International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0026
e ISSN: 2584-2854
Volume: 03
Issue:02 February 2025
Page No: 150-156

Integrating Traditional Indian Architectural Practices into Modern Hospital Designs for Energy Efficiency: A Literature Review

Meghna Vij[1], Bhupinder Pal Singh Dhot[2], Jatinder Kaur[3], Santosh Tiwari[4]
[1]PhD Research Scholar, GZS School of Architecture and Planning, Maharaja Ranjit Singh Punjab Technical University, Dabwali Road, Bathinda, 151001, India.
[2]Professor, GZS School of Architecture and Planning, Maharaja Ranjit Singh Punjab Technical University, Dabwali Road, Bathinda, 151001, India.
[3]Associate Professor, Department of Architecture, School of Planning and Architecture, New Delhi, 110002, India.
[4]Visiting Professor, Department of Architecture, Indira Gandhi Delhi Technical University for Women, Kashmere Gate, New Delhi,110006, India.
Emails: *meghna.vij3@gmail.com[1]*

Abstract
Buildings are among the largest consumers of energy in the world and hospitals consume approximately 2.5 times more energy per square meter than standard commercial buildings. This high energy demand underscores the need for innovative and sustainable energy-saving solutions in healthcare design. Traditional Indian architecture wisdom, which is deeply rooted in strategies for climate and indigenous residents, provides practical and effective solutions to solve these problems. In this literature review, the traditional Indian architecture principle is integrated into modern hospital designs to enhance energy efficiency. The study highlights successful case studies, including Fortis Mohali, Aakash Hospital, AIIMS Bhopal, Fortis Gurgaon, and Fortis Hospital New Delhi, which have effectively incorporated features such as natural ventilation, courtyards, and locally sourced materials. These elements are combined with the latest technologies of renewable energy sources to demonstrate significant reduction in energy consumption and operating costs, and at the same time creates healing and sustainable environments. Summarizing these examples and emphasizing the importance of amalgamating traditional wisdom with modern technologies, this article emphasizes the essential role of use traditional architecture techniques in developing energy-efficient, environmentally resilient hospital designs. The findings advocate for adopting traditional architectural practices to achieve sustainable healthcare infrastructure that aligns with global and national sustainability goals.

Keywords: *Healthcare infrastructure, energy efficiency, traditional Indian architecture, climate-responsive design, renewable energy, healing environments.*

1. Introduction
India's healthcare sector is experiencing swift changes due to population growth, urbanization, and technological advancements in medicine. Consequently, hospitals are emerging as major energy consumers, resulting in increased operational expenses and heightened environmental issues. According to the Bureau of Energy Efficiency (BEE), hospitals in India use around 2.5 times more energy per square meter than standard commercial buildings (BEE, 2017); (Escombe et al., 2019). This significant energy consumption highlights the urgent need for implementing effective energy efficiency strategies

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0026
e ISSN: 2584-2854
Volume: 03
Issue:02 February 2025
Page No: 150-156

in hospital infrastructure. Traditional Indian architecture encompasses a rich repository of knowledge and techniques that can be utilized to develop energy-efficient hospital designs. Grounded in local climate conditions, cultural contexts, and indigenous materials, these practices have historically proven to be both sustainable and resilient. This literature review seeks to examine how traditional Indian architectural principles can be incorporated into contemporary hospital designs, with an emphasis on energy efficiency and environmental sustainability. With its deep-rooted understanding of local climatic conditions, cultural practices, and sustainable materials, traditional architecture presents an opportunity to inform modern hospital designs. By integrating these practices into contemporary designs, hospitals can enhance energy efficiency, reduce operational costs, and create healing environments that prioritize patient well-being.

2. Methodology

This study examines how traditional Indian architectural ideas might be incorporated into contemporary hospital designs by thoroughly reviewing secondary data sources using a qualitative research methodology. The gaps in energy efficiency and environmental sustainability in modern hospital infrastructure were identified by reviewing scholarly articles, government reports, and case studies to understand the current energy consumption patterns in hospitals, traditional architectural practices, and sustainable design strategies. The successful examples, including Fortis Mohali, Aakash Hospital, and AIIMS Bhopal are selected based on their implementation of traditional design features and measurable energy efficiency outcomes and further examined important components such as the use of local materials, passive design strategies, and renewable energy integration, as well as their effects on patient health and energy savings. To identify places for integration and synergy, historic design principles and modern hospital practices were compared. The results offer a paradigm for improving patient-centered care, sustainability, and energy efficiency by integrating classical design principles into contemporary hospital infrastructure.

2.1 Current Scenario of Hospital Design in India

India has one of the highest levels of private expenditure on healthcare. The cost of services in private hospitals is significantly high, making access to quality healthcare challenging for many individuals. The commercial sector, including hospitals, has been experiencing rapid growth at a rate of 14% and hence looking at this situation it becomes very important for the commercial sector to put huge efforts in conservation of energy (Kapoor, 2009). Contemporary hospital designs in India tend to focus more on functionality and technological advancements, often overlooking sustainability and cultural significance. Hospitals have inherently high energy demands due to their continuous operations. Primary contributors include the need for an uninterrupted energy supply to power lighting, HVAC systems, and medical equipment significantly increases operational expenses. The use of advanced medical devices and equipment plays a major role in driving energy consumption (Petroianu, 2020) These modern designs are typically characterized by high energy usage, minimal alignment with the local context, and an emphasis on patient-centered features. This dependence on non-renewable energy sources further amplifies the environmental impact of their activities (Zadeh et al., 2016). In present healthcare buildings, increased energy consumption triggers a continuous increase in electricity costs and the depletion of natural gas, which generate significant environmental outcomes (Bujak, 2010). The need for hospital services has grown substantially because of factors like population expansion, the increase in chronic diseases, and crises resulting from unexpected events such as the COVID-19 pandemic (Borges de Oliveira & de Oliveira, 2022) Numerous modern hospitals are constructed with little regard for the local climate, culture, and available materials. This disregard for contextual factors often results in inefficient designs that underutilize natural resources and lead to increased operational expenses (Alruwaili et al., 2023). Although modern hospitals increasingly focus on patient-centered design, incorporating traditional architectural practices can significantly improve the

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0026
e ISSN: 2584-2854
Volume: 03
Issue:02 February 2025
Page No: 150-156

healing environment. Traditional designs emphasize elements such as natural light, ventilation, and green spaces, which are vital for promoting patient well-being. The healthcare industry is a major source of greenhouse gas emissions. The World Health Organization (WHO) reports that healthcare facilities are responsible for about 5% of global carbon emissions (Ali et al., 2017). Numerous hospitals pursue certifications like LEED (Leadership in Energy and Environmental Design) to showcase their dedication to sustainability (Petroianu, 2020). The ECBC (Energy Conservation Building Codes) offers guidelines aimed at enhancing energy efficiency in commercial buildings, including hospitals. Adhering to these standards can result in substantial energy savings and better indoor environmental quality (Olaniyi et al., 2019). According to a recent report by the Confederation of Indian Industry (CII), nearly 60% of hospitals and healthcare facilities in India fail to meet the minimum Energy Performance Index (EPI) standard of 200 kWh/sq.m/year (Desai, 2010). Studies show that hospitals can reduce energy consumption by up to 42% by implementing the energy-efficient measures recommended in the ECBC (ABDULLAHI et al., 2022). Enhancing the building envelope is a valuable strategy for reducing energy consumption in hospitals. It improves comfort, decreases environmental impacts, and is cost-effective, making it a worthwhile retrofit measure for healthcare facilities (Ascione et al., 2013). Hence integrating traditional practices or passive strategies in the building envelope can be an effective solution to improve the efficiency of modern hospitals. [11-15]

3. Integrating Traditional Practices into Modern Hospital Designs: Principles and Benefits

3.1 Key Principles Contributing Towards Energy Efficiency and Sustainability

3.1.1 Climate Responsiveness

Traditional Indian architecture is naturally adapted to local climatic conditions. Structures are crafted to optimize natural airflow, utilize daylight effectively, and maintain thermal comfort. In energy of benefits Of the energy in the climate of the contributing in the Features such as thick walls, tall ceilings, and central courtyards contribute towards regulating indoor temperatures, thereby minimizing dependence on mechanical cooling systems (Wang et al., 2023).

3.1.2 Use of Local Materials

A defining feature of traditional Indian architecture is the use of locally available materials. Resources like mud, stone, and bamboo known for their high thermal mass lower the energy required for transportation and improve the thermal efficiency of buildings. These materials are typically well-adapted to the local climate, offering natural insulation and reducing reliance on artificial heating and cooling systems (Alruwaili et al., 2023). Integrating such materials into contemporary hospital designs can significantly lower energy usage for heating and cooling.

3.1.3 Integration with Nature

Traditional Indian architecture prioritizes alignment with the natural environment. Structures are typically positioned to optimize the benefits of prevailing winds, sunlight, and surrounding landscape features. This seamless integration with nature adds to the visual appeal and improves energy efficiency by minimizing the dependence on artificial lighting and climate control systems (Bashir et al., 2022).

3.1.4 Benefits of Energy Efficiency

Lowering energy usage can substantially decrease operational expenses, enabling hospitals to better allocate funds toward patient care and other critical services. Hospitals can achieve energy savings of up to 30% through the adoption of energy-efficient technologies and practices (Koroglu et al., 2019). Creating a comfortable indoor environment through natural ventilation and thermal regulation can improve patient healing and overall satisfaction. Studies suggest that hospital environments incorporating natural elements and cultural aspects can improve patient comfort and recovery. Features such as gardens, water elements, and ample natural light have been found to significantly enhance patient well-being (Ali et al., 2017). Reducing energy consumption and integrating renewable energy sources allow hospitals to lower their carbon footprint and support national sustainability objectives. Several strategies like passive design in techniques can be employed to enhance energy efficiency in hospitals such as natural ventilation, thermal mass, and daylighting, which can

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0026
e ISSN: 2584-2854
Volume: 03
Issue:02 February 2025
Page No: 150-156

significantly reduce energy consumption(Annura et al., 2022). [1-5]

3.2 Integration of Traditional Practices in Modern Hospital Designs-Case Studies

Several hospitals in India, located in regions with a composite climate, have effectively incorporated traditional architectural practices into their designs to achieve greater energy efficiency. This climatic zone, characterized by seasonal variations including hot, humid, and cold periods, poses unique challenges for maintaining thermal comfort while minimizing energy consumption. To address these challenges, architects and planners have embraced traditional Indian architectural principles that align well with the local climate. Hospitals have adopted features like courtyards, jaalis (perforated screens), and water elements to enhance natural ventilation, reducing reliance on air conditioning. Courtyards, in particular, promote airflow and act as thermal regulators, maintaining cooler indoor temperatures. The use of materials with high thermal mass, such as stone and brick, enables hospitals to absorb and store heat during the day and release it during cooler periods. This minimizes the need for mechanical cooling, especially in summer. Buildings are designed to reduce direct sunlight exposure during peak hours while maximizing the use of natural daylight. Architectural elements like overhangs, louvered windows, and shaded walkways are used to limit heat gain and enhance energy efficiency. The inclusion of green roofs and vertical gardens helps insulate buildings, mitigate the urban heat island effect, and improve the surrounding microclimate, contributing to overall energy efficiency. Traditional water conservation methods, such as rainwater harvesting systems and step wells, are integrated to optimize water use and create sustainable environments within hospital complexes. Traditional design principles are combined with modern, energy-efficient HVAC systems to utilize daylight effectively Of the energy in the climate of the contributing in the significantly reduce operational energy demands while ensuring a comfortable and safe environment for patients and staff. These strategies not only lower energy consumption and operational costs but also foster sustainable, climate-responsive hospital environments that balance modern functionality with traditional design wisdom.

3.2.1 Case Study 1- The Fortis Memorial Research Institute, Gurgaon

The Fortis Memorial Research Institute (FMRI) has been rated as a 4-star by the TERI GRIHA. The Hospital has implemented certain traditional strategies to reduce its energy consumption. For instance, the use of Autoclaved Aerated Concrete (AAC) blocks, an optimal percentage of cement mixed with fly ash as low-energy materials, and roof insulation in the hospital building's envelope have significantly reduced thermal heat gain. By harnessing renewable energy, the hospital has significantly reduced its reliance on grid electricity, contributing to its sustainability goals. A drip irrigation system was implemented on-site, combined with the use of native plant species, reducing landscape water consumption by 50%. A drip irrigation system, combined with native plant species, was implemented on-site, reducing landscape water consumption by 50%. Additionally, 100% of the treated water from the sewage treatment plant is reused for cooling towers and irrigation. The Energy Performance Index(EPI) achieved after implementing these strategies on site reduced the EPI of the hospital to 109 KWh/m^2 /year hence giving a reduction of 53% from the proposed EPI (Fortis Memorial Research Institute, n.d.).

3.2.2 Case study 2- Fortis Hospital Shalimar Bagh, New Delhi

The Fortis Hospital Shalimar Bagh is a 3-star rated hospital by TERI-GRIHA. The AAC blocks have been used in the hospital building envelope instead of conventional bricks. To avoid the heat, gain from roofs vermiculite and highly reflective tiles have been used. The use of double glazing in the windows reduces the thermal transmittance from fenestrations. All these strategies help reduce the heat gain in summer through the building skin in the composite climate of Delhi. Major site areas have been covered using grass pavers to reduce the Urban Heat Island Effect (Health.Pdf, n.d.).

3.2.3 Case study 3-Fortis, Mohali

Fortis multispecialty hospital built in 2001. It is 472 bedded hospital built on an area of 8.22 acres with a

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0026
e ISSN: 2584-2854
Volume: 03
Issue:02 February 2025
Page No: 150-156

built up area of 50336 sq.m. The Specific Energy Consumption of Fortis Mohali is 107 kWh/m², which is 52% lower than the global benchmark and 54% below the national benchmark of BEE i.e. 200 kWh/m. Around 65% area inside the hospital has daylight which further reduces the need for artificial lighting thus reducing the energy consumption by 5%. To reduce the heat gain through the building, the fenestrations on the North-West façade of the building is equipped with double glazed glass and low U-Double glazed units on the South-West façade. To reduce the cooling load on the building, a low window-to-wall ratio is used. A green central courtyard is provided to create a healing environment besides reducing the heating load in the building. The solar PV panels installed on the rooftop reduces the energy consumption by 0.75%.(Mohali & Hospital, 2020).Further the hospital aims to achieve the net zero plan by the year 2030.

3.2.4 Case study 4-Akash hospital, New Delhi

Aakash Super-Speciality Hospital, a LEED Gold-certified facility, embodies the principles of Healing Architecture. Designed by CDA architects and completed in year 2019, the Akash super speciality hospital is situated in Dwarka, New Delhi. The project was envisioned as a compact structure with thoughtfully planned departmental relationships centered around around a spacious, open courtyard featuring a serene water body inspired by Japanese Zen gardens. The building's longer side is precisely aligned along the north-south axis, allowing ample natural light to illuminate the interiors throughout the day. The use of highly efficient double-glazed units (DGU) enabled large sections of the building's facade to be glazed, allowing significant natural light to enter the interiors and greatly reducing the need for artificial lighting. At the same time, the glass's low emissivity (low-e) value effectively minimizes heat gain, significantly reducing the building's cooling load and contributing to overall energy efficiency. With an on-site bio-STP and an ETP intended for zero discharge, Aakash Healthcare is a model green hospital. Micro-crystalline solar panels, which are directly connected to the grid and contribute significantly to energy savings, cover around 75% of the roof space. In order to effectively supply hot water throughout the winter, the hospital also uses a geothermal water heating system. This thoughtfully planned space, along with a landscaped refuge area, is intended to create a calming environment and move away from the traditional, institutional feel often associated with hospitals. The incorporation of natural elements and tranquil settings fosters a therapeutic atmosphere, enhancing the overall experience for patients, visitors, and staff. The meticulously designed departments on the upper floors are arranged around the central courtyard, facilitating seamless horizontal and vertical circulation to enhance operational efficiency and elevate the patient experience (Creative Designer Architect, 2021). The hospital also plans to expand its facilities in the future anticipating the rapid technological advancements in the future thus ensuring flexibility in design. [6-10]

3.2.5 AIIMS, Bhopal

One example of a sustainable healthcare facility is the Smriti Upvan Green Campus at AIIMS, Bhopal which shows its commitment to sustainability. The Horticulture committee at AIIMS Bhopal enhances the greenery and aesthetic appeal of the campus by planting native plant species, preserving the natural habitat. AIIMS Bhopal's dedication to sustainable water management is demonstrated by the installation of recharge wells and rainwater harvesting systems through the SMRITI UPVAN Project. The installation of media filters and the successful building of 14 recharge wells provide effective rainwater collection and groundwater level augmentation. The creation of herbal gardens, frequent tree planting events, and environmentally friendly maintenance procedures at AIIMS Bhopal have all helped to create a green campus atmosphere. The campus has installed vertical gardens to improve aesthetics and make the most use of available space. To maximize water use and preserve the lush foliage, effective irrigation and watering systems are used, including the supply of water through specialized horticultural features such STP water treatment plants. The campus's green space fosters both mental and physical health. AIIMS Bhopal has used solar energy to meet its electricity needs since it

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0026
e ISSN: 2584-2854
Volume: 03
Issue:02 February 2025
Page No: 150-156

understands the value of sustainable energy sources. Warm water is produced in geysers, labs, auditoriums, and street lights throughout the campus are all powered by solar energy. This shift promotes a greener future by lowering reliance on non-renewable energy sources. Its environmental advantages and cost-cutting potential are highlighted by the importance of renewable energy sources, especially solar energy, in meeting the energy needs of establishments like AIIMS Bhopal and by integrating solar power for lighting. Human comfort and health are greatly influenced by the outdoor temperature, which also has an impact on environmentally friendly transportation options. Outdoor temperature settings have a significant impact on the value of walking as a sustainable form of transportation on campuses. AIIMS Bhopal promotes the potential advantages of lowering vehicle emissions and increasing physical activity through walking by using green infrastructure, urban design considerations, shading strategies like the campus pathways connecting buildings, and cool materials to create welcoming and comfortable outdoor areas that encourage walking (Raghuwanshi, 2023). [16-20]

Conclusion

Growing energy consumption, rising operating expenses, and environmental effects present serious issues for India's healthcare industry. There is a pressing need for sustainable and energy-efficient design techniques because hospitals use 2.5 times as much energy as typical commercial buildings. A useful foundation for contemporary hospital designs that aim to achieve energy efficiency, lessen environmental effects, and enhance patient well-being is provided by traditional Indian architectural concepts, which are based on regional climate and cultural customs. As evidenced by case studies like Fortis Mohali, Aakash Hospital, and AIIMS Bhopal, the incorporation of elements like courtyards, natural ventilation, locally sourced materials, and renewable energy technologies has been successful in improving energy efficiency and establishing healing environments. These illustrations show how integrating contemporary technology with conventional architectural methods can lower energy usage, operating expenses, and greenhouse gas emissions while simultaneously fostering environmental resilience and sustainability. Adopting such strategies is in line with national and international sustainability goals in addition to being environmentally responsible. Policymakers, architects, and healthcare managers must actively integrate traditional practices into hospital infrastructure and give sustainable design principles top priority going ahead. By adopting this, India's healthcare system can set an example for sustainable growth by striking a balance between the needs of contemporary healthcare and cultural legacy and environmental stewardship.

References

[1]. ABDULLAHI, H. O., ENIMOLA, D. J., & Cynthia Unekwu. (2022). Adopting Information and Communication Technology (ICT) in Public Healthcare Facilities in Kogi State, Nigeria. *Governance and Society Review*, *1*(2). https:// doi.org/ 10.32350/ gsr.12.01

[2]. Ali, M., Debela, M., & Bamud, T. (2017). Technical efficiency of selected hospitals in Eastern Ethiopia. Health Economics Review, 7(1). https://doi.org/10.1186/s13561-017-0161-7

[3]. Alruwaili, R. F., Alsadaan, N., Alruwaili, A. N., & Alrumayh, A. G. (2023). Unveiling the Symbiosis of Environmental Sustainability and Infection Control in Health Care Settings: A Systematic Review. Sustainability (Switzerland), 15(22), 1–16. https://doi.org/10.3390/su152215728

[4]. Annura, S., Arabikum, J., Aminingrum, R., Ulu, Z., Saputra, P., Wahyudi, D., & Zuhriyah, L. (2022). Efficient and Sustainable Energy Management for Hospital Building. Journal of Community Health and Preventive Medicine, 2(2), 1–9.

[5]. Ascione, F., Bianco, N., De Masi, R. F., & Vanoli, G. P. (2013). Rehabilitation of the building envelope of hospitals: Achievable energy savings and microclimatic control on varying the HVAC systems in Mediterranean climates. Energy and Buildings, 60, 125–138.

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0026
e ISSN: 2584-2854
Volume: 03
Issue:02 February 2025
Page No: 150-156

https://doi.org/10.1016/j.enbuild.2013.01.021

[6]. Bashir, S., Nasir, M., Grasic, K., Moulin, M., & Ali, S. (2022). Association between efficiency and quality of care of public healthcare facilities: Evidence from Pakistan. International Journal of Health Planning and Management, 37(4), 2240–2255. https://doi.org/10.1002/hpm.3465

[7]. Borges de Oliveira, K., & de Oliveira, O. J. (2022). Making Hospitals Sustainable: Towards Greener, Fairer and More Prosperous Services. Sustainability (Switzerland), 14(15). https://doi.org/10.3390/su14159730

[8]. Bujak, J. (2010). Heat consumption for preparing domestic hot water in hospitals. Energy and Buildings, 42(7), 1047–1055. https://doi.org/10.1016/j.enbuild.2010.01.017

[9]. Creative Designer Architect. (2021). No Title. Https://Www.Architectmagazine.Com/Project-Gallery/Aakash-Healthcare-Super-Specialty-Hospital. https://www.architectmagazine.com/project-gallery/aakash-healthcare-super-specialty-hospital

[10]. Desai, V. (2010). A Report on Energy Efficient Hospitals-visiting the realities 2 Foreword. www.SEreply.com

[11]. Escombe, A. R., Ticona, E., Chávez-Pérez, V., Espinoza, M., & Moore, D. A. J. (2019). Improving natural ventilation in hospital waiting and consulting rooms to reduce nosocomial tuberculosis transmission risk in a low resource setting. BMC Infectious Diseases, 19(1), 1–7. https:/ /doi.org/ 10.1186/s12879-019-3717-9

[12]. Kapoor, D. S. K. and R. (2009). Energy Efficiency in Hospitals Best Practice Guide. USAID ECO 3 Project, 1–55.

[13]. Koroglu, M., Irwin, B. R., & Grepin, K. A. (2019). Effect of power outages on the use of maternal health services: Evidence from Maharashtra, India. BMJ Global Health, 4(3), 1–11. https://doi.org/10.1136/bmjgh-2018-001372

[14]. Mohali, F. H., & Hospital, A. M. S. (2020). Presented By: - Mr Neeraj Tandon Chief Engineer.

[15]. Olaniyi, F. C., Ogola, J. S., & Tshitangano, T. G. (2019). Efficiency of health care risk waste management in rural healthcare facilities of south africa: An assessment of selected facilities in vhembe district, limpopo province. International Journal of Environmental Research and Public Health, 16(12). https://doi.org/10.3390/ijerph16122199

[16]. Petroianu, A. (2020). Clinical Case Reports : Open Access. 3(1), 3–6.

[17]. Raghuwanshi, B. (2023). SMRITI Upvan Project : Transforming a Tertiary Care Centre into a Sustainable Green Campus in Central India. 6(10), 57–61.

[18]. Wang, H., Yan, Z., He, X., Song, Y., Huang, Y., Zhang, J., Zhou, Q., Yan, Z., & Jiang, X. (2023). Research on Architectural Art and Sustainable Design of Ginling College Historic District (Nanjing, China). Buildings, 13(7). https://doi.org/10.3390/buildings13071725

[19]. Zadeh, R. S., Xuan, X., & Shepley, M. M. (2016). Sustainable healthcare design: Existing challenges and future directions for an environmental, economic, and social approach to sustainability. Facilities, 34(5–6), 264–288. https://doi.org/10.1108/F-09-2013-0067