales brindan una medición más eficiente y precisa de los niveles de luminancia, mientras que los dispositivos tradicionales contribuyen a una comprensión más amplia del entorno de iluminación. Se recomienda emplear una combinación de herramientas digitales y dispositivos tradicionales en las evaluaciones de luminancia para lograr los resultados más precisos y completos.

### Daylight, Luminance maps, Public space

### Espacio público, Luz natural, Mapas de luminancias

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## Introduction

Evaluating luminance levels in outdoor public spaces is a fundamental aspect of lighting design. Luminance refers to the amount of light emitted or reflected by a surface and is measured in candelas per square meter (cd/m<sup>2</sup>) (Rea, 2019). In outdoor settings, luminance is influenced by several factors, including the position of the sun, locations of light sources, and the reflectivity of the surface (Krawez et al., 2021).

Measuring luminance is essential to ensure lighting design is appropriate for the intended use of outdoor spaces and to comply with safety and energy efficiency standards (Kwong, 2020). Natural light in built environments allows for comfortable and environmentally sound conditions for occupants, while providing the necessary light levels to meet human visual requirements (Córica & Pattini, 2005).

Using light as art can create comfort and various sensations, such as spaciousness and safety. The qualities of light, whether from natural or artificial sources, can be evaluated through either qualitative or quantitative parameters (Hosamo et al., 2023). In lighting, two terms are to be considered: illuminance and luminance:

- Illuminance is the amount of light needed to distinguish what we see, measured in lux or lm/m<sup>2</sup>.
- Luminance is the amount of brightness or luminous energy perceived by the human eye from a surface, caused by a light source, measured in cd/m<sup>2</sup> or fL.

The difference between the two is that illuminance is a measure of light (quantitative) and luminance is related to visual perception and psychological sensations of light in relation to brightness (qualitative).

Visual comfort is an essential aspect of the design of both interior and exterior spaces. Therefore, studies using various tools and devices to evaluate outcomes and enhance proposals for the benefit of users are necessary.

Córica & Pattini (2005) suggest that predicting the behavior of natural light in urban settings requires an appropriate method that considers both objective (measurement-based) and subjective (occupant visual comfort evaluations) parameters.

Gutiérrez, Quintero, and Bermeo (2016) note that the performance of a digital camera as a luminance measuring instrument directly depends on the image format in which the camera processes and delivers the files. The amount of light the electronic sensor can capture and convert into an electrical signal depends on user-configurable parameters.

Rodríguez, Dumit, and Pattini (2019) compared illuminance values obtained with an LMT Pocket Lux 2 lux meter (as a gold standard) to illuminance readings from three Android applications installed on two different mobile devices in various scenarios with decreasing illumination levels, from 19 to 7495 lux. Their results showed an average error of 81.8%, indicating that these applications are still not suitable for ergonomic practice. The values obtained varied depending on the application and device used, without statistical significance, so it's not possible to recommend a specific application based on its accuracy. However, the selection criteria for illuminance measuring applications should be based on usability.

## Digital tool or traditional device?

Evaluating luminance levels in outdoor spaces is an important aspect of lighting design. Luminance refers to the amount of light emitted or reflected by a surface and is measured in candelas per square meter (cd/m<sup>2</sup>) (Rea, 2019). In outdoor spaces, luminance is affected by various factors, including the position of the sun, the location of light sources, and the reflectivity of surfaces (Maskrenj et al., 2022). Measuring luminance is crucial to ensure that the lighting design is appropriate for the intended use of the outdoor space and to comply with safety and energy efficiency standards (Lamphar, 2023).

There are two main methods for measuring luminance levels in outdoor spaces: digital tools and traditional devices (Pan & Du, 2021). Digital tools include luminance meters that use digital cameras to capture images and software to analyze the images and calculate luminance levels (Kamath et al., 2022). Traditional devices include luminance meters that use photometers to directly measure light levels (Pan & Du, 2021). Both methods have their advantages and limitations, and the choice of method depends on the specific context and evaluation objectives.

Below is a comparative chart summarizing the advantages and disadvantages of digital tools and traditional devices in measuring luminance levels in outdoor spaces.

This chart aims to provide a quick visual comparison of the key features of both measurement methods, see Table 1.

| Aspect to Compare                        | Digital Tools  | Traditional Devices  |
|--|--|--|
| Efficiency                               | Fast and accurate in measuring luminance in outdoor spaces                                     | Laborious and slow process in large areas  |
| Complex Lighting Environments            | May be more accurate than traditional devices  | Possible difficulty in capturing all variations in luminance levels                |
| Visual Representation of the Environment | Provide images showing the distribution of luminance levels                                    | Limited ability to provide a visual representation of the lighting environment     |
| Dependence on Software and Algorithms    | Yes  | No   |
| Measurement of Other Light Parameters    | Limited ability to measure color temperature and color rendering                               | Ability to measure color temperature and color rendering                           |
| Comprehensive Lighting Evaluations       | May be limited in their utility due to the inability to measure other parameters               | Provide more comprehensive evaluations of the lighting environment                 |
| Reflective Surfaces and Shadows          | Possible difficulty in capturing all variations in luminance levels in these areas             | Possible difficulty in capturing all variations in luminance levels in these areas |
| Identification of Luminance Areas        | Facilitate the identification of areas of high and low luminance levels for design adjustments | Limited utility to identify areas of high and low luminance levels                 |

|                                 |  |   |
|---------------------------------|--|---|
| Accuracy in Simple Environments | May be less accurate compared to traditional devices | Higher accuracy in simple lighting environments with low surface reflectivity |
|---------------------------------|--|---|

**Table 1** Comparison of digital tools and traditional devices regarding various aspects of luminance measurement in outdoor spaces

Source: Miriam Mery-Ruiz 2023

Based on what has been previously stated, the main objective of this study is to compare a traditional device with a digital tool in evaluating luminance levels in outdoor spaces during daylight conditions. This analysis will take place in the children's play area of a public space known as La Alameda, located in the city of Saltillo, Coahuila.

Heat map images, a form of qualitative data visualization, have gained importance in various fields due to their ability to transform quantitative data into easily understandable visual representations (Kochhar et al., 2020). These visualizations help identify patterns, trends, and areas of interest, leading to more informed decision-making (Dzidic, 2023).

#### *Revealing patterns and trends: the impact of qualitative visualization through heat maps from quantitative photographs*

Heat maps have become a predominant tool for visualizing data and revealing patterns and trends in quantitative data (Khder et al., 2021). With the advancement of new technologies, they have evolved to include luminance maps as a way to visualize qualitative data from quantitative photographs (Zuo et al., 2022).

Heat maps are graphical representations of data that use color to represent data values. They are used to visualize large amounts of data and are particularly useful for identifying patterns and trends in complex datasets. They are created by plotting data values in a matrix format and using color to represent the data values. (Crameri et al., 2020). The color used in a heat map typically ranges from cool colors like blue and green to warm colors like red and yellow (Tham et al., 2020). This color representation allows users to quickly identify areas of high and low data values in the dataset.

Luminance maps, on the other hand, are a type of heat map that uses luminance values to represent data values (Stoelzle & Stein, 2019). These are created by plotting data values in a matrix format and using luminance values to represent the data values. The luminance values used in a luminance map usually range from dark to light, where darkness represents low data values and light represents high data values (Hattab et al., 2020).

Luminance maps have gained popularity in recent years as a means to visualize qualitative data from quantitative photographs. This is because luminance maps allow users to visualize the relative brightness of an image and identify areas of the image with high and low brightness values. Luminance maps are particularly useful for analyzing photographs because they allow users to identify patterns and trends in the image's brightness values. This can be used to identify areas of the image that are more likely to be of interest to the viewer and to emphasize areas that might require further investigation (Kheradmandi & Mehranfar, 2022).

The application of luminance maps as a method for visualizing qualitative data has had a significant impact on the analysis of patterns and trends in qualitative data (Levit et al., 2021). Luminance maps allow users to identify patterns and trends in the data that may not be immediately apparent when viewed in their raw form. This can be particularly valuable for identifying patterns and trends in large datasets, where it can be a challenge to identify patterns and trends simply by examining the data (Li et al., 2021).

## Methodology

The research was conducted with a quantitative approach and at an explanatory level. A selection and map of the study area was elaborated, see Figure 1.



**Figure 1** GIS location map of children's playground at Alameda "Zaragoza" Park in Saltillo

Source: Miriam Mery-Ruiz, based on OpenStreetMap, 2023.

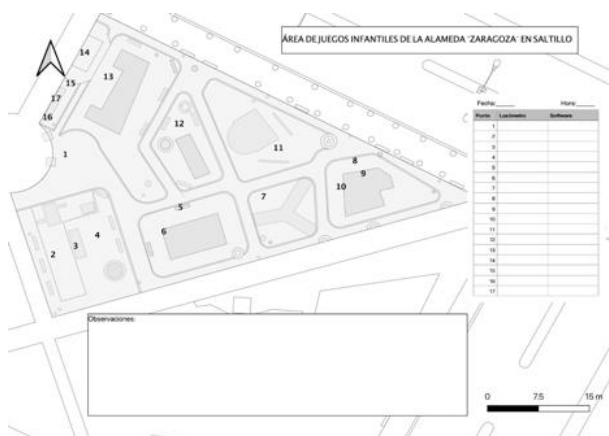
The method used was fieldwork in which measurements were made using a lux meter (traditional device), and the Fusion Optix digital tool, an application that identifies the amount of luminance in the space through photographs (Fusion Optix, 2023; Espinoza Cateriano et al., 2020). This free application was installed on a Samsung A71 cellphone and set up to measure luminance in units of  $\text{cd}/\text{m}^2$ .

The Klein Tools ET130 lux meter is an automatic digital light meter that can measure light intensity in both foot-candles and lux. It has a wide measurement range of 0 to 40,000 fc or 0 to 400,000 lux, making it suitable for a variety of applications. The meter features an easy-to-read LCD display, a hold function to freeze the current reading, and a low battery indicator. It also has a data hold and max/min function to capture and display the highest and lowest readings. The meter is compact and durable, with a protective rubber casing and a handy built-in stand. It also comes with a 9V battery and a carrying case for easy transportation and storage (Klein Tools, 2023).

The Samsung Galaxy A71 cellphone is a mid-range smartphone with a strong focus on camera capabilities. The A71 has a quad-camera setup on the back, featuring a main camera with a 64MP sensor with an f/1.8 aperture, a 12MP ultra-wide camera with a 123-degree field of view and an f/2.2 aperture, a 5MP macro camera with an f/2.4 aperture, a 5MP depth camera with an f/2.2 aperture, and a 32MP front camera with an f/2.2 aperture (GSMarena, 2020).

Fusion Optix is an advanced application designed for professionals in the optics and photonics industry. It provides a comprehensive set of tools and features to simulate, analyze, and optimize optical systems. Key features of the software include an easy-to-use interface, extensive optical component libraries, and powerful algorithms for ray tracing, radiometry, and diffraction analysis. With Fusion Optix, users can efficiently design and optimize complex optical systems, reducing development time and costs while ensuring optimal performance and accuracy (Fusion Optix, 2023).

A map, GIS in QGIS, of the study area was created. A measurement plan was established that included the selection of 17 measurement points and the hours at which the measurements would be made (one measurement every hour between 2:00 pm and 5:00 pm), see Figure 2.



**Figure 2** Instrument for measurements

Source: Miriam Mery-Ruiz, 2023.

## Results

The children's playground at Alameda Zaragoza in Saltillo is a recreational space located in Coahuila, Mexico.

According to the city government's website (Municipal Government of Saltillo, 2022), the playground was designed with the intent to promote physical activity and healthy habits among children and families in the area. The playground is equipped with a variety of features, including swings, slides, climbing structures, and a central play area, see Figure 3.



**Figure 3** Photographs of children's playground at Alameda "Zaragoza" Park in Saltillo

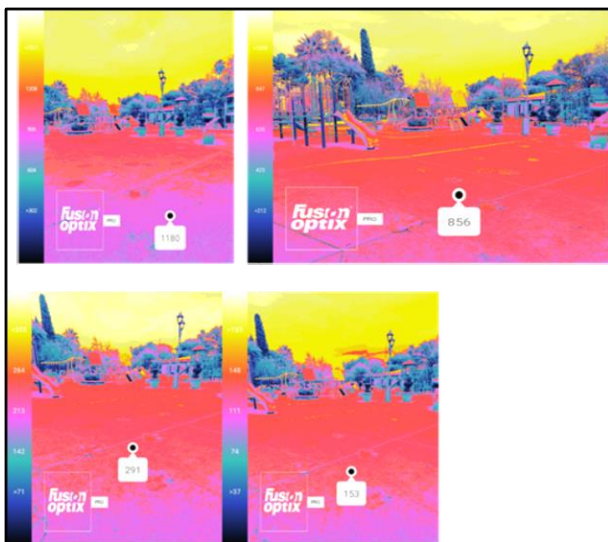
Source: Miriam Mery-Ruiz, 2023.

The measurements with the lux meter and luminance maps using the Fusion Optix software were carried out between 2:00 pm and 5:00 pm on December 21, 2021, at the measurement points shown in Figure 4.

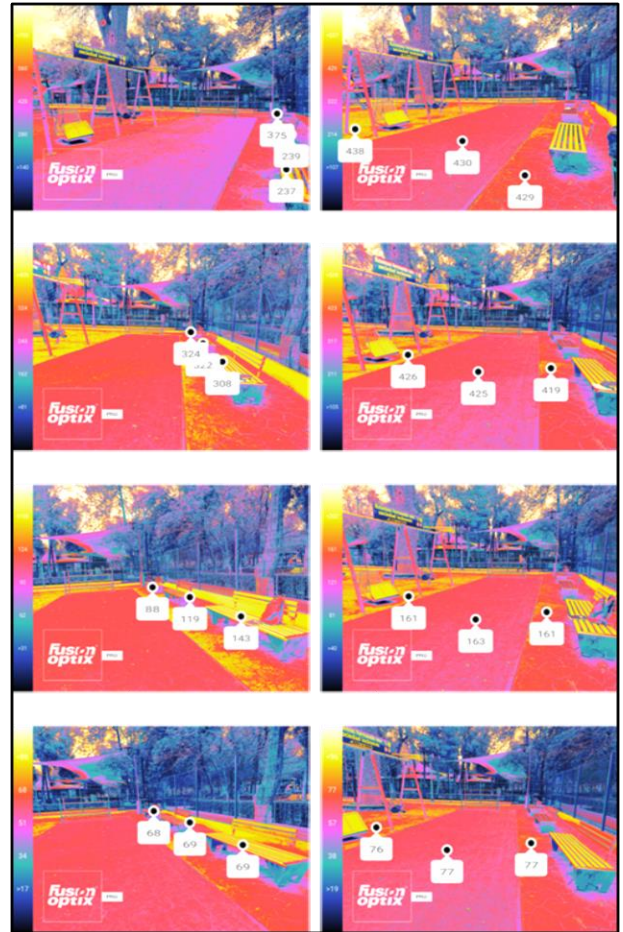


**Figure 4** GIS Map with measurement points in children’s playground at Alameda “Zaragoza” Park in Saltillo  
 Source: *Miriam Mery-Ruiz. 2023*

A photograph was taken every hour to capture the different points. The luminance maps were obtained, which can be seen in Figure 5, Figure 6, Figure 7, Figure 8, Figure 9, Figure 10, Figure 11, Figure 12, Figure 13, and Figure 14.



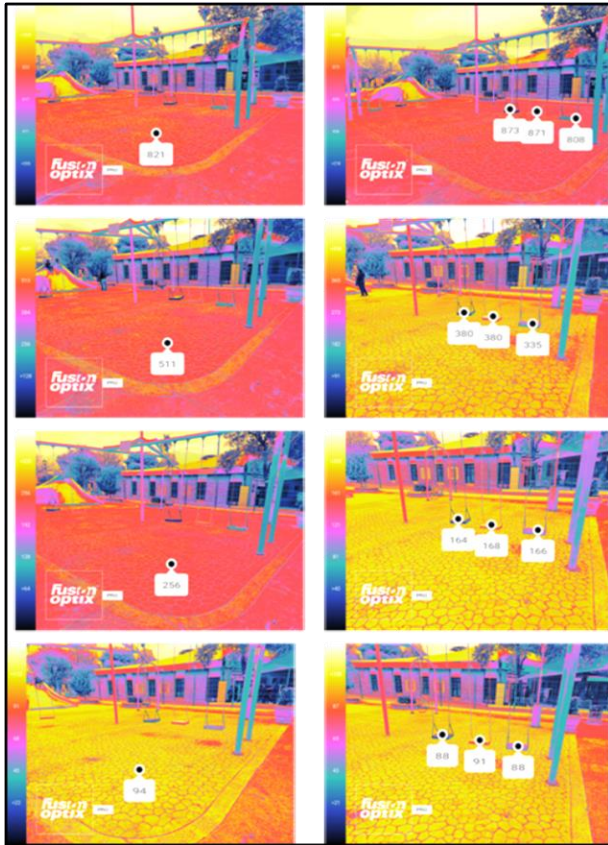
**Figure 5** Luminance maps 14:00, 15:00, 16:00 and 17:00h at point 1  
 Source: *Miriam Mery-Ruiz. 2023. Photographs taken with Fusion Optix app.*



**Figure 6** Luminance maps at 14:00, 15:00, 16:00 and 17:00h at points 2, 3 and 4  
 Source: *Miriam Mery-Ruiz. 2023. Photographs taken with Fusion Optix app*



**Figure 7** Luminance maps 14:00, 15:00, 16:00 and 17:00h at points 5 and 6  
 Source: *Miriam Mery-Ruiz. 2023. Photographs taken with Fusion Optix app*

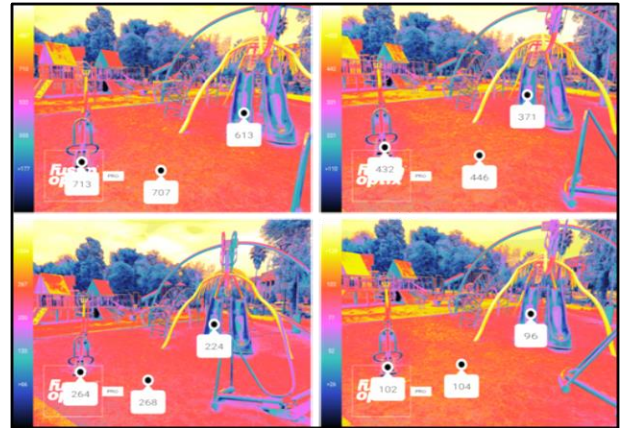


**Figure 8** Luminance maps 14:00, 15:00, 16:00 and 17:00h at point 7  
 Source: Miriam Mery-Ruiz. 2023. Photographs taken with Fusion Optix app



**Figure 9** Luminance maps 14:00, 15:00, 16:00 and 17:00h at points 8, 9 and 10

Source: Miriam Mery-Ruiz. 2023. Photographs taken with Fusion Optix app.



**Figure 10** Luminance maps 14:00, 15:00, 16:00 and 17:00h at point 11  
 Source: Miriam Mery-Ruiz. 2023. Photographs taken with Fusion Optix app.

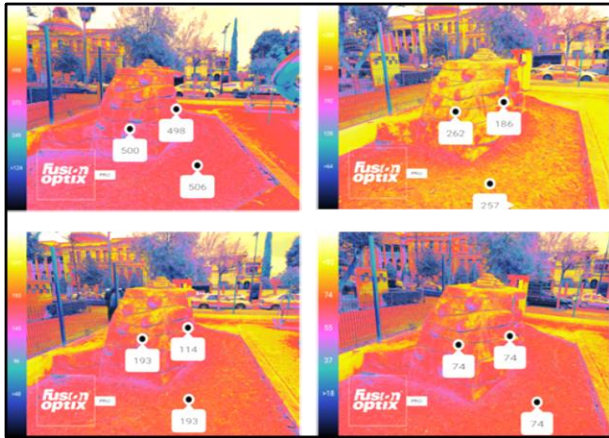


**Figure 11** Luminance maps 14:00, 15:00, 16:00 and 17:00h at point 12  
 Source: Miriam Mery-Ruiz. 2023. Photographs taken with Fusion Optix app.

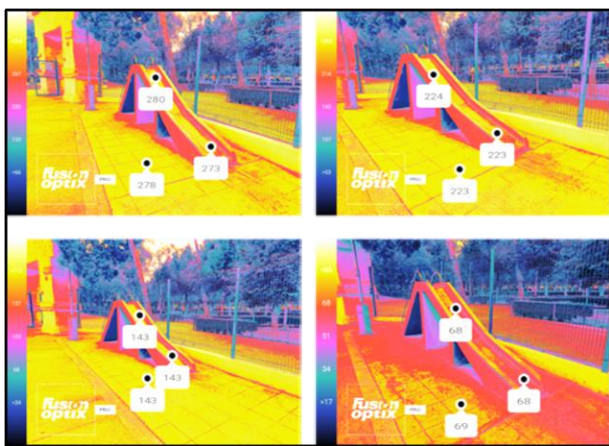


**Figure 12** Luminance maps 14:00, 15:00, 16:00 and 17:00h at point 13  
 Source: Miriam Mery-Ruiz. 2023. Photographs taken with Fusion Optix app.





**Figure 13** Luminance maps 14:00, 15:00, 16:00 and 17:00h at point 14  
 Source: Miriam Mery-Ruiz. 2023. Photographs taken with Fusion Optix app.



**Figure 14** Luminance maps 14:00, 15:00, 16:00 and 17:00h at points 15, 16 y 17  
 Source: Miriam Mery-Ruiz. 2023. Photographs taken with Fusion Optix app.

Subsequently, the information was processed into a table to identify the variations of light energy based on the time and the device or tool, see Table 2.

| Measurement hour  | Measurement with lux meter (traditional device) |       |       |       | Points on luminance maps with digital tool (Fusion Optix) |       |       |       |
|-------------------|---|-------|-------|-------|---|-------|-------|-------|
|                   | 14:00   | 15:00 | 16:00 | 17:00 | 14:00   | 15:00 | 16:00 | 17:00 |
| Measurement point | FC  |       |       |       | cd/m <sup>2</sup>   |       |       |       |
| 1                 | 2086  | 2044  | 626   | 184   | 1180  | 856   | 291   | 153   |
| 2                 | 1906  | 1868  | 703   | 220   | 429   | 419   | 161   | 77    |
| 3                 | 2339  | 2222  | 786   | 237   | 430   | 425   | 163   | 77    |
| 4                 | 2506  | 2471  | 756   | 228   | 438   | 426   | 161   | 76    |
| 5                 | 2268  | 2158  | 846   | 266   | 730   | 627   | 200   | 101   |
| 6                 | 2539  | 2295  | 851   | 273   | 836   | 657   | 237   | 101   |
| 7                 | 2359  | 1702  | 884   | 281   | 821   | 511   | 256   | 94    |
| 8                 | 2650  | 2043  | 888   | 255   | 1042  | 811   | 349   | 148   |
| 9                 | 2737  | 2101  | 909   | 241   | 1046  | 804   | 348   | 148   |
| 10                | 2757  | 2130  | 917   | 259   | 1060  | 822   | 363   | 149   |
| 11                | 2480  | 1776  | 982   | 206   | 707   | 446   | 268   | 104   |
| 12                | 2268  | 1958  | 1083  | 200   | 564   | 384   | 223   | 94    |
| 13                | 1954  | 1852  | 986   | 175   | 621   | 352   | 150   | 78    |
| 14                | 1836  | 1772  | 908   | 163   | 506   | 257   | 193   | 74    |
| 15                | 1713  | 1497  | 793   | 140   | 278   | 223   | 143   | 69    |
| 16                | 1606  | 1470  | 756   | 132   | 280   | 224   | 143   | 68    |
| 17                | 1595  | 1341  | 743   | 123   | 273   | 223   | 143   | 68    |

**Table 2** Measurement results with luxometer and in heat map photographs with luminances. (Fusion Optix)  
 Source: Miriam Mery-Ruiz. 2023

*Comparison between luxmeter measurements and photographs*

Luxmeter measurements generally yielded higher luminance values compared to the Fusion Optix photographs at all measurement points and times.

The greatest difference between luxmeter and Fusion Optix measurements was observed at point 1 at 14:00, with a difference of 906 FC (2086 FC for the luxmeter versus 1180 FC for Fusion Optix) and 864 cd/m<sup>2</sup> (2044 cd/m<sup>2</sup> for the luxmeter versus 1180 cd/m<sup>2</sup> for Fusion Optix).

The smallest discrepancy between the two measurement methods was observed at point 17 at 17:00, with a difference of only 6 FC (123 FC for the luxmeter vs. 117 FC for Fusion Optix) and 5 cd/m<sup>2</sup> (68 cd/m<sup>2</sup> for the luxmeter versus 63 cd/m<sup>2</sup> for Fusion Optix). Differences between luxmeter and Fusion Optix measurements tended to be more pronounced with higher luminance values, whereas differences were relatively smaller with lower luminance values.

The general trend of luminance values at different times of the day was similar between luxmeter and Fusion Optix measurements, with higher values recorded at 14:00 and 15:00, followed by a decrease at 16:00 and 17:00.

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## Conclusions

The analysis of measurements with the luxmeter and luminance points in Fusion Optix photographs showed significant variations in luminance values throughout the day.

Specifically, peak luminance values were identified between 14:00 and 15:00 hours, with a noticeable drop between 16:00 and 17:00 hours. Such data is instrumental for enhancing lighting conditions and furthering energy efficiency, as highlighted by (Córica & Pattini, 2005).

To gain deeper insights into these fluctuations, it may be beneficial to delve into influencing factors such as the angle of light incidence, surface attributes, or the presence of shading elements.

When comparing the data from the luxmeter and Fusion Optix, there were evident discrepancies. Typically, the luxmeter reported higher values. However, despite these disparities, both methodologies showcased a parallel trend in daily luminance values. It becomes pertinent to understand the factors behind these discrepancies, which could stem from diverse measurement techniques, calibration differences, or varied sensitivities to light conditions. Exploring these nuances further can help in discerning the most precise luminance assessment method in varying settings, as indicated by research from Córica & Pattini (2005) and Sosa Domínguez (2016).

The choice of method to measure outdoor luminance levels depends on the specific needs of the lighting designer or researcher. In some cases, digital tools might be more suitable, especially in large or complex lighting environments, while in others, traditional devices might be more appropriate, especially when a more comprehensive analysis of the lighting environment is needed.

It is pivotal to understand that utilizing digital tools for outdoor luminance measurements is still a burgeoning approach. As such, comprehending their precision, reliability, and efficacy necessitates more extensive research.

Further studies can offer clarity about the strengths and limitations of digital tools in varied contexts. They can also guide the creation of more precise and trustworthy software and algorithms designed for the analysis of outdoor lighting visuals.

The choice between digital tools or traditional devices to measure outdoor luminance levels depends on several factors, such as the complexity of the lighting environment, the accuracy and precision required, and the specific needs of the lighting designer or researcher. Ultimately, combining the use of digital tools and traditional devices can provide valuable insights into the lighting environment and contribute to the development of more efficient and sustainable lighting designs for outdoor spaces.

Existing literature underlines that both digital tools and traditional apparatus come with their set of strengths and limitations in the context of outdoor luminance measurements. While digital tools offer efficient and precise luminance measurement capabilities, traditional devices grant a more exhaustive comprehension of the lighting environment.

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## The impact of the environment on MYPES companies a comparison Mexico-Colombia

### El impacto del medio ambiente en las empresas MYPES un comparativo México-Colombia

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#### Abstract

Micro and small enterprises (MSEs) play a role of great importance in the development of any economy due to their relationship and impact on the generation of employment and economic growth, and generally worldwide, represent on average 80% of the businesses of an economy. The results determined that Colombia and Mexico should reconcile the objectives of trade and environmental policies in order to achieve the most efficient use of natural resources, the reduction of environmental damage and the most efficient use of market instruments. In the end, it was concluded that the entrepreneurs of the MSEs should attach greater importance to the construction of the reputation and prestige of their company in the market, and achieve the support and acceptance by the community, in achieving greater dynamism. Likewise, and given the importance of the knowledge, skills and abilities of employees, these companies must work to improve the low educational level of their employees and increase their professionalization.

#### Resumen

Las micro y pequeñas empresas (MyPes) juegan un papel de gran importancia dentro del desarrollo de toda economía debido a su relación e incidencia en la generación de empleo y crecimiento económico, y de manera general a nivel mundial, representan en promedio el 80% de los negocios de una economía. Los resultados determinaron que Colombia y México deberían de compatibilizar los objetivos de las políticas comerciales y ambientales a fin de alcanzar el uso más eficiente de los recursos naturales, la reducción de los daños ambientales y el uso más eficiente de los instrumentos de mercado. A final se concluyó que los empresarios de las Mypes deben conceder mayor importancia a la construcción de la reputación y del prestigio de su empresa en el mercado, y lograr el apoyo y la aceptación por parte de la comunidad, en lograr un mayor dinamismo. Así mismo, y ante la importancia que revisten el conocimiento, las habilidades y las destrezas de los empleados, estas empresas deben trabajar por mejorar el bajo nivel educativo de sus empleados e incrementar su profesionalización.

#### Environment, Impact, Companies

#### Medio ambiente, Impacto, Empresas

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## Introduction

### *Background*

Micro and small enterprises (MSEs) play a very important role in the development of any economy due to their relationship and impact on employment generation and economic growth, and in general, worldwide, they represent on average 80 per cent of the businesses in an economy. Microenterprises are all those businesses that have less than 10 workers, generate annual sales of up to 4 million pesos and represent 95 percent of the total number of companies and 40 percent of employment in the country; they also produce 15 percent of the Gross Domestic Product, according to an article published by the Ministry of Economy in 2012. A sustainable company is one that seeks success in various aspects such as: well-being of its employees, quality in its products or services, care for the environment from its responsibility to both society and its employees. Sustainability is also known as sustainability, and refers to a type of work that by taking responsible actions with the environment, innovation in its production or the impact of its work in the social and economic spheres of its country will obtain great benefits that will allow it to be maintained for a long time without exhausting its own and external resources. In this sense, the importance of this sector of the economy is transcendental for the generation of jobs, development of production, and sustainable management of the economy, according to the author (Ponce & Mercado, 2020).

In Mexico, measures and presentations have begun to be put together so that companies begin to implement sustainability programmes. Currently, one of the most common practices for companies is to send their waste to cheaper treatment plants, without really looking at whether this is the best disposal option for what they produce. This then becomes a mismanagement of industrial waste that generates a high negative impact on the environment and society. Similarly, not many companies are concerned about their participation in the social life of the country, feeling that their job is to produce or offer products and services directly and almost unilaterally to their clients, but those that take into account the social context in which they develop may have better chances of survival and success in the long term.

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It is important to highlight that environmental management is made up of the set of policies and activities that companies develop with the aim of protecting and conserving the elements that make up the environmental system in Mexico, and also has programmes focused more on visual noise, which is why in this research we want to find out how important social responsibility is for businessmen, through integrated management that leads to the prevention and mitigation of problems of an environmental nature.

Van Hoof (2005) highlights that for most MSEs, environmental management is not a relevant and priority element for their management. This low priority is due to a set of factors such as the high level of informality, the low demand of their markets, mainly local, and the low capacity of the environmental authorities to exercise control and compliance with environmental regulations. For their part, Bercovich & López (2005) mention, among the causes of the inadequacies in the environmental management of MSEs, the following: The lack of information and lack of knowledge of the regulations in force and the standards they must comply with, their requirements and deadlines; economic difficulties, as companies are reluctant to face the costs involved in the whole environmental audit process, as well as the identification of technologies that must be incorporated; difficulties in accessing financing, in particular specific lines for environmental management or clean production, added to the fact that banks, in general, have neither specific lines nor staff trained to understand projects in the environmental area; in addition, firms need support to prepare and submit applications for financing environmental projects.

In this sense, Rodríguez & Velez (2018) express that business environmental management in MSMEs can become one of the weapons to face the opening of markets, as long as the different actors of the business and environmental sector manage to orient themselves towards potential niches, for this it is required to adapt a new management that strengthens the coordination between them and leave the traditional approach of an isolated environmental management, integrating it to the competitiveness of companies and region as a whole, since as indicated by Ojeda & Mul (2015) there is a positive linear relationship between environmental management and competitiveness.

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Saavedra, Milla & Tapia (2013) citing Solleiro & Castañón (2005), point out that competitiveness is the ability of an organisation to maintain or increase its market share based on new business strategies, in a sustained growth of INNOVA Research Journal 2018, Vol 3, No. 1, 117-129. Monthly Review of UIDE Extension Guayaquil 119 productivity, on the inter-firm capacity to participate in negotiations with different institutions and other companies within its environment, on the existence of a competitive environment determined by the sector and the consumer market, and on policies introduced by national governments and regional economic alliances.

In the global economic context, Micro and Small Enterprises constitute an important part of the productive sector. In the growth of developed countries, as well as those that are in the process of achieving it, these economic units are of great relevance due to their contribution to their economic development. In Mexico, based on information from the National Institute of Statistics, Geography and Informatics (INEGI) in 2009, it is estimated that MSMEs make up 99.8% of all economic units in the country, contribute around 69% of GDP and generate 78.5% of jobs.

For these reasons, in 2011 the Sustainability Index was created in the Mexican Stock Exchange (BMV), which certifies sustainable or sustainable companies mainly according to three criteria:

- Management and use of natural resources.
- Social responsibility.
- Corporate governance.

On the other hand, the Ministry of Environment and Natural Resources (Semarnat) has registered approximately 2,000 companies with the Clean Industry certificate, which refers exclusively to their commitment to the sustainable development of the regions in which they are located. Those companies that have been certified by SEMARNAT have taken actions that in reality could be easily implemented by almost any company.

## **Problem**

The environmental irresponsibility of most corporations is one of the main causes of the environmental deterioration of the planet. This corporate attitude is expressed in global, international damage at all levels, as well as local damage. In Mexico, the environmental impacts caused by Petróleos Mexicanos (Pemex) stand out, especially in southeastern Mexico. Pemex has dramatically damaged vast regions of ecosystems rich in biodiversity and productivity, affecting the quality of life and the economy of thousands of people. This corporate environmental irresponsibility is not only found in Mexico, but also in Colombia, such as visual noise, among others. In Mexico, the Federal Environmental Protection Agency (Profepa) lacks autonomy and resources, which demonstrates the government's insensitivity and lack of interest in natural resources.

In Mexico, as in Colombia, where democracy is incipient, it is common to find that the companies with the greatest impact on the environment are those that invest the most in advertising campaigns claiming to be environmentally responsible. Pollution is one of the most important environmental problems affecting our planet; that is why it has become a subject of inevitable discussion, from the 1960s when environmental awareness began to emerge (on a global scale), to the present day, since we are both victims and perpetrators of this serious problem on a daily basis. During the last 200 years, man has added a large amount of chemicals and physical agents to the environment as a consequence of his dominance over natural resources, especially energy resources". In this way, it is easier to understand what the problem of environmental pollution means, and therefore, the approach to the current reality that covers this issue in terms of the impact of the environment on MYPES companies begins, which is why the following research objectives arise from this problem:

## **Research objective**

To identify the level of commitment of MYPES companies to the environment between Mexico and Colombia.

## **Specific objectives**

- To analyse the current situation of MSEs.

- To identify the environmental factors that influence companies and their regulation with the government.

- To design a social responsibility plan.

This research will be developed in the South of Tamaulipas with the companies affiliated to the National Chamber of Commerce and Tourism Services of Tampico, Altamira, Cd. Madero and part of the Huasteca Veracruzana. In the period 2021-2022, and in the northwest of the country in the centre of the valley in Medellín Colombia.

### **Theoretical approach**

The Micro and Small Enterprise (MSE) is the economic unit constituted by a natural or legal person (enterprise), under any form of organisation, whose purpose is to carry out activities of extraction, transformation, production, commercialisation of goods or provision of services.

The growth of micro and small enterprises in these economies is the result of an amalgam of facts, where it is necessary to highlight: the structural changes generated by the universal productive forces, particularly in the electronics industry, which caused changes in the communications and services industry; the collapse of 500 large companies in the United States (USA), a fact that Iberofórum. *Revista de Ciencias Sociales de la Universidad Iberoamericana* July-December Valdés, J (2016) mentions that in the USA decides to adopt the Neoliberal Monetarist paradigm by Keynesianism.

The implementation of the Monetarist Neoliberal paradigm, due to the size and personnel structure of the American company, which also generated durable and expensive products, combined with the fact that in all its production was in a margin of decline, which resulted in loss of financial resources and competitiveness, caused the American economy to lose spaces in international markets, decreasing levels of competitiveness, showing the exhaustion of the Fordist and Taylorist model of large scale.

In Japan, under the new Juran and Deming philosophy of Total Quality and Kaizen, a new organisational paradigm was generated within the economic space, allowing it to dominate new markets, including the North American market, with high-tech products within the reach of most consumers.

Colombia is a country whose business fabric is mostly made up of small-scale enterprises. Micro and small enterprises (mypes), defined under Colombian law as those with fewer than 200 employees and total assets of up to 30,000 legal monthly minimum wages, represent 99.5% of the national business park (Murillo and Restrepo, 2016). Given their size and the key role they play, these enterprises are fundamental for the development of the country in this sense, MSEs are considered the backbone of modern economies, being vital to sustain economic growth in the long term and with the potential to stimulate economic expansion and act as stabilisers in recessions.

A sustainable company is one that seeks success in various aspects such as: the well-being of its employees, the quality of its products or services, the origin of its inputs, its environmental impact, the social, political and economic impact of its activity and the social and economic development of its country. Sustainability is also known as sustainability, and refers to a working model that by taking environmentally responsible actions, innovation in your production or the impact of your work on the social and economic spheres of your country you will obtain great benefits that will allow you to maintain yourself for a long time without exhausting your own and external resources. The company Innovest Strategic Value Advisors creates an annual list of the 100 Most Sustainable Global Companies. What can be verified thanks to this study is that, nowadays, companies that care about their environment have more opportunities in the market due to the fact that consumers are beginning to prefer products that meet these types of conditions.

In Mexico, measures and programmes have begun to be incorporated for companies to start implementing sustainability programmes. Currently, one of the most common practices for companies is to send their waste to cheaper treatment plants, without really looking at whether this is the best disposal option for what they produce.

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This then becomes a mismanagement of industrial waste that generates a high negative impact on the environment and society. Similarly, not many companies are concerned about their participation in the social life of the country, feeling that their job is to produce or offer products and services directly and almost unilaterally to their customers, but those that take into account the social context in which they develop may have a better chance of survival and long-term success.

The General Law on Ecological Balance and Environmental Protection establishes that for the formulation and conduct of environmental policy and the issuing of official Mexican standards, the following principles, among others, must be observed: everyone has the right to enjoy an adequate environment for their development, health and well-being; the authorities and individuals must assume responsibility for the protection of the ecological balance; those who carry out works or activities that affect or may affect the environment are obliged to prevent, minimise or repair the damage they cause, as well as assume the costs that such affectation implies. Likewise, incentives should be given to those who protect the environment and prevent the causes that generate ecological imbalances, as this is the most effective way to avoid them. As the country's population and productive activities have grown, the generation of municipal, hospital and industrial solid waste has increased to such an extent that the impact and risk caused by its management, treatment and final disposal currently represent a real problem, especially for those wastes considered hazardous. It is therefore necessary to expand and diversify the infrastructure and systems for waste minimisation, reuse, recycling and treatment. One technological disposal alternative is incineration, which reduces the volume and hazardousness of waste. The incineration of waste from any activity, including hazardous waste, produces emissions that cause environmental pollution and thus damage ecosystems and human health, which requires the adoption of preventive actions aimed at promoting appropriate operating conditions and acceptable emission limit values, in particular with regard to dioxins and furans.

Preventive actions, in accordance with ecological policy, require an approach that includes the different receiving environments, which implies considering the control of air emissions and the management of ashes in an integrated manner. Therefore, the publication of this Mexican Official Norm establishes the first of the different commitments that will derive from the Stockholm Convention, since by establishing maximum permissible limits of emissions into the atmosphere for existing and new incineration facilities in the country, care for the health of the population and the environment is being sought.

1. **Objective** This Mexican Official Standard establishes the operating specifications, as well as the maximum permissible limits for the emission of pollutants into the atmosphere for waste incineration facilities.
2. **Scope of application** This Mexican Official Standard is mandatory and applicable throughout Mexican territory, with the exception of territorial seas where the nation exercises jurisdiction, for all waste incineration facilities, except for crematoria, industrial furnaces and boilers that use waste as an alternative fuel. It does not apply to the incineration of radioactive waste, for which the provisions issued by the National Nuclear Safety and Safeguards Commission shall apply.

3. Official Mexican Standard NOM-001-SEMARNAT-1996, which establishes the maximum permissible limits of pollutants in wastewater discharges into national waters and property, published in the Official Gazette of the Federation (D.O.F.), on January 6, 1997, as NOM-001-ECOL-1996, which changed its nomenclature by the Agreement issued in the D.O.F. on April 23, 2003, remaining with the name that appears at the beginning of this quote. 3.2 Official Mexican Standard NOM-002-SEMARNAT-1996, which establishes the maximum permissible limits of pollutants in wastewater discharges to urban or municipal sewage systems, published in the Official Gazette of the Federation (D.O.F.), on June 3, 1998, as NOM-002-ECOL-1996, which changed its nomenclature by the Agreement issued in the D.O.F. on April 23, 2003, remaining with the name that appears at the beginning of this citation. Norma Oficial Mexicana NOM-008-SCFI-1993, Sistema General de Unidades de Medida, published in the Diario Oficial de la Federación on 14 October 1993. Norma Oficial Mexicana NOM-052-SEMARNAT-1993, Que establece las características de los residuos peligrosos, el listado de los mismos y los límites que hacen a un residuo peligroso por su toxicidad al ambiente, published in the Diario Oficial de la Federación (D.O.F.) on October 22, 1993, published in the Diario Oficial de la Federación (D.O.F.) on October 22, 1993, published in the Diario Oficial de la Federación (D.O.F.) on October 22, 1993. ) on 22 October 1993, which has changed its nomenclature on two occasions, the first one, by the Secretary Agreement published in the D.O.F. on 29 November 1994, being modified to NOM-052-ECOL-1993 and, the second one, by the Agreement issued in the same organ of diffusion on 23 April 2003, remaining with the name that appears at the beginning of this quote.

In Colombia, according to the Law for the Promotion of Micro, Small and Medium Enterprises, Law 590, SMEs are classified as follows:

- Microenterprise: Personnel no more than 10 workers. Total assets of less than 501 legal monthly minimum wages in force.
- Small Company: Staff between 11 and 50 workers. Total assets greater than 501 and less than 5,001 legal monthly minimum wages in force.
- Medium: Staff between 51 and 200 workers. Total assets between 5,001 and 15,000 legal monthly minimum wages in force.

The contribution of micro, small and medium-sized industrial enterprises is reflected in these indicators:

- The Annual Manufacturing Survey allows us to assess the incidence of MSMEs in the Colombian business landscape. They represent 96.4% of establishments, approximately 63% of employment, 45% of manufacturing production, 40% of wages and 37% of value added. There are more than 650,000 entrepreneurs contributing to the social security system.

In terms of productivity, there is no data in ACOPI.

The geographical distribution of the units establishes that SMEs in general terms follow the same trend as the manufacturing industry as a whole, with almost 70% in the four (4) main production centres: Cundinamarca-Bogotá, Antioquia, Valle and Atlántico.

## **Development**

Research methods are an essential part of all research and refer to the set of rational procedures that are used to achieve the research objectives. In short, they are responsible for defining the strategies, procedures and techniques that are subsequently used in data collection. The form of data collection and interpretation is usually more dynamic, as it does not follow a standardised process. It allows for a systematic analysis of more subjective information. As it favours the comparison of results and interpretation.

The type of research is descriptive, as this type of research looks for situations and events. That is, to say how a certain phenomenon is and manifests itself. Descriptive studies seek to specify the important properties of people, groups, communities or any other phenomenon that is subjected to analysis, measure or evaluate various aspects, dimensions or components of the phenomenon or phenomena to be investigated. From a scientific point of view, to describe is to measure. That is, in a descriptive study, a series of questions are selected and each of them is measured independently, in order to describe what is being investigated.

The process of description is not exclusively the collection and accumulation of data and their tabulation, but relates to existing conditions and connections, practices that have validity, people's opinions, views, attitudes held and processes at work. Descriptive studies focus on measuring and explanatory studies on finding out.

In this type of research, non-probability sampling is used where sample persons are selected on the basis of convenience, accessibility and proximity to related research subjects. The sample will be taken in Southern Tamaulipas, Mexico City and Medellin, Colombia.

Based on the research objectives, convenience sampling is a non-probability sampling technique where samples of the population are selected only because they are conveniently available to the researcher.

These samples are selected only because they are easy to recruit and because it was considered to select a sample that represents the whole population ideally, in the research, it is good to analyse samples that represent the population of the companies in the Zone, a sample is obtained according to the formula of Infinite Population where the total to sample is 384 companies.

$$m = \frac{Z^2 * p * q}{e^2}$$

m = sample

Z = Critical Z value, calculated from tables of the area under the normal curve. Also called confidence level (95%).

p = approximate proportion of the phenomenon under study in the reference population.

e = absolute precision level. Referred to the width of the desired confidence interval in the determination of the mean value of the variable under study.

Replacing the data we have:

$$Z^2 = 3.84$$

$$p = 0.5$$

$$q = 0.5$$

$$e^2 = 0.0025$$

Obtaining as a result: 384 Therefore, the number we took as a population is 384 entrepreneurs (Mexico-Colombia). Considering 50% for each country.

The data collection will be done with an online questionnaire is a tool designed for the collection of quantitative data, and is widely used in research, as it is a good research instrument to collect standardised data and make generalisations.

Questionnaires can provide quick responses, but due care must be taken when designing them to ensure that you do not influence the response you receive. The design of the questionnaire should reflect the objectives of the research.

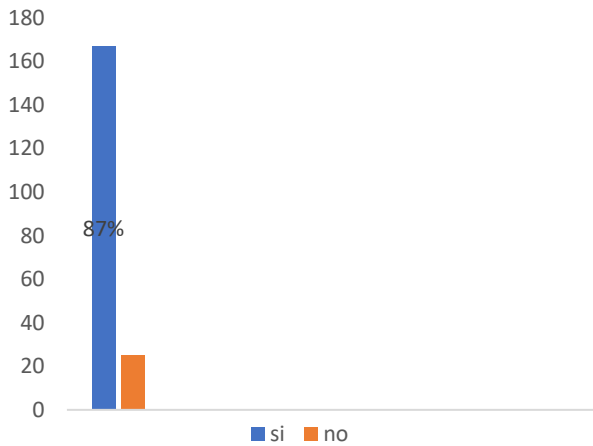
The variable to be measured is the level of companies' commitment to environmental impact. The instrument will be applied virtually in those companies in both Mexico and Colombia that do not allow access through COVID-19.

Mode of administration: online and face-to-face.

### **Analysis of the results**

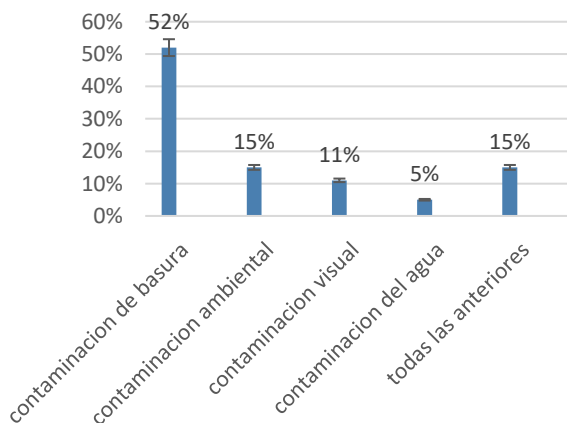
The following graphs will show comments from employees and from the organisations themselves on the social impact of these organisations in Mexico and Colombia.

The graphs are presented in order of importance according to the research objective.



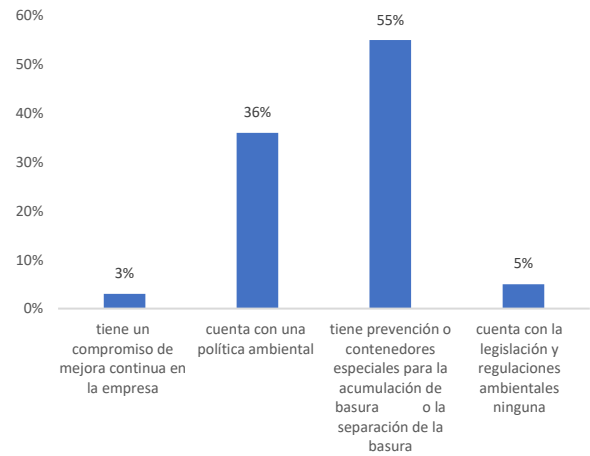
**Graphic 1** The impact of companies on the environment  
Source: Own elaboration

The graph shows that 87% of the companies surveyed in Mexico-Colombia are aware that they have an impact on the environment.



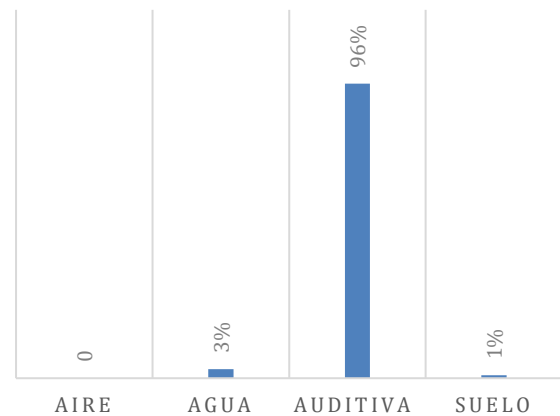
**Graphic 2** Type of impact your company has on the environment  
Source: Own elaboration

This graph shows the companies that have an impact on the environment, 52% in terms of waste contamination. 15% in environmental pollution considering (aromas, visual, noise, etc.)



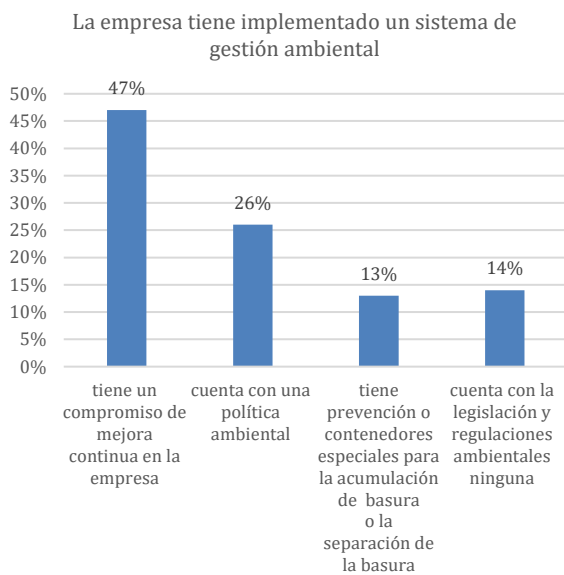
**Graphic 3** Area most affected by the company in which it works  
Source: Own elaboration.

As we can see this graph coincides with 52% of the companies that pollute with rubbish when asked, they tell us that in fact 90% of the soil is the most polluted part in Mexico compared to Colombia, as shown in Graph 3, the pollution is auditory.



**Graphic 4** Implementation of a Quality Management System.  
Source: Own elaboration

Graph 4 shows that in Mexico 47% of the surveyed population does not say that the company has a commitment to continuous improvement, their commitment is to care for the environment, but it is not enough, because if we add 53%, they say that they know about the policies, legislation and damages, but it is not enough to care for the environment. In the 4th graph, Colombia manages prevention or has collectors for the accumulation of waste, as their problem is more focused on the auditory part and here there is still no regulation in the country, as there is no regulation in the country.



**Graphic 5** Are you satisfied with the measures used in the company with respect to the environment?

Source: Own elaboration

|                           |     |
|---------------------------|-----|
| Mexico (Rubbish)          | 90% |
| Colombia (Auditory-Noise) | 96% |

**Table 1** Type of Mx-Co Contamination

Source: Own elaboration

In this graph No.5 only one is marked for Mexico-Colombia, as 47% of the respondents are dissatisfied with the measures taken by companies to protect the environment, as well as their social responsibility towards society.

According to the analysis carried out in the area of Medellín, Colombia, we can see that one of the biggest problems for micro and small enterprises is the pollution they generate, and according to the results we can conclude that the main pollutant is auditory pollution. On the other hand, in Mexico, the pollution is the soil, as they consider that they do not have the system, nor the knowledge of the appropriate separation of waste, which is their main problem. This is shown in table 1.

**Conclusions**

The conclusions according to the research analysis in the Southern Zone of Tamaulipas show that Micro and Small Enterprises one of their biggest problems is the pollution they generate and that according to the results the employees as well as the owners or managers conclude that the fact of collecting the rubbish, controlling the pollutants generated by their company is more than enough and that they do not damage the environment that much.

But they do not see the magnitude of this problem and the responsibility that this situation entails at a global level; they believe that because they are small, they do not have an impact.

The research allows the identification of the most relevant characteristics of the MSMEs, the results obtained suggest that the MSME entrepreneurs should attach greater importance to building the reputation and prestige of their company in the market, achieving support and acceptance by the community. Also, given the importance of employees' knowledge, skills and abilities, these enterprises should work with their employees and increase their professionalisation. On the other hand, the governmental institutions that support MSEs, as well as technological development institutions, financial institutions, Chambers of Commerce, trade unions and universities, among others, can design programmes that propose to improve the entrepreneurial preparation of employees to increase their access to sources of financing and alternatives other than bank credit; reduce administrative obstacles for the creation of companies; design special tax contribution schemes; and promote the transfer and use of technology and specialisation in the economic sectors.

Thus, based on the characteristics of the Mexiquense-Colombian Mypes, they can support the development of these enterprises and empower them to respond better to their environment.

Considering that this research is an approximation to the definition of the profile of the Mypes companies in Mexico-Colombia, they have a similarity in the way they manage and act. Some of these are mentioned below:

To make the objectives of commercial and environmental policies compatible in order to achieve the most efficient use of natural resources, the reduction of environmental damage and the most efficient use of work tools.

The environmental issue has undergone a tremendous evolution in recent decades, with changes in society's demands on industry affecting its performance and competitiveness, with consequences for international trade.

On the demand side, consumer pressure has led to the emergence of a "green market", making environmental concerns a strategic competitiveness factor for companies.

International trade must consider new voluntary environmental standards, which constitute factors of comparative advantage in the market and apply to processes, products and environmental management.

Implementation of corrective measures.

Monitoring and control of impact factors and their effects on the environment.  
impact factors and their effects on the environment.

The demand for stricter environmental quality standards environmental quality standards set unilaterally can be turned into advantages and act socially responsible.

### Financing

This research was developed with own resources of the Academic Body of Competitiveness and Marketing (UAT-CA-94) as well as in collaboration with teachers of the University of Medellin of the Marketing Programme.

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General explanation of the subject and explain why it is important.

What is your added value with respect to other techniques?

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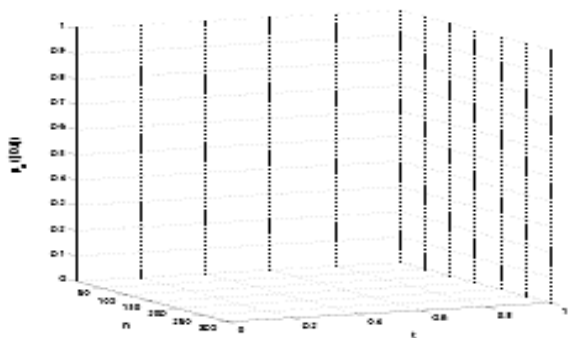
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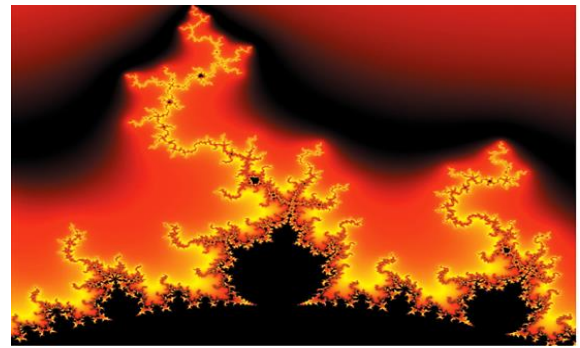
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