Indicators of sustainable rehabilitation of hospital buildings

1 Ebtisam S. Alsawaf

1,2 Department of Architecture Engineering /collage of Engineering / University of Baghdad, Iraq
e.idrees1304d@coeng.uobaghdad.edu.iq

2 Dr. Amjad M. Albadry

1,2 Department of Architecture Engineering /collage of Engineering / University of Baghdad, Iraq

ABSTRACT

The organizing principle of sustainability concepts in the built environment have often been seen as the principles of sustainable development or development that meet the needs of the present without compromising the ability of future generations to meet their own needs. Preserving buildings is an important factor in sustainability indicators because it achieves the economic, cultural, social, and environmental principles associated with sustainable development paths, as building rehabilitation is one of the means of preserving it. In addition to the exacerbation of global environmental problems, especially the problems of contemporary climate change, the energy crisis, as well as the lack of material resources, which negatively affected healthcare facilities **.The research problem** was represented by, "insufficient knowledge that explains the indicators of rehabilitation of existing hospital buildings by the principles of sustainable architecture". From this standpoint, hospital buildings became a central focus of international discussions, necessitating the transition to a sustainable healthcare system, and for most of the existing health buildings. The research dealt with the importance of sustainable rehabilitation of the reality of existing hospital buildings, to keep pace with contemporary medical developments, and new and innovative technologies for most of its nursing, diagnostic, and therapeutic departments, through the principles of sustainability, and for the general urban environment of its basic components and environmental surroundings. The research methodology represented the descriptive analytical approach of the most important elements of rehabilitation and its levels according to the foundations of sustainability (environmental, social, and economic) of the architectural structure system of hospital buildings and how it was applied to international experiences of hospitals.

Keywords Sustainability, Sustainable Development, Sustainable Hospitals, Rehabilitation of Buildings, Sustainable Rehabilitation, Energy.

1. Introduction

Sustainability is defined as permanence over time in the long term and refers to a group of automated systems and processes that can operate on their own and continue over long periods .The adjective sustainable means 'capable of continuing without interruption' or 'capable of enduring without failure'[1]. Sustainable development is defined as a comprehensive challenge in meeting the growing human needs for natural Resources , industrial products, energy, food, transportation, shelter, and effective waste management while preserving and protecting the quality of the spatial environment and the natural resource base necessary for life and development in the future. This concept confirms that meeting long-term human needs will be impossible unless we also preserve the natural physical, chemical, and biological systems of the Earth [2]. As for the most

quoted definition adopted by the Commission's 1987 report, Our Common Future, which is often called the "Brundtland Report", it is: that sustainable development is "meeting the needs of the present without compromising the ability of future generations to meet their own needs" [3]. While the United Nations Summit on Sustainable Development was held in September 2015 and developed a major plan and goals to transform the world towards sustainable development and achieve a prosperous future by 2030 called the Sustainable Development Goals (SDGs) . Which defines the so-called 17 goals, 169 goals, and 244 indicators, as a global plan to support people, the planet, prosperity, peace, and partnership. Which aims to make international efforts for sustainable development until 2030, and to achieve sustainable development, it is necessary to reconcile three basic elements: economic growth, social inclusion, and environmental protection [4]. Taking into account the goals of the United Nations Development Plan for the year 2030 which refer to sustainable principles, it is necessary to improve the performance of the built environment and to preserve and improve existing buildings to reduce their environmental impact in line with climate changes and reduce the occurrence of natural disasters. The research aimed to identify opportunities for rehabilitation and improvement of health facilities, especially existing hospital buildings, according to new concepts related to sustainable hospitals. The research path included studying the levels of the architectural structure system of the hospital building, including (the location and external spaces, the structural and structural aspects, the functional aspect and the interior design of the spaces, the level of the building envelope, and the effective management of energy) according to the principles of sustainable architecture (environmental, social and economic). Defining and defining a methodology to promote the rehabilitation of hospital buildings and establishing a method of decision support to establish actionable strategic measures, as under the current situation, rehabilitation, renovation, and development of buildings is a necessary and sustainable process.

2. Methodology

The research adopts the descriptive analytical approach of the most important elements of rehabilitation according to the pillars of sustainability (environmental, social, and economic) and how it was applied to international experiences of hospitals.

3. Literature Review

The main objective of reviewing the previous literature is to study the concept of rehabilitation of buildings according to the principles of sustainability (sustainable rehabilitation) of hospital buildings and to demonstrate the environmental, economic, health and social benefits of sustainable development in the health care industry. In addition, extracting the most important effective indicators for sustainable rehabilitation in existing hospitals to guide health care managers interested in applying the principles of sustainable design in the rehabilitation and renovation of existing hospitals.

3.1 Rehabilitation of buildings

The term is known in the language (Rehabilitation) or (Rehabilitatan) Rehabilitation, or subject to rehabilitation, or reform, or re-existence and use, and it is a noun for the verb (Rehabilitate) that comes in the meaning: to restore, or to rehabilitate: to return a person to a constructive useful activity, or It qualifies him to earn his livelihood again [5]. The term rehabilitation is a term with branching connotations and is used in different contexts, and in different fields such as the medical field, the professional field, the social field, the economic field, the educational field and the societal field. as it refers to the return of individuals, places and things to the previous conditions or their renewal and restoration [6]. The rehabilitation of the building is an opportunity to modernize it and make it suitable for the requirements of the present era in terms of comfort, comfortable living and giving the building a new age. Whereas, the successful engineer is the one who challenges all the difficulties associated with the project

and is able to present a modern engineering and technical building while maintaining its characteristics that distinguish it from other buildings .

3.2 Sustainable rehabilitation

Since the sixties and seventies of the last century, the advanced scientific community began to discuss the issue of rehabilitation of existing buildings due to the growing interest in contemporary environmental variables, and the idea of rehabilitation expanded on a large scale within a sustainable strategy, capable of reducing the use of materials and energy and reducing environmental pollution. By increasing the effectiveness of the life cycle of buildings [7] .

In addition, rehabilitation andsustainability complement each other, as the rehabilitation of existing buildings is a (green and sustainable) endeavor mainly that works to restore the embodied energy present in our current buildings, and reactivate it functionally, or add other uses required by contemporary reality, while preserving the architectural heritage of our societies. and necessarily making it a critical component of any long-term strategy for sustainable design and development [8]. Where the success of the rehabilitation (re)construction program depends on the ability to recycle and reuse, or add to the existing buildings, and is governed by a set of essential texts for sustainability.

Sustainable rehabilitation is defined as: it is an act of corrective development or a process to present the added capabilities that are appropriate to the reality of existing buildings, through repair, modifications, and new additions while preserving the existing origin or the heritage, historical, cultural, or architectural features that it enjoys. The term rehabilitation has two connotations: it can be seen as a procedure in the building itself, or in a more comprehensive way, a procedure that involves the urban restructuring of the area in which the building is located [9].

The rehabilitation of existing buildings includes a wide range of developmental measures that seek to maximize the usability of the existing structure as shown in Figure 1, and the most important possibilities for the Rehabilitation of buildings are (restoration, renovation, maintenance, and retrofitting) [9]. It can be defined as follows:

1. **Restoration**: It is a set of procedures aimed at preserving the archaeological, heritage, aesthetic, and historical values of the buildings for the permanence of their preservation, and based on respect for the material, the historical heritage, heritage, and indigenous customs [10].
2. **Renovation**: Changing some conditions of the existing buildings to restore or improve the use or increasing its validity for the occupants, or its ability to be reused or improve the safety conditions, while maintaining the function, whereby the renovation results in a building with new qualifications within the framework of the basic building. It usually meets the requirements of the contemporary building code.
3. **Maintenance:** The set of remedial activities to be carried out to maintain or restore the functional capacity of the building and the existing systems so that they meet the needs and safety of their users.
4. **Retrofitting:** It consists of the union of the term (Retro) from the Latin, which means to move back, and the English term (fit), which means to adjust, which leads to the concept of (reconversion). That is, it relates to the renovation of an existing building, and to intervene in its content so that its current configurations are reformulated into a new building. The term retrofit is a concept related to the reformulation of an existing building, but intending to comply with the decisions of the main building, that is, “the change within the conditions of the existing building, with or without changing the function, to restore, improve or expanding the conditions of housing, use, or structural safety [11].

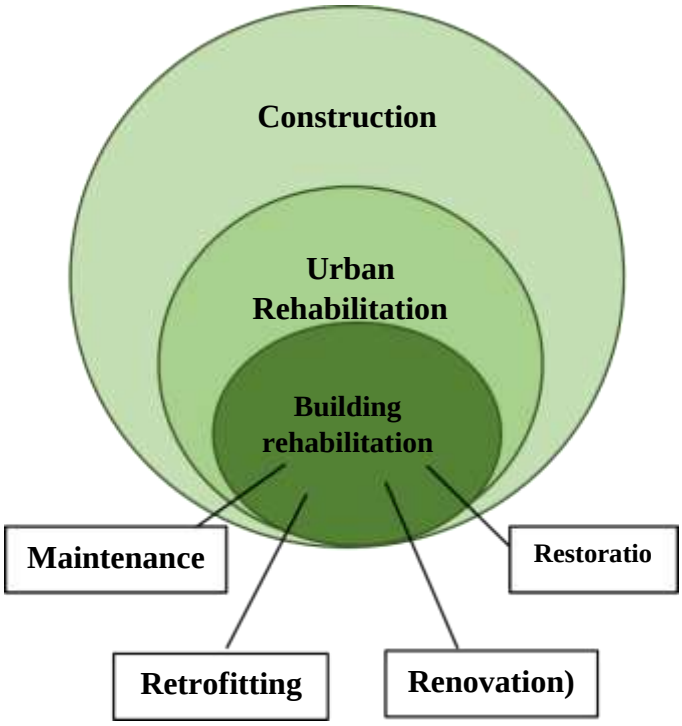

Figure 1: possibilities of rehabilitation of existing buildings [9].

4. Levels of sustainable rehabilitation of the hospital building system

4.1 The level of the site and the external spaces

The site reflects a consideration to minimize the building's multiplier effect on the surrounding community, by enabling easy access by healthy modes of transportation (walking, cycling, and mass transit). The site should also be suitable for community and service vehicles, fire trucks, ambulances, and other emergency vehicles. In addition to giving special attention to accessibility and ease of circulation for patients, employees, and visitors - disabled and non-disabled - on foot, on bicycles, in cars, or public transportation. Understanding the building as a series of flows enables the hospital's physical structure to achieve good alignment [12].

In the ideal case . The optimal distribution of the total site area of the hospital complex should be as follows: 30% for buildings, 15% for internal communication roads and parking lots, 50% for the vacant area (25-30% in the case of hospitals with limited capacity for future growth) of which 10% is reserved for recreational areas [13].

Hospital outdoor spaces play an important role in healthcare facilities, with a particular impact on the healing process, which can be assessed through its cultural, social, environmental, and economic characteristics and values. Since the hospital's external spaces need to accommodate different types of activities and experiences that are closely related to the users' special needs, they must be planned by the following requirements [14]:

1. Create opportunities for movement and exercise
2. Providing a choice between social interaction and solitude
3. Providing both direct and indirect connections to nature and other positive distractions .

When creating a garden for a healthcare facility, the focus should be on location, accessibility, patient requirements and preferences, and the design elements to be included. A garden should have opportunities for movement and exercise, offer a choice between social and solitary spaces, and facilitate beneficial distraction and direct or indirect interaction with nature [15].

4.2 The level of the physical structure

The structural audit is an initial step toward the rehabilitation of buildings. The health assessment, or what is called the structural audit of any existing structure, determines whether its function is as required and acceptable. Examining the existing structure thoroughly by the relevant codes and techniques ensures the serviceability of the structure and is judged based on it. The audit helps to understand the critical areas for repair and enhancement of the life cycle of the building by suggesting preventive and corrective measures such as repairs and retrofits [16].

It is necessary to improve the performance of structures, especially those that face loss of strength due to deterioration or that exceed the expected life span, and analyze the appropriate load path by a structural engineer

and make a decision if there is a need to add any additional part such as walls or others, and conduct engineering analysis, design and construction of any Necessary modifications, taking into account the following aspects [16]:

1. Functional aspect: The basic function should not be impeded by the basic operation of the building.
2. Structural safety aspect: the structure's susceptibility to disasters and earthquakes must be within acceptable standards.
3. The aspect of the level of importance: historical buildings of archaeological importance sometimes exceed the cost factor of reformatting without changing their aesthetics and elegance.
4. The construction methodology aspect: retrofitting using the latest construction techniques that have little impact on the usual performance of buildings.
5. The economic aspect: the full cost of the constructions must be practical and rational in order to extend the life of the structure.
6. Availability of skilled labor: Retrofitting practices require an unusual construction method and are a highly technical job that requires utmost care to carry out.

4.3 The level of functionality and interior space design

The sustainable rehabilitation processes must meet the functional requirements, and include a set of strategies to adapt the building to new uses, and improve the performance of the building within the requirements of comfort, energy efficiency and water consumption [17]. The hospital is a facility with complex functions and needs to be organized so that all services can be provided safely and effectively. The functional requirements may not be met due to design problems, construction defects, lack of maintenance, improper use, or incomplete inclusion in the urban fabric, so it is rehabilitated. And renewing them in accordance with the following functional requirements [18]:

1. Safety and Security Requirements: It includes issues related to the conditions that ensure physical and psychological protection, comfort and confidence, and includes (structural integrity, fire safety, normal use safety, security safety, including (intrusion, attack, theft)) [19].
2. Requirements for promoting health and well-being: It includes requirements for hygiene, health and user comfort, including (health promotion, indoor air quality, protection against moisture and leakage, protection against noise, visual comfort, thermal performance and energy efficiency).
3. Requirements of adequacy and flexibility: These are aspects related to spaces with spaces, dimensions, equipment, and relationships that enhance efficient use, individual identity, and social interaction, and include (space, equipment, devices, privacy, and accessibility).

4.4 The level of the building envelope

In general, the building envelope includes the external walls, ceiling, foundation, windows, and doors, and works to resist air, water, heat, light, and noise transmission. The main purpose of the envelope is to prevent the transfer of heat from the inside to the outside in winter and vice versa in summer [20].

Rehabilitation and renewal techniques for the building envelope of hospital buildings focus on additional thermal insulation and can be divided into two parts

a. The external walls are as follows:

1. Replacing existing walls or parts of them .
2. Adding external thermal insulation layers, including (external thermal insulation thermal bridges, air tightness in external thermal insulation), in addition to that there are different concepts for applying external thermal insulation layers, including (External Thermal Insulation Composite System ETICS) is a solution Multi-layer compact insulation designed to improve energy efficiency for both new and existing buildings, ventilated facades, external thermal insulation board systems, insulating plasters) [21].

3. Adding layers of internal thermal insulation, including (thermal bridges, and air tightness in internal thermal insulation), in addition to that there are different concepts for applying internal thermal insulation, including (plasterboard slices fixed to the existing wall, insulating panels fixed to the wall with wooden beams and covered with panels Gypsum, insulating panels fixed to the wall and covered directly with adhesive) [22].
4. Finishing materials: These include (Phase Change Materials (PCM's), nano coatings, and transparent insulation materials).
5. Green walls
6. Energy generation interfaces (photovoltaic interfaces, solar cell interfaces)
7. Intelligent kinetic interfaces
8. Double facades

B. The Roof :

1. Adding thermal insulation
2. Cultivation of roofs (green roofs)
3. Rooftops to generate energy (solar cells)
4. Surfaces with active and passive technologies

4.5 The level of management and use of energy

Energy savings are one of the main benefits of a retrofit project. Energy savings result from improved operational efficiency, lower operating costs, and allowing funds to be distributed to address basic medical services. In addition to reducing greenhouse gas emissions and improving the indoor environment.

Energy efficiency is defined as using less energy to achieve the same level of results, or improving the level of results for the same amount of energy. Three key principles can help guide energy-related actions in health systems [23] :

1) Reduce unnecessary use

2) Increase energy efficiency

3) Understand where the flexibility of power supplies can be improved.

Energy efficiency is achieved by the following [24]:

1. Smart Building Technologies: Control and automation technologies for smart buildings can significantly increase energy efficiency and sustainability in healthcare facilities. These technologies use a combination of sensors, software, and internet connectivity to monitor various building characteristics, analyze data, and generate insights into usage patterns and trends.
2. Designing the outer envelope of the building as a filter and the relationship between the internal and external environment
3. Implementing active and passive bioclimatic strategies
4. Designing efficient stations.

5. International Experiences of Hospitals

5.1 Whitby Community Hospital

Whitby Hospital is a community hospital in Springhill, Whitby, North Yorkshire, England. Managed by the Humber NHS Trust, The War Memorial Hospital was first built in 1925 to commemorate the lives lost in the First World War in Springhill and was opened by Princess Mary. The hospital was then demolished and replaced with a modern facility, opened by Princess Margaret in 1979, and is regarded as the first community hospital in England. In February 2018 it was agreed to redevelop the hospital building and site, converting it into a "Health and Wellbeing Center" with an urgent care center and the addition of 19 inpatient beds [25]. The £13m site rehabilitation process began in March 2021. Whitby Community Hospital provides inpatient, outpatient, and community services to the City of Whitby and the surrounding area.

Since its opening and with time the breadth of services available has decreased considerably until the facility has become largely underutilized and inefficient. At the same time, the internal arrangement of the spaces did not facilitate workforce integration, and employees often worked in isolated parts of the sprawling building where services were not normally compatible. The rehabilitation and redevelopment of Whitby Hospital have transformed it from an inefficient and underutilized community hospital in the 1970s into an integrated healthcare facility with a holistic approach to health and wellbeing. Where the patient and staff experience is enhanced by a therapeutic

community garden and scenic framed views across the historic coastal city [26].

5.1.1 Location and outdoor spaces

The site's 3.8 acres steeply sloping site, overlooking Whitby Harbour, provided the opportunity to re-design the existing hospital site, rehabilitate, and open up the area for future development. The site design focuses on three main spaces that add value to the patient, visitor, and staff experience: the main entrance foyer, the therapeutic garden, and public access areas. The complex scheme will be implemented in multiple phases necessary to keep the hospital functioning [27].

The rehabilitation works of the site consisted of establishing a new parking area, an area for ambulances, facilities for disembarking patients, external walkways for pedestrians, and a yard to connect the retained area with the hospital tower block [28]. With a focus on redeveloping the seven-story tower and removing the basement buildings, this has a role in freeing up the rest of the site for further development options, which include an additional care facility in the future with local authority support, to further enhance the 'Health and Home' offer [26]. The process of rationalizing and renovating the underutilized site, as well as taking advantage of the elevated hospital site, which overlooks the historic coastal town of Whitby, led to the reorganization of the site to the creation of an important new pedestrian road through the site as well as to the construction of car parks, where the extension of the corridor is determined Pedestrians, the entrance to the new hospital clearly which responds to the sloped site, allowing pedestrian access through the site, which was previously limited [26], as shown in Figure 2.

Before 

After

Figure 2: Shows the master plan of the site before and after the rehabilitation, including the redeveloped hospital and additional care facility [28].

In addition to the establishment of the therapeutic garden, which is accessible, and which reflects the proactive approach to community health encourages movement, activity and time spent in nature, outdoors. The therapeutic garden, designed jointly with the local community, contains sensory plantings, a paved road, and a variety of quiet and private seating areas, and plantings as a shield from the weather and create habitats to attract wildlife, to provide a comfortable outdoor space for patients, staff, and visitors as shown in Figure 3 , creating a quiet, secluded haven for activity or contemplation. General design principles have also been incorporated into the landscaping strategy to ensure the site is accessible to all [27].

Figure 3: The therapeutic garden that was designed in partnership with the local community [28].

All signage around the new building is patient-friendly and clear, with the addition of Glowing banners, making it easier for patients to navigate their way, while artwork will be part of a plan for a group of exhibits, which will be displayed in different areas of the building working to create a welcoming feeling, with a glow that reflects the city's heritage. Wetby, collect the community, be neutral about culture and politics, and easy to clean and maintain [29].

5.1.2 Functionality and interior space design

The rehabilitated hospital maintains the qualities of the existing building while ensuring hospital safety and accessibility for all users. Where the interior stairs dating back to the seventies were preserved with the addition of modern elements that complement the original aesthetic, as shown in Figure 4. Where care has been taken to reuse as much fabric and spaces as possible from the existing building, while ensuring the addition of an additional care facility to complement the hospital's current services, which will support current and future models of care, through flexibility in adaptation [26]. The new hospital facilities will house dental and podiatric services, and inpatient facilities, including mental health facilities, an audiology suite, and a cafeteria on the ground floor. The added facilities were chosen after public consultation with the residents of Whitby [28]. The Existing Hospital Tower, known as the Tower Block, has been comprehensively renovated and modernized to provide healthcare accommodation with a 19-bed inpatient ward. The designed extension of the tower's newly renovated exterior pedestrian walkway provides a new entrance to the hospital that unifies the hospital spaces, with better access for those using the steep site [30]. Old artworks are planned to be digitized so that people in the waiting areas of the new hospital can see them on display [29].

Figure 4: The staircase of the building dating back to the 1970s, as well as the war memorial that forms part of the existing hospital [26].

5.1.3 Building envelope

The upgrades to the building envelope included enlarging the size of the windows and larger areas of glass, to take advantage of the natural light and provide long scenic views towards the harbor and Whitby Abbey, where the landscaping provides a positive focal point for patients to promote the healing process, and a good working environment for medical staff and staff, by taking advantage of The process of reconfiguring the elevated site of the hospital overlooking the city and the coast of North Yorkshire [26] , as shown in Figure 5.

Figure 5: Enlargement of windows looking out towards the coast, St Mary's Church and Whitby Abbey throughout the building [26].

While a vertical red-colored fin façade wraps around the new two-story annex and connects the bridge to the main entrance, it serves to connect and group the new and the old and provide a new visual identity for the hospital. In contrast to the brickwork of the original existing building, it acts as a focal point to clearly define entry points and guide visitors easily through the site as shown in Figure 6.

Figure 6: The colorful vertical fin façade helps to 'bring together' the new and old elements of the building [26].

5.1.4 Terminations materials

The goal in choosing finishes is to create attractive and functional environments, as well as to enhance and protect healthcare interiors. All finishing materials for floors, exterior and interior walls throughout the site are of the highest standards, innovative and high-performance materials (sustainable), as Gerflor, a specialist in international flooring,

will provide more than 7,000 square meters of high-quality flooring, in addition to a range of handrail materials. and process corners.

Materials chosen provide both chemical and stain resistance, and our world-class vinyl and linoleum flooring collections are well-suited to hard-working spaces, including the intensive movement of beds, buggies, wheelchairs, and heavy medical equipment on a 24-hour basis. In addition to choosing the colors and patterns available to give a more homely and environmentally friendly character. In addition to paying attention to materials for stair edges, floor edges, barrier mats, and wall protection [30].

Through what was presented, the research reached a set of indicators at the level of hospital rehabilitation according to the foundations and principles of sustainability (environmental, economic and social), shown in Table 1. It can be used as a guide for health care officials interested in applying the principles of sustainable architecture, to reach an ideal hospital environment It has high environmental and economic performance to be applied to existing hospital buildings.

Table 1: shows indicators of sustainable rehabilitation according to the foundations and principles of sustainability**.**

Dimensions of sustainability	Indicators of sustainable rehabilitation	Details
Environmental Social Economic	**Location and outdoor spaces**	Gardens and landscapes Reducing parking space, and establishing suitable parking lots and bicycle paths, to encourage the use of alternative means of transportation Natural ventilation of public places
	Physical Structure	Strengthen the structural strength overlap with supports sustainable building materials Build system assembly
	Functionality and interior space design	division of spaces walk paths Health services website Remove commas Determine the way Flexibility and adaptability Terminations materials noise reduction color considerations Introducing the natural environment (biophilia)
	Building envelope	**Walls** Replacing existing walls or parts thereof Adding external thermal insulation layers Adding layers of internal thermal insulation Terminations materials green walls Energy generation interfaces (photovoltaic interfaces, solar cell interfaces) Intelligent interfaces dual interfaces **Roofs** Replacement of interior secondary ceilings Adding layers of external thermal insulation Adding layers of internal thermal insulation Terminations materials Planting green roofs
	Energy Management And Use	Intelligent building technologies Design of the outer cover of the building Implement active and passive biological climate strategies Designing efficient plants Use of low carbon and renewable source

Conclusions

Taking into account the goals of the United Nations Development Plan for the year 2030, which refer to sustainable principles, it is necessary to improve the performance of the built environment and to preserve and improve existing buildings to reduce their environmental impact and in line with climate changes and reduce the incidence of natural disasters, so sustainable practices must be adopted for future constructions and renovations of health care facilities. Not only will these practices save money over the life of most healthcare facilities, but they will also make spaces more efficient for healing. Improving energy efficiency is the most cost-effective way to save energy and has a faster effect on global warming. In addition, improving the energy performance of the hospital building saves money on maintenance and energy bills, which results in more money being saved for patient care.

References

1. Robertson, M. (2021). Sustainability principles and practice. Third edition published 2021 by Routledge.
2. Council, U. G. B. (1996). Sustainable building technical manual: green building design, construction, and operations.
3. WCED, S. W. S. (1987). World commission on environment and development. Our common future, 17(1), 1-91.
4. UNDP. (2019). Transforming our world: the 2030 Agenda for Sustainable Development. Retrieved from: https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf
5. Baalbaki, Mounir, 2008, "The Resource", an English-Arabic dictionary, Dar Al-Ilm for Millions, Beirut, Lebanon.
6. Appleton, J. (2011). Reabilitação de edifícios antigos: patologias e tecnologias de intervenção. 2ª Edição, Editora Orion, Amadora.
7. Conejos S., Langstrom C., Smith J. (2013). "AdaptSTAR model: a climate-friendly strategy to promote built environment sustainability". Habitat International, vol. 37, pp. 95-103
8. Qualharini, E. L., Oscar, L. H. C., & da Silva, M. R. (2019). Rehabilitation of buildings as an alternative to sustainability in Brazilian constructions. Open Engineering, 9(1), 139-143.
9. Coffey, D. P. (1994). Renovation, rehabilitation and restoration of office buildings. American Society of Real Estate.
10. ABNT, N. ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS NBR (2015) . 16280 Reforma em edificações–Sistema de Gestão de Reformas–Requisitos Gerais . Rio de Janeiro.
11. Chías, P., & Abad, T. (2017). Green hospitals, green healthcare. International Journal of Energy Production and Management, 2(2), 196-205.
12. Nedučin, D., Krklješ, M., & Kurtović-Folić, N. (2010). Hospital outdoor spaces: Therapeutic benefits and design considerations. Facta universitatis-series: Architecture and Civil Engineering, 8(3), 293-305
13. Ulrich, R. S. (1999). Effects of gardens on health outcomes: Theory and research. in Cooper-Marcus, C., Barnes, M. (Eds.): Healing Gardens: Therapeutic Benefits and Design Recommendations, John Wiley & Sons, New York

.
14. Epstein, M. (2006). Hospital gardens help patients heal. Seattle Daily Journal Health Care Design & Construction, 11
15. Chandar, S. S. (2014). Rehabilitation of buildings. International Journal of Civil Engineering Research, 5(4), 333-338.
16. Qualharini, E. L., Oscar, L. H. C., & da Silva, M. R. (2019). Rehabilitation of buildings as an alternative to sustainability in Brazilian constructions. Open Engineering, 9(1), 139-143.
17. EPOS,2015, Green Hospitals Concept Manual For Improving Infrastructure :Section 1 Best Practice: Basic Planning Principles , Developed as part of the 'Greening Hospitals Integrated Infrastructure Competence Project' in Tajikistan, co-funded by EPOS, ETLog and GIZ • December 2013 - October 2015 .
18. Vilhena, A., Pedro, J. B., & Paiva, J. V. (2010). Assessment method for buildings' rehabilitation needs. Development and application. TG75, W014, W080, W083 &W086, 444.
19. Natural Resources Canada ,2018 , Major energy retrofit guidelines for commercial and institutional buildings : hospitals, This report is available online at , https://publications.gc.ca/site/eng/9.850959/publication.html .
20. Häkkinen , T. (2012). Sustainable refurbishment of exterior walls and building facades: Final report, Part A-Methods and recommendations.
21. De Berardinis, P., Rotilio, M., & Capannolo, L. (2017). Energy and Sustainable Strategies in the renovation of existing buildings: An Italian Case Study. *Sustainability*, *9*(8), 1472.
22. World Health Organization. (2017). Environmentally sustainable health systems: a strategic document (No. WHO/EURO: 2017-2241-41996-57723). World Health Organization. Regional Office for Europe.
23. Hegger, M., Fuchs, M., Stark, T., & Zeumer, M. (2012). *Energy manual: sustainable architecture*. Walter de Gruyter
24. Whitby Hospital,2017, Retrieved 10 March 2023 https://whitby.co.uk/whitby-hospital/
25. Medical Architecture, 2023, Redeveloping Whitby Hospital for the health of the community, https://medicalarchitecture.com/redevel oping-whitby-hospital-for-the-health-of- the-community/
26. One environments,2018, "landscape proposals", https://www.one-environments.co.uk/project/whitby-hospital/
27. Victoria Finan, 2021, Redevelopment of Whitby Hospital giving town's residents 'the facilities they deserve'' https://www.yorkshirepost.co.uk/health/redevelopment-of-whitby-hospital-giving-towns-residents-the-facilities- they-deserve-3166983
28. Duncan Atkins,2022, Whitby Hospital: here's the latest on the site renovation project, https://www.thescarboroughnews.co.uk/health/whitby-hospital-heres-the-latest- on-the-site-renovation-project-3552493
29. Press Release,2023, "Gerflor 'go large' with 7000m2 installation at Whitby Hospital, Yorkshire",https://www.gerflor.co.uk/media/12-uk-website/whitby-hospital-pr-final.pdf