

AMBIENT LIGHTING AND ENERGY EFFICIENCY IN INTERIOR DESIGN

ILUMINATUL AMBIENTAL ȘI EFICIENȚA ENERGETICĂ
ÎN DESIGNUL DE INTERIORINGA MATCAN-LISENCO¹PhD student, university assistant,
Technical University of Moldova<https://orcid.org/0000-0002-2419-1396>

CZU 747:628.93

DOI <https://doi.org/10.55383/amtap.2025.1.20>

In this study, ambient, artificial light is targeted, which among other things is the main element in interior design. The collaboration and experience with more experienced colleagues highlighted the need for future designers to know the typology of existing luminaires including those in the trade, their correct positioning and the expected effects obtained with light in their projects regardless of their purpose, social importance, etc., for the purpose of capitalizing on the spaces. Therefore, the types, the color of light, and the classification of luminaires for the subsequent application of knowledge in practice were specified. It should be noted that at the same time, the local, general and mixed light, correctly used, helps to highlight the space or necessary elements, and the result must be pleasant. In this way, we can from an ordinary interior, get an exciting space only with the help of a properly selected and placed light.

Keywords: light, lighting fixtures, types of lighting, classification of lighting fixtures, visual effects

Articolul analizează lumina ambientală, artificială, care reprezintă, printre altele, o componentă esențială a designului de interior. Colaborarea reciprocă și experiența câpătată în realizarea proiectelor cu colegii mai experimentați au scos în evidență necesitatea cunoașterii de către viitorii designeri a tipologiei corpurilor de iluminat existente, inclusiv cele din comerț, poziționarea corectă a acestora și efectele obținute cu ajutorul luminii în scopul valorificării spațiilor, indiferent de menirea acestora, importanța lor socială etc. De aceea, au fost specificate tipurile și culoarea luminii, clasificarea corpurilor de iluminat pentru aplicarea ulterioară a cunoștințelor în practică. Trebuie de remarcat faptul că lumina locală, generală și mixtă, utilizată corect, ajută, în același timp, la evidențierea spațiului sau a elementelor necesare, iar rezultatul trebuie să fie îmbucurător. În acest mod, dintr-un interior obișnuit putem să obținem un spațiu interesant doar cu ajutorul unei lumini selectate și amplasate corespunzător.

Cuvinte-cheie: lumină, corpuri de iluminat, tipuri de iluminat, clasificarea corpurilor de iluminat, efecte vizuale

Introduction

This research explores the influence of ambient and artificial lighting on mood and visual perception, highlighting its role in reshaping and optimizing interior spaces. The study proposes an interdisciplinary approach to lighting design, integrating new technologies and energy efficiency criteria. It identifies the types of lighting fixtures and the appropriate light colors for various interior space functionalities, providing future designers with applicable knowledge for selecting and positioning lighting correctly to achieve the desired visual effects.

Energy efficiency in artificial lighting for interior design is crucial but often compromised in favor of aesthetic or functional considerations. This research addresses the challenges related to selecting and positioning lighting fixtures to maximize energy efficiency without sacrificing the design quality.

Previous studies have examined aspects of ambient and localized lighting, as well as the differentiation of lighting functions in interior design. However, these approaches have been limited in integrating energy-efficient lighting with aesthetic considerations.

¹ E-mail: inna.matcanlisenco@gmail.com

Light influences human mood and is directed towards the surrounding environment enabling the acquisition of information about the world. Insufficient lighting diminishes this objective, underscoring the undeniable importance of this subject.

Light, in all its forms, is the most significant element in interior design and one of the vital components of human life. Due to this, engineers and architects strive to design spaces with large or panoramic windows to extend natural lighting duration. However, when natural lighting is insufficient or entirely absent, artificial lighting becomes necessary, involving various categories of lighting fixtures present in any environmental setting.

Materials and Methods

The study was conducted through a multidisciplinary approach, combining theoretical analysis, visual research, and direct observation. The documentation focused on specialized literature regarding lighting in interior design, emphasizing its classification and impact on spatial perception and the user's well-being. Academic sources, scientific articles, and technical standards were consulted, including the works of Richard Kelly. A comparative analysis of lighting typologies - general, local, and mixed - was conducted, along with an examination of the influence of light color temperature on perception and spatial functionality.

Direct observation and photographic documentation in museums, art galleries, and historical buildings facilitated the analysis of applied lighting solutions and their effects on visual ambiance. Photographs taken in locations such as the National Museum of History of Moldova and the National Museum of Art of Moldova served as illustrative material.

The methodology also included an evaluation of lighting fixtures, analyzing factors such as intensity, direction of light flux, and compatibility with architectural materials. Additionally, emerging technologies, such as LED lighting and smart systems, were studied to determine their impact on energy efficiency and sustainability. As a result, the research provides a detailed perspective on the role of lighting in interior architecture, emphasizing its importance in creating functional, aesthetic, and energy-efficient spaces.

Lighting typologies and their importance in interior design

Richard Kelly describes the first and most fundamental form of light as ambient light. This type of lighting ensures the general illumination of the environment, guaranteeing visibility of the surrounding space, including objects and people within it. This general and uniform lighting allows for orientation and the completion of basic tasks. It largely aligns with the principles of quantitative lighting design, except that ambient lighting, in Kelly's sense, is not the ultimate goal of a lighting concept but rather a foundation for further planning. When designing a lighting plan, a designer must rely on instinct, experience, and the limited support offered by quantitative standards when analyzing a particular lighting context, determining the space's specificities, purpose, and the preferences of its users.

Illuminance power. This parameter is crucial when selecting a lighting fixture in relation to the installation surface. Traditional spotlights must be used with caution on work surfaces as inappropriate materials may deform or pose a fire hazard. LED spotlights, with their low operating temperature, are suitable for mixed use with suspended ceilings.

Lighting design opportunities: Lighting technologies are evolving rapidly, continuously introducing new tools that transform the role of lighting in interiors, enabling spatial transformations without altering the architectural structure. Light can highlight specific sections of a space, instantly changing the interior and shifting design to the background. Emerging technologies offer incredible possibilities. The concentration of multiple light points within a confined space can radically transform the ambiance. Modern lighting in interiors creates numerous optical illusions, making it challenging to accurately assess spatial volume.

In interior design, there are three main types of lighting: general, local, and mixed. The selection of lighting fixtures depends on these types, ensuring the creation of desired effects. A beautifully designed décor without proper lighting loses its charm entirely.

General lighting is the most commonly used type in various spaces, regardless of their purpose. It is used to illuminate an entire area, typically through a central lighting fixture or multiple fixtures serving the same function (**Figure 1**). The central fixture may be a chandelier with one or more arms, while general lighting with multiple fixtures may include spotlights, recessed lighting, or chandeliers for larger spaces.

Local lighting is used in specific areas where additional light is required for practical or decorative purposes. A common example of local lighting is the table lamp, which provides supplementary light for a workspace. Floor lamps and wall-mounted sconces (**Figure 2**) can also serve as sources of light in the evening when general lighting is no longer necessary, creating a pleasant and relaxing atmosphere. Local lighting is also found in kitchens, where a pendant light above the workspace or an LED strip on the countertop provides additional illumination [1]. Another example of local lighting is seen in museums and art galleries, where a painting or exhibit is highlighted by a spotlight or wall-mounted fixture.

Mixed lighting, the most frequently encountered type, combines local and general lighting. This allows for flexible use based on necessity, making it a highly practical choice. Both types of lighting can be used together or separately (**Figures 3, 4**).

Figure 1. General lighting through multiple lighting fixtures. Blue Room. National Museum of History of Moldova.



Source: photo by Matcan-Lisenco Inga, from the personal archive.

Figure 2. Types of local lighting fixtures. Satu Palace, Bucharest, Romania.



Source: photo by Matcan-Lisenco Inga, from the personal archive.

Figure 3. Mixed lighting. National Museum of Ethnography and Natural History.



Source: photo by Matcan-Lisenco Inga, from the personal archive.

Figure 4. General lighting through multiple light fixtures. Palace Hotel, Romania.



Source: photo by Matcan-Lisenco Inga, from the personal archive.

The *color of light* is an important element, as it can create specific effects that make an interior space more practical and comfortable. Color is the sensation perceived when light rays enter the eye.

Depending on the hue and intensity of the light, we can distinguish three types of white light: cool, neutral, and warm [2]. The proper selection of lamps, bulbs, and LED tubes for lighting is equally important. Depending on the color rendering index (CRI) of the lamp, the light can be categorized as cool or warm.

The diversity of light colors significantly influences the perception of space, and understanding these nuances is essential for creating a harmonious and functional environment. Among them, neu-

tral light stands out for its natural and versatile balance. *Neutral light* (4000K) closely resembles natural daylight, is pleasant to the eye, and reproduces interior colors most accurately without altering them. This type of light is suitable for spaces requiring good illumination, such as living rooms and bathrooms.

While neutral light provides chromatic harmony and an authentic rendering of colors, cool light is distinguished by its intense clarity and functional character, whereas warm light brings a distinct dimension through its ability to create a comfortable and relaxing atmosphere, influencing spatial perception with its pleasant tones. *Cool light* (above 6000K) is a stronger light with a bluish tint, which can alter colors by making them appear cooler. Interiors illuminated with this type of light appear cleaner and are best suited for work areas, offices, kitchen preparation zones, hospitals, medical centers, and commercial spaces.

Warm light (2700-3000K) is the most comfortable for the eyes, its orange undertones can alter the perception of colors, making them appear warmer [3 pp. 46-48]. However, warm light specifically creates a comfortable ambiance, making it the most suitable choice for bedrooms, relaxation areas, and living rooms.

The importance of lighting systems in interior architecture, energy efficiency, and aesthetics

Lighting is essential in interior architecture, significantly influencing both the aesthetics and functionality of a space. In today's context, where energy efficiency is a priority, lighting plays a crucial role in reducing energy consumption and creating a healthy, sustainable environment. LED technology is one of the most remarkable innovations in this field, consuming far less energy than conventional bulbs while offering a much longer lifespan. Additionally, LEDs provide a variety of colors and intensities, allowing designers to create different atmospheres according to specific needs. The integration of smart technologies into lighting systems, such as motion sensors, timers, and smartphone-controlled lighting, optimizes energy use by adjusting light intensity based on the user's presence or available natural light, thus contributing to the reduction of excessive energy consumption. Maximizing natural light utilization is a fundamental practice in interior architecture. Well-designed and strategically positioned window systems can reduce dependence on artificial lighting. The use of glass panels and strategically placed openings in buildings facilitates optimal natural lighting, enhancing visual comfort while lowering energy costs. Furthermore, adopting renewable and biodegradable materials in the design of lighting fixtures reduces environmental impact, while integrating renewable energy sources, such as solar panels, enhances lighting efficiency. Promoting an energy-efficient culture by educating users about the importance of effective lighting can encourage more responsible behavior. Awareness campaigns and training programs can further stimulate the proper use of lighting systems, contributing to energy conservation. Thus, lighting systems have a profound impact on interior architecture. Contemporary energy efficiency strategies not only improve functionality and aesthetics but also contribute to sustainability. In this way, lighting becomes a central element in creating comfortable and eco-friendly spaces.

At the conceptual stage of interior architecture, the lighting system applied in the project must be carefully considered, taking into account not only the surface area but also the amount of natural light, the chromatic spectrum, and the saturation of white tones. Different lighting fixtures direct light in different ways, which affects the final visual perception [4].

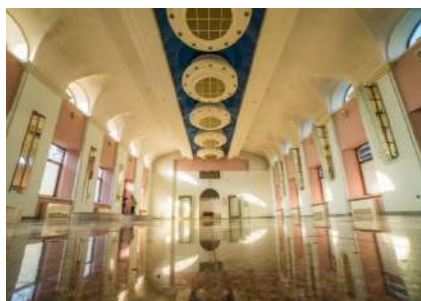
Currently, artificial light is highlighted through the installation of light bulbs in lighting fixtures, which can be categorized as follows: chandeliers; wall sconces and ceiling lights (lighting fixture for paintings/mirrors with LED) (**Figure 5**); pendants (pendants, lanterns); spotlights (wall-mounted, recessed, sensor-equipped, track-mounted, step lighting, clips for recessed spotlights); directional lighting fixtures (floodlights, tracks, directional lighting fixtures) (**Figures 6 a, b**); table lamps and desk lamps (nightlight, LED nightlight, nightlight with sensor, LED nightlight, desk lamp, LED desk lamp);

lighting fixtures for suspended ceilings (LED panels, lanterns, LED lanterns); linear lighting fixtures (LED lamp, electronic lantern, fluorescent tube lantern, LED lighting fixture) (**Figure 7**); floor lamps (floor lamps, LED light floor lamps, table lamps); high Bay - industrial lighting; lighting fixtures for children (LED nightlight, LED ceiling light, LED chandelier); lighting fixtures for stairs [5 pp. 8-19].

Lighting fixtures can vary based on: color range (LED and bulb color, material from which it is made...), configurations, purpose, etc. Every lighting fixture must have the *characteristic of being resistant to humidity*. Moisture ingress can lead to fire or damage.

Selecting suitable lighting fixtures for the ambient environment during the design phase ensures a pleasant environment with maximum comfort. It is essential that the procedure corresponds to the style and parameters of the designed space.

Figure 5. Lighting spotlights. Railway Station. Chișinău.



Source: photo by Matcan-Lisenco Inga, from the personal archive.

Figure 6a. Spotlights, directed light fixtures. National Art Museum. Bucharest.



Source: photo by Matcan-Lisenco Inga, from the personal archive.

Figure 6b. Directed light fixtures. National Museum of Art of Moldova.



Source: photo by Matcan-Lisenco Inga, from the personal archive.

Lighting is essential in interior architecture, having a major impact on the aesthetics and functionality of spaces. Technologies such as LEDs, smart control systems, and the use of natural light contribute to energy efficiency, reducing energy consumption, and supporting a sustainable environment. The proper selection of lighting fixtures, considering design and moisture resistance, is vital for creating comfortable and energy-efficient spaces [6].

Principles of quality lighting design, Kelly Richard's theory

Currently, specialized color charts have been developed that easily show the transition from white light to warm and cool light. The use of various types of lamps for lighting fixtures aims to achieve diverse effects. Kelly Richard made a significant contribution to the theory behind quality light design by differentiating the basic functions of light [7]. He systematically presents the available means. A lighting system should not waste energy by providing more light than necessary or using inefficient systems. While energy efficiency is important, it should not be considered the primary measure of good lighting if it excessively compromises aesthetic or functional considerations.

Important criteria useful in design: project analysis (preferences, needs, constraints of the client), data collection (budget, age, flexibility, purpose of the space, etc.). Understanding the visual perception process and knowing the nature of the visual task at hand is necessary, as it determines the lighting design objectives for the space. Lighting design cannot exist independently. Creating and implementing a well-balanced lighting environment that meets the visual task requirements is a process correlated with other elements (e.g., flooring, furniture, etc.). Therefore, it is essential to define the concept's goals together and then implement them.

It is important to focus on the necessary objectives in the design process. *Quantitative objectives*: the lighting level must be adequately defined for the task at hand; natural light should be considered,

factoring in the amount of light that enters the interior. Daylight can contribute to the lighting level and help proportionally reduce artificial lighting; maintenance should be considered, including the maintenance characteristics of the lighting fixtures and design (changing bulbs, upkeep) [8]. *Qualitative objectives*: visual guidance – creating subtle differences in brightness, highlighting specific areas; architectural accent – architectural features can be either diminished or emphasized depending on the type of lighting; perceived brightness depends on: the refractive value of all surfaces that define the space, the distribution of light intensity of the installed lighting fixtures and the lighting level achieved; the style of the lighting fixtures – their specific lighting features can help in diversifying the environmental settings; the image produced through various types of lighting – the type of lighting fixtures, color gamut, brightness, intensity, and distribution modify the appearance of a space, affecting the overall image; color – the characteristics of color affect visual perception, including temperature and color rendering [9]. An important part of the lighting design process is selecting the appropriate lighting fixtures.

The development of the lighting concept depends on the imposed requirements, where solutions must be verified to fit within the budget and reasonable constraints.

The result of the project analysis is a series of lighting tasks assigned to specific areas of the space, all forming a characteristic matrix of the requirements for a visual environment. The next step after the project analysis is the development of a qualitative concept that outlines the qualities the lighting should possess, without providing exact details on the selection of lighting fixtures or the compositional scheme.

The practical implementation of the design, according to the space's requirements, means that the designer must determine the proper distribution of light, light sources, and, last but not least, the direction of the light. The light source can be linear or point-based, and the lighting fixture can be hidden or visible, suspended, recessed, or mounted. Such requirements guide the designer to use specific lighting articles [10].

A true challenge lies in designing quality lighting, which involves developing a concept that must meet a wide range of requirements through a lighting installation, both technically and aesthetically. In contrast to quantitative concepts, which derive from a general set of lighting qualities based on the requirements for a project, leading to a standardized design, well-planned consideration of a wide range of lighting tasks frequently leads to a systematic distribution of a varied range of lighting fixture configurations [11].

From an economic, technical, and design perspective, the goal of lighting design should be to find solutions that focus not only on achieving an overall uniform lighting effect but also on covering a wide variety of lighting requirements. The concept should produce a structurally clear distribution of lighting qualities through an intentional lighting scheme. However, the best solution is a concept that achieves high results with minimal technical equipment and the highest clarity of design.

Discussions

The study of lighting typologies and their importance in interior design brings to the forefront several fundamental aspects that shape both the functionality and aesthetics of spaces. The role of general lighting, referred to by Kelly Richard as ambient light, is to ensure basic visibility and a uniform background, over which other types of lighting, such as task or mixed lighting, are layered. Task lighting is essential for highlighting specific functional areas, while mixed lighting successfully combines both categories, addressing the vital needs of users.

Technological innovations in lighting, such as LED spotlights and pendant light fixtures, have opened new horizons in interior space planning [12 p. 158]. These solutions not only enhance visual quality but also highlight architectural and design elements. In this context, the color of light plays a decisive role in influencing the perception of the space.

Another emphasized aspect is the importance of energy efficiency in interior design, a growing concern within the context of sustainability. LED lighting and the use of smart technologies, such as

motion sensors and digital control systems, ensure low energy consumption without compromising lighting quality [13]. At the same time, maximizing natural light through well-thought-out architectural design not only saves energy but also improves the quality of life and activity within the building.

From the perspective of Kelly Richard's theory, lighting should not only be designed from a functional or energy standpoint but also as an integrated element of interior architecture. The concept of qualitative lighting emphasizes the importance of customizing solutions, starting with analyzing the user's needs and incorporating these requirements into the space's design. Thus, specific visual tasks, guiding the eye, highlighting architectural elements, or creating a balanced atmosphere, interweave to offer a complete experience.

The selection of lighting fixtures also plays a key role. From their aesthetics to their technical performance, each piece contributes to defining the character of a space. Moreover, lighting design requires a holistic approach, considering the economic, technical, and aesthetic elements to create functional and attractive spaces.

Therefore, this study highlights not only the complexity of the lighting design process but also its significant impact on how we perceive and use interior spaces. The constant adaptation of innovative technologies, optimal use of natural resources, and a detailed analysis of the relationship between light and design transform lighting into an indispensable element of contemporary architecture.

Conclusions

The research concludes that lighting plays a crucial role in interior design, influencing not only the aesthetic aspect but also the energy efficiency of spaces. An interdisciplinary approach and the integration of modern technologies in lighting design can significantly contribute to improving the ambient quality. It is vital for designers to understand not only the principles of lighting but also their effects on users.

Regarding future research directions, it is recommended to continue studies on energy efficiency, including the use of smart lighting sources and automated control systems to reduce energy waste. Additionally, it is important to investigate the long-term effects of different types of lighting on the mental and physical health of users, including the influence of color and light intensity on mood. Another significant aspect is analyzing the ecological impact of different lighting fixtures, aiming to identify renewable and biodegradable materials that can be used in their design. The study of adaptable lighting systems, which can adjust lighting parameters according to the user's needs and environmental variables, also represents a promising direction.

Finally, exploring the potential of emerging technologies, such as intelligent LED lighting and IoT connectivity, will contribute to optimizing energy use and enhancing the user's experience. These directions will help improve the understanding of lighting complexity in interior design and assist in developing more efficient and sustainable solutions.

Acknowledgments. This article is the result of the scientific project, entitled: *Models, systems and technologies for energy efficiency, decarbonization and digitalization of processes in energy, industry, construction and transport* (acronym Mosited) for the years 2024-2027, with the cipher 02.04.06.

Bibliographic references

1. KAHN, L. *Light and space gebundene ausgabe*. Watson-Guptill Pubns, 1995. ISBN 0823-027-732.
2. SPECHTENHAUSER, G. and M. CORRODI. *Illuminating (Living Concepts)*. Boston: Birkhauser, 2008. ISBN 3038216410.
3. MATCAN-LISENCO, I. Improving energy efficiency in buidings through the use of panoramic glazing. *Art and design*. 2024, nr. 2 (26), pp. 44–53. ISSN 2617-0272.
4. SCHLEUNING, S. and C. STRAUSS. *Electrifying design: a century of lighting*, Yale Universty Press, 2021. ISBN 9780300254570.
5. КАШКАРОВ, А. Современные осветительные приборы: выбор, подключение, безопасность. Москва: ДМК-Пресс, 2017. ISBN 978-5-97060-480-9.

6. HEE, W.; M. ALRHOUL; B. BAKHTYAR; E. OMKALTHUM; M. SHAMERI et. al. The role of window glazing on daylighting and energy saving in buidings. *Renewable and Sustainable Energy Reviews, Elsevier*. 2015, vol. 42 (C), pp. 323–343. ISSN 1364-0321.
7. Richard Kelly's three tenets of lighting design. *Architect Magazine*. American Institute of Architects. Online. 20 January 2021. Disponibil: https://www.architectmagazine.com/technology/lighting/richard-kellys-three-tenets-of-lighting-design_ [accesat 2025-03-13].
8. LIU, X. and Y. WU. A review of advanced architectural glazing technologies for solar energy contrversion and intelligence daylighting control. *Architectural Intelligence*. 2022, nr. 1 (10), pp. 1–32. ISSN 2731-6726.
9. KONG, Z.; Q. LUI; H. LI; K. HOU and Q. XING. Indoor lighting effects on subjective impressions and mood states: A critical review. *Building and Environment*. 2022, vol. 224. ISSN 0360-1323.
10. FIGUEIRO, M. Light in the built environment: The ceiling si not the limit. *Building and Environment*. 2019, vol. 157. ISSN 0360-1323.
11. GORDON, G. *Interior Lighting for Designers* 4th. ed. John Wiley&Sons, Inc, 2003. ISBN 978-0471441182.
12. MATCAN-LISENCO, I. From LED to IoT, optimizing interior design and energy efficiency through lighting technologies. *Intertext*. 2024, nr. 2 (64), pp. 157–165. ISSN 1857-3711.
13. MATCAN-LISENCO, I. and A. BARBANEAGRA. The need to create a suitable environmental setting for the development and support of children with autism spectrum disorders in the Republic of Moldova. In: *Învățământul artistic – dimensiuni culturale: conferința de totalizare a activității științifico-didactice a profesorilor [AMTAP]* (aprilie 2024). Chișinău: Notograf Prim, 2024, pp. 174–181. ISBN 978-9975-176-05-7.