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Economic Feasibility of Sustainable Architecture

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Abstract:

This study aims to highlight the economic feasibility of sustainable architecture. Sustainable architecture refers to a method of designing which reduces the harm on the environment. The construction sector is responsible for over a third of CO_2 emissions, consequently, essential to embrace sustainability in this sector to fight against climate change. By using secondary data sources in relation to the Life-Cycle Costing (LCC), Return On Investment (ROI), and occupant productivity and health sustainable buildings will be compared to conventional buildings. The research on the said topic led to the deliberation that over the lifecycle of a sustainable building the cost borne will be lesser than traditional buildings due to lower operational costs, higher property and rental rates, and better occupant productivity and health. The research suggested that the ROI of sustainable constructions will be 14% more than conventional ones. The research also highlights the need for government policies to foster a culture of sustainability. This is not limited to the use of legislation, financial and structural incentives, and training programs.

Keywords: Economic Feasibility, Sustainable Architecture

Introduction:

(“8 Sustainably Designed Green Buildings in Singapore", Sholeen Damarwala)

The word ‘sustainability’ seems to be echoing across the concrete jungles that we live in today. Unsurprisingly, it has also spread into the world of architecture. In fact, the building and construction sector accounted for 37% of energy and process-related CO_2 emissions in 2021 [19] hence, propelling sustainable architecture as a core concept for the future. So, what is sustainable architecture? Green Architecture or sustainable architecture is a method of designing which curtails the negative environmental impact by focusing on natural resource preservation, addressing user needs, and enhancing quality of life. Energy and resources are wisely used with great emphasis on renewable and clean energy systems [12].

Consequently, it might be expected that sustainable buildings already are a prominent part of today's infrastructure. However, it's quite the contrary. As it stands, only 1% of all buildings can be deemed 'sustainable'[3]. Why is this so? Buildings with sustainable architecture tend to be approximately 2% more expensive [23] to construct than conventional building designs, this acts as a repelling factor when it comes to the building's construction. This leads us to the main problem of green architecture and construction, it's cost.

While green architecture might be the way ahead due to its environmental benefits, is it economically feasible to convert all buildings and construct all new buildings using this framework by 2050, the deadline set by the signers of the 'Paris Agreement'[14][3]? What steps can world governments take to ensure that builders want to build sustainable buildings and not GHG emitting and high-energy consuming conventional buildings that are lighter on their pockets?

Through this research paper, the economic feasibility of sustainable architecture is to be discussed. This analysis will be done by studying case studies and examining research that use metrics such as lifecycle costing and potential return on investment (ROI). The research conducted will prove that the higher short-term cost will be mitigated by the lower long-term costs of sustainable buildings due to a combination of factors that include more energy-efficient materials, increased energy efficiency and sustainability, water conservation strategies and sustainable materials. Furthermore, the research will also showcase that sustainable buildings will have greater property values, higher occupant productivity and higher rental rates than conventional buildings to further incentivize constructors. Lastly, by putting forward potential courses of action for the world governments the research will also mention the ways in which the initial costs of construction can also be lowered to ensure that sustainable buildings are not only environmentally sustainable but also economically viable for all stakeholders.

Research Objectives:

1. To understand the lifecycle costing of conventional versus sustainable buildings.
2. To quantify the long-term costs of using sustainable systems in building design.
3. To evaluate how sustainable building certifications such as LEED and BREEAM affect the property value and rental costs

4. To decipher correlation between sustainable buildings and occupant productivity and well-being.
5. To give policy suggestions to further incentivize sustainable building construction.

Research Methodology:

1. Literature Review: Will be secondary data based, hence, conduct literature review to develop comprehensive knowledge of sustainable architecture practices. Also, conduct economic analysis of sustainable buildings.
2. Case Study Analysis: Compile examples of various building types [schools, office complexes, residencies, etc. (Both sustainable and conventional buildings)] and collect data relevant to the topic. Primarily will include initial cost of construction, life-cycling coting, ROI, and sustainable practices.
3. Data Analysis: To find potential relationships and correlations between two subjects. For example, between the building sustainability index and the occupant productivity. Then create graphs to display this gathered information concisely.
4. Policy Analysis: To evaluate current government policies by different countries regarding sustainable architecture and building construction and their current implications. Conduct research and consult experts for suggestions on potential policies that can aid the adoption of sustainable buildings to a greater extent.

Research Analysis:

Life-cycle costing:

Life-cycle costing (LCC) or Life-cycle costing analysis (LCCA) is a method used to estimate the total cost of ownership of an entity. In this scenario, it refers to the total costs associated with constructing the buildings, operating the buildings, maintaining the building and also the potential costs associated with decommissioning the building from usage. [20]

The initial construction costs include (but are not limited to) land acquisition, site preparation, building permits and approval, architectural and engineering, labour, material, equipment, and insurance. The operational costs go in utility, taxes, insurance, maintenance and security. To add onto these costs, the building's demolition needs to be also considered, hence, the fourth phase the life cycle costing of buildings include is end of life. This includes the cost of demolition, waste disposal of the materials, and site remediation.

Consequently, LCC is a great analysis tool to evaluate financial viability of a building project due to its comprehensive list of various costs it considers. This makes it one of the most suitable analysis techniques to compare the total cost of two buildings with similar dimensions and amenities. Due to these reasons, LCC is integral to our analysis of understanding the economic feasibility of sustainable buildings when compared against conventional buildings.

Stakeholders, specifically clients fall under a false pretence that buildings with sustainable architecture are 'more expensive' than conventional buildings. This, however, cannot be further from the truth. While the initial costs of construction may be higher than conventional buildings, over the life cycle of a construction with sustainable architecture this initial price becomes a small sacrifice to pay post the construction process. This reduced long run cost is a resultant of better optimized energy systems leading to reduced utility bills, better insulation resulting in reduced need for air-conditioning & heating, and better materials reducing need for maintenance. Solar panels, Low-e glass, LED lighting, and Mechanical Ventilation Heat Recovery system (MVHR) are some common installations in buildings with sustainable architecture. A study by HP Virtual Booth [23] found out that the operational costs of sustainable buildings are approximately 14-19% lesser than conventional buildings. To break this down further, 25-50% of energy can be saved by green buildings on an annual basis, maintenance costs can be 12% lesser and water consumption can be minimized by up to 40% [10]. The usage of the WINT water system (IoT based system that uses artificial intelligence to detect leaks and water waste giving real-time data for users to make informed decisions.) in the empire state building resulted in cost-saving of USD 100,000 on a yearly basis coupled with reducing carbon emissions by over 300 metric tons. [10]

Furthermore, it is not as if the short-term costs of such buildings with a sustainable stature are considerably more than conventional buildings. The initial costs only vary in a higher architectural & engineering fee, a higher material & equipment fee, and higher insurance costs for sustainable buildings. This in total only accounts for a 2% more construction cost as made evident by the same study by HP Virtual booth [23]. Other sources such as ET Insights [13] have suggested a 3-5% premium in initial costs for sustainable buildings in India, however, still suggesting that these higher construction costs are offset in the long run due to operational savings as previously discussed. As an example, the Infosys campus in Hyderabad has reported a 40% reduction in energy costs due to sustainable building practices [13].

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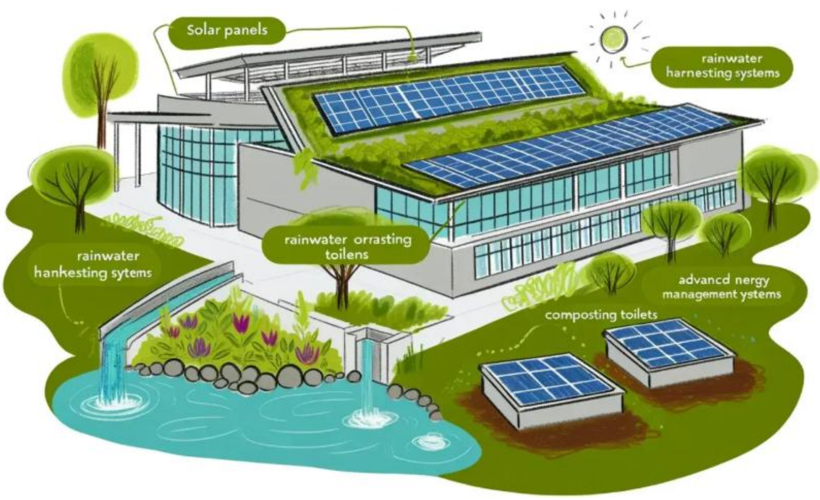
The Bullitt Center, Seattle, USA is an example of a Net-carbon zero building that was a product of sustainable-green architecture. The 6-storey, 50,000 square foot building had an upfront cost of USD 30 million, more than other similar buildings in the area due to its sustainable design and architecture [16]. The building had multiple layers, a '50-year skin' to increase insulation, a 50,000 Gallon cistern to hold rainwater, greywater treatment on site, natural ventilation, heat recovery energy system, 100% renewable energy sources on site, energy cap and trading for occupants and more [15]. This enabled the building to increase its energy efficiency by 77% to compared to an average Seattle office building (EUI = 72 kBTU/sf year) consequently achieving net-carbon zero [15] and also offsetting the initial additional cost in 10 years' time [25], in this case offset in the year 2023. This example proves that if the necessary sustainability steps were put in places effectively the additional cost of sustainable buildings can be mitigated in a short duration (10 years) when put against a buildings life which would be over 100 years.



("Sustainable Building Case Study: The Bullitt Center, Seattle")

ROI, Property Value and Rental Costs:

Return On Investment (ROI) is a financial metric which is used as an evaluative tool in comparing the gain or loss relative to its cost. Consequently, it can be used to compare potential returns of various investments. A higher ROI signals more profitable investments while a lower ROI means the investment will have a comparatively lesser return.

In context of sustainable architecture, ROI is dependent on operational costs, property value, rental rates, and governmental incentives.

As established, operational costs of sustainable buildings are approximately 14-19% [23] lesser than conventional buildings. Property values and rental costs tend to be also higher for 'certified' green buildings. Certifications prove that the building is in fact 'green' and meet global sustainability standards. This can give clients the assurance that their buildings will in fact have lower operational costs as promised, meet the ESG criteria, and boost their brand image as they tackle a global problem, climate change. Two notable 'green architecture' certifications are 'LEED' (Leadership in Energy and Environmental Design) and 'BREEAM' (Building Research Establishment Environmental Assessment Method). Studies suggest that buildings certified by LEED tend to see an increase in their property value by 10% in the USA [25] and high as 20% in India when compared to traditional buildings [13]. Rental costs are also higher for the same reasons. In 8 North America cities leases for certified green buildings are 7% higher than non-certified buildings, approximately 10% higher in 9 cities in Asia and over 11% in London, UK [6]. All in all, his showcases that building certifications LEED and BREEAM have a positive relationship with the property cost and rental rates. Furthermore, results in a higher ROI for sustainable buildings when stacked up against conventional ones. According to 'WINT' [10] sustainable buildings have a payback period of as little as 3-5 years and a ROI of up to 40% over the building's lifetime due to the factors discussed about earlier. Another study by CIM [5] states that the ROI of these sustainable buildings is 14% more than buildings that are not sustainable. This showcases buildings with sustainable architecture will have greater economic upsides than conventional buildings.

Occupant productivity and well-being:

Sustainable buildings also have indirect economic benefits in the form of occupant productivity and better health. As these two things increases the economic benefits too increase. Based on research by NewSchool of Architecture & Design [7], ET insights [13], Sehgal Foundation [1], and the Zigurat Institute Of Technology [9] green buildings have a tendency to have better indoor air quality, greater natural light, controlled acoustics, improved temperature control, strong ventilation and the use of non-toxic paint when compared to conventional non-certified buildings.

The publishment of Zigurat Institute Of Technology [9] refers to a study conducted by the Harvard T.H. Chan School of Public Health which put forwards that employees who work in well-ventilated sustainable constructions scored 61% more in cognitive function tests when compared to employees who work in traditional office settings.

Furthermore, research [7] has suggested that these improvements in air quality, lighting, sound, and materials have also resulted in significant improvements in health of working individuals along with lesser stress and an overall improved quality of life. In turn, this improves the ability of an individual to have a greater economic impact due to higher productivity as mentioned in the study by ET Insights [13] and also by the Sehgal foundation [1]. The same study by the

Sehgal foundation [1] emphasizes that improved exposure to daylight results in an approximate 18% increase in productivity while productivity gains from ventilation is around the 11% mark. This strengthens the importance of sustainable architecture in building construction.

Government Policies:

As made evident by the points mentioned earlier, sustainable buildings are the future. Consequently, it is essential that the construction of these buildings is not stopped by any external factor. A study by the World Economic Forum [6] found that only 34% of projected demand for sustainable corporate buildings will be met in the next few years across 20 different global markets. This translated to only 1 in every 3 sustainable building demanded to be constructed. The unmet demand of these ‘green’ corporate building varies significantly city to city, with New York City having 65% unmet demand while Sydney is over 80%. This highlights that the problem of increasing the number of sustainable buildings is a supply-related issue. Therefore, governments should majorly target supply-side policies to cater to this problem.

The first step should be to reduce the burden of the initial investment costs of sustainable buildings. The higher initial investment cost is the main reason why constructors do not prefer to build ‘green’ buildings. Hence, imposing subsidies on sustainable construction materials can be an essential change. Furthermore, governments can also subsidise the renewable energy installation costs for the building to help in incentivizing renewable energy and a green future. Financial incentives can also expand to tax breaks and reduced interest rates on loans. For this to be carried out efficiently it will be crucial for governments to allocate a certain amount of money in their official budget itself. Few examples are the allocation of SDG 63 million as part of the Green Mark Incentive Scheme from June 30, 2022, to March 31, 2027 in Singapore [17]. The United States of America has seen the infusion of USD 370 billion worth of tax incentives, loans, and grants to improve energy efficiency and climate resiliency through the passing of the Infrastructure Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA) [17]. Additionally, this highlights the importance of strong legislation along with financial incentives to create substantial change. Legislation being critical to success can also be seen in Singapore’s philosophy of enabling a green revolution. Apart from the financial incentives, a new legislation by the government of Singapore mandates that new constructions and existing buildings undergoing significant retrofitting adhere to a specified minimum standard of environmental sustainability. Specifically, this refers to the Singapore Green Building Masterplan (SGBMP) which says that 80% of new developments (by Gross Floor Area) are mandated to be Super Low Energy (SLE) buildings from 2030 onwards. These new constructions will achieve an approximate 60% higher energy efficiency compared to the 2005 standards. "Such government intervention — in the form of a carrot-and-stick approach using a combination of incentives and legislation — is critical to accelerating the transition to net-zero carbon" was the response of Andrew Macpherson, Head of Asset Development, Asia Pacific, JLL when commenting on the above discussed legislation [17].

Incentives should not only be limited to direct financial incentives but also can be expanded to structural incentives. Structural incentives help to simplify construction processes and improve cost-efficiency. Some examples can be a density bonus or Increased Floor Area Ratios (FAR) which allows builders to construct additional floors beyond the usual limit for conventional buildings and can consequently translate into increased revenue potential for building owners. Also, an expedited permitting process for sustainable- certified buildings like LEED accredited buildings can be instated to streamline the construction process by reducing bureaucratic delays. Notable examples include San Borja 623-MSB and Miraflores 539-2020, which offer incentives like height bonuses and flexibility in urban parameters for buildings certified under green standards such as LEED, EDGE, or BREEAM [17].

Furthermore, governments can start programs that help train individuals in the sustainable architecture and construction sector to bolster the number of individuals who can successfully design 'green' buildings. This will also indirectly reduce the cost of skilled labour like architects and structural engineers who are LEED accredited as there will be more such individuals in the market, consequently incentivizing further construction of sustainable buildings. New York's Accelerator program is one such example. It provides free technical assistance to over 9,000 buildings. This program enables constructors to receive assistance with regard to not only NYC zoning and building laws but also information regarding financial incentives, sustainable service providers and technical assistance about new energy technology and sustainable systems through constant online training services [17].

Lastly, governments should lead from the front and by example. They should ensure all new public buildings and complexes are 'green', this could be shown by gaining LEED, BREEAM, and other such certifications. Public constructions should not harm the environment but embrace it.

Conclusion:

To conclude, sustainable architecture and construction is not just economically feasible but the most practical option as over the building's lifecycle it will have a greater monetary return than conventional buildings. This is a result of reduced operational costs estimated to be between 14-19% [23] lesser than traditional buildings, higher ROI by an approximated 14% [10] due to greater property values and rental costs, and further increased economic return due to better occupant productivity and health.

Therefore, sustainable buildings are the future as they save the environment while also reducing economic costs. Additionally, as carbon emissions will be minimized due to increased sustainability, the costs borne by individuals, governments, and firms related to climate action will also eventually reduce, which is an economic upside. Hence, sustainable buildings need to be the common trend in tomorrow's world. Through a combination of strong legislation, financial incentives, structural incentives, and training programs we can see sustainable buildings grow in number and additionally also reduce their upfront costs.

As a concluding note, 'green' buildings do not just reduce environmental impact but also help foster a circular economy which revolves around the concept of reduce, reuse and recycle. It is more than just a building, it's a movement that will revolutionize sustainability in both the environmental, and economic sense.

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