Study of lighting and noise levels in a higher education institution in the Lagunera region

Estudio de iluminación y ruido en institución de educación superior de la comarca Lagunera

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Abstract

The study of lighting and noise determines whether the educational institution complies with an accreditation criterion and how they influence the work and school environment, taking into account the physical surroundings for the development of activities within the institution.The research type is descriptive, utilizing a qualitative-quantitative methodology. Data collection tools are based on document review, creating mappings, and measurement points in the environments. Regarding noise, it emphasizes its importance to health, taking into account the environmental regulations of the Mexican Ministry of Labor and Social Welfare. Therefore, the results should ensure compliance and make recommendations for the university community in order to maintain the quality of infrastructure within the standards set by accrediting bodies for noise and lighting, thus avoiding disturbances and health issues.

Lighting, Noise Level, Accreditation, Work Environment

Resumen

El estudio de iluminación y ruido determina si se cumple con un criterio de acreditación en la institución educativa y como influyen en el ambiente laboral y escolar teniendo en cuenta el entorno físico, para el desarrollo de las actividades en la institución. El tipo de investigación es descriptivo, la metodología cualitativa – cuantitativa, las herramientas de recolección de datos se basan en la revisión documental, elaborando los mapeos y los puntos de medición en los entornos, en el aspecto de ruido se resalta la importancia sobre la salud, contando con las legislaciones ambientales de la Secretaria de Trabajo y Previsión Social Mexicanas, por lo tanto los resultados deben dar cumplimiento y realizar las recomendaciones para la comunidad universitaria, con el fin de mantener dentro de los estándares la calidad de la infraestructura como marcan los organismos acreditadores de ruido e iluminación evitando perturbaciones y daños a la salud.

Iluminación, Ruido, Acreditación, Ambiente laboral

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Introduction

In Mexico, Higher Education Institutions offer various training options to Mexicans based on their interests and professional objectives. Consequently, the country hosts a range of higher education institutions, both public and private. According to the OECD, the statistics are as follows: In the year 2000, 28.4% of the total population of university-age individuals were enrolled in Higher Education Institutions. By 2005, this figure had risen to 32.1%, reaching 35.8% in 2010, 40.3% in 2015, and 45.5% by 2020 (OCDE, 2015).

Therefore, the provision of quality service is of paramount importance for the effective execution of activities within these institutions. This entails two significant aspects in this study: ensuring the safety of activities and fostering an environment conducive to creativity and motivation for those involved. This research encompasses two dimensions: the first pertains to the safety during activity execution, and the second dimension revolves around the development of the environment where creativity and motivation of the participants occur.

The Higher Education Institution named the National Technological Institute of Mexico, Instituto Tecnológico de la Laguna, boasts a 57-year history with a focus on engineering education. It occupies a sprawling area of 178,816 square meters, comprising 43 buildings, extensive courtyards illuminated by natural light, sports fields, and a swimming pool.

Initially known as Instituto Tecnológico Regional de La Laguna, it was established to fulfill the need for specialized technicians and professionals capable of fostering, planning, directing, and organizing existing and emerging industries.

Its inception was the result of the initiative by a group of graduates from the National Polytechnic Institute, combined with the collaborative efforts of then-President of the Republic, Lic. Gustavo Díaz Ordaz, and the mayor of Torreón, Ing. Heriberto Ramos González.

Until 1987, the institution provided education at both upper secondary and higher levels.

Subsequently, it exclusively focused on Higher Education and postgraduate programs, spanning various engineering fields such as Computer Systems Engineering, Electrical Engineering, Electronics, Renewable Energies, Industrial Engineering, Mechanical Engineering, Mechatronics, Chemical Engineering, Business Management, and Business Administration. At the postgraduate level, it offers Master's and Doctorate degrees in Electrical Engineering, with a reputation extending locally, nationally, and internationally.

The study analyzes the risks arising from noise and lighting exposure faced by personnel and students engaged in activities within the institution, specifically within the buildings designated for the Computer Systems Engineering program. This includes Building 19, housing a student population of 600, and the Computer Lab in Building 28, with a daily population of 1,150 students and 46 teachers. These are distributed as follows: Building 19 comprises 9 classrooms on the ground floor, each accommodating 30 students, and 4 classrooms on the upper floor, of which three are actively utilized. In the Computer Lab in Building 28, which serves the entire community of 5,000 university students, there are 1,428 daily students distributed across 46 classes with 30 students each, a common area with a capacity of 28 students, and a CISCO workshop with space for 20 students.

Exposure to noise-generating sources not only correlates with health issues but also leads to disruptions in physical, social, and psychological well-being, manifesting in various ways and intensities for humans. A study conducted on populations of similar age groups in rural and urban areas revealed that the rural population, exposed to lower noise levels, had lower auditory thresholds than their urban counterparts. This underscores the subjectivity of noise assessment, dependent on individual factors and location (Abatte, Concetto, Forfunato, Brecciaroli, & Tringali, 2018).

Noise and lighting play pivotal roles in accreditation bodies, influencing the comprehensive development of male and female students, as well as the degree to which educational institutions meet quality standards.

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Failure to regulate these factors according to official norms can negatively impact the well-being of teachers, students, and administrative staff, giving rise to physiological and psychological health issues. Adverse effects of inadequate noise and lighting encompass vision loss, auditory impairments, and disruptions in brain, respiratory, and cardiac functions. These issues can affect focus, mental concentration, sleep, rest, and communication. Moreover, they can lead to irritability and aggression in individuals exposed to unfavorable noise and lighting conditions.

Literature Review

Noise. Specifically, the unit for measuring noise is the decibel (dB), and according to the World Health Organization (WHO), it establishes that a suitable environment for education should not exceed 65 dB. For instance, for an educational or cultural space, a maximum of 40 dB creates a relaxed atmosphere, while a reading room is recommended to be at 35 dB. Noise substantially affects reading, concentration, attention, and memory, consequently directly impacting academic performance. The issue can become particularly serious for schools located near sources of noise that surpass the aforementioned recommendations, such as industries, airports, and heavily trafficked roads. In such cases, effects can include delayed reading skills, aggressive states, fatigue, anxiety, and even cases of isolation.

In classrooms exposed to noise, there is a risk for teachers if they have to raise their voice to 70 dB, for example. This jeopardizes the normal functioning of the vocal cords, which in the long run can lead to aphonia (loss of voice) or dysphonia (loss of the normal voice tone), in addition to mental fatigue, irritability, and a decrease in attention and concentration (Noismart, 2023).

Ecophon (2023) emphasizes the risks faced by both students and teachers when exposed to an environment that does not meet noise standards. They break down the issue into external noise and internal noise, with the latter being the responsibility of the teacher to maintain at appropriate levels. They recommend designing (or remodeling) classrooms to isolate them based on the sources of external noise they are exposed to.

In the case of internal noise, they mention a Reverberation Time (RT) that should not exceed half a second, as this distorts the noise itself and hampers verbal communication. This implies that to achieve a comfortable classroom environment in terms of noise, one must take into account both decibels (dB) and echo or reverberation time (RT). They add that an aspect of inclusion is to consider that students who are most at risk from noise exposure are those with special education needs such as hearing loss, cognitive problems, and additionally: "students with (a) permanent sensorineural/conductive hearing problems, (b) fluctuating conductive hearing problems (caused by colds, ear infections, etc.), (c) attention deficit hyperactivity disorder (ADHD), (d) auditory processing disorder (APD) (Ecophon, 2023, pág. 34).

It is important to clarify that all matters related to noise exposure are regulated by the Ministry of Labor and Social Welfare (STPS), with the purpose of preventing health issues due to noise exposure. This involves classification based on activities conducted, setting noise levels, and establishing maximum exposure times. It's worth noting that this regulation solely considers the preservation of auditory health and does not include aspects of comfort and performance (DOF, 2022). Lighting. Inadequate lighting, besides hindering our ability to carry out activities efficiently, can impact our vision and overall mood. Therefore, it's crucial to consider the risks that workers and students are exposed to due to insufficient lighting; their performance, and more importantly, the gradual and permanent long-term damage it can cause to their visual capabilities (Segurmanía, 2023).

Since 2008, the Mexican Official Standard NOM-025-STPS-2008 has regulated lighting in workplaces, establishing conditions to provide a safe and healthy environment for work with appropriate lighting for carrying out relevant activities in workspaces, offices, and educational spaces (STPS, 2008). From the perspective of educational program accreditation, the Accreditation Council for Engineering Education, A.C., in their Criterion 5 Infrastructure and Equipment, indicator 5.1 Classrooms, laboratories, cubicles, and support offices, emphasizes that these spaces should have adequate lighting, among other aspects such as sufficient and ergonomic space (Cacei, 2018).

The company Simón Electric (2021) specifies appropriate lighting levels for each location and activity. As known, lighting intensity can be measured with a lux meter, and the units are lux (lx). For example, lighting for a desk or reading area is 500 lx, and generally, for an educational center, it ranges from 300 to 1,000 lx.

In the European Union, there is a specific directive for lighting in educational institutions, the UNE-EN 12464.1 standard. It considers that spaces for students and teachers should be illuminated in a way that represents pleasant and stimulating environments, minimizing visual effort and avoiding fatigue, which can lead to headaches. The standard details relevant aspects for good lighting, such as Glare Control, Color Rendering, Uniformity, Illuminance, and Luminaire Types for Educational Classrooms (Sinelec, 2023).

In 2021, a significant experiment was conducted on dynamic lighting. It measured the main photometric variables (color temperature and illuminance) and the continuous and selective attention of students. This was done using a Gesell chamber, Emotiv Epoc EEG 14-channel headphones that measure brain activity, and eye-tracking glasses. It was determined that selective and continuous attention increases substantially with dynamic lighting (Nieto-Vallejo, Camacho, Cuervo-Pulido, & Hernández-Mihajlovic, 2021).

It's worth mentioning that dynamic lighting refers to lighting that changes its brightness, color, or angle for specific periods of time to provide a tailored experience for individuals. This not only personalizes people's experiences but can also lead to energy and cost savings (Secom, 2022).

Furthermore, it has been established that the biological clock (also known as the circadian rhythm) influences (a) attention, (b) behavior, (c) hormonal production, (d) body temperature, (e) metabolism, and (f) sleep. Ambient light is a significant stimulus for synchronizing the circadian rhythm. Consequently, due to individuals' varying sensitivity to light exposure, there are important variations in the production of melatonin and cortisol—substances that directly affect mood (Tonello, 2015).

Studies conducted at a clinic in Hamburg determined that appropriate classroom lighting, considering intensity, color temperature, and dynamics, increased reading speed by up to 35%, reduced comprehension errors by up to 45%, and decreased hyperactivity incidents by 76%. In general, they have found that good lighting leads to effects that enhance the educational experience. This is because lighting affects not only visual clarity but also mood, with color temperature being a significant factor, all in favor of academic performance.

The company Lamp Worktitud for Light recommends creating spaces with dynamic lighting, incorporating variations in color temperature and light flux. They achieve this with LED Wellbeing technology, which illuminates with a spectrum similar to natural sunlight. Temperature variations can range from relaxing warm light (2700 K) to gradually transitioning to cooler illumination (4000 – 5000 K) at higher intensity (Lamp, 2012). To provide further clarity, the color temperature scale ranges from warm (1000 K) to cool light (10000 K); warm light has an orange hue, transitioning to white around 6000K and gradually taking on a slight blue hue up to 10000K (Luxiform, 2023).

A specialized lighting company based in Barcelona, Spain, defines the objectives of educational space lighting as follows: (a) Improved light quality, (b) Enhanced visual comfort for users, (c) Increased concentration leading to improved activity performance, (d) Energy consumption efficiency, (e) Optimized installation costs, and (f) Reduced maintenance. The company emphasizes the interaction between natural sunlight and artificial lighting, utilizing architectural designs that leverage natural light, sensor-based management of both light sources, and energy-efficient practices, enabling light regulation by zones and even its elimination in specific areas when not needed (Eld Design light studio, 2010).

When designing an educational space, it's imperative to consider the role of light in visual stimulation for developing minds. A study by the Heschong Mahone Group in 1999 found that students in areas with more sunlight achieved grades 26% higher than those exposed only to artificial light.

The study demonstrated that natural light regulates individuals' biological or circadian rhythms and cortisol levels, which in turn enhances intellectual performance (Zaire, 2023).

In the realm of architecture and lighting, there's a modern lighting management system that incorporates what is referred to as "Lighting Reform," an essential aspect for contemporary classrooms. This system, known as Livelink, employs sensors and an intelligent network to manage the lighting in specific areas, such as a classroom. It involves architectural features like windows and skylights to harness natural sunlight, combines them with LED lamps, and utilizes digitization and connectivity to create an intelligent system that automates and customizes lighting management (Trilux, 2023).

In Austria, they have established Smart Teaching Centers, where the central focus is on adapting spaces to people's needs, prioritizing the use of natural light, ensuring uniform lighting, and illuminating specific points only when necessary. For instance, lighting in a classroom is activated only if the room is in use or if the teacher is giving a presentation. All of this is achieved through sensors for automatic operation, while still allowing for teacher intervention to achieve greater precision. The entire system is integrated wirelessly for aesthetic purposes. Additionally, the application provides statistics on usage and energy performance, enabling the planning of visualization system enhancements and gradual adaptations and improvements (XAL, 2023).

Furthermore, as observed in Colombian education, particularly at the Universidad Militar Nueva Granada, the need to adapt to Information and Communication Technologies (ICT), new Learning and Knowledge Technologies (LKT), as well as Empowerment and Participation Technologies, arose due to the COVID-19 contingency. In this context, it became necessary to identify risks related to teacher safety and comfort, taking care of factors such as lighting and noise (Díaz Melgarejo & Mantilla Bautista, 2023).

Overall, the well-being and comfort of teachers, in the pursuit of enhancing the educational practice of the teaching and learning process, are highly sensitive to the conditions within educational institutions. In this regard, administrative management of education holds great importance.

To address this, an evaluation tool was developed at the Technological Institute of Sonora in Mexico, covering aspects such as (a) planning, (b) execution, (c) collaborative work, (d) leadership, (e) responsible social participation, and (f) monitoring and control. This tool serves to identify areas of opportunity for improving the administration and operation of educational centers (Méndez Rodriguez, Arellano González, & Carballo Mendívil, 2023.).

In a similar vein, at the Instituto Tecnológico Superior de Guasave, an organizational climate measurement tool was developed, alongside assessing physical and environmental conditions such as (a) lighting, (b) noise, (c) equipment, and (d) workspaces. The study was conducted in a commercial construction materials company and was later adapted for application in a higher education institution under Mexico's National Technological System, incorporating aspects like identity, regulations, customer satisfaction, and social well-being, which involves balancing personal and work life. The resulting evaluation serves as a foundation for designing and implementing strategies that contribute to an improved organizational climate. This is achieved through monitoring behaviors, making modifications, or redirecting them as objectives are achieved (Osuna Armenta, Lopez Rodríguez, Gálvez Rodríguez, & Reyes Zúñiga, 2022).

The assessment tool developed at the Universidad César Vallejo in Lima, Peru, to measure self-regulated learning in higher education students is also of great interest. Among the 60 criteria it evaluates, one criterion involves characterizing educational spaces, considering factors such as noise levels, lighting, and other elements like access to information sources (Ángeles Sanchez, 2023).

Speaking specifically about lighting, there's a study conducted at the Instituto Universitario Vida Nueva in Quito, Ecuador, that demonstrated a significant increase in selective attention and concentration. This was done by applying a d2-R attention test, which measures selective attention and concentration, to two groups of students—one with low lighting (60 lux) and another with proper lighting (700 lux). This underscores the importance of appropriate lighting, especially in educational spaces with nocturnal activities (Tituaña Diaz , Guamán Freire, & Basantes Paredes, 2022).

Methodology

An analysis of the existing literature on lighting and noise was carried out, along with field observations, considering both qualitative aspects in the collection of related information from readings, and quantitative aspects involving the creation of various tables for the interpretation of different data such as lux measurements, shifts, and characteristics of the work area. This research was conducted in several stages:

A bibliographic review was conducted regarding the international, national, and local lighting sector, following the standards established by the Ministry of Labor and Social Welfare. Based on the bibliographic review, the national and local context during the specified period was established.

Evaluations were performed at the specific workstations including computers, work tables, desks, and workbenches.

Comparisons were made between the obtained lighting levels and the recommended levels based on the type of activity, as outlined in the Official Mexican Standard (Norma Oficial Mexicana).

The reflection percentages on work surfaces that affect lighting conditions were determined, following the guidelines of the Official Mexican Standard NOM-025-STPS-2008.

Areas of risk or non-compliance were identified in relation to appropriate noise levels, as established by the Official Mexican Standard NOM-011-STPS-2001.

A detailed recommendation was developed to enhance the lighting and noise conditions in classrooms and laboratories of the Computer Systems Engineering program.

The lighting and noise study was conducted by a specialized company called North Zone Microanalysis, accredited by the Mexican Accreditation Entity (EMA) and approved by the Ministry of Labor and Social Welfare (STPS). Regarding the lighting study, the selection of measurements in each classroom was determined based on the arrangement of the chalkboard and desks, as each classroom has a unique layout.

The aim was to gather information on whether the classrooms were adequately illuminated. Measurements were taken for each workspace in offices, positioning the lux meter as close as possible to the work surface and taking precautions to avoid casting shadows or reflecting additional light onto the lux meter. The measurements were taken using a lux meter, which is an instrument for measuring lighting levels. The Extech Instruments Light Meter was utilized. To ascertain whether the lighting levels complied with established standards, the Official Mexican Standard NOM-025-STPS-2008 for lighting conditions in workplaces was consulted. The minimum lighting level for classrooms and offices is set at 300 lux, and for corridors, it's 50 lux.

In order to conduct the noise study within the parameters of the Official Mexican Standard NOM-011-STPS-1999, a survey was conducted. In the work areas, noise levels exceeding the specified limit of 70 decibels were not identified. This is because the human ear can tolerate and assimilate such noise levels without causing temporary or permanent damage. The permissible maximum exposure limits for noise are outlined in the following Table 1.

NER	TMPE
90 db(A)	8 hours.
93 db(A)	4 hours.
96 db(A)	2 hours.
99 db(A)	1 hour
102 db(A)	30 minutes
105 db(A)	15 minutes

Table 1 Permissible Noise Levels

When the noise exposure level (NER) is between 90 and 105 dB(A), the maximum allowable time should be calculated using the following equation:

$$MPE = \frac{8}{2(\frac{NER-90}{3})}$$

The research is based on environmental noise quality standards that should not be exceeded in order to protect human health, considering application areas and schedules. The measurement is conducted using the equivalent continuous sound level (LAeqT), which is an indicator used to describe acoustic pollution at a particular location. It represents the accumulated noise level over a period of time (T), standardized with respect to that interval.

The measuring time interval will be between 5 to 10 minutes, during which operational activities should be consistently present. The installation of the sound level meter follows the national monitoring protocol. The sound level meter is positioned on a tripod at a height of 150 centimeters above the ground in the ambient environment. Calibration is performed both before and after each measurement. Refer to Figure 1.

Figure 1 Location of Noise Study Points

Both the lighting and noise studies were conducted during a time frame ranging from 7:00 AM to 9:00 PM. The monitoring shifts were as follows: Morning shift from 8:30 AM to 11:00 AM, and evening shift from 7:00 PM to 9:30 PM.

Field Materials:

Field notebook: Used for written and illustrated notes, serving as a record of each work area.

Pencil: Graphite writing instrument made from a slender wooden cylinder, utilized for writing or drawing.

Equipment:

Lux meters: Measure light while considering prior conditions, defining the distance and angle between the lux meter and the object being measured.

Brand: EXTECH Model: EASY VIEW 30, Serial Number: 070100338, with cosine-corrected +/- 5% photopic spectral response and +/- 5% accuracy. The lux meter should be verified before and after each assessment as specified by the manufacturer, and illumination should not be blocked during evaluations. It possesses a calibration certificate in accordance with the Federal Law on Metrology and Standardization.

Sound level meter: Electronic tool that measures noise levels in a specific area, compliant with prevailing norms for audible sound measurement and acoustic calibrators.

Computer: Used for spreadsheet calculations, relevant measurements for each activity, and results in word processing software. Also, image and photography editing tools are utilized.

Cameras: Capture evidence for research documentation.

Tape measure (Flexometer): Measurement instrument consisting of a thin, flexible metal tape that self-winds into a casing, which can be made of metal or plastic, equipped with a brake or locking system to keep measurements steady. It's used to determine measurement spaces in the work area.

Tripod: A three-legged frame, usually articulated and foldable, designed to support specific instruments or devices.

Gathered Information:

Data collection. To achieve research objectives, including records, direct observations, and report presentations.

Desk Materials:

Tools used by researchers to perform tasks optimally within the indicated timeframe.

Figures 2 and 3 depict the trained personnel and dimensions of a randomly selected classroom.

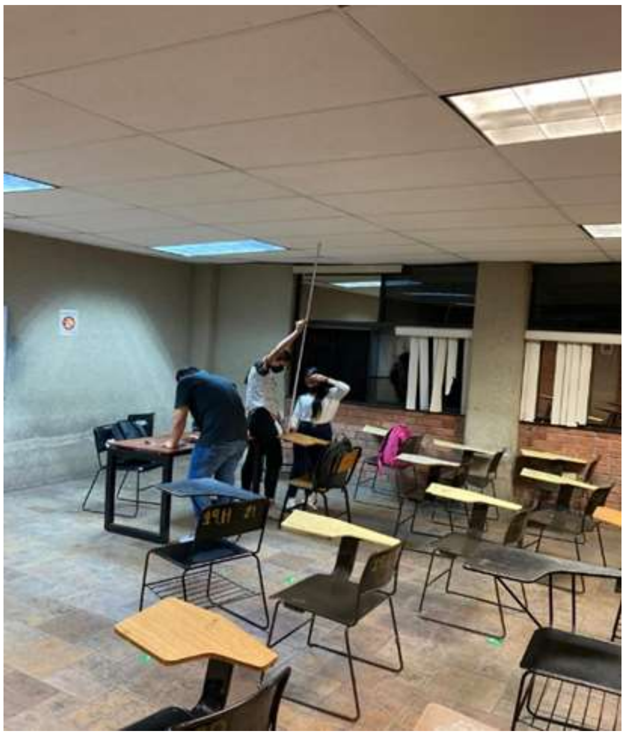

Figure 2 Materials

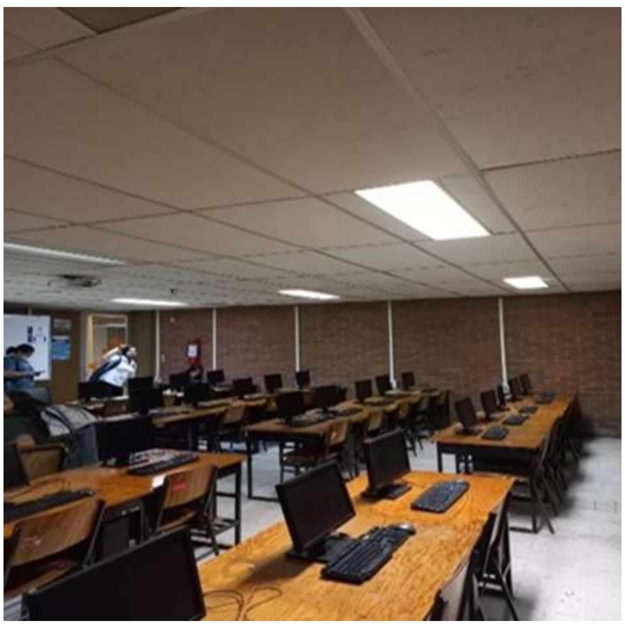

Figure 3 Classroom Evidence

Results and Discussion

In the lighting study, the selection of measurement points yielded 18 measurement points in Building 19 and 10 measurement points in Building 28. The measurements vary based on the dimensions of the work area, as shown in Table 1. The work areas should be divided into zones of the same size, according to the guidelines in Column A (minimum number of zones to evaluate). Measurements should be taken in areas with the highest concentration of workers or at the geometric center of each of these zones.

If the measurement points coincide with the focal points of the luminaires, the number of evaluation zones should be determined based on Column B (minimum number of zones to consider due to limitations) as specified in Table 2. If the geometric center of each evaluation zone coincides with the location of the luminaire's focal point, the previously defined number of zones should be maintained.

The value of the area index, which determines the number of zones to evaluate, is calculated using the following equation:

$$IC = \frac{(X)(Y)}{h(X+Y)}$$

Area Index	Minimum Number of Zones to Evaluate	Number of Zones to Consider Due to Limitation
IC < 1	4	6
1 < IC < 2	9	12
2 < IC < 3	16	20
3 < IC	25	30

Table 2 Relationship between the Area Index and the Number of Measurement Zones

Where:
IC = area index.
X, Y = dimensions of the area (length and width), in meters.
h = height of the luminaire above the work plane, in meters.

Here, x represents the value of the area index (IC) of the location, rounded up to the nearest integer, except for values equal to or greater than 3, where x is set to 4. The equation provides the minimum number of measurement points. Refer to Figure 4.

In corridors or staircases, the work plane to be evaluated should be a horizontal plane at 75 cm ± 10 cm above floor level. Measurements should be taken at midpoints between adjacent luminaires.

For workstations, at least one measurement should be taken on each work plane, placing the lux meter as close as possible to the work surface and taking precautions to avoid casting shadows or reflecting additional light onto the lux meter.

h = 1.65 meters.

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$$IC = \frac{8.17*9.00}{1.68(8.17+9.00)} = \frac{73.53}{1.68(17.17)} = \frac{73.53}{28.845} =$$
$$IC = 2.5$$

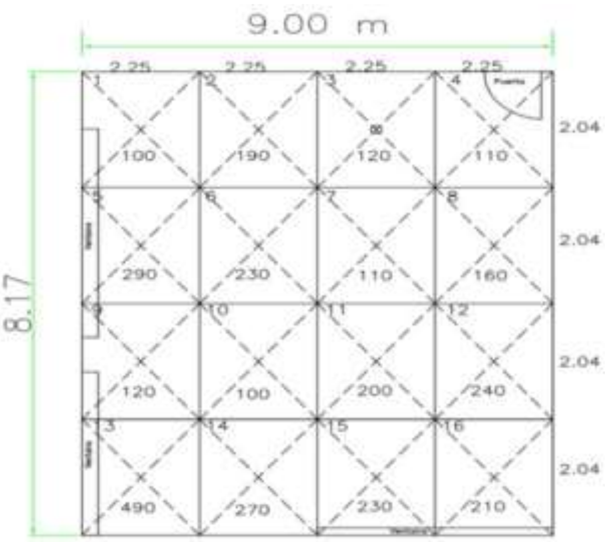


Figure 4 Work Area

Once the evaluation areas are defined, the process involves assessing the average illumination level using the following formula:

$$Ep = \frac{1}{N}(\sum Ei)$$

Where:
Ep = Average illumination level in lux.
Ei = Illumination level at the center of each point in lux.
N = Number of evaluated points.

Evaluation Method on the Work Plane: Applied to specific tasks, especially those requiring higher illumination levels due to factors such as size, contrast, time, and task complexity, Figure 5.

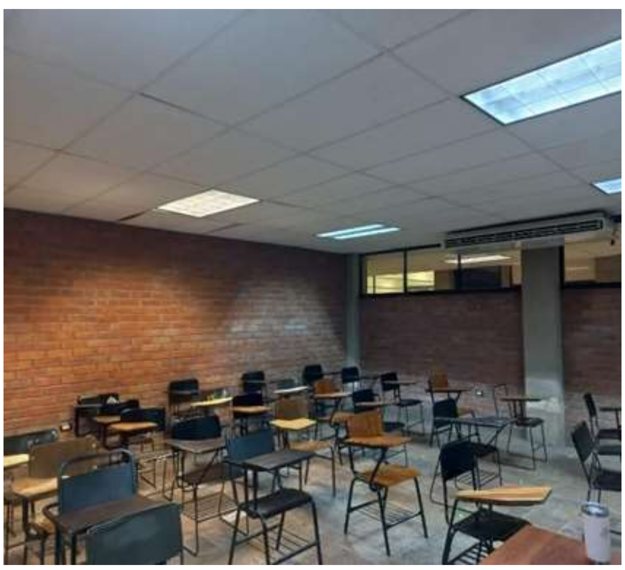
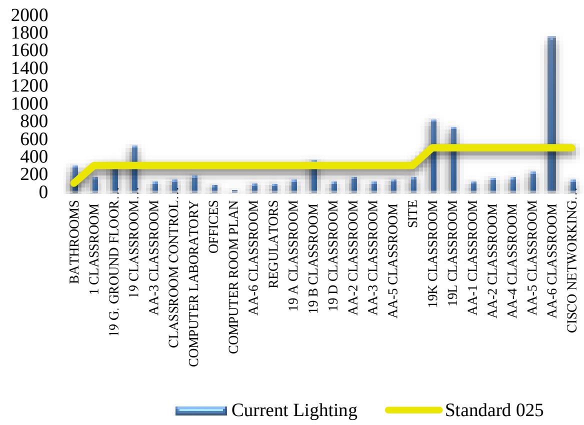


Figure 5 Work Area Example

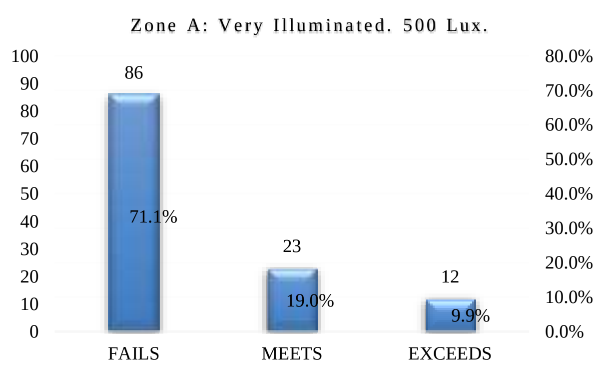
Preliminary Results

According to Standard 025, there are environments that need to be brightly illuminated with 500 lux, known as Zone A; other areas should be illuminated with 300 lux, referred to as Zone B, and there are areas that require 100 lux, identified as Zone C. This graph provides an overview of the entire study, compared to the limits set by Standard 025, represented as a yellow line. The blue bars that fall below the yellow line represent environments that do not meet the standard. Graph 1.

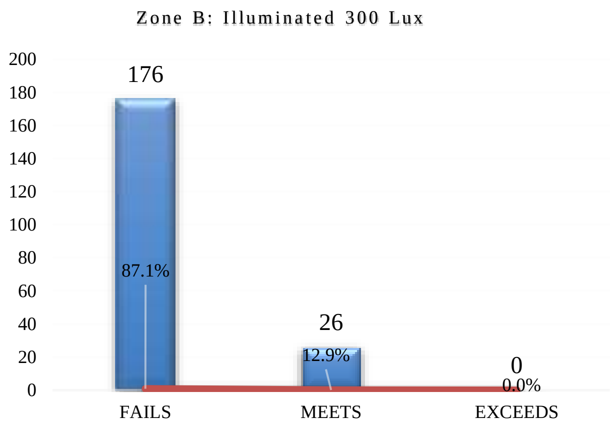


Graph 1 General Results

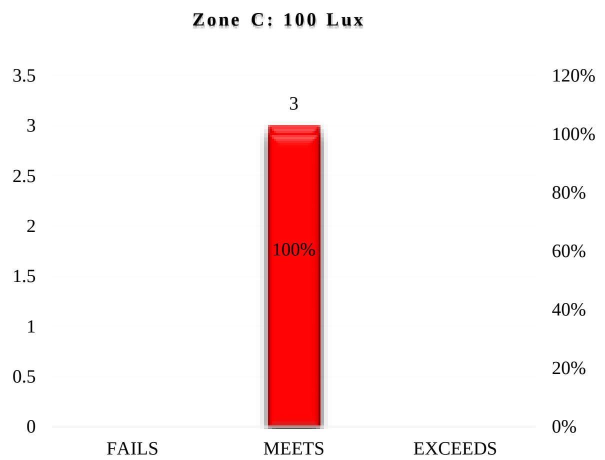
These graphs show the number of environments in Zone A that comply and do not comply with the mentioned standard, along with their percentage measurements. As a result, it is evident that more than 70% of the facilities in Zone A do not meet the Official Standard of the Ministry of Labor and Social Welfare. Graph 2 represents Zone B, indicating compliance and non-compliance with Standard 025 at an illumination level of 300 lux. In this case, 87.1% do not comply, while 12.9% comply, as shown in Graph 3. This contrasts with Graph 4, which represents Zone C, demonstrating 100% compliance.



Graph 2 Zone A



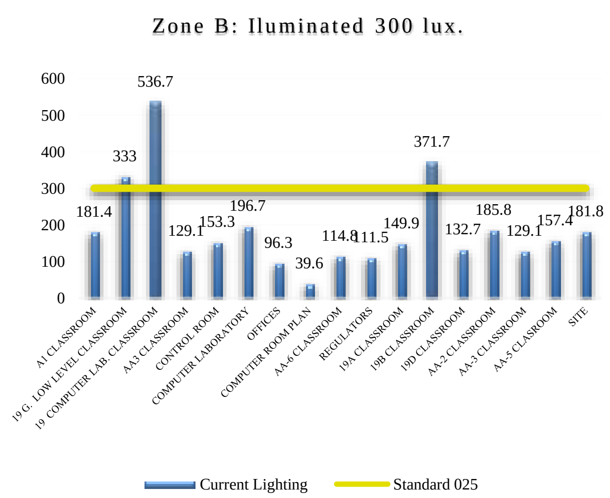
Graph 3 Zone B



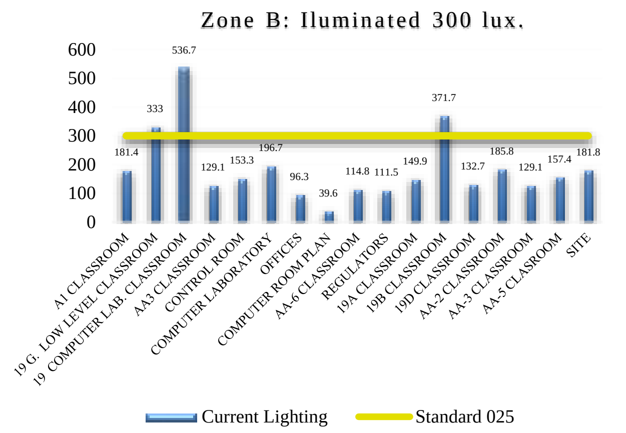
Graph 4 Zone C

Second Results

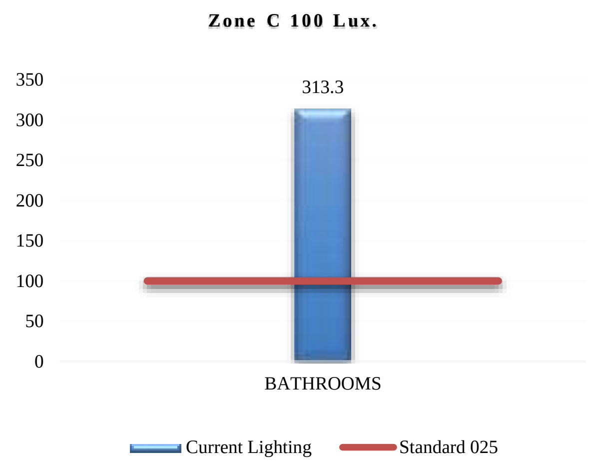
According to the findings presented in the study, the breakdown of the three zones A, B, and C is as follows, as shown in Graphs 5, 6, and 7**.**



Graph 5 Zone A (500 Lux)



Graph 6 Zone B (300 Lux)

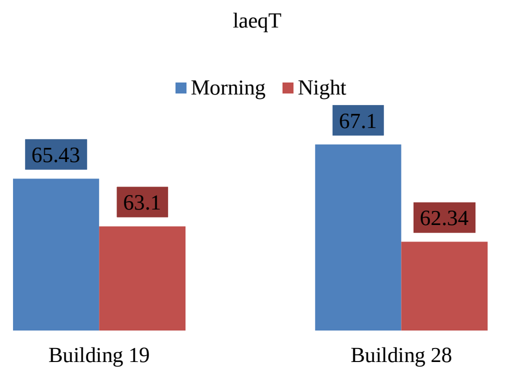


Graph 7 Zone C (100 Lux)

Noise originates from an initial disturbance, occurs periodically, and is perceived by the ear, especially in a work environment such as a higher education institution. This noise comes from various emitting sources and is considered both annoying and unwanted. For this reason, the Official Mexican Standard 011 of the Ministry of Labor and Social Welfare establishes safety and hygiene conditions in workplaces where noise is generated, based on its characteristics, levels, and duration of exposure, capable of impacting the health of all users of these workplaces during the workday.

Considering that preserving health is a universal right for every individual, it's essential to note that noise can lead to adverse health conditions. The most well-known and concerning effect of noise exposure is hearing loss. This effect primarily depends on the level of acoustic pressure and the duration of exposure. It's important to remember that noise-induced hearing loss can be of two types: conductive and sensorineural. Conductive loss can result from eardrum rupture or dislocation of the middle ear bones.

In the measurements and surveys conducted, sound levels exceeding those specified in Standard 011-STPS-2001 were not identified. Graph 8.



Graph 8 Average Noise by Shift and Building

Future Work

Based on the study's results, merely complying with legislation and accreditation requirements will necessitate a significant investment. The lighting system in general exhibited deficiencies, and simply replacing similar lamps won't suffice. Lamps of higher capacity will be needed, which in itself will be costly, mainly due to the quantity of lamps involved. The noise study showed no alterations to the work environment, preventing noise-induced illnesses like hearing loss, cataracts, otopathies, and sleep disorders.

Subsequently, an investigation is undertaken to prevent occupational hazards related to lighting. It's suggested to appoint a safety officer in accordance with Standard 025 and 11 of the Ministry of Labor and Social Welfare. This officer would identify the potential consequences for each stakeholder in the university through methods such as questionnaires, interviews, checklists, mapping, and evaluation matrices.

Conclusions

To enhance the quality of life for students, employees, and the university community, competent authorities should implement action plans to meet the established environmental lighting and noise standards set by the Ministry of Labor and Social Welfare.

By complying with legislation, undergoing reaccreditation processes, creating better work environments, and developing activities to mitigate health-related consequences.

Competent institutions should conduct awareness campaigns against noise and highlight the importance of proper lighting within the university community. This is crucial for environmental awareness and industrial safety protection. The infrastructure of classrooms, buildings, laboratories, offices, and bathrooms should be examined and adjusted for both lighting and acoustic isolation.

Having trained and professional staff in place to address infrastructure needs, plan and execute the institution's plans, is crucial. In the short term, it's pertinent to conduct a cost-benefit analysis for changing luminaires and providing suitable spaces, resulting in well-being for the entire university community.

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