



Post-COVID Hospital Designs: A Review of Greening and Sustainability Practices

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Abstract: The concept of sustainability and green assessment in the built environment has not only put forth a challenge for architects but also for the governing bodies that deal with the development of codes, guidelines, and building standards. Sustainability and green assessment criteria have over the past decade become a crucial initiative discussed around the globe with different modifications being established to address generic issues in private and public buildings. With the advent of the COVID-19 pandemic that spread across the globe, some of the studies now concentrate on design implementation in health systems, sustainable hospital buildings, and patient-centeredness in hospital designs. These are frequently discussed with less reference being made to the greening of hospitals. Greening and a sustainable hospital environment are vital as it necessitates strict cleaning measures, regular air changes, and sophisticated medical equipment which will in turn add to the already escalating cost of energy consumed in hospitals. This research paper aims to address through a review of existing literature, the importance of adopting sustainability and green criteria in hospital designs. Questions, with regards to sustainability and green assessment, were asked and evaluations used were identified. The intended product of this research is to proffer a guide for the regulatory bodies for architecture in developing countries to adopt in the promotion of sustainability in hospital designs for the post-COVID era.

Keywords: Green Buildings, Greening Criteria, Hospital Building Design, Pandemic, Sustainability

1. Introduction

The subject of sustainability is a term that has become popular in the built environment circle. In recent times, the importance of sustainability has moved gradually from being a concept propagated only in first-world countries to developing countries. As climatic conditions across different parts of the world are changing along with the depletion of natural resources, there is an increasing awareness of a crucial look into the term “green”. Many countries over the past years have established sustainability standards for which their various public structures can be built with some of these standards becoming easily applicable to residential building design.

As the global pandemic continues to affect various parts of the world, retrospect on the healthcare sector since 2020, has gained the attention of the ruling authorities in government and private sectors. Hospital designs as well as infrastructure are now being tied to patients’ overall well-being [1]. Most developing countries caught ill-prepared when the pandemic hit, bringing with it an over-flooding of hospital facilities (especially public). It is now clear to see the importance of sustainability and greening in the hospital-built environment. In the healthcare sector, massive efforts were required to re-plan and re-engineer buildings almost overnight so that they could safely cope with COVID-19, and attention is turning to how the switch to “pandemic mode” might be made more easily in the future [2]. Greater

flexibility will be required for hospital facilities to be more resilient in future outbreaks. The pandemic has so far instigated the ability of institutions to overcome existing gaps in provision and to respond to other radical changes in health service delivery that was unforeseen in times past.

This research aims to provide a review of various literature on the application of sustainability and greening to hospital design. To achieve this aim, two research objectives were developed which were; to investigate the factors that contribute to sustainability and greening in hospital building design; to explore, using critical research questions derived, other relevant measures that can help to improve the current state of hospital designs. The scope of this study is limited to sustainability and greening topics and the findings are based on existing literature on hospital buildings.

2. Literature Review

The words “sustainability and green” are most times considered the same and therefore, used interchangeably but this should not be the case. The design of a building with green products is not enough to make the whole system sustainable [3]. Hence the importance of the study of the two concepts individually and how they can be related to each other. Sustainability is not defined alone by how efficiently energy is used or the ecology of the building but focuses on the experience of the end user, having people being placed at the center of the design process. Sustainability is also about finding solutions to design that help to increase the quality of life for persons in the present and not about sacrificing comfort or lifestyle for environmental benefit. [4]. The sustainable design process lays more emphasis on the people who will utilize the project. For this reason, sustainability applied to hospital building design has the most potential to benefit building users.

The concept of greening on the other hand is energy-denominated. ‘Green building strategies help to reduce buildings’ operating costs, increase building value and raise returns on investments [5]. It is not new and has been the same response over time that green buildings attract more attention in the built environment. Green buildings, recycling resources, and improving energy efficiency are without any doubt very vital social and even planetary goals [6].

Sustainability and greening in hospital buildings: The field of medicine is beginning to admit that sustainability is important to incorporate into building practices. The profession is not one where risks should be taken and this disposition should also influence the hospital building designs, as it is one of the facilities that is focused on the well-being of the patient. It has however been noted over time, that the medical sector is slow in adapting to changes when compared to other sectors in the economy [4]. These reasons have made sustainability not very prominent in hospital building designs. Hospital designs can be planned in such a way that it combines behaviour and health [7]. Just as the development of medications is guided by the comprehension of evidence-based medicine, the development of the design of the hospital guided by various perceptions of

sustainability connected to research is progressing in the direction of knowledge of evidence-based Design. This has been noted to connect the patient wellness and staff satisfaction outcomes to their physical environment.

A green hospital is said to aim to utilize renewable resources, be environmentally friendly, and cut waste by applying green practices to boost patients’ recovery. The concept of a green hospital aligns with the principle of the three R’s – Reduce, Reuse and Recycle. Green hospitals are very innovative and decrease the release of carbon to a huge degree [1, 8]. Although the early cost of construction for sustainable and green hospitals are expensive, it has a lasting effect on reducing energy cost [9]. The perception of a sustainable and green hospital necessitates interaction between professionals from different fields in the built environment. The combination can be termed the “Integrated Design Process” which begins from planning, through implementation to the functioning of buildings [10]. The Integrated Design Process produces sustainable, green, and high-performance buildings which are designed, constructed, and operated to make the world a healthier place by refining the environment through fostering lives, re-establishing environmental resources, and offering motivation by deriving from the collaborative experience professionals from different fields in the built environment.

Reducing energy use is a key focus for green designers of hospital buildings, specifically bearing in mind lighting and ventilation. Exploiting the practice of lighting through natural means during the day can decrease energy expenses and improve the atmosphere for occupants. The significance of access to natural light and the impact it has on occupants has been identified in previous publications [11] It can pointedly transform behaviours; for example, the use of natural lighting better sales size at retail channels when compared with artificial light [5]. Healthcare facilities generally and hospitals, in particular, especially teaching hospitals are also major contributors to environmental pollution contributing pathological, chemical, pharmaceutical, health risk, radioactive, and other wastes [1, 12]. Hence, the importance of questioning the hospital design process and how they can properly incorporate practices that can make the design more sustainable while having green properties, as well.

3. Research Methodology

This research began with reviewing existing literature in the area of discussion. The process was done to achieve the objectives of this research which are to investigate the factors that contribute to sustainability and greening in hospital building design and to explore, using critical research questions derived, the measures that can help to improve the current state hospital building design. The existing literature discovered during the cause of this research was mainly dated before the global pandemic in 2020. Some of the researchers interchanged the terms ‘sustainability and greening’, while others focused on the patient perspective. The general search, however, yielded very little on the subject of sustainability and greening in the concept of

hospital design. In fulfillment of the objectives stated in the introduction, research questions would be asked concerning sustainability and greening. The questions are;

- 1) What are the recent trends in greening and sustainability especially in hospital designs?
- 2) What are the major green building assessment tools that are acceptable in the current disposition?
- 3) What criteria are more relevant in assessing green designs for hospital buildings?

To acquire as much information regarding the subject of sustainability and greening, several databases were searched.

These included Science Direct, Springer Link, Taylor and Francis, Google Scholar, and other websites. The initial search string “sustainable green hospitals” returned an overwhelming number of papers, many of which were on each keyword with some relevance to the subject. The revised search string “sustainability and greening in hospital design” yielded more positive results which were used in this research. After revising a number of these papers, the list of related sustainability and greening papers was used. For the paper selection on the search strategy, suitable inclusion and exclusion criteria for selecting primary studies were used as shown in Table 1.

Table 1. Article selection criteria.

Inclusion Criteria	Exclusion criteria
A. It was tried to select studies that provide Researches that majored in patient’s health in the following analyses: hospital design for sustainability and	
1. Defining greening sustainability and green.	
2. Defining the connection between sustainability and hospital design.	
3. Exploring green criteria for hospitals.	
B. Researches that were conducted in English	Research that discussed outside the scope of the hospital building

Source: Adapted from [13, 14]

The literary findings were organised according to the objectives to inform the discussions and conclusion.

4. Findings and Discussions

The criteria for the development of green building design have gained acceptance globally starting with LEED in the US and BREEM in the UK [15]. With this advent, various countries, including developing ones, are starting to adopt their criteria for rating green buildings. They also make use of the parameters such as energy and consumption of water, site sustainability choice of material, reduction in waste, indoor air quality, and innovation to improve the performance of the environment [16]. The sole purpose of these systems is to reduce the environmental impacts of buildings [17] and the overall sustainability of buildings [18]. A few of the green assessment criteria that are

very well known and are often mentioned in the research are Building Research Environment Assessment Method Consultancy (BREEAM)—(UK), Leadership in Energy and Environmental Design (LEED)—(the US), Leadership in Energy and Environmental Design (Canada), Green Star—(Australia), Comprehensive Assessment System for Building Environment Efficiency (CASBEE)—(Japan), Building Environment Assessment Method (HK-BEAM)—(Hong Kong), The Green Globe Rating System—(US), BCA Green Mark—(Singapore), Ecology, Energy Saving, Waste Reduction and Health (EEWH)—(Taiwan), Australia Greenhouse Building Rating (AGBR), Green Building Index (GBI) – Malaysia [19], etc. Few rating systems not only certify buildings in their own countries but also provide green building certification at the international level for example LEED, Green Star, and BREEM [16].

Table 2. Six criteria were identified as the focus of greening.

Demand Quality	Demand Requirements.
Energy efficiency	Natural ventilation. Natural light. Renewable energy. Healing environment.
Indoor environmental quality	Atmospheric conditions. Safe for occupants and users. Strategic landscaping.
Sustainable site planning and management	Plan for car parks and greenways. Pedestrian pathways with plants. Use of environment-friendly materials.
Materials and resources	Materials free from toxic chemicals. Long-lasting materials. Install water-efficient equipment.
Water efficiency	Use rainwater harvesting. Limit disruption of stormwater flows.
innovation	Attractiveness of appearance. Existence of a safety mechanism.

Source: [5]

Six criteria of sustainability that are to be considered when creating a sustainable architecture can be seen in table 3 below.

Table 3. Sustainability criteria.

Sustainability criteria	Description
Ecology	Respecting and repairing network. A balance needs to be established between inhabitants of a network, despite how dynamic. 1. Humans are the main integral part of an ecosystem that can cause effects to it. 2. Restoration of nature parks.
Embeddedness	Self-sufficiency and local reliance. It is to attain self-sufficiency by becoming partly reliant on local resources. For instance, 1. Use of water. 2. Energy from wind and sun.
Efficacy	An act of integrating managed balances and interactions within a whole. It is said that waste from one process can become a resource for another for example, – Electrical power and thermal energy produced is utilised. 1. Water: use of rainwater instead of city supply. 2. Solid waste recycling.
Wellness	Described as the connection with the community, outdoors, and nature. This has to do with engineering well-being to the goal of fostering wellness. These involve. 1. Links to community and place. 2. Connectivity with outdoors. 3. Assess to nature.
Integration	Aligning process towards performance. For an alignment of the process towards integration, three things are important. 1. Performance continues to the end of the project. 2. Performance should consider the ecology and social agenda, and not only economic value. 3. Description of qualitative and quantitative indicators for performance.
Advocacy	Building as a cultural force. Because building speaks to its occupants and those who encounter them. An example can be seen as: 1. The use of daylight sensors that can adjust the brightness of electrical lights can send information to occupants about climate. 2. Another is community engagement, that is, the involvement of building users in decision-making during design and construction.

Source: [20].

The findings based on the questions that have been asked and the answers provided now connect to answer the second objective of the research: what connects hospital buildings to sustainable and green design? When considering the design of hospitals, some of the focus areas for green include Lighting, indoor air quality, green housekeeping, clean and green interior building materials, gardens, and landscaping, [9]. In the case of sustainability, the focus areas are based on the criteria listed for both suitability and greening, they can be said to be different in three aspects [20]:

- 1) Want vs needs: while sustainability sees the occupant, whose needs and wants are negotiated during design, greening is concerned with the assumption of what is needed or wanted by the occupant.
- 2) Certainty vs risk: sustainability focuses primarily on a long-term perspective while greening seeks certainty of outcome and calculatable risks for short time gains.
- 3) Whole vs parts: sustainability design looks at building

from a wider perspective, as it connects to neighbourhoods and cities, while green design focuses on a combination of strategies and technologies to bring about a gradual increase in performance improvement.

These differences can be bridged from green to sustainable when concerned with hospital design. While sustainability takes into consideration the patients, as the primary agent, and their effect or response to the hospital in the long run during design, greening seems to focus on the things that might not have been considered by the patient but would be needed looking at things from short term standpoint. This, in turn, provides a holistic and, at the same time, a detailed view of hospital design and later on construction. It goes further to highlight the importance of the two which would benefit and country that it is being applied [21]. Table 4 shows the green assessment score of the famous countries when applied to hospital design. This demonstrates the applicability of sustainability and greening to hospital design once a connection has been established between them.

Table 4. Green Assessment for hospitals.

S/N	System in Country	Year	Elements and Points	Rating and Level of Certification
1	LEED, US	2009	Sustainable Sites (18), Water Efficiency (9), Energy and Atmosphere (39), Materials and Resources (16), Indoor Environmental Quality (18), Innovation in Design (6), Regional Priority Credits (4). Total points = 110	Certified 40–49 Silver 50–59 Gold 60–79 Platinum 80 and above
2	BREEAM, UK	2008	Management (12), Health and Wellbeing (15), Energy (19), Transport (8), Water (6), Materials (12.5), Waste (7.5), Land Use & Ecology (10), Pollution (10), Innovation (10). Total points = 110	Unclassified < 30 Pass ≥ 30 Good ≥ 45 V Good ≥ 55 Excellent ≥ 70 Outstanding ≥ 85
3	Green Star, AUSTRALIA	2009	Management (17), Indoor Environment Quality (32), Energy (29), Transport (12), Water (14), Materials (35), Land use & Ecology (8), Emissions (20), Innovation (5). Total points = 172	Best Practice (4 stars) 45–59 Australian Excellence (5 stars) 60–74 World Leadership (6star) 75–100

Source: [3]

The figures shown in Table 4 above for the US-LEED, were a result of a report issued by the Institute for Medicine in 2001. It concluded that the U.S. health system was inefficient, unsafe, and lacked patient-centered focus. This caused it to make a turnaround in patient safety and quality that led to the revolution of hospitals across the country [8].

5. Conclusion

From this paper, it is clear to note that sustainability and greening concepts cannot be completely separated from each other although, in many instances, they are considered the same. The two concepts overlap and therefore, help to produce a better quality of design for the hospital building. The research has noted that in designing hospital spaces, the topics of sustainability and greening cannot be overemphasised, as it is proven to link to patient health and recovery. Given this, the pandemic that has affected various parts of the world has seen a drastic increase in the use of hospitals as a place for quarantine and treatment for the very contagious virus [4] – COVID-19. For instance, the past year was flooded with news of various countries, especially developing ones, requesting ventilators to install in hospitals in order to contain the spread of the virus [21]. These situations could have easily been avoided if the aspect of indoor air quality, found as one of the focus areas for greening, had been taken into consideration from the design phase. Another aspect that can be seen from the area of sustainability, is the overcrowding that occurred as various hospitals in different parts of the world were filled, thereby affecting the environment.

In conclusion, to achieve sustainability and greening on a global scale, it is recommended that the choice of architects to create sustainable and green design should be promoted by developing design codes that are distinctively and comprehensively sustainable, and guidelines and standards should be made available locally, by the collaboration of the architectural body and builders, as a sole set of guiding principle to follow and construct sustainable and green building only.

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