Design in Context: Ecology, Economics and Politics

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Abstract: This dissertation investigates the sustainability of architectural service platforms in the context of ecology, economics, and politics. Focusing on two iconic buildings, the Bahrain World Trade Centre and Powerhouse Telemark, the study examines their ecological, economic, and political contributions to sustainable development. The Bahrain World Trade Centre, featuring innovative wind turbines and environmentally conscious design, demonstrates ecological sustainability. It effectively reduces solar radiation, employs district cooling systems, and utilizes renewable energy sources. The economic sustainability of the Bahrain World Trade Centre is evident through efficient wind turbines, which produce electricity and minimize operational costs. The government's endorsement and the project's environmental design reflect political sustainability. On the other hand, Powerhouse Telemark showcases its ecological sustainability through material selection, energy-efficient lighting, and solar energy utilization. This case also exemplifies economic sustainability by reducing electricity consumption and generating surplus solar energy. The building's political sustainability is evident through its contribution to the local community and its alignment with regional renewable energy goals. By comparing the two cases, this dissertation provides insights into the role of technology, architectural materials, and renewable energy sources in achieving sustainability across ecological, economic, and political dimensions.

Keywords: Ecological Sustainability; Environmental Design; Sustainable Architecture; Sustainable Development; Economic Sustainability

Introduction

Under the premise of delivering human services and needs, sustainable service and product system must not harm or damage the environment; it may also govern human behavior and increase environmental safety awareness. It seeks to produce a cohesive and harmonious growth of the economy, resources, society, and environment. On the flip side, all actions must take future effects into account and minimize them for the sake of future generations (Lee et al., 2021). As the globe places a greater emphasis on sustainable development, several sectors seek dependable sustainable development strategies, especially construction firms. Due to the use of numerous heavy metal compounds and other chemical substances, construction items' manufacture, recycling, and disposal pose a significant risk to human and environmental safety (Hu et al., 2020). The Bahrain World Trade Centre and Powerhouse Telemark assert that their architectural service platforms are sustainable. This study evaluates and proves the sustainability of these two buildings and identifies their ecological, economic, or political benefits and drawbacks.

The Bahrain World Trade Centre

Figure 1: The Bahrain World Trade Centre

The Bahrain World Trade Centre (WTC), a pair of 50-story buildings in the shape of sails that are situated on the King Faisal Highway in Manama, is the first skyscraper in the whole world to be built with wind turbines to aid with electricity consumption reduction.(Afsari & Sarat). The Bahrain World Trade Center, designed by architect Atkins, earned multiple honors for incorporating renewable energy into the design of its massive skyscraper, including the 2009 NOVA Award in Innovation for using technology to enhance quality and lower construction costs. In 2007, the WTC earned the EDIE Award for Environmental Excellence, in 2006 the LEAF Award for Best Use of Technology in a Large Scheme, and in 2008 the Best Tall Building Award, Mena Region. (Ahmed, 2021). Atkins received the Building Design Awards' Architect of the Year 2008 honor for the Bahrain World Trade Center.

Ecological Sustainability

The building of this architectural design was motivated primarily by the desire to improve ecological sustainability. The Bahrain World Trade Center (WTC) earned the 2009 NOVA Award in Innovation for using technology to raise standards. The Bahrain World Trade Center was built with consideration for the ecological environment. Excessive solar radiation can create high temperatures or drought. (Yu et al., 2009). The designer seeks to reduce the solar radiation on the building, and sufficient buffer spaces have been added between the outside environment and air-conditioned areas. Low solar gain results from two parking decks above and on the southern side of the structure, reducing solar air temperature (Subramanian et al., 2021). Deep gravel roofs with kinetic insulation are an additional alternative. The air temperature of the structure is decreased by using additional premium solar glasses with a low shading coefficient. The sloping façade with overhanging balconies also provides a moderate amount of shade. The opaque fabric elements of the building provide better insulation.

/With a high energy conversion efficiency that contributes to low carbon emissions, the district cooling system used by Atkins uses seawater for cooling and heating rejection. Besides, the building's low-leakage, operable windows help the mixed-mode operation throughout the winter. The solid concrete core and floor slabs in the building balance the load and reduce peak demand, thus minimizing the utilization of the chilled water and air transport systems. Pumping chilled water at a variable volume uses less energy than traditional pumping (Szolomicki et al., 2019). By using solar energy to generate electricity instead of fossil fuels, glasshouse gas emissions, especially carbon dioxide, may be significantly reduced ($CO2$). (Mercer et al., 2011). This engagement of architecture with ecology represents a continuation of architecture's historical relationship with nature. (Lassen et al., 2021). The building has several other eco-friendly components that help it be more environmentally responsible by reducing carbon emissions. Among these components are the connection of district cooling systems, the recycling of water, the use of insulation materials, airtight windows, and insulated glazing made of low solar radiation materials.

Economic Sustainability

Typically, economic sustainability means minimizing the waste of critical economic resources. The sail-shaped towers that will direct the sea breeze into the three enormous wind turbines were designed and built by Shaun Killa, the chief architect of Atkins. Three sky bridges that link the two towers support the turbines. The airflow between them is funneled and accelerated by them, acting as aerofoils. When paired with the increasing speed of the onshore breeze at higher altitudes, the vertical shaping of the towers also gradually lowers the pressure, resulting in a nearly equal regime of wind velocity on each turbine (Zuo et al., 2012). The elliptical towers accelerate and funnel the airflow between them by acting as aerofoils. The turbines work 50% of the time, producing between 1,100MWh and 1,300MWh annually, and provide between 11 percent and 15 percent of the building's electrical demands(Smith & Killa, 2007).

This is the first time wind turbines have been successfully installed on a massive scale inside a structure. In the past, the problem was the high cost of creating turbines, which could be as high as 30% of the construction cost. Because more commercially available technology was used for the turbines in this project, expenditures have only accounted for around 3.5 percent of the overall project cost. Arabian wind towers served as inspiration for the Bahrain World Trade Center's architecture (Zhigulina & Ponomarenko, 2018). By creating a precedent, the BWTC demonstrates that it can integrate wind turbines into built environments. In an obvious fashion, it puts environmental design at the front of customers' and designers' priorities and should spur more environmentally friendly construction throughout the globe. This project establishes a standard for other projects, and the cost of the wind turbine technology is not exorbitant.

Political Sustainability

Political sustainability is the capacity to satisfy the social requirements of the present generation without depleting future generations' resources. The BWTC can power 11–15 percent of the office tower's electrical requirements using wind energy generated by three turbines, which is about comparable to lighting 200–250 households for a full year.(Smith & Killa, 2007). The Bahraini government is constantly working on expanding the use of renewable energy in the nation's energy mix. By 2030, it wants to generate 5% of the power used in the nation from renewable sources (Shuang, 2019). As a representative of sustainable and energy-efficient buildings, BWTC has played an active role in globally sustainable design awareness with the response of governments and designers.

Powerhouse Telemark

The Powerhouse Telemark, an 11-story office skyscraper with a diamond shape, is situated close to the Skeins river. The structure will mostly be home offices, however it will also have a cantina, conference rooms, and smaller meeting spaces. It will feature an 8000 m2 heated floor space. To optimise the amount of solar radiation reaching the photovoltaic (PV) modules put on the roof, the building's roof is angled southward at a 24-degree inclination. The south-facing façade is also completely covered with a building integrated PV system. (Tapper & Dokka, 2019). By receiving the BREEAM Excellent accreditation as proof of their ambitious sustainability goals, Powerhouses are shining examples of environmental sustainability in their local communities and serve as models for how the rest of the world could adopt sustainable architecture and design in the future.

Figure 2: Powerhouse Telemark

Ecological Sustainability

Recycled materials from the wood and other sectors, such as plastic and rubber, have recently been employed as raw materials. (Mercer et al., 2011). The Powerhouse Telemark's material selection was made with the environment in mind. The structure is made of sturdy materials with minimal embodied energy and resilience. This means using materials such as local wood, plaster, and eco-friendly concrete that are sustainable and untreated. The carpet tiles and furniture are made up of high-quality, long-lasting materials. 70% of the carpet tiles are made up of recycled fishing nets (Tapper & Dokka, 2019). In addition, solid wood flooring is sustainable wood flooring made from wood waste. Furthermore, a mainly developed foliating signage system allows some flexibility in adapting the visual expression of the various office spaces without generating needless waste that may be generated when brand-specific signage has been removed or made. Besides, the structure seems to have an outstanding rooftop.. The entire roof slopes at an extensive inclination angle, and the top of the building expand the roof's surface to ensure that the maximum amount of light can shine on the photovoltaic roof through natural light, thus receiving solar energy to generate electricity.

Economic Sustainability

In the case of lighting inside buildings, while lighting products maintain our way of life, they also negatively impact the environment regarding energy and material consumption, harmful emissions, and waste (Casamayor & Su, 2013). To reduce the need for artificial lighting to an absolute minimum and reduce harmful emissions., the building has a conservative but efficient lighting system. Traditional office buildings all have a significant demand for lighting (Tapper & Dokka, 2019). By matching the lighting design to the architects' seating layout, Powerhouse Telemark uses the least amount of electricity for lighting. This ensures that there is enough light where it is needed. For the entire structure, it is estimated that the average annual energy consumption will indeed be 49591 kWh or around 2,3 W/m2. (Tapper & Dokka, 2019). This is achieved by using daylight and motion-activated sensors as well as using the most energy-efficient commercially available LED lighting. The building's roof similarly features vertical glazing slots that allow daylight to penetrate the top floor and increase the amount of light in the interior. There is no doubt that the design is economically sustainable, minimizing energy consumption while achieving spatial sustainability.

Political Sustainability

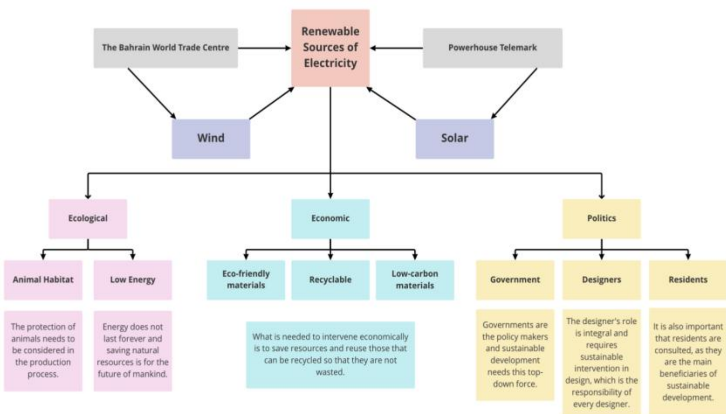
The new 11-story skyscraper in the ancient industrial district of Porsgrunn in the county of Vestfold and Telemark is a symbolic continuation of the district's rich heritage since Telemark is home to one of the most extraordinary hydroelectric power plants in the early nineteenth century (Nilsen, 2014). Powerhouse Telemark reflects the region's expanding investment in the renewable energy industry, establishing the county as either a pioneer in the decarbonizing of new buildings. Both the south-east facade and the entire roof are covered in high-efficiency solar cells. The carport next to the building is also covered in solar cells. The system is planned to provide 243000-kilowatt hours of solar electric energy every year. The extra energy produced during the summer, when the product reaches its peak (210 kW), will be exported to the electrical grid (Tapper & Dokka, 2019). When the energy produced by solar energy reaches saturation, additional energy will be generated. At this point, the excess energy will be fed into the grid, and people will be able to buy electricity from the grid. During the COVID-19 epidemic, the isolation of people in their homes and offices brought about a considerable consumption of electricity (Krarti & Aldubyan, 2021). This design reduced the impact of the power shortage to a large extent. Consequently, the building is politically viable.

Comparison of the Two Products

The designs of the building products discussed in the preceding sections are both increasingly sustainable. Both have substantial capacity for achieving ecological, economic, and political sustainability objectives. However, there are a few differences in their powers in these three settings. Both buildings have higher ecological sustainability capabilities. Both employ renewable energy sources and are constructed with eco-friendly components. Accordingly, they do less damage to the environment. Regarding economic sustainability, The Bahrain World Trade Centre generates more economic benefits per year of electricity generation than Powerhouse Telemark. In terms of political sustainability, the governments of both sites are active in promoting sustainable development. Both buildings have received government intervention and have brought benefits to the local population.

Conclusion

The two cases studied use wind and solar energy to achieve sustainable goals. However, due to weather factors, they also face several limitations, such as a lack of wind power and shortened sunshine hours. In addition, ecological building materials can be used wherever possible. In sum, technology plays an essential role in satisfying sustainability objectives. Combining nature and technology may aid in achieving greater sustainability. Moreover, the combination of two renewable energy sources may contribute to sustainability. The proposed strategic design intervention will be reflected in the final flow chart. (2026 words)



Appendix

References

[1] Afsari, K., & Sarat, S. Rising Trends in Tall Building Design: Environmental Sustainability through Renewable Energy Technologies. British Journal of Civil and Architecture Engineering. Volume 01, Issue 01, August, 2019.

[2] Ahmed, Z. I. (2021, November). Sustainable neighbourhood: A urban improvement strategy for the Kingdom of Bahrain. *In 2021 Third International Sustainability and Resilience Conference: Climate Change* (pp. 445-451). IEEE.

[3] Casamayor, J.L., & Su, D. (2013). Integration of eco-design tools into the development of eco-lighting products. *Journal of Cleaner Production*, 32–42.

[4] Hu, J., Ouyang, T., Wei, W. X., & Cai, J. (2020). How do manufacturing enterprises construct e-commerce platforms for sustainable development? A case study of resource orchestration. *Sustainability*, 12(16), 6640.

[5] Krarti, M., & Aldubyan, M. (2021). Review analysis of COVID-19 impact on electricity demand for residential buildings. *Renewable and Sustainable Energy Review*s, 110888.

[6] Lassen, N., Hegli, T., Dokka, T. H., Løvold, T., Edwards, K., Goia, F., & Andresen, I. (2021). Enabling holistic design for high-energy efficient office buildings through the use of subjective occupant feedback. *Sustainable Cities and Society*, 102867.

[7] Lee, V., Marasini, D., Dong, W., Lee, H. J., & Lee, D. (2021). Comparative study of key supply chain management elements in sustainability reports. *Businesses*, 1(3), 168-195.

[8] Mercer, A. M., Keith, D. W., & Sharp, J. D. (2011). Public understanding of solar radiation management. *Environmental Research Letters*, 4, 044006.

[9] Nilsen, R. (2014). Rural modernisation as national development: The Norwegian case 1900–1950. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography*, 1, 50–58.

[10] Shuang, B. (2019, April 27). Bahrain World Trade Center: The energy-saving skyscraper. CGTN. Available from: https://news.cgtn.com/news/3d3d514d78417a4d34 457a6333566d54/index.html.

[11] Subramanian, K., Chopra, S. S., Cakin, E., Liu, J., & Xu, Z. (2021). Advancing neighbourhood sustainability assessment by accounting for sustainable development goals: A case study of Sha Tin neighbourhood in Hong Kong. *Sustainable Cities and Society*, 66, 102649.

[12] Smith, R. F., & Killa, S. (2007). Bahrain World Trade Center (BWTC): the first large-scale integration of wind turbines in a building. *The Structural Design of Tall and Special Buildings*, 4, 429–439.

[13] Szolomicki, J., & Golasz-Szolomicka, H. (2019). Technological advances and trends in modern high-rise buildings. *Buildings*, 9(9), 193.

[14] Tapper, C.S.F., & Dokka, T.H. (2019). Powerhouse Telemark: A plus energy building with a low exergy heating and cooling system. *IOP Conference Series: Earth and Environmental Science,* 1, 012056.

[15] Yu, B., Liu, H., Wu, J., & Lin, W.-M. (2009). Investigating impacts of urban morphology on spatio-temporal variations of solar radiation with airborne LIDAR data and a solar flux model: a case study of downtown Houston. *International Journal of Remote Sensing*, 17, 4359–4385.

[16] Zhigulina, A. Y., & Ponomarenko, A. M. (2018). Energy efficiency of high-rise buildings. In E3S Web of Conferences (Vol. 33, p. 02003). *EDP Sciences*.

[17] Zuo, J., Read, B., Pullen, S., & Shi, Q. (2012). Achieving carbon neutrality in commercial building developments–Perceptions of the construction industry. *Habitat International,* 36(2), 278-286.