

## Research Article

## Submission Date

01 / 11 / 2023

## Admission Date

15 / 04 / 2024



How to Cite:

# The Role of Environmentally Responsible Interior Design in Healthcare for Enhanced Patient Well-being

## Çevre Sorumlu İç Mekân Tasarımının Sağlık Yapılarında Kullanımının Hasta Sağlığı Üzerindeki Rolü

Esra Bayır<sup>1</sup>

Bayır, E. (2024). The Role of Environmentally Responsible Interior Design in Healthcare for Enhanced Patient Well-being. *Journal of Environmental and Natural Studies*, 6 (1), 23-36. <https://doi.org/10.53472/jenas.1384245>

### ABSTRACT:

While the healthcare industry is struggling with environmental impacts, it is also trying to bring together holistic design practices to create sustainable, patient-centered, and ecologically responsible, energy-efficient healthcare areas. With the increase in studies focusing on the positive effects of the ecological design approach on the well-being and recovery processes of patients, the integration of green elements into healthcare structures becomes even more important. Integrating environmentally responsible design (ERD) principles into hospital interior design; It contributes significantly to reducing carbon emissions, resource consumption, and environmental waste. At the same time, by optimizing energy-efficient systems, adopting sustainable materials, and creating patient-centered healing spaces by utilizing natural light and natural ventilation, it can both contribute to the treatment process and reduce carbon footprints. This study proposes a novel approach that integrates ERD elements with healthcare interior design. Recognizing that the built environment and human health are interconnected, the research examines innovative design strategies to promote healing through environmentally responsible interior design (ERID). The focus of this approach is on combining ERD strategies such as healing design, patient-centered design, evidence-based design, and the use of sustainable materials, daylight, natural ventilation, energy-efficient design, sustainable design, and biophilic design. As a result of this integration, drawing attention to the role that patient-centered green interior designs play in improving the health and well-being of patients and the efforts to minimize the negative effects of hospitals on the environment. Also, it is aimed to encourage the health and construction sectors in this sense and propose a path towards a green future.

**KEYWORDS:** *Environmentally Responsible Interior Design, Healthcare Buildings, Patient Wellbeing, Healing Environment*

### ÖZ:

Sağlık sektörü geldiği nokta itibarı ile bir yanda çevresel etkilerle boğuşurken, diğer bir yanda sürdürülebilir, hasta odaklı ve ekolojik açıdan sorumlu, enerji-etkin sağlık hizmetleri alanları yaratmak için bütüncül tasarım uygulamalarını bir araya getirme çabası içindedir. Ekolojik tasarım yaklaşımının hastaların iyi olma ve iyileşme süreçleri üzerindeki olumlu etkilerine odaklanan çalışmalardaki artışla beraber de yeşil unsurların sağlık yapılarına entegrasyonunu daha da önemli hale getirmektedir. Çevresel açıdan sorumlu mimari ilkelerinin hastane iç mekân tasarımına entegrasyonu; karbon emisyonlarının, kaynak tüketiminin ve çevresel atıkların azaltılmasında önemli ölçüde katkı sağlamaktadır. Aynı zamanda; enerji verimli sistemleri optimize ederek, sürdürülebilir malzemeleri benimseyerek, doğal ışık ve doğal havalandırmadan yararlanarak hasta-odaklı iyileştiren mekanların oluşturulması sayesinde hem tedavi sürecine katkı sağlanabilir hem de karbon ayak izlerinin azaltılması sağlanabilir.

<sup>1</sup> **Corresponding Author:** İstanbul Medipol University, Faculty of Fine Arts Design and Architecture, İstanbul, [bayiresra@gmail.com](mailto:bayiresra@gmail.com), <https://orcid.org/0000-0002-2298-8326>



Bu çalışma, çevre sorumlu tasarım unsurlarının, sağlık yapıları hizmetleri ve iç mekân tasarım kriterleri ile bütünleştiren yeni bir yaklaşım önermektedir. Yapılı çevre ile insan sağlığının birbiriyle bağlantılı olduğunu kabul eden araştırma, çevre sorumlu iç mekân tasarımı yoluyla iyileşmeyi teşvik edecek yenilikçi tasarım stratejilerini irdelemektedir. Bu yaklaşımın odağında, iyileştiren tasarım, hasta-odaklı tasarım, kanıta dayalı tasarım öğeleri ile sürdürülebilir malzemelerin kullanımı, gün ışığı, doğal havalandırma, enerji-etkin tasarım, sürdürülebilir tasarım, biyofilik tasarım gibi çevre sorumlu tasarım stratejilerinin birleştirilmesi yer almaktadır. Bu entegrasyonun sonucu olarak geleceğin sağlık yapılarında; hasta odaklı yeşil mekân tasarımlarının, hastaların sağlığını ve refahını geliştirmede oynadığı role ve hastanelerin çevreye olan olumsuz etkilerinin maksimumda minimize etmeye çalışılmasına dikkat çekilerek, sağlık ve yapı sektörünü bu anlamda teşvik etmek hedeflenmektedir.

**Anahtar Kelimeler:** Çevre Sorumlu İç Mekân Tasarımı, Sağlık Yapıları, Hasta Sağlığı, İyileştiren Çevre

## INTRODUCTION:

A paradigm change is occurring in the field of healthcare design today due to the pressing need for environments that not only promote patient and environmental well-being but also physical healing. Conventional healthcare interior design has frequently been utilitarian yet impersonal, with little thought given to how the physical environment affects the healing process. In response, this study offers a revolutionary viewpoint—a innovative method of environmentally conscious interior design for healthcare facilities that prioritizes the health of the patient.

Integrating environmental responsibility with healthcare design involves a comprehensive rethinking of the therapeutic environment, not just an artistic undertaking. Inspired by the ideas of biophilic design, our method highlights the natural bond between people and the natural world. This innovative method aims to build interiors that go beyond conventional norms, establishing a therapeutic environment that is both patient-centric and ecologically sensitive. It does this by integrating sustainable materials, evidence-based design strategies, and a deep understanding of patient requirements.

The importance of this endeavor becomes clear as we set out on this exploration. Human health is significantly impacted by the built environment, which also affects stress levels, recuperation times, and general satisfaction with medical care. This paper aims to explore the potential of environmentally responsible interior design as a catalyst for improved patient well-being through a thorough review of the literature, an analysis of current healthcare design paradigms, and the proposal of a prototype embodying our novel approach.

In addition to adding to the theoretical conversation about healthcare design, this research aims to provide real-world knowledge and useful applications for designers, architects, and health service providers intending to construct professional environments that not only treat illnesses but also holistically care for the people who inhabit them. We hope to provide a blueprint for a future in which environmental stewardship is seamlessly integrated into the therapeutic environment, ushering in a new era of patient-centered care, as we negotiate the uncharted area of this innovative method. Therefore, this study has been focused mainly to identify important design criteria of ERID in hospital design and scrutinize relationship between ERID and patient wellbeing. At this context, the questions were in this study,

- What are the design strategies in ERID in hospital buildings?
- What is the relationship between ERID and patient wellbeing?
- How can ERID be including in hospital interior design?

### 1. Environmentally Responsible Design (ERD)

In order to comprehend the approach of Environmentally Responsible Design (ERD), it is necessary, first and foremost, to understand the definitions of green design and sustainability, and question their assumptions on building design. Fundamentally, the starting points of green-focused design approaches often revolve around minimizing the harmful effects of construction and the life cycle of the environment. The increasing trends in consumption, materials, production technologies in the construction sector, and user expectations/needs continually update the focus and scope of green design approaches. (Sassi, 2006; Jones, 2008) A macro view of environmental responsibility is suggested by sustainable design, which emphasizes safeguarding the wellbeing and vitality of global ecological systems for now and future descendants. A detailed viewpoint is implied by eco-friendly design, which is the safeguarding of human well-being and health within the constructed surroundings. The advantages of environmentally responsible design (ERD), which merges sustainable and eco-conscious design, are vast for our planet and its inhabitants. (Jones, 2008) ERD strategies cover a range of techniques meant to lessen the influence on the environment and encourage sustainability in building and design. Among the design strategies covered by ERD are adaptive reuse and renovation, life cycle assessment, energy efficiency, renewable energy integration, sustainable materials, water efficiency, passive design, and educational and community engagement.

ERD focuses primarily on three environmental aims known as the "3 Rs": reduce, reuse, and recycle. Using renewable materials, maximizing energy efficiency, putting passive design concepts into practice, and incorporating green spaces into constructed environments are some of these tactics. Environmentally responsible design (ERD), green design, and sustainable design concepts all aim to reduce ecological footprints and promote environmental stewardship. ERD might place a higher priority on protecting regional ecosystems, reducing water use in areas with limited water resources, or addressing environmental issues in a certain location. Furthermore, while community involvement and inclusivity may not necessarily be the focus of more comprehensive green or sustainable design initiatives, ERD can concentrate on social and cultural elements. (Wehrli, 1986; Jones, 2008) Midtown Lofts Buildings in Minneapolis were built according to ERD criteria. (Figure 1)





Figure 1. ERD Building; MIDTOWN LOFTS, Minneapolis (Url-1)



**1.1. Environmentally Responsible Interior Design (ERID)**

Despite the existence of various groups like the U.S. Green Building Council that disseminate information about green and sustainable building construction methods and materials, none of them focus on a design philosophy that encompasses environmentally responsible interior design and the indoor environment. This lack of focus on interiors creates a knowledge gap for architects, interior designers, and facility managers who want to establish an environmentally sensitive design approach for indoor environments. (Jones, 2008)

Environmentally responsive interior design (ERID) focuses the sustainable interior architecture with ecological responsibility including reducing energy consumption, minimizing adverse effects on the natural environment, and ensuring healthy use of the interior. This framework also focuses on the importance of achieving sustainability goals in interior design by incorporating current technology tools, environment-based programs, and graphic-based methods into the interior design process. (Fadeti and Taha, 2013) (Jones, 2008) Moreover, decision-making process in ERID includes evaluating all aspects together in terms of interior design components, environmental impact and users' health and well-being. (Celadyn, 2018) (Url-2) ERID encompass various aspects, including respect for the wisdom of natural systems, interconnectedness, environmental impact of human behavior, use of sustainable products, continuous education, and vigilance. Also under these aspects, ERID has core principles such as materials selection, energy efficiency, indoor air quality, waste reduction and recycling, water conservation, flexible and adaptable design, green-essentials design criteria's, social responsibility, educational outreach and awareness and certifications and standards. (Jones, 2008) (McCoy, 2012) (Fadeti and Taha, 2013) (Farooq and others, 2015) (Boehm, 2015) These strategies reflect the comprehensive approach of ERID, encompassing respect for natural systems, human behavior, and the environment, as well as the use of sustainable products and the need for ongoing education and vigilance. (Table 1)

Table 1. ERID Strategies (by Author)

Strategies	Objectives	Indicators	Real Example	Images
Sustainable Material Selection	to reduce the environmental impact of construction and building, to contributes to carbon neutrality.	using recycled, reclaimed, locally sourced materials or rapidly renewable sources and certifications.	<b>The Edge</b> is one of the greenest buildings globally. Design elements of this building consist of life cycle assessment, timber structure, sustainable materials, smart lighting, energy-efficient and extensive green roofs. (URL-3)	
Energy Efficiency	to optimize energy usage, reduce waste, and lower greenhouse gas emissions, to integrate of energy-efficient technologies, to minimize the carbon footprint of buildings, to contribute to net-zero or carbon-neutral structures.	using renewable energy sources, wind turbines, geothermal systems and solar panels making high-performance insulation, using energy-efficient windows advanced lighting systems with natural light, optimizing HVAC systems.	<b>The King Abdullah Petroleum Studies and Research Center</b> has solar panels and a heliostat system for energy generation, natural daylight into all interiors; buffer zones glaring exterior to a cool, filtered interior. (URL-4)	

Indoor Air Quality (IAQ)	to ensure proper ventilation to improve indoor air quality, to reduce the concentration of pollutants, to use low VOC Materials.	using non-toxic interior materials and natural materials, applying proper ventilation and humidity control.	<b>the French Lycée and renovate the Studio Molière</b> has low VOC materials of building's structure and its equipment, advance the ventilation system with natural sources, eco-friendly interior materials. (URL-5)	
Waste Reduction and Recycling	to focus zero waste in architecture, to reduce waste during construction and operational practices, to prioritize recycling of materials, to decrease carbon emissions associated with waste disposal.	rethinking, reducing, reusing and recycling waste management, recycling and reusing interior materials, minimizing single-use products.	<b>Kamikatsu Zero Waste Center</b> was built with wasting materials, earth-friendly design aspect and complex facility with research, education, and dialog. It has the goal of recreating coterie and enhance this region. (URL-6)	
Water Efficiency	to reduce water consumption and manage water sustainably, to implement water-efficient landscaping design both indoors and outdoors.	rainwater harvesting, graywater recycling, efficient irrigation, specifying water-saving plumbing fixtures and appliances.	<b>The Building of California Academy of Sciences</b> is called as The Water Planet. The building has a design approach including water efficient landscaping, providing a savings of 50% by captured or recycled site water from the green roof, water use reduction-a saving of 76.9% through graywater re-use, low-flow lavatories, kitchen sinks and showers. (URL-7)	
Biophilic Design	to integrate natural elements into the interior design, to prioritize access to outdoor views and maximize natural daylight within interior spaces.	using plants, water features, and natural materials, using proper windows and facade to connect to nature to interior.	<b>ATRI House</b> has minimum carbon footprint, eco-friendly materials, climate shells to protect, automatic irrigation and ecocycle-systems giving back nutrients from wastewater to garden plants. (URL-8)	
Flexible and Adaptable Design	to design interiors with durability and adaptability in mind to reduce the need for frequent renovations.	using modular furniture and design elements to allow for flexibility in spatial arrangements.	<b>MJE House</b> has a system consisting of each partitioning wall is a module also these modular walls have both storages inside them and can rotate around to create extra bedrooms or free spaces for guests. (URL-9)	
Social Responsibility	to give precedence to moral sources that endorse equitable labor practices and accountable resource stewardship.		<b>The Bullitt Center</b> has a Living Building certification. The building was designed as a carbon-neutral office. All wood of building was Forest Stewardship Council certified. Also, it was used steel frames and timber materials from native Douglas Fir certified by the Forest Stewardship Council. (URL-10)	
Educational Outreach and Awareness	to encourage sustainable educational programs and educate clients, designers, and occupants about the principles and benefits of ERID.			
Certifications and Standards	to seek and follow guidelines from recognized sustainability certifications, such as LEED, BREAM for Interior Design.	creating aesthetically pleasing and functional interiors contributing positively to the environment and the well-being of users.	<b>Children's Healthcare of Atlanta Support Center</b> is a building having LEED v4.1 interior design certificate and LEED silver. It is a special building because of interior design certificate from LEED except the other LEED certificated building. (URL-11)	

### 1.2. Environmentally Responsible Interior Design (ERID) for Healthcare Buildings

The integration of ERID features in hospital architecture necessitates a careful balance between traditional infrastructure requirements and green strategies. Utilizing natural light through increased daylighting strategies not only enhances patient and staff well-being but also reduces reliance on artificial lighting, thereby conserving energy (Url -12). In tandem with natural lighting, the implementation of better water systems, including water conservation and harvesting provisions, plays a crucial role in minimizing wastage and supporting sustainability within healthcare facilities (Alsawaf and Albadry, 2022). Furthermore, the choice of materials used in construction and interior design is pivotal; by opting for sustainably sourced materials, healthcare buildings can considerably reduce their carbon impact and help to a greener future. (Guenther and Vittori, 2013) These components, when combined with energy-efficient equipment and hygiene considerations, ensure that environmentally responsible design is not only about reducing ecological impact but also about maintaining ambitious standards of patient care and safety. (Hamed and Maksoud, 2017) The key components of ERID for hospitals include promoting government policy, promoting social responsibility, good care, professionalism, sustainable purchasing, minimizing wasting, recycling all waste, checking risky materials, sustainable use of all materials, supporting modern technology, designing efficient architecture, and using devices correctly. (Kallio and others, 2018) ERID in hospitals also involves implementing energy-efficient technologies and practices, water conservation, sustainable materials, waste reduction, sustainable transportation, and creating healing environment and healthful outdoor spaces. Additionally, ERID for hospitals emphasizes the efficient use of energy, adherence to government regulatory frameworks for sustainability, and the use of environmentally friendly products. (Dion and Evans, 2023) (Kallio and others, 2018) These components are essential for creating ERID in hospitals, promoting sustainability, and ensuring the health and well-being of patients, staff, and the wider community.

Also, ERID emphasizes the importance of incorporating effective lighting design, recognizing that the quality of light has significant implications for both the efficiency of medical staff and the comfort of patients. To this end, the inclusion of LED lighting is advocated, not only for its superior illumination properties but also for its energy efficiency, which can lead to reduced operational costs and a lower environmental impact. Moreover, ERID guidelines suggest the strategic placement of windows and skylights to harness the benefits of natural light, which has been shown to support the circadian rhythms of both patients and staff, enhancing mood and aiding in the recovery process. These design considerations underscore the holistic approach of ERID, where the well-being of healthcare providers is intricately linked to environmental factors, ultimately influencing the quality of patient care. (Peavey, 2011) (Guenther and Vittori, 2013) (Hamed and Maksoud, 2017) As the core principles ERID in hospital buildings should focus on design approaches of patient centered (PCD) and healing environment (HE) involves balancing sustainability goals with the unique requirements of healthcare environments. Strategies are tailored to patient-centered design and healing environment in hospital interiors at below table. (Table 2)

Table 2. ERID Strategies for Hospital Buildings (by Author)

	Strategies	Objectives	Indicators	Hospitals
ERID <sup>1</sup>	Sustainable Materials and Finishes for patient health	to select environmentally friendly materials that contribute to better indoor air quality and patient well-being.	choosing low-emission paints, recycled content materials, and flooring options that are easy to clean and maintain.  Case 4	
ERID	Energy Efficiency	to minimize the carbon footprint of interiors, to contribute to net-zero or carbon-neutral interiors.	using of clean, renewable energy sources, wind turbines, geothermal systems, solar panels, energy-efficient windows, advanced lighting systems with natural light, optimize HVAC systems. Case 1	
ERID	Indoor Air Quality (IAQ)	to ensure proper ventilation to improve indoor air quality, to reduce the concentration of pollutants, low VOC materials.	using non-toxic interior materials, natural materials, proper ventilation, humidity control.  Case 3	
ERID	Water Efficiency	to reduce water consumption and manage water sustainably, to implement water-efficient landscaping design both indoors and outdoors.	using rainwater harvesting, graywater recycling, efficient irrigation. specifying water-saving plumbing fixtures and appliances. Case 1	
ERID HE <sup>2</sup>	Biophilic Design for Healing	to integrate biophilic elements to promote healing and reduce stress, to connect nature to interiors with landscaping.	designing patient rooms with views of nature, incorporate indoor gardens, and use natural materials.  Case 2	
ERID PCD <sup>3</sup>	Flexible and Adaptable Design	to design interiors that can adapt to different patient needs and accommodate various healthcare activities.	creating flexible waiting areas that can be reconfigured, allowing for different seating arrangements or collaborative interiors.  Case 2	
HE	Natural Lighting for HE	to maximize natural light to enhance patient well-being and reduce reliance on artificial lighting.	designing interior with large windows, use light shelves to direct sunlight, and install adjustable blinds for patient comfort.  Case 5	

HE	Noise Reduction for HE	to implement strategies to minimize noise levels, creating a tranquil environment for patients.	using acoustic panels, sound-absorbing materials, and design layouts that reduce noise transmission.  Case 2	
HE	Healing Art Installations	to use art as a therapeutic element in the interior design, fostering a positive and calming atmosphere	integrating nature-inspired artwork, healing gardens, and interactive installations that engage patients.  Case 5	
HE	Wellness Rooms	to design dedicated spaces for patient and staff wellness.	including meditation rooms, relaxation spaces, or areas for staff to recharge, promoting overall well-being.  Case 1	
PCD	Patient-Centric Furniture	to choose furniture that prioritizes patient comfort, functionality, and infection control.	selecting antimicrobial and easily cleanable materials, incorporate comfortable seating, and provide adjustable furniture for various patient needs.  Case 5	
PCD	Patient Privacy and Dignity	to prioritize patient privacy and dignity in the design of individual and shared spaces.	incorporating private rooms, use smart design layouts to maintain patient confidentiality, and provide isolated areas for discussions.  Case 1	
PCD	Patient Engagement Technology	to integrate technology that empowers patients and enhances their experience.	providing patient-centric technology like bedside tablets for communication, entertainment, and access to health information.  Case 1	
HRq <sup>4</sup>	Wayfinding and Accessibility	to design intuitive wayfinding systems for patients and visitors and ensure accessibility for all.	designing interiors more accessible and easier to navigate for all patients, without considering their physical abilities or age.  Case 5	
HRq	Infection Control Measures	to integrate materials and design elements that support infection control protocols.	using easily cleanable surfaces, antimicrobial finishes, and hands-free fixtures to reduce the risk of infections.  Case 3	

<sup>1</sup> Environmentally Responsible Interior Design (ERID)

<sup>2</sup> Healing Environment (HE)

<sup>3</sup> Patient-centered Design (PCD)

<sup>4</sup> Hospital Requirements (HRq)

By incorporating these strategies into the interior design of hospital buildings, it is possible to create healing environments that prioritize patient comfort, well-being, and environmental sustainability. Each design decision should align with the overarching goal of enhancing the patient experience and supporting positive health outcomes.

### 1.2.1. ERID Impacts to Patient Wellbeing and Recovery

ERID is close on creating a therapeutic environment that supports the well-being of patients during their stay, speeds recovery, and increases the well-being and motivation of staff. ERID principles focus on creating healthier, more sustainable, and environmentally friendly interior spaces, which can have a positive impact on patient outcomes. For example, ERID emphasizes the use of natural light, indoor plants, and low-VOC materials to improve indoor air quality, which can contribute to patient comfort and recovery. (Alsawaf and Albadry, 2022)

Additionally, studies have shown that elements such as nature, daylight, fresh air, and quiet, which are key components of ERID, can contribute to the healing of patients and have a positive impact on their recovery. (Rechel and others, 2009) Furthermore, the design of hospitals that incorporate ERID principles has been associated with better clinical outcomes, including shorter postoperative hospital stays and reduced need for pain relief medications. (Peavey, 2011) (Huisman and others, 2012) (Mahmoud and Tayib, 2019)

In addition to ERD elements highlighted previously, human-centered design strategies play a pivotal role in creating a healing environment within healthcare facilities. By prioritizing the creation of comfortable and welcoming spaces, these strategies focus on the needs and experiences of patients as central to the design process. (Douglas and Douglas, 2004) Comfort is not just a matter of aesthetics; it directly contributes to how patients experience their healing journey. The implementation of reduced chemical use in building materials and cleaning products, for instance, can mitigate the risk of adverse reactions and promote a toxin-free environment, which is essential for patient well-being and can lead to shorter recovery times. (Jalal, 2018) Moreover, the enhancement of indoor air quality through increased ventilation is another strategic design consideration that can have a significant positive impact on patient health, reducing the potential for airborne infections and contributing to faster healing. (Settimo and Capolongo, 2019) Furthermore, access to natural light is a design strategy that can have a profound effect on patient recovery. Numerous studies have shown that exposure to sun or daylight can contribute regulate sleep patterns, increase mood, and therefore optimize the healing process. Access to daylight and nature views has also been correlated with more positive clinical outcomes, such as better recovery, less pain, reduced stress and shorter postoperative stays. (Ari pin, 2007) (Simonsen and others, 2024) This strategy aligns with the broader objective of sustainable design, which seeks to create not only a healthier environment for patients by leveraging natural resources but also a more comfortable one. For instance, the incorporation of natural elements such as indoor plants and water features can reduce patient stress and improve healing times, demonstrating the therapeutic benefits of integrating natural beauty within hospital settings. (Huisman and others, 2012) These design strategies, when applied thoughtfully, can transform hospitals into patient-centric environments that not only aid in recovery but also enhance the overall satisfaction and well-being of those in care. (Intreva do and others, 2019) (Prakash, Srivastava, 2020) (Douglas and Douglas, 2004)

Studies have shown that well-designed hospitals, such as those following standardized patient room designs, sufficient ventilation, and better ergonomic design, enhance staff and patient safety, diminish healthcare mistakes, and enhance the productivity and efficacy of medical services provision. (Capolongo and Settimo, 2017) (Simonsen and others, 2024) Additionally, rooms with views have been found to have a noticeable influence on patient recovery, leading to fewer doses of analgesics and shorter postoperative hospital stays. (Huisman and others, 2012) Also, ERID strategies incorporating natural elements like indoor gardens improve patient healing times by tapping into 'biophilia', a deep human-nature connection. Such integration in healthcare design offers patients a visually soothing environment, reducing stress and promoting faster recovery. (Simonsen and others, 2024) ERID considers the patient's sensory experience, using soft lighting, comfortable furniture, and calming colors to support healing. These choices meet patients' psychological needs, providing comfort and tranquility, reducing anxiety, and enhancing the healthcare experience. Thus, ERID's holistic principles are crucial in enhancing patient recovery and creating a healing-friendly environment.

## 2. Methodology and Case Study

In this study, an analytical methodology is adopted to examine the relationship between the ERID approach and patient well-being. The methodology depends on to solve problem according to a theoretical information to get the findings. It is a method of dividing a certain subject into parts and reaching the whole again with these parts in accordance with certain rules. (Almamoori, 2014) This paper includes in detailed searching on literature extracting key sources related to the ERD over the sustainable and green approaches, hospital (interior) design, patient wellbeing. Because there is a few study about ERD or ERID hospital design. Through a methodical arrangement of collected information and data from primary sources, a conceptual framework takes shape. This research draws a knowledge from various disciplines in a theoretical foundation, particularly emphasizing healthcare complexity challenges, environment, patients, interiors and nature. These conceptual frameworks are utilized via the analytical approach, enabling the reevaluation and scrutiny of the subject matter from an interdisciplinary viewpoint, with the subject positioned at the core of the theoretical framework. (Paç, 2023) The research method consists of three stages. Initially, strategies related to sustainable design, green design, ERD, and ERID will be extracted from literature. In the second stage, challenges, and requirements in creating environmentally responsible hospital interiors will be examined and a model, integrating ERID with hospital design, will be proposed along with suggestions and hospital examples. In the third stage, the hospitals, having green and sustainable design strategies at the same time in interior and architecture design with some national or international certificates, were analyzed and compared aspect of proposal strategies of ERID. After all these stages, it is aimed to present a conceptual model for ERID for hospitals including relationship between patient wellbeing and ERID.

### 2.1. Case 1: Khoo Teck Puat Hospital in Singapore

Khoo Teck Puat Hospital (KTPH), a LEAF-certified, award-winning like the 2011 SIA Architectural Design Award for Best Healthcare Building, healthcare institution, is renowned for its biophilic design. Boosting the indoor environment is central to their operations

and was the foundation of every design choice. Comprehensive studies, notably by the World Green Building Council, have demonstrated that a sustainable hospital structure that maximizes indoor environmental standards can elevate patient recuperation rates by 20%.” Its ‘forest-like’ structure includes water features, diverse flora, and fauna, creating a calming atmosphere with the goal of human well-being. The design ensures natural light, ventilation, and views, reducing energy costs by 50%. 82 percent of the inpatient beds are primarily passively cooled and naturally ventilated in the tropical climate, Photovoltaic solar panels and systematic garden maintenance through stormwater run-off further enhance efficiency. With 18% of the total floor area as green and blue spaces, it also serves as a public health educator. The building was built to get to live practice involving profound integration of vegetation and construction according to below five strategies;

- Sight (visual access to water and green),
- Smell (choosing of scented plants),
- Sound (falling water),
- Diversity (for plants, birds and butterflies),
- Community (public areas situated within blue-green zones).

With carefully planned cover leaves, breezeways, light wells, and flow-through ventilation, the building was naturally ventilated. The idea was to provide patients with vistas, pleasant breezes, and natural light without having to worry about rain or sun glare. It has cutting-edge energy-saving technologies including photovoltaic solar panels and a special structural arrangement that may save energy expenditures by up to 50% while supplying natural air to up to 70% of the floor surface. The garden motif aims to reduce some of the stress that comes with spending extended amounts of time in a busy hospital, for both staff and patients. Gardens and balconies on the higher floors bring the experience right to the patient's bedside. The quantity of heat and light that enters the hallways is managed by sunscreens and large overhangs, while air-conditioned areas of the building, including operating rooms and labs, were grouped together to reduce their exterior surfaces and heat gain. The hospital may further lower the cost and carbon footprint of hospital maintenance by ensuring that the several gardens are routinely maintained by stormwater runoff and therefore minimizing the quantity of water imported from other places. (Url-12; Url-13; Url-14)



Figure 2. Khoo Teck Puat Hospital, Singapore (Url-12:17)

## 2.2. Case 2: The Deventer Hospital in the Netherlands

Excellent testing facilities, nursing departments, testing rooms, multipurpose rooms, stores, parking, and other facilities are all features of the Deventer Hospital. Its layout provides plenty of room for expansions and future reorganizations, fostering an atmosphere that makes patients, physicians, and guests feel secure, at ease, and at home. The architectural, interior, and structural design was done by DHA. The Netherlands' Deventer Hospital uses a few eco-friendly design techniques. Effective insulation, natural ventilation, heat-cool storage, heat pumps, alternate renewable energy sources, and exhaust ventilation with heat recovery applications are a few of these. The hospital also uses concrete core activation and a heat pump for low-temperature heating, heat recovery from ventilation air, and cascading rainfall to open-surface water. A wooden window frame, a green roof, and energy-recovery methods like energy wheels—which collect heat, cold, and latent energy—are among the extra features. These environmentally friendly practices have a major positive impact on patient wellbeing, environmental sustainability, energy efficiency, and decrease in energy usage inside the hospital. (Sala, 2017) (Url-18; 19; 20)





Figure 3. The Deventer Hospital, Netherlands (Url-18,19,20)

### 2.3. Case 3: Great Ormond Street Hospital, UK

As one of the few hospitals in the UK to declare a climate emergency, GOSH is dedicated to sustainable business practices and is a member of the Sustainable Medicines Partnership. (Url-21) (Url-22) Great Ormond Street Hospital (GOSH) hired Sable in 2008 to design a new Landor-inspired environment and naturalistic wayfinding system. The goal was to create situations that were interesting, entertaining, and disarming in order to help visiting patients and their families feel less anxious and afraid. Since 2008, we have produced and overseen the installation of many surroundings, such as public spaces, hallways, and wards, in addition to several signage options and teaching materials that make use of the enormous library of characters that our in-house artists have created. Patients can improve their skills in producing visual arts projects for the NHS. (Url-23)



Figure 4. Great Ormond Street Hospital, UK (Url-24,25)

### 2.4. Case 4: Maggie's Centre Barts, United Kingdom

Maggie's Centre at Barts Health NHS Trust in the UK is a cancer care center, providing dedicated support for patients and families. The building's design includes a public roof garden with flowering trees, offering space for activities like yoga and meetings. The interior features carefully curated colored lighting that transforms with the day and seasons, creating a unique ambiance. Strategic lighting placement, colored lenses, and translucent glass on the facade uplift the corner of Barts Hospital square. Barts Health, a distinguished healthcare provider in Britain, attends to the healthcare needs of 2.5 million patients, specializing in heart and cancer services and employing state-of-the-art healthcare equipment and devices. Notably, the institution has committed to ambitious carbon reduction targets from the baseline year of 2018, encompassing a 67% reduction in CORE emissions by 2032, a 50% reduction in energy and water emissions, a 75% reduction in emissions from business and patient transport, and a 25% reduction in emissions from waste.

Key performance metrics reveal substantial accomplishments, with a notable 22.5% reduction in energy demand for gas and 30% for electrical energy, resulting in a 28% reduction in energy expenditure and a concurrent 27% reduction in CO2 emissions, as modeled. A strategic review of energy management practices and data acquisition activities was undertaken, leading to the development of an enhanced calibrated model utilizing authentic building data. The calibration process successfully met the stringent thresholds outlined in ASHRAE Guideline 14. Utilizing a combination of building data and advanced computer modeling techniques, Integrated Environmental Solutions (IES) has successfully generated a virtual benchmark of the building. This benchmark not only meets but surpasses the calibration criteria outlined in ASHRAE Guideline 14. The calibration process achieved hourly precision for electricity-related data, while monthly calibration was realized for gas consumption, accurately modeling daily durations. The data encompassed various aspects, including energy consumption, plant operation, and indoor environmental conditions. Additionally, IES sourced hourly weather data crucial for Heating & Cooling Degree Day calculations and comprehensive building energy simulations." (Url-26; 27; 28; 29; 30)



Figure 5. Maggie's Centre at Barts Health NHS Trust, United Kingdom (Url-26-30)

**2.5. Case 4: Royal Adelaide Hospital in Australia**

An excellent illustration of a healthcare institution that incorporates healing, biophilic design, sustainability, and patient-centered initiatives is Adelaide, Australia's Royal Adelaide Hospital. Green construction materials, rainwater collection, and energy-efficient equipment are just a few examples of the ecologically friendly elements incorporated into the design. With all inpatient beds in single rooms with ensuite and movable windows that provide patients access to solitude, fresh air, and views of gardens, the hospital is intended to be a journey to health. It has a communal shopping district, therapeutic gardens, and natural features like light and ventilation.



Figure 6. Royal Adelaide Hospital, Australia (Url-31;35)

The hospital also makes use of cutting-edge energy-saving elements, such as a special structural arrangement that lowers energy expenses by up to 50% while allowing natural ventilation to reach up to 70% of the floor surface. Moreover, the hospital utilizes rainfall to transfer waterfalls to open-surface water, a heat pump, and concrete core activation for low-temperature heating and heat recovery from ventilation air. These strategies contribute to creating a healing environment that puts the patient experience first, reflecting international best practice. The hospital incorporates natural elements such as indoor gardens and green spaces to create a connection with nature. There is an emphasis on maximizing natural light and views of greenery in patient areas under biophilic aspect. Patient rooms are designed to be spacious and comfortable, and there are dedicated spaces for relaxation and reflection. The overall layout is intended to reduce stress and contribute to the healing process. Also, the hospital focuses on patient well-being by providing amenities like single-patient rooms, personalized care plans, and areas for families to be involved in the healing process. (Url-31, 32, 33, 34, 35)

#### CONCLUSION:

ERID aims to create interior environments that enhance the health and well-being of patients, staff, and the wider community while minimizing negative impacts on the environment. These strategies, encompassing sustainability, energy efficiency, renewable energy, sustainable materials, waste reduction, biophilic design, patient-centered spaces, and a commitment to life cycle sustainability, converge to create healthcare environments that optimize patient care while reducing carbon emissions, contributing to a sustainable and environmentally responsible future for healthcare facilities. ERID is closely related to patient well-being by creating interior environments that promote healing, comfort, and recovery, contributing to better clinical outcomes and patient satisfaction. The integration of ERID principles within hospital interiors holds the promise of cultivating healing environments that transcend traditional healthcare spaces. Through thoughtful design interventions such as biophilic elements, access to natural light, and the incorporation of sustainable materials, ERID becomes a catalyst for transforming sterile clinical spaces into therapeutic sanctuaries. The evolving landscape of healthcare design presents an exciting canvas for designers, architects, and healthcare professionals to continue pushing the boundaries of what is possible, marrying environmental responsibility with patient-centered excellence.

ERID, when applied with a patient-centric lens, places the needs, comfort, and well-being of patients at the forefront. The intentional design of spaces that promote privacy, personalization, and accessibility contributes to a more compassionate and supportive healthcare environment. Patient-centered ERID recognizes the inherent dignity of individuals within the healthcare setting and acknowledges the role of the physical environment in enhancing their healing journey. The selection of materials, consideration of energy-efficient systems, and incorporation of biophilic elements must align seamlessly with the clinical and emotional needs of patients. Achieving this equilibrium demands a nuanced approach, where each design decision reflects a conscientious understanding of the dual imperative of sustainability and patient-centered care. Implementing ERID in hospital interiors would have some challenges. Implementing sustainable materials and design practices may initially incur higher costs. Navigating complex regulations and ensuring compliance with healthcare standards can be challenging. The empirical evidence linking specific design elements to patient outcomes is still evolving. Institutional inertia and resistance to change within healthcare organizations. Ensuring the sustainability of the entire supply chain for materials and furnishings. However, within these challenges lie opportunities for innovation, collaboration, and the establishment of best practices that can propel the field forward. Overcoming these challenges requires a united effort from stakeholders to champion the cause of sustainable and patient-centric design.

The aspect of ERID for hospital interiors, contributes to the holistic well-being of patients by reduced energy consumption, minimized environmental footprint, and improved indoor air quality collectively to creating healing environments and eco-conscious healthcare facilities. This approach can be reduced stress, anxiety on patients, shortened the time of inpatient, support their healing process. Also, ERID interiors present more healthier environments than regular hospital and help the healing process of patients. In addition, hospitals can also focus on improving indoor air quality, using environmentally friendly products, and creating healthful outdoor spaces to support physical and mental health. Moreover, cooperation, education, and a variety of staff-motivation programs can aid in the implementation of ERID. Additionally, the hospital organization as a whole can benefit from ongoing practice development that promotes environmental responsibility. This study is not merely about constructing structures but about crafting compassionate, sustainable, and regenerative spaces that play a role in enhancing the well-being of people and the environment in the future. The journey towards achieving this vision is ongoing, and as stewards of healthcare design, we are poised at the threshold of a future where each decision holds the potential to heal, comfort, and sustain. In the healthcare design, the exploration of environmentally responsible interior design (ERID) principles has revealed a transformative potential that extends beyond ecological sustainability to encompass healing environments and patient-centered care.

**ETİK STANDARTLAR:**

**Çıkar Çatışması:** Yazarlar herhangi bir çıkar çatışması olmadığını beyan eder.

**Etik Kurul İzni:** Bu makalede etik kurul iznine gerek yoktur, buna ilişkin ıslak imzalı etik kurul kararı gerekmediğine ilişkin onam formu sistem üzerindeki makale süreci dosyalarına eklenmiştir

**Finansal Destek:** Yoktur.

**RESOURCES**

- Almamoori, H.S. 2014. Urban Design, Urban Housing Design and Sustainability: Interrelated Values & Concept. 1st International Urban Planning-Architecture Design (UPAD) Congress, Proceeding Book, pp:211-228, Kocaeli, Turkey, May 8-11.
- Aripin, S. 2007. Healing Architecture': Daylight in Hospital Design. Conference on Sustainable Building Southeast Asia, 5-7 November 2007, Malaysia, 173-181
- Alsawaf, E.S., Albady, A.M. 2022. Principles for the Sustainable Design of Hospital Buildings, International Journal of Sustainable Development and Planning Vol. 17, No. 6, October 2022, pp. 1797-1808
- Boehm, S. 2015. Facilitating Comprehension, Connection and Commitment to Environmentally Responsible Design, The International Journal of Art & Design Education (iJADE), vol: 34-1, pp-72-88, <https://doi.org/10.1111/jade.12010>
- Capolongo, S., Settimo, G. 2017. Indoor Air Quality in Healing Environments: Impacts of Physical, Chemical, and Biological Environmental Factors on Users, Chapter of Indoor Air Quality in Healthcare Facilities, Part of the Springer Briefs in Public Health book series, pp 1-11
- Celadyn, M. 2018. The use of visuals in environmentally responsible interior design, World Transactions on Engineering and Technology Education, Vol.16, No.3
- Douglas C.H., Douglas, M.R. 2004. Patient-Friendly Hospital Environments: Exploring the Patients' Perspective, Blackwell Publishing Ltd 2004 Health Expectations, 7, pp.61-73.
- Dion, H., Evans, M. 2023. Strategic frameworks for sustainability and corporate governance in healthcare facilities; approaches to energy-efficient hospital management, Benchmarking: An International Journal, ISSN: 1463-5771, DOI 10.1108/BIJ-04-2022-0219
- Fadeyi, M.O., Taha R., 2013. Provision of Environmentally Responsible Interior Design Solutions: Case Study of an Office Building, JOURNAL OF ARCHITECTURAL ENGINEERING, March, pp:58-70, DOI: 10.1061/(ASCE)AE.1943-5568.0000098.
- Farooq, A., Forsi, A.H., Ovacık, M. 2015. Planting Paper: An Environmentally Responsible Design Project in an Art and Design Institution, Journal of Yasar University, 2015, 10 (Special Issue), 1-12
- Gola, M.; Settimo, G.; Capolongo, S. 2019. Indoor air in healing environments: Monitoring chemical pollution in inpatient rooms. Facilities Vol. 37 No. 9/10, pp. 600-623. <https://doi.org/10.1108/F-01-2018-0008>
- Hamed, A., Maksoud, A. 2017. Interior Design in Improving Smart and Sustainable Healthcare A Case study on Pediatrics Clinics, International Design Journal, Volume 7, Issue 3, pp:15-36.
- Huisman, E.R.C.M., Morales, Hoof, J.V., Kort HSM., 2012. Healing Environment: A Review of The Impact of Physical Environmental Factors on Users. Building and Environment 58 (2012) 70-80, <http://dx.doi.org/10.1016/j.buildenv.2012.06.016>
- Intrevado, P., Verter, V., Tremblay, L. 2019. Patient-centric design of long-term care networks. Health Care Management Science, Volume 22, pages 376-390
- Jones, L. 2008. Environmentally responsible design: Green and Sustainable Design for Interior Designers, Published by John Wiley & Sons, Inc., Hoboken, New Jersey, 2008, ISBN 978-0-471-76131-0, (sf:4)

- Jalal, K.J. 2018. Considerations in Design of Interior Environment of Outpatient Department in Hospitals, Master of Science in Interior Architecture, Eastern Mediterranean University September 2018 Gazimağusa, North Cyprus
- Kallio, H., Pietilä, A.M., Johnson, M., Kangasniemi, M. 2018. Environmental responsibility in hospital care: Findings from a qualitative study, *Journal of Hospital Administration*, Vol. 7-5, DOI: 10.5430/jha.v7n5p56
- Mahmood, F.J., Tayib, A.Y. 2019. Healing environment correlated with patients' psychological comfort: Post-occupancy evaluation of general hospitals, *Indoor and Built Environment*, Volume 30, Issue 2, DOI: 10.1177/1420326X19888005.
- McCoy, J. 2012. Sustainability: Environmentally Responsible Interior Design, *Journal of Interior Design* 37(1), v-vi
- Oberti, I. 2017. Chapter of Indoor Air Quality in Healthcare Facilities, Part of the Springer Briefs in Public Health book series, pp 73-81
- Paç, D.G. 2023. Analysis of Space in Architecture: A Perspective on Subject-Meaning Relationship. *Journal of Science Part B: Art, Humanities, Design and Planning*, 11(3): 499-512 (2023)
- Peavey, E. 2011. Healing Spaces: The Science of Place and Well-Being, Book Review, *HERD* Volume 4, Number 2, pp 144-146, ISSN: 1937-5867
- Prakash, G., Srivastava, Ş. 2020. Exploring value-dense environment in the healthcare service delivery: A patient-centric perspective, *The TQM Journal*, Vol. 32 No. 2, pp. 331-347. <https://doi.org/10.1108/TQM-04-2019-0093>
- Rechel, B., Wright, S., Edwards, N., Dowdeswell, B., McKee, M. 2009. Investing In Hospitals of The Future, *Observatory Studies Series N°16*, the European Centre for Health Assets and Architecture (ECHAA), ISBN 978 92 890 4304 5
- Robin Guenther, Gail Vittori, 2013. Sustainable Healthcare Architecture, Published by John Wiley & Sons, print 2, ISBN: 9781118416112
- Sala, M., Alcamo, G., Nelli, L.C. 2017. Energy-Saving Solutions for Five Hospitals in Europe, *Mediterranean Green Buildings & Renewable Energy*, book chapter, pp 1-17, DOI 10.1007/978-3-319-30746-6\_1
- Sassi, P. 2006. Strategies for Sustainable Architecture, published by Taylor & Francis Group, 270 Madison Avenue, New York, NY10016, ISBN13: 978-0-415-34142-4
- Simonsen, T. P. H., Brown, S.D. Reavey, P. 2024. Vitality and nature in psychiatric spaces: Challenges and prospects for 'healing architecture' in the design of inpatient mental health environments. *Health & Place* 85 (2024) 103169
- Wehrli, R. 1986. Environmental Design Research How to Do It and How to Apply It, A Wiley Interscience publication, John Wiley and sons, 1986, Canada.

URL 1, 05.01.2024

[https://www.builderonline.com/design/details/midtown-lofts\\_o](https://www.builderonline.com/design/details/midtown-lofts_o)

URL 2, 05.01.2024

<https://www.ache.org/blog/2021/designing-for-healthcare-sustainability-a-framework>

URL 3, 10.01.2024

<https://fokkema-partners.nl/projects/deloitte-and-akd-in-the-edge/>

URL 4, 10.01.2024

<https://archello.com/project/king-abdullah-petroleum-studie-and-research-centre>

URL 5, 10.01.2024

<https://journals.openedition.org/factsreports/6072>

URL 6, 10.01.2024

<https://www.dezeen.com/2021/11/09/kamikatsu-zero-waste-center-hiroshi-nakamura-architecture/>

URL 7, 10.01.2024

<https://www.arup.com/projects/california-academy-of-sciences>

URL 8, 10.01.2024

<https://wevux.com/atri-the-sustainable-house-designed-by-naturvillan0070505/>

URL 9, 10.01.2024

<https://www.dezeen.com/2016/01/10/mje-house-pkmm-architectures-apartment-spain-rotating-walls/>  
URL 10, 10.01.2024

<https://www.archdaily.com/363007/the-world-s-greenest-commercial-building-opens-in-seattle-today>  
URL 11, 10.01.2024

<https://www.usgbc.org/leed/rating-systems/new-interiors>  
URL 12, 12.01.2024

<https://www.healthcarefacilitiesjournal.com/posts/Sustainable-hospital-design-reduces-environmental-impact-while-improving-performance--24395>  
URL 12, 15.01.2024

<https://rmjm.com/the-architects-perspective-khoo-teck-puat-hospital/>  
URL 13, 15.01.2024

<https://blog.interface.com/khoo-teck-puat-hospital-singapore-biophilic-design/>  
URL 14, 15.01.2024

<https://www.dpsd.com.sg/projects/sengkang-general-and-community-hospitals/>  
URL 15, 15.01.2024

<https://wikoffdesignstudio.com/singapore-hospital-wins-sustainable-design-excellence-award/>  
URL 16, 15.01.2024

<https://interiorplantscape.asn.au/wp-content/uploads/2019/06/toilet-block-Khoo-Teck-Puat-Hospital-min-300x225.jpg>  
URL 17, 15.01.2024

<https://en.idei.club/36669-khoo-teck-puat-hospital.html>  
URL 18, 15.01.2024

<https://www.dutchhealtharchitects.nl/portfolio/deventer-hospital-the-netherlands/>  
URL 19, 15.01.2024

<https://www.gaf.eu/en/projecten/deventer-hospital/>  
URL 20, 15.01.2024

<https://studiomommersteeg.nl/zorg/deventer-ziekenhuis/>  
URL 21, 15.01.2024

<https://healthcare-digital.com/hospitals/top-10-sustainable-hospitals>  
URL 22, 15.01.2024

<https://blueandgreentomorrow.com/sustainability/10-most-sustainable-hospitals-in-world/>  
URL 23, 15.01.2024

<https://sableandhawkes.co.uk/portfolio/nhs-visual-arts-project-environment-graphics-and-wayfinding/>  
URL 24, 15.01.2024

<https://www.architecture.com/awards-and-competitions-landing-page/competitions-landing-page/great-ormond-street-hospital>  
URL 25, 15.01.2024

<https://www.ericparryarchitects.co.uk/projects/great-ormond-street-hospital/>  
URL 26, 15.01.2024

<https://www.healthdesign.org/system/files/AIA%20AAH%20Research%20Initiatives%20Committee%20-%202017%20-%20Maggie%27s%20Centre%20Barts%20%28London%2C%20United%20Kingdom%29%20Cas.pdf>  
URL 27, 15.01.2024

<https://www.iesve.com/services/projects/2542/d2-stbarts-nhs-alex-wing>  
URL 28, 15.01.2024

<https://www.archdaily.com/885886/maggies-centre-barts-steven-holl-architects>  
URL 29, 15.01.2024

<https://darrenhawkeslandscapes.co.uk/project/maggies-barts-hospital-roof-terrace/>  
URL 30, 15.01.2024

<https://www.healthdesign.org/system/files/AIA%20AAH%20Research%20Initiatives%20Committee%20-%202017%20-%20Maggie%27s%20Centre%20Barts%20%28London%2C%20United%20Kingdom%29%20Cas.pdf>  
URL 31, 15.01.2024

<https://www.maaparchitects.com/projects/royal-adelaide-hospital>  
URL 32, 15.01.2024

<https://www.designinc.com.au/project/royal-adelaide-hospital>  
URL 33, 15.01.2024

<https://www.sth.com.au/Projects/Royal-Adelaide-Hospital.aspx>  
URL 34, 15.01.2024

<https://www.rockfon.co.uk/about-us/blog/2022/natural-light-in-healthcare/>  
URL 35, 15.01.2024

<https://www.designinc.com.au/content/uploads/2022/06/Royal-Adelaide-Hospital-5.jpg>