Sustainable development practices and its effect on green buildings

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Abstract. Sustainable development is an important aspect of society which fulfils the present needs without compromising the ability of future generations to meet their own needs. It gives us a new way of thinking through and managing human impact on the world that can generate long lasting positive results for the greater benefit of human societies. The concepts of sustainability and sustainable development are discussed and analyzed from different theoretical perspectives. The alternative paradigms and main objectives which provide supporting sustainable development are explored. They show the complexity of choosing the right actions towards sustainable development. And, the three pillars of sustainable development which are social, economic and environmental should be considered together to achieve the effective planning for sustainable future through a collaboration of experts from different disciplines. International goals of sustainability have led to the development of the green building movement that has had unprecedented success. Sustainable development and green buildings are often used interchangeably. Although, they are related, they are not the same. There are many green building rating systems over the world. United States Green Building Council administered Leadership in Energy and Environment Design (LEED) is the global market leader in the rating systems. LEED is a laudable and has a great effort in moving towards sustainable development by converting the built environment into green. Furthermore, some other rating systems that have been developed to measure the sustainability level of green buildings and provide best practice experience in their highest certification level are illustrated. This paper aims to provide an overview of how green building relates to sustainable development practices which is divided into two sections. The first section defines green building and discusses what makes buildings green. And, the second section discusses the environmental impacts of traditional buildings and explains common green building practices.

1. Introduction

In 1987, the Bruntland Commission published its report, Our Common Future, in an effort to link the issues of economic development and environmental stability. In doing so, this report provided the definition of sustainable development as “it is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs” [3].

The concept of sustainability and sustainable development figure among the most ambiguous and debatable in the literature reviews. This concept aims to maintain economic advancement and progress while protecting the long term value of the environment as it provides a framework for the integration of environment policies and development strategies [3]. There is an assent on the fact that sustainable development does not only focus solely on environmental issues but broadly based on three
interdependent and mutually reinforcing pillars. These pillars are economic development, social
development, and environmental protection as shown in Figure 1.

![Sustainable development pillars](image)

**Figure 1**: Sustainable development pillars

Social thinkers have argued that cultural diversity is also the fourth pillar of sustainable development. Sustainable development was a key theme by lay claim to explicitly that it was possible to achieve economic growth and industrialization without environmental damage [8].

The concept of sustainable development does imply not absolute limits but limitations imposed by the present state of technology, social organization on environmental resources and ability of the biosphere to absorb the effects of human activities. But technology and social organization can be both managed and improved to make way for a new era of economic growth.

Therefore, sustainable development can only be pursued if population size and growth are in harmony with the changing productive potential of the ecosystem. Thus, sustainable development is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are made consistent with future as well as present needs. This paper attempts to examine these concepts from different perspectives seeking to conclude their fundamental aspects.

2. Definition and principles of sustainable development

The term sustainable development has been widely and variously defined but a consensus as to its general implication is that sustainable development requires a non-declining level of well-being for future generations [8]. Sustainable development is a pattern of growth in which resource use aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but also for upcoming generations.

Brundtland defined Sustainable development is the development that fulfills the needs of the present without compromising the ability of future generations to meet their own needs [3]. It contains two key concepts; the first is the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given. And the second is the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs [9-14]. This definition was vague but it cleverly captured two fundamental issues, the problem of the environmental degradation that so commonly accompanies economic growth and the need for such growth to alleviate poverty [11].

In the application of this definition of sustainable development, one issue concerns the substitutability of capital. There are several types of capital; social, natural, and man-made. The definition of weak sustainable development explains that only the aggregate level of capital matters; man-made, or
manufactured, capital is an adequate alternative to natural capital. Strong sustainability, on the other hand, recognizes the unique features of natural resources that cannot be replaced by manufactured capital. Most ecologists and environmentalists are proponents of the strong sustainability definition [12].

Contained within the common definition of sustainable development, intergenerational equity recognizes the long-term scale of sustainability in order to address the needs of future generations [5-12]. Also, the polluter pays principle states that “governments should require polluting entities to bear the costs of their pollution rather than impose those costs on others or on the environment” [5]. Thus, government policy should ensure that environmental costs are internalized wherever possible as it also serves to minimize externalities.

The key principle of sustainable development underlying all others is the integration of environmental, social, and economic concerns into all aspects of decision making. All other principles in its framework have integrated decision making at their core [6-12]. It is this deeply fixed concept of integration that distinguishes sustainability from other forms of policy.

An interlocking relation exists where the sustainability approach is contained by interactions between environmental, social and economic factors which are the three poles of sustainability as shown in Figure 2 [6].

![Figure 2. Poles of sustainable development.](image)

Sustainable development is “a strategy that manages all assets, natural and human resources, as well as financial and physical assets for increasing long-term health and wellbeing. It is a goal that rejects policies and practices that support current living standards by depleting natural resources and leaves future generations with poorer prospects and greater risks” [8]. It means living on the earth's income rather than eroding its capital, keeping the consumption of renewable natural resources within the limits of their replenishment [1].
For effective implementation of sustainable development, individuals and societies must be able to sustain their environments while ensuring a healthy and prosperous lifestyle for future generations. It will be achieved by concentrating mainly on reaching equilibrium between natural, sustainable systems and the built environment where they occupy. Therefore, sustainable development’s goals are concerned with an environmental protection. The overall goal of sustainable development is only achievable through the integration and acknowledgment of economic, environmental, and social concerns throughout the decision making process.

3. Aspects of Sustainable Development

Technical detail that it is necessary to include, but that interrupts the flow of the article, may be consigned to an appendix. Sustainable development has three aspects; economic, social, and environmental as shown in Figure 3. Effective planning for sustainable future could only be achieved through a collaboration of experts from different disciplines including environmental science, technology, economic science, social science and ethics.

![Figure 3. Aspects of sustainable development.](image)

3.1. Social aspect

“The social dimension of sustainability encompasses the political, the cultural and all people-centered issues, except the economic that ensures the basic conditions for human life to flourish within society” [15]. These include food, shelter, clothing, healthcare, education, social interaction, sense of belonging, and spiritual enrichment. These conditions cannot be met without a healthy, economic and sustainable natural environment.

3.2. Environmental aspect

The ecological footprint of neighbourhoods in terms of resource use and pollution rates is high, and it continues to grow in certain respects and ought to be reduced. Waste production and recycling, water consumption and pollution, air quality and energy use, and biodiversity are related to the ecologic sustainability of any development [10].

3.3. Economic aspect

Issues related to that aspect are those of the Economic growth and economic diversity. Employment rates, individual income, transportation expenditures, and personal consumption are all essential to form the economic sustainability of any settlement. The economic aspect of sustainability needs local political commitment and effective partnership community, public and private sector [10].
4. Sustainable Development Objectives
There are five objectives providing support for sustainable development as shown in Figure 4, and they are [10]:

![Sustainable Development Objectives Diagram]

**Figure 4.** Sustainable development objectives.

4.1. *Improving our quality of life and well-being*
For enhancing wealth creation by the diversity of local entrepreneurial opportunities, recycling the financial resources locally and promoting urban regeneration and renewal. It is altogether in an excellent relationship with improving the safety and security of the community, enhancing its freedom of choice, and increasing the decision-making.

4.2. *Promoting equity*
Equity is a primary aim of sustainable development. The sustainable development reflects a desire to consider the impacts that our current decisions could have on future generations, called intergenerational equity.

4.3. *Sustaining our natural resources, communities and industries*
It could be achieved through improving the environmental quality and safeguarding the natural resources by using them in an efficient way, and being recognized as environmentally responsible. It would help people to interact with the environment in a sustainable way of life.

4.4. *Protecting the health of humans*
Public health is not just a matter of hospitals and health centres: amongst other influences, the planning and design of a community has a vital role. Some health problems rely on factors such as healthy exercise, air and water quality, fresh food, and local social networks, all of which are dependent on the health of the environment as a whole.

4.5. *Meeting our international obligations*
That is for catching up with the global family of healthy communities, meeting the standards of their environmental safety and social equity together with the promotion of our own community's prosperity.

5. Green building
Green building is also known as a sustainable or high performance building. While the definition of what constitutes a green building is constantly evolving, the Office of the Federal Environmental Executive offers a useful working definition. This agency defines this term as “the practice of
increasing the efficiency with which buildings and their sites use energy, water, and materials; and reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal the complete building life cycle” [13].

Similarly, the Environmental Protection Agency (EPA) defines green building as follows; “The practice of creating structures and using processes that is environmentally responsible and resource-efficient throughout a building’s life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the building design concerns of economy, utility, durability, and comfort” [13].

Both of these definitions mention life cycle assessment. It is the investigation and valuation of the environmental, economic, and social impacts of a product or service. In the context of green buildings, life cycle assessment evaluates building materials over the course of their entire lives. It takes into account a full range of environmental impacts, including a material’s embodied energy; the solid waste; the air and water pollution associated with it; and its global-warming potential. Life cycle assessment is an important tool because it can demonstrate whether a product used in a green building is truly green [16].

5.1. History of Green Building
The concepts of building green and, on a larger scale, sustainability are ideas that we hear all of the time. These two concepts, however, are rarely properly understood. Sustainability is a systemic concept, relating to the continuity of economic, social, institutional and environmental aspects of human society, as well as the non-human environment.

It is intended to be a means of configuring civilization and human activity so that society, its members and its economies are able to meet their needs and express their greatest potential in the present, while preserving biodiversity and natural ecosystems, and planning and acting for the ability to maintain these ideals for a very long time. Sustainability affects every level of organization, from the local neighbourhood to the entire planet. Thus, the concept of sustainability refers to thinking holistically about how everything you do affects everything around you. It is an attempt to minimize each person’s impact on the world.

Today, green building is one of the fastest growing building and design concepts. Architects, designers, and homeowners are becoming infatuated with the cost saving possibilities, energy saving emphasis, modern look, and the symbiotic relationship with nature that green buildings possess. The United States Green Build Council (USGBC) is the foremost leader and educator within the world of green building today. They are the sanctioning body for LEED, the program with which points are awarded to various design applications within a building ultimately resulting in LEED certification for the building.

5.2. Making buildings green
The beginning of the twenty-first century has ushered in the era of green buildings. In contrast to conventional buildings, green buildings seek to use land and energy efficiently, conserve water and other resources, improve indoor and outdoor air quality, and increase the use of recycled and renewable materials. While green buildings still constitute a tiny subset of existing buildings, their numbers are increasing rapidly.

In November 2006, the U.S. Green Building Council, the non-profit group responsible for the creation of the Leadership in Energy and Environmental Design (LEED) green building rating system, announced that 623 buildings had achieved some level of LEED certification [18]. As of December 2009 this number had grown to more than 2,400, and over 35,000 buildings were in the process of achieving some level of LEED certification [17].
6. Global Rating Systems for Sustainable Buildings

Rating systems have been developed to measure the sustainability level of Green Buildings and provide best-practice experience in their highest certification level. With the given benchmarks, the design, construction and operation of sustainable buildings will be certified. Using several criteria compiled in guidelines and checklists, building owners and operators are given a comprehensive measurable impact on their buildings’ performance.

The criteria either only cover aspects of the building approach to sustainability, like energy efficiency, or they cover the comparison of different rating systems for sustainable buildings whole building approach as shown in Figure 5. It could be covered by identifying performance in key areas like sustainable site development, human and environmental health, water savings, materials selection, indoor environmental quality, social aspects and economical quality [2].

Furthermore, the purpose of rating systems is to certify the different aspects of sustainable development during the planning and construction stages. The certification process means quality assurance for building owners and users. Important criteria for successful assessments are convenience, usability and adequate effort during the different stages of the design process. The result of the assessment should be easy to communicate and should be showing transparent derivation and reliability.

6.1. Structure of rating systems

The different aspects are sorted in overall categories, like ecology, economy and social demands triple bottom line. For each aspect, one or more benchmarks exist, which need to be verified in order to meet requirements or obtain points. Depending on the method used, individual points are either added up or initially weighted and then summed up to obtain the final result. The number of points is ranked in the rating scale, which is divided into different levels: The higher the number of points, the better the certification.

6.2. The built environment and problem of the existing buildings

Although green buildings represent the next phase of buildings, the reality is that the vast majority of buildings are not green, and these buildings will continue to be used for many years to come. Improving the energy efficiency of existing buildings typically involves a process called retrofitting, which can mean anything from installing more energy-efficient fixtures to increasing the amount of insulation in a building.

The U.S. Green Building Council has a rating standard specifically focused on existing buildings, referred to as LEED-EBOM (EBOM stands for “existing buildings operation and maintenance”) [4]. While greenin g existing buildings does not receive the attention that new green buildings do, it is certainly more important when looking at reducing the environmental impacts of buildings nationwide.

6.3. Impacts of rectified conventional buildings towards green buildings

The environmental impacts of buildings are enormous. Conventional buildings use large amounts of energy, land, water, and raw materials for their construction and operation. They are responsible for large greenhouse gas emissions as well as emissions of other harmful air pollutants. They also generate large amounts of construction and demolition waste and have serious impacts on plants and wildlife. An analysis of these issues demonstrates the scope of the problem [4].

These are some impacts that green buildings seek to rectify such as; energy use in buildings, greenhouse gas emissions, indoor air pollution, building water use, land use and consumption, construction materials, construction, operation, and demolition waste [4].
6.4. Energy performance directive

An important building certification, incorporated by the EU, is the Energy Performance Certificate. They developed the prototype of the federally uniform Energy Performance Certificate. The certificate has been legally compulsory since 2007 as a result of the energy saving regulation which is a part of the EU building laws.

For example in Germany, Energy Saving Regulation defines maximum values for primary energy demand and the heat loss by transmission for residential and non-residential buildings. The maximum value depends on the type and use of the building. The maximum value for modernization in general lies 40% below the values of new construction.

![Figure 5. Comparison of different rating systems for sustainable buildings](image-url)
Energy balancing comprises beyond heat loss of transmission heat input of solar radiation, internal heat input, heat loss of distribution, storage and transfer inside the building as well as the energy loss by the energy source through primary production, transformation and transport.

Green Building is a European program setting target values 25% or 50% below compulsory primary energy demands. Its focus is especially on buildings with non-residential use, like office buildings, schools, swimming pools and industrial buildings as shown in Figure 6 [2].

6.5. The green pyramid rating system

There is expanding proof that owners, investing specialists and public society are beginning to put a premium on certified green buildings. Because of the requirement for an Egyptian green building assessment system, and with the advantage of the encounters of early-adopters in different nations, the Housing and Building National Research Centre has produced The Green Pyramid Rating System (GPRS).

The Green Pyramid Rating System is a national ecological rating system for buildings. It gives authoritative criteria by which the environmental accreditations of buildings can be assessed, and the buildings themselves can be evaluated. Furthermore, the System should help building designers, constructors and developers to settle on contemplated decisions in view of the environmental effect of their decisions [7].

The Green Pyramid Rating System is intended for utilize in new building works. The Rating can be utilized to assess individual new buildings at either or both of the design stage and post-construction stage.

The main goals of the Green Pyramid Rating System are [7]:

- Supplying a benchmark to evaluate buildings in Egypt for their green accreditations through a straightforward ecological rating system.
- Empowering building designers, constructors and developers to settle on contemplated decisions in view of the ecological effect of their decisions.
- Fortifying the awareness and demand for sustainable green buildings.
- Contributing to more extensive discussions on Green Building in Egypt.
- Supporting the design and development of sustainable green buildings, and contribute altogether to a superior and more sustainable building.
7. Concluding Summary
Sustainability is progressively turning into a key thought of building professionals, approach creators, and industry alike since the globe is moving towards zero-vitality construction. At the point when buildings have net zero energy consumption, the impact of encapsulated energy and greenhouse gas emissions end up plainly vital.

A zero energy building can be produced with various materials and construction techniques that make diverse total carbon footprint. Renewable materials can have low or negative carbon impression. In this way, the use of sustainable renewable materials, in all parts of human presence gives off an impression of being the best approach to upgrade the utilization of assets and to diminish the ecological impact related with humankind's activities.

Regularly, the utilization of sustainable materials brings about lower emissions and along these lines a lower environmental impact. Be that as it may, to accomplish sustainable advancement, certain criteria inside a structure of economic, environmental and social frameworks must be taken after. Just compelling utilization of sustainable materials through the entire esteem anchor and handling innovations to new end-utilize ideas, can prompt sustainable development.

Accordingly, research, advancement and innovation which are concerned with green buildings should concentrate on the environmental analysis in all product stages, from essential preparing and use to disposal, and coordinate knowledge and experience from different disciplines. The activities ought to be arranged towards new product advancement from renewable materials into green buildings.

8. Recommendations
Through the previous conclusion and analysis over sustainable development practices and green buildings, there are some recommendations to be taken into considerations;

- Enhancing the vision of sustainable development through board discourses, dialogs, and programs over digital media.
- Encouraging movement towards the sustainable advancement over the institutional limit which is considered as noteworthy aspect.
- Masterminding the sustainable development and its diverse aspects throughout distinctive projects for raising awareness.
- Sustainable development programmers must be locally pertinent and socially fitting, reflecting the environmental, economic, and social states of the society and nation.
- Providing the procedures of public participation over the community into sustainable advancement.
- Several benefits of tangible sustainable development could be conducted from updated and broadcast communications frameworks.

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