



The Essentiality of Sustainable Architecture Design of Medical Centers with the Physical Therapy Approach

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Abstract: *The aim of this study was to assess the essentiality of sustainable architecture design of medical centers with the physical therapy approach. Using library resources, this study was attempted to descriptively-analytically evaluate the role of sustainability components on the environmental quality of physical therapy centers. The physical therapy centers, not only need to meet the requirements of their users in terms of functionality, but also need to use sustainable architectural components such as proper location, use of clean and renewable energy, selection of appropriate materials, management of pollution and water resources in reducing the consumption of non-renewable energy, reducing the production of pollution and waste and losses to reduce environmental degradation. Due to the sensitivity of the patients and the direct impact of designed environment on their recovery, following the principles of sustainability and providing design solutions tailored to the environmental needs of physical therapy centers, including connection with nature, use of antibacterial materials, pollution and waste management, and attention to water supply sources, can promote the process of patients' mental and physical health. It can be concluded that attention to sustainable architectural components should be considered not only as a suggestion but also as a requirement in the design of medical centers.*

Keywords: *therapeutic centers; treatment; physical medicine; rehabilitation centers; rehabilitation*

I. Introduction

Throughout the history of human life, man, in order to satisfy his needs, has inadvertently conquered nature and changed the environment, so that after the industrial revolution and the discovery of fossil fuels, the greatest ecological disasters occurred, including the hole in the ozone layer and the extinction of animals and plants, as well as atmospheric and climatic disturbances. On the other hand, the construction industry was the most influential and destructive industry for nature and the ecosystem due to the population explosion and the growing need for shelter and buildings, as well as the expansion of cities. The continuation of this destructive trend led to a new attitude in the late twentieth century called "sustainability" by experts and practitioners (Reyhane, 2011: 71-73; Sodagar, 2017: 517-532).

One of the most important goals of sustainability is to conserve energy in order to reduce the consumption of non-renewable resources and pollution, and to preserve the environment and sustainability. The purpose of this approach to design and architecture is to find architectural solutions that can ensure coexistence with nature to improve the quality of life and continue the healthy life on earth by formulating rules and regulations (Bahraini, 2001: 25-43; Arabani, 2020: 45-51). In this context, attention to the architecture of buildings and structures, especially public places, is of particular importance. Health centers are special public buildings where, on the one hand, patients, as the main users, and their companions, according to the duration of the treatment, and, on the other hand, medical staff, according to their task, have to stay for a long period of time, so that all phases of the design of these centers, from design to construction, and even the technology used, have a significant impact

on the context of such places (nature) and the health of the users (patients and staff). Therefore, it would be useful to pay attention to the concepts of sustainability in this area in order to increase productivity and improve therapeutic performance (Mohammad, 2016: 28-36).

Physical medicine is a branch of therapy that uses physical methods such as heat, cold, hydrotherapy, massage, meditation, exercise, and electrical currents in the treatment of patients with mental, psychological, and physical disorders. Both physical therapy and rehabilitation lead to individual physical therapy and rehabilitation. The treatment process in this medicine lasts at least 15 days, and the stay and hospitalization of patients in these centers are crucial for the improvement of therapeutic function (Arasıl, 2008: 1-3).

Contend

Due to the lack or even absence of such physical therapy centers and the need to find solutions for the design and construction of these centers in the first phase, as well as the classification of these buildings in the category of medical centers, it will be important to pay attention to sustainability in the design and architecture of physical therapy centers, reduce environmental damage, increase productivity and improve therapeutic performance.

II. Research Methods

The purpose of this study was to investigate and describe the role of sustainable architecture in the design of medical, especially physical therapy and rehabilitation centers.

The hypothesis of the present study was that in the design of physical therapy centers, the components of the design of the spaces of these centers are related to the principles and solutions of sustainability, both with the aim of improving the quality of treatment and reducing environmental damage (energy consumption, pollution, etc.). In other words, the attention to the principles of sustainability as basic principles in these centers will be a response to the fundamental factors in the design of rehabilitation complexes. In this descriptive-analytical study, documentary library sources and available scientific articles, books, etc., were used to discuss the concept of sustainability, classification and description of sustainable components in the context of architecture and design. In particular, the influence of this architectural approach on the use of physical therapy centers was presented. Finally, through these characteristics, the effective role of sustainable design in the realization of architectural design components of physical therapy centers was determined.

III. Discussion

3.1 Findings

a. Sustainability

The origin and meaning of the word "sustain" are used in English since 1290 AD and according to the meaning of the root, this word means "to hold" or "to maintain". Over the years, various other meanings have been derived from the word, but in recent decades, the word sustainability has evolved to mean "what will persist in the future (Bahraini and Maknoon, 2001: 25-43). In the Dekhoda dictionary, sustainability is defined by the words "durable" and "lasting." Sustainable development involves an important and even contradictory change in the relationship between man and the environment. The broad and varied meanings of sustainability and sustainable development have attracted the attention of

many experts. In general, sustainability refers to anything that will persist in the future without the damage caused by its use and will not be terminated (Arabani, 2020: 45-51). In 1986, the World Committee for Environmental Development first proposed the theory of "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Mohammad, 2016: 28-36; Reva Şermet, 2017: 290-303). The World Commission on Environment and Development (WCED), also known as the Brundtland Commission, defines sustainable development in a theory entitled "Our Common Future": "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Friedman, 2014: 78-94; Nouri, 2021: 120-134). After the "Leaders' Debate" conference in Rio in 1992, the issue of sustainable development was taken up in the global arena and in other sciences and fields such as economics, technology, urban planning, architecture, materials, and so on (Bahraini, 2001: 25-43). Sustainable development in the three areas of environmental, economic and social sustainability is a profound issue.

To achieve these goals in architecture, environmental sustainability is more important, and architects' attention to environmental issues is inevitable (Pour Ali, 2020: 11-17).

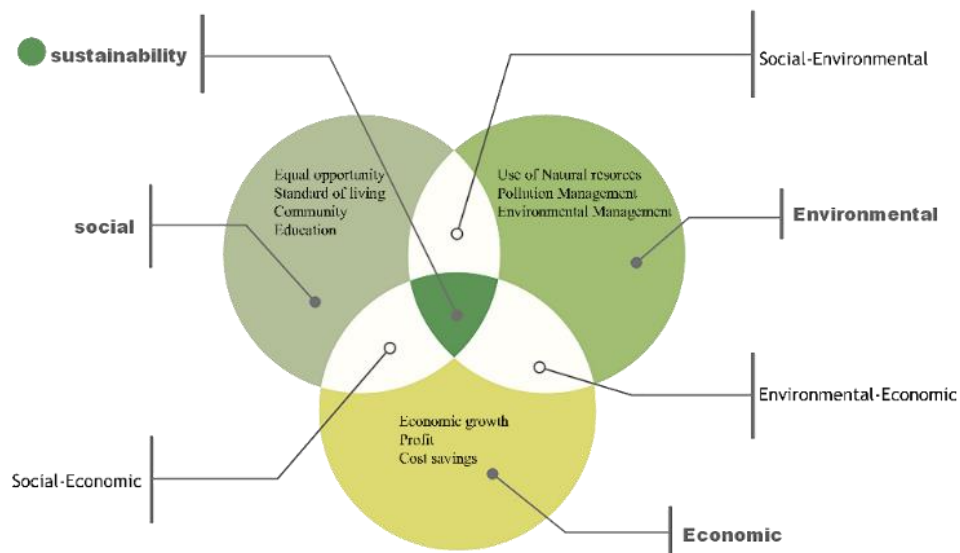


Figure 1. *The Three Pillars of Sustainable Development as a Result of the 1992 RIO Conference and the Relationship between the Three Environmental, Social and Economic Objectives in Achieving Sustainable Development*

1. Sustainable Architectural Design

Sustainable architecture has emerged due to the concepts and goals of sustainability in architecture and aims to reduce energy waste and pollution. From the perspective of sustainable architecture, the building is not only built-in accordance with climatic conditions, but also establishes a kind of interrelationship with its environmental context. Richard Rogers' simile states that he "sees the building as a bird that fluffs its feathers in winter to adapt to the environment and regulate its metabolism accordingly" (Mohammad, 2016: 28-36). In the goals of sustainable architecture, the preservation and conservation of nature is central because it is an urgent human need, while in the past the relationship between man and the environment was sacred in addition to its conquest, and this sanctification brought about respect for nature in its use (Pour Ali, 2020: 11-17).

Pioneers of the sustainable architecture movement include John Ruskin, William Morris, and Richard Lethaby, who presented theories on this. In *The Seven Lamps of Architecture*, Ruskin refers to imitating the harmonious order of nature to achieve growth and development. Morris, too, advises a return to suburban green space and self-sufficiency, as well as the revitalization of local industry. Lethaby also emphasizes architects' attention to the order and beauty of nature. Years later, other architects such as Frank Lloyd Wright, Peter Eisenman, and others spread the ideas of these pioneers. According to study by Ulrich R revealed that sustainable hospital building architecture has benefits for both hospital staffs and patients (Ulrich R, 1984; 420–421). According to Ulrich's 2006 study RS, absenteeism seems to be lower in sustainable work environments, although this has rarely been studied in healthcare (Ulrich RS, 2006; 538–539.).

In fact, architecture has a significant impact on nature and our surrounding environment. The growth and survival of plants can also be influenced by architecture. Nature can be affected by different aspects of architecture. The used materials for construction of different architectural constructions, like buildings, streets, roads, etc. With use of nature compatible materials, nature less severely affect by architecture and constructions. On the hand, less compatible materials with the nature, it affects more seriously with architecture. Therefore all pioneers of this idea emphasis on the direct impact of architecture on the nature. In addition to this, architecture can make the nature more beautiful. More compatible construction with the nature make it more beautiful that in some extend is due to less destruction of the nature via the architecture and constructions (Khizrian Alireza, 2015: 2-9).

Sustainable architecture in the context of hospital and medical centers have several issues. In hospital construction, not only essential requirement such as instrument and space are essential, but also need to use sustainable architectural components such as proper location, use of clean and renewable energy, selection of appropriate materials, management of pollution and water resources in reducing the consumption of non-renewable energy, reducing the production of pollution and waste and losses to reduce environmental degradation. Proper location of the hospital can affect spiritual aspects of the patient and reduce hospitalization time and recovery time. The use of renewable energy is another important factor that can decrease energy waste and subsequently affect the patient's health and safety. The selection of appropriate materials is another important factor that directly can affect the patient's health, safety, recovery time and hospitalization time. In fact, all these issues can affect the patient's health and recovery time and subsequently his/her health care costs. Therefore, architecture not only should physical aspects of the hospitals and medical care centers, but also should consider sustainable architecture principals to improve patient's health status (Khizrian Alireza, 2015: 2-9).

In the context of architecture, the term sustainability is used to describe the design of sustainable buildings from a variety of ecological, technological, material, and environmental perspectives (Reyhane, 2011: 71-73). In general, sustainable architecture is a type of architecture in which the original idea of design is to meet the characteristics and capabilities of the climate and environment, and to use these capabilities as infrastructure to create optimal conditions. This unique attitude in architecture takes into account the needs of aesthetics, but behaves perfectly in harmony with natural and environmental capacities (Maryam Golshani. 2009: 1-7).

2. Sustainable Hospitals Medical Centers

Hospital and medical centers have a significant impact on patient's recovery and a well-being. All aspects of a hospital can affect the patient's physical and spiritual issues. A well-designed hospital can increase patient's recovery and therefore decrease his/her hospitalization period and subsequently can decrease disease burden for both health care system and patients.

Therefore hospital architecture is an important issue in patient's recovery. All materials use for construction of a hospital are useful to improve the patient's health. For instant, a hospital with suitable air circulation and even appropriate sunlight can affect the patient's health and recovery period. These factors can affect wound healing process and post-surgical recovery. Therefore, a suitable architecture of the hospital is an important factor for recovery of patients (Ashourpour, 2017: 6-12).

The structure of hospitals and medical centers is constantly changing over time as the population grows and the nature of diseases, medical and health needs, or even rehabilitation change. This change becomes broader and deeper in developing countries with each passing decade, so that after five decades the structure or original design of a medical building is rarely recognizable (Ashourpour, 2017: 6-12).

The quality of the spatial design of health centers has a significant impact on the mental and physical health of patients, and ensuring the physical and mental well-being of patients is one of the most important goals of medical systems (Zakeri, 2014: 33-44). A medical center or a healing house is a place where a group of physicians and professionals who are knowledgeable in the science of body and soul try to heal those who have a defect in their body or soul (Mirzadeh, 2016: 21-28).

A sustainable medical center is a place that first recognizes the healthy relationship between people and the environment, and then improves the health of its users by continuously reducing environmental impacts and eliminating their negative effects. Moreover, sustainable design strategies and criteria in medical centers have significant impact on therapeutic performance and increase their efficiency (Mohammad, 2016: 71-74).

Medical centers and hospitals are an absolute priority for sustainable design due to the high consumption of energy resources and the production of large amounts of waste and garbage. Direct energy consumption by the health sector accounts for about 20% of total public sector energy consumption in Australia and is likely to be similar in other industrialised countries. Burger B in 2013 showed that heating, ventilation, and air conditioning typically account for at least half of direct energy consumption in hospitals, with lighting and equipment accounting for the remainder (Burger B, 2013, 15-19).

Sustainable design in medical centers is pursued with the following three objectives:

1. Reduce the negative impact of the medical center building on the environment (environmental, economic and resource impacts).
2. Improving therapeutic performance
3. Reducing costs (Mohammad Jafar Karbaschi and Safari, 2016: 71-74).

According to the study by Schroeder KTT in 2006, a 1°C increase in room temperature in a summer or winter can reduce annual cooling/heating costs by five percent (Schroeder KTT, 2013, 18-23).

Through the study and review of numerous research papers on sustainable medical center design and architecture, we arrive at some common factors that make adherence to these principles a priority when designing a sustainable medical center:

- Suitable location:

Before planning and implementing the project, selecting the right location and infrastructure with therapeutic use is one of the most important issues for the sustainability of a medical center. The location of the medical center must meet the main criteria for locating medical centers (Sodagar, 2017: 517-532). Flexible design must be considered. Flexible design facilitates expansion and reconfiguration as needed to meet future needs through modular and flexible planning (Yilmaz, 2006: 142-149).

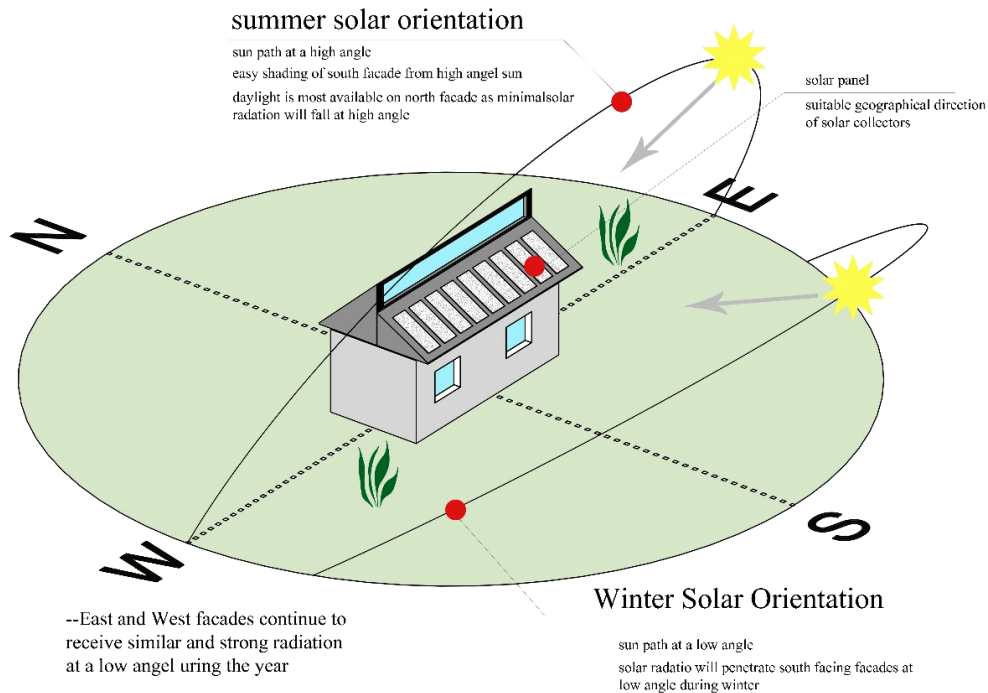


Figure 2. *The Correct Orientation of the Building in Relation to the Geographical Directions for the Use of Solar Energy during the Different Seasons of the Year*

- Location of the building on the plot

Attention to the points related to climate design to take advantage of the direction of sunlight, adequate access to nature and good connectivity are the basic requirements for sustainable design. North facades tend to have fewer openings than south facades. The direction of radiation also affects the amount of vertical radiation. In winter, for example, a south-facing façade gets the most benefit from sunlight. In summer, however, when the sun is highest at noon, the south façade receives less direct radiation, while the east and west façades are most affected during the evening and morning hours (Yilmaz, 2006: 54-57; Sodagar, 2017: 517-532). (Figure 2)

- Use Clean and Renewable Energy Sources

Buildings consume 40% of the world's energy, which is equivalent to about one-third of global carbon dioxide emissions from fossil fuels. Therefore, building design should reduce reliance on fossil fuels and consider the use of clean and renewable energy sources. Examples include fuel cells, photovoltaic cells, solar water heaters, etc (Yilmaz, 2006: 54-57). Moreover, medical centers are among the places with the highest energy consumption. In addition to the above measures, measures such as the construction of double-walled surfaces, green roofs, etc., can effectively reduce the energy consumption of these centers. Green roofs

have a significant impact on reducing energy losses due to the lower heating and cooling load of the building by modulating indoor air in summer and reducing heat loss in winter (Sodagar, 2017: 517-532) (Figure 3)

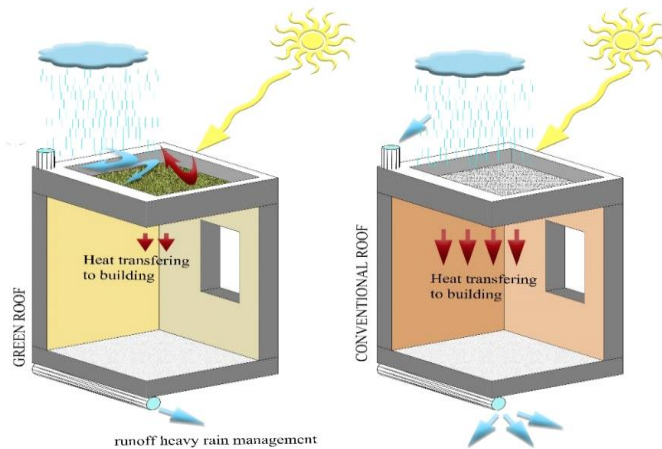


Figure 3. Comparison of Thermal Energy Exchange and Stormwater Management for Green Roofs and Conventional Roofs

- The Selection of Appropriate Materials for the Building in Terms of Sustainability

One of the most important factors in the approach of sustainable design of medical centers is the selection of appropriate materials that are compatible with the particular use. One of the most common diseases during hospitalization and in medical centers is "clinical disease" or "hospital-acquired infection." The use of special materials for therapeutic purposes and the use of suitable and antibacterial materials for indoor flooring and wall coverings will prevent the accumulation of infections and bacteria in tissues and thus their infection over time (Mohammadabadi, 2011: 580-590; Sodagar, 2017: 517-532).

- Water Management

Medical centers around the world are large consumers of water and generators of waste (Mohammadabadi, 2011: 580-590). In a study in 2011, it was revealed that about one percent of a city's total water consumption is occur in hospitals. In fact, there are four main sources of water consumption in hospitals: Washbasins, sinks and showers, which account for about 20% to 40% of total water consumption; toilets, with 15% to 30% of water consumption; laboratories, cooling towers, macerators and sterilizers, which consume 15% to 40% of water consumption; and food preparation, with 5% to 25% of water consumption, is the last source of water. According to sustainable architecture, 10 to 25% water savings can be achieved by simple means that do not require further innovation or research: Reviewing consumption, including installing metres with data collection and sub-metres, checking for leaks, applying flow restrictors to hand basins and showers, installing dual-flush toilets, and recovering water from dialysis machines and sterilisers Therefore, it is important to pay attention to the following measures: Water supply sources, use of materials to reduce water consumption, recovery and purification of water and its reuse for other purposes (irrigation of green areas, which constitute a large part of medical centers and hospitals, and refraining from using potable water for non-essential purposes and cleaning medical centers), the use of water-free ventilation systems in hospitals, treatment of hospital wastewater, etc., which has a significant impact on the sustainability of medical centers (Gözde, 2020: 97-133) (Figure 4).

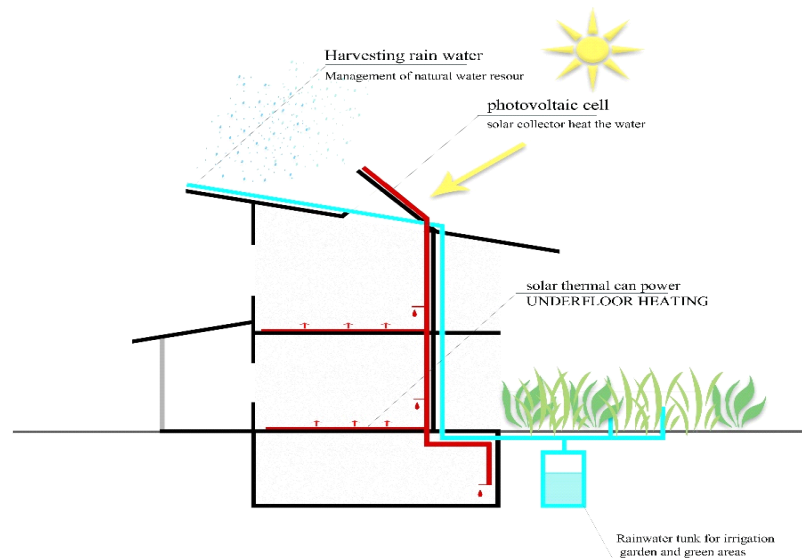


Figure 4. *Use of Natural Resources in Heating, Control and Management of Water Consumption*

- Pollution Management

The mass production of hospital waste and the failure to equip these facilities with modern technology for the destruction and incineration of hospital waste is an important problem that has made these applications one of the biggest polluters of the environment. Hospitals in the USA alone produce an average of 5500 tons of waste every day. Based on the study of Soares SR et al. the study of waste disposal shows that the treatment of infectious waste by microwaves instead of autoclaving, lime or incineration has financial and environmental benefits (Soares SR. 2013, 23-29). Sustainable healthcare facilities should be designed to control the production of contaminants (Mohammadabadi, 2011: 580-590).

The following solutions may help:

Provide patterns for waste segregation in the form of freezing and disposal in incinerators so that waste is disposed of on the same hospital grounds. The architectural design of the interior should be such that the transport route of dirty and clean equipment is separated from each other (Sodagar, 2017: 517-532).

3.2 Discussion

a. Physical Medicine

Physical medicine is a branch of medicine that focuses on the person rather than the disease and seeks to enhance the quality of life and improve performance, which has opened a new perspective for medicine through a variety of therapeutic approaches. The focus of this specialty is on diagnosis, treatment, and prescription of rehabilitation using physical methods and rehabilitation interventions (Raissi, 2012: 78-85). Physical medicine, which uses physical methods such as heat, cold, hydrotherapy, and techniques such as massage, exercise, and meditation, as well as acupuncture, has been used by people since ancient times and was mentioned as early as 400 BC in the writings of Hippocrates (Raissi, 2011: 369-370). One of the most important tasks of this type of medical and rehabilitation centers is to eliminate or reduce physical and mental problems that play a significant role in the lives of patients referred to these centers. If the follow-up to reduce these problems is not done through psychological counseling or appropriate treatments, it leads to mental disorders, depression and isolation from society, etc.

b. The Architecture of Physical Therapy and Rehabilitation Centers

The design and architecture of these medical centers play an important role in restoring patients' physical, mental and emotional health. Since the patients are more sensitive than healthy people and the special psychological and physical conditions of this group of people, more attention is paid to the design of these centers in terms of physical, functional and architectural aspects than before, to the extent that architects are required to consider them more accurately and scientifically than all the principles and components of the architecture of medical centers (Yousef, 2018: 75-61).

Among the environmental factors that affect the promotion of health and improve the quality of treatment in rehabilitation centers, which can be applied to the design and architecture of physical therapy centers, can be such as noise control and acoustic status of rooms, the selection of appropriate floor and wall materials, and pointed to the component of color and light, green areas and communication with nature, cooling, heating and ventilation systems (Alireza, 2019: 37-42).

The role of design and architecture of these medical centers will not be ineffective in restoring patients' physical, mental and emotional health. Since the patients are more vulnerable than healthy people and the special mental and physical conditions of this group of people, the design of these centers in terms of physical, functional and architectural aspects will be given more attention than before, to the extent that architects will be required to consider them more precisely and scientifically than all the principles and components of the architecture of medical centers (Yousef, 2018: 75-61).

Environmental factors that affect the promotion of health and the improvement of the quality of treatment in rehabilitation centers and that can be applied to the design and architecture of physical therapy centers include, for example, protection from noise pollution and the acoustic status of the rooms, the selection of appropriate floor and wall materials and the consideration of the component of color and light, green spaces and communication with nature, cooling, heating and ventilation systems (Alireza, 2019: 37-41).

Based on the studies conducted, it can be analyzed that physical therapy centers play a more important role in the treatment of a number of environmentally vulnerable patients in the category of medical centers. In other words, on the one hand, as a medical center, they should offer solutions to play a role in their sustainability to preserve nature, and on the other hand, they should respond to the needs of their audience (patients) to maximize the effectiveness of treatment. Therefore, these two categories cannot be considered separately. The architecture of a physical therapy center essentially establishes a two-way connection between people and nature, which will influence each other. The table below presents both sustainability strategies and effective design strategies for the environmental quality of the physical therapy center.

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Table 1. Common Components between Medical Center Sustainability and Physical Therapy Center Design (Yilmaz 2006, Mohammadabadi and Ghoreshi 2011: 580-590, Sodagar and Dr, 2017: 517-532; Alireza Meshbaki Esfahani and Esfahani, 2019: 37)

Design components	Sustainability solutions in medical centers	Design solutions for rehabilitation centers
Location of the site and location of the building on the site.	<ul style="list-style-type: none"> - Placement of the building on the site according to the geographical location and use of the south light. - Access to nature - Use of natural light and daylight - Planning and design of a healing garden 	<ul style="list-style-type: none"> - Selection of the appropriate site for the construction of the building and the appropriate locations for the openings and windows (easy ventilation). - Possibility of access for people with disabilities on one level (connection with nature) - Coordination of color and light and use of natural light and its effect on patients' health and staff productivity - Green areas, the most important factor of the ecosystem
Clean and renewable energy	<ul style="list-style-type: none"> - Energy-saving (insulations) - Reduce heat loss - Use of photovoltaic cells - Solar water heaters 	<ul style="list-style-type: none"> - Design and construction of double-walled areas - Require the design of green areas on the roof to reduce energy losses and adjust the temperature in winter and summer. - Underfloor heating
The correct selection of materials	<ul style="list-style-type: none"> - Suitable materials for infection control - Use seamless hospital cover - Antibacterial materials 	<ul style="list-style-type: none"> - Use of materials with the least details to create tranquility and order. - Non-glossy flooring without light reflection. - Use the right color and harmonize with the light

Pollution	<ul style="list-style-type: none"> - Management of chemical pollution - Use of incinerators - Waste separation - Isolation of the transport route of dirty and clean equipment 	- Noise control as one of the effective elements in rehabilitation centers (acoustic materials to reduce noise pollution).
Water management	<ul style="list-style-type: none"> - Paying attention to water supply sources - Reduce water consumption - Recovery and purification of water and use in non-drinking applications such as irrigation and washing 	- Carpeting for soundproofing

IV. Conclusion

When designing a physical therapy center, architectural solutions can be proposed by investigating and recognizing design requirements. By examining sustainability solutions in architecture and recognizing the components that affect environmental quality in the design of rehabilitation centers and the relationship between nature and people, steps can be taken to improve the mental health of patients and keep nature alive and used without harm. The sustainability approach should be considered not only as a design proposal, but also as an ongoing requirement in the design process of medical and physical therapy clinics. This will have a significant impact on environmental quality and promote human peace and environmental health.

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