The Impact of Green Buildings on Urban Sustainability and Energy Consumption

Abdul Karim Shajal
PhD Candidate, Urban Studies, Guangxi University of Science and Technology

Abstract

Bike Green buildings have emerged as key contributors to urban sustainability, offering significant potential to drive positive environmental and economic outcomes. This research study explores the multifaceted impact of green buildings on energy consumption and their role in mitigating climate change, enhancing energy efficiency, and fostering a healthier living environment within urban settings. The study examines the following key aspects of their impact: energy efficiency, renewable energy integration, water conservation, sustainable materials, indoor environmental quality, waste management, and mitigation of the urban heat island effect. The research findings reveal that green buildings prioritize energy efficiency through innovative building envelope design, advanced insulation techniques, and optimized heating, ventilation, and air conditioning (HVAC) systems. Implementation of smart lighting controls, occupancy sensors, and energy management systems significantly optimizes energy usage and minimizes wastage. Furthermore, green buildings embrace renewable energy technologies, such as solar panels, wind turbines, and geothermal systems, to offset their energy demand from traditional power grids. This integration of renewable energy sources reduces reliance on fossil fuels and lowers greenhouse gas emissions. Water conservation is another key aspect of green buildings, employing water-efficient fixtures, rainwater harvesting, and greywater recycling systems. These measures conserve water resources, alleviate strain on municipal supply, and foster sustainable water management practices in urban areas. In terms of sustainable materials, green buildings prioritize the use of environmentally friendly construction materials with low embodied energy. Recycled content, responsibly sourced timber, and low VOC paints are employed to reduce environmental impacts. Indoor environmental quality is a paramount concern in green buildings. Incorporating natural daylighting strategies, efficient air filtration systems, and optimal thermal comfort control enhances occupant well-being, productivity, and reduces the risk of indoor pollutants. Waste management practices integrated into green buildings, including recycling facilities, composting systems, and the utilization of recycled materials during construction, minimize waste generation and promote a circular economy approach. Green buildings combat the urban heat island effect through the incorporation of green roofs, vertical gardens, and permeable surfaces. These features mitigate temperature rise in urban areas, improve air quality, and reduce cooling energy demand.

Indexing terms: Green buildings, Urban sustainability, Energy efficiency, Renewable energy integration, Indoor environmental quality

Introduction

Green building, also known as sustainable or eco-friendly building, refers to the practice of designing, constructing, and operating structures in an environmentally responsible and resource-efficient manner. It involves integrating various strategies and technologies that aim to minimize the negative impact of buildings on the environment while optimizing energy efficiency, water conservation, indoor air quality, and overall occupant health and comfort [1]. Green building encompasses a holistic approach that considers the entire life cycle of a building, from its design and construction to its operation and eventual demolition or renovation [2].

One of the key principles of green building is energy efficiency. This involves employing advanced insulation materials, efficient heating, ventilation, and air conditioning (HVAC) systems, and energy-efficient lighting fixtures to reduce energy consumption [3]. Renewable energy technologies such as solar panels and wind turbines can be incorporated to generate clean and sustainable power on-site, further reducing reliance on conventional energy sources. Additionally, green buildings often utilize smart technologies and automated systems to optimize energy usage and monitor performance in real-time [4].

Water conservation is another critical aspect of green building. Through the implementation of water-efficient fixtures such as low-flow toilets and faucets, rainwater harvesting systems, and gray water recycling systems, green buildings significantly reduce water consumption. Efficient irrigation systems and landscaping practices can also minimize water usage for outdoor spaces [5]. Moreover, green buildings prioritize stormwater management techniques, such as permeable pavement and green roofs, which help reduce the burden on municipal stormwater systems and mitigate the risk of urban flooding [6].

Material selection and waste management are fundamental considerations in green building. Sustainable materials with low embodied energy and reduced environmental impact, such as recycled content, rapidly renewable resources, and non-toxic materials, are preferred [7]. Construction waste is minimized through proper planning and implementation of waste reduction strategies, including recycling and salvaging materials. Furthermore, green buildings aim to promote the health and well-being of occupants by ensuring excellent indoor air quality through the use of low-emission materials, proper ventilation systems, and the avoidance of harmful pollutants [8] [9].

Green building also encompasses the concept of sustainable site development. This involves selecting building locations that minimize environmental disruption, preserve ecosystems, and promote alternative transportation options. Site planning strategies include preserving open spaces, incorporating green infrastructure elements like bioswales and retention ponds to manage stormwater runoff, and utilizing native vegetation for landscaping to reduce the need for irrigation and chemical inputs. Additionally, green buildings often prioritize the integration of bicycle parking, pedestrian-friendly pathways, and access to public transportation to encourage sustainable commuting practices and reduce carbon emissions associated with transportation [10].

An eco-friendly commercial building in a city center refers to a sustainable and environmentally conscious structure designed specifically for commercial purposes, such as offices, retail spaces, or mixed-use developments. These buildings incorporate a range of design features that contribute to their eco-friendliness [7]. For instance, they prioritize the efficient use of space by employing open floor plans and flexible layouts that maximize natural light penetration and reduce the need for artificial lighting during daylight hours. Additionally, eco-friendly commercial buildings often integrate green roofs or rooftop gardens, which provide multiple benefits such as insulation, stormwater management, and urban heat island mitigation [11].

Energy-efficient systems play a crucial role in eco-friendly commercial buildings. They utilize advanced technologies to minimize energy consumption and reduce carbon emissions. These systems include high-efficiency HVAC systems that incorporate variable refrigerant flow (VRF) technology, energy recovery ventilation, and smart controls to optimize temperature regulation and indoor air quality. Lighting systems employ energy-efficient LED fixtures combined with occupancy sensors and daylight harvesting strategies to minimize electricity usage [12]. Furthermore, renewable energy sources like solar panels or wind turbines can be integrated into the building's design to generate clean electricity, further reducing reliance on fossil fuels [13].

Sustainable materials are integral to eco-friendly commercial buildings, as they minimize environmental impact and promote resource conservation. These buildings prioritize the use of recycled or reclaimed materials, such as reclaimed wood, recycled steel, or recycled glass, which reduces the demand for virgin materials and diverts waste from landfills. Additionally, sustainable materials with low volatile organic compound (VOC) emissions are preferred, ensuring better indoor air quality. Building envelopes are designed with highly efficient insulation materials, low-emissivity windows, and high-performance glazing to minimize heat transfer and optimize energy efficiency. Furthermore, water-saving fixtures and efficient plumbing systems contribute to water conservation within these buildings [14].

Green Buildings on Urban Sustainability and Energy Consumption

Energy Efficiency

Green buildings are at the forefront of sustainable architecture, with a strong focus on energy efficiency. One key aspect of green buildings is their advanced building envelope design. The building envelope acts as a barrier between the interior and exterior environments, and green buildings employ innovative strategies to minimize energy loss and optimize thermal comfort. This includes the use of high-performance insulation materials, such as spray foam or cellulose insulation, which greatly reduce heat transfer and prevent air leakage. By minimizing thermal bridging and improving air tightness, green buildings significantly reduce the need for artificial heating and cooling, leading to substantial energy savings [15].

In addition to advanced building envelope design, green buildings utilize efficient heating, ventilation, and air conditioning (HVAC) systems. These systems are designed to provide optimal indoor air quality while minimizing energy consumption. Energy-efficient HVAC systems employ technologies such as variable speed drives, demand-controlled ventilation, and heat recovery ventilation[16]. By dynamically adjusting fan speeds, regulating fresh air intake based on occupancy, and recovering heat from exhaust air, these systems reduce the energy required for heating, cooling, and ventilation, resulting in significant energy savings and improved occupant comfort [17].

Smart lighting controls and occupancy sensors are integral components of green buildings, enabling precise control over lighting usage. These systems utilize sensors to detect occupancy and adjust lighting levels accordingly. Occupancy sensors automatically turn off lights in unoccupied areas, eliminating unnecessary energy consumption [18]. Moreover, smart lighting controls allow for individual control of light fixtures, enabling occupants to customize lighting levels based on their preferences and needs. By optimizing lighting usage and reducing wastage, green buildings minimize energy consumption and contribute to a more sustainable future [19].

Energy management systems play a vital role in green buildings by providing centralized control and monitoring of energy usage. These systems integrate various components, such as lighting, HVAC, and other electrical systems, to optimize energy efficiency. Through real-time monitoring, energy management systems identify energy consumption patterns and enable proactive energy-saving measures. They can automatically adjust settings, such as temperature and lighting levels, based on occupancy, time of day, or specific energy-saving strategies. Energy management systems also provide detailed energy usage data, allowing building operators to identify areas for improvement and make informed decisions regarding energy conservation initiatives [20].

Green buildings prioritize energy efficiency through a comprehensive approach that encompasses advanced building envelope design, high-performance insulation, efficient HVAC systems, smart lighting controls, occupancy sensors, and energy management systems [21]. By implementing these technologies and strategies, green buildings minimize energy wastage, reduce greenhouse gas emissions, and contribute to a more sustainable built environment [22]. As the demand for sustainable and energy-efficient buildings continues to grow, the development and adoption of green building practices will play a crucial role in mitigating climate change and creating a more sustainable future [23].

Renewable Energy Integration

Green buildings are increasingly incorporating renewable energy technologies as a key component of their sustainability strategies. Solar panels, for instance, are commonly installed on rooftops or integrated into building facades to harness the abundant energy from the sun. These photovoltaic (PV) systems convert sunlight directly into electricity, which can be used to power various building operations. By generating clean and renewable energy on-site, green buildings significantly reduce their dependence on fossil fuel-based electricity from the grid, thereby mitigating the environmental impact associated with conventional energy generation [24].

Wind turbines are another renewable energy technology that can be integrated into green buildings, particularly in areas with ample wind resources. Small-scale wind turbines, designed to operate efficiently in urban and suburban environments, can be installed on rooftops or within building premises. These turbines convert the kinetic energy of the wind into electrical energy, further diversifying the renewable energy portfolio of green buildings [25].

. By harnessing wind power, these buildings contribute to the reduction of greenhouse gas emissions and help combat climate change [26].

Geothermal systems, or ground-source heat pumps, are yet another renewable energy solution commonly incorporated in green buildings. These systems leverage the relatively constant temperature of the ground to provide both heating and cooling. By utilizing underground pipes and a heat pump, geothermal systems extract heat from the ground during winter for heating purposes and transfer excess heat back into the ground during summer for cooling [27]. This efficient method of utilizing the Earth's thermal energy reduces the energy consumption associated with traditional heating and cooling systems, thereby reducing carbon emissions [28].

The integration of renewable energy technologies in green buildings not only reduces reliance on non-renewable energy sources but also contributes to the overall energy resilience of the built environment. By generating their own clean energy on-site, these buildings are less vulnerable to power outages or fluctuations in energy prices. Moreover, the surplus energy produced by renewable systems can be fed back into the grid, further promoting the adoption of sustainable energy practices within the broader community [29]. Through the integration of solar panels, wind turbines, and geothermal systems, these buildings actively contribute to the transition to a low-carbon future. As renewable energy technologies continue to advance and become more cost-effective, their incorporation in green buildings will play a crucial role in promoting sustainable development and mitigating the environmental impact of the built environment [30].

Water Conservation

Water conservation is a fundamental aspect of green buildings, and they implement various strategies to promote sustainable water management. One of the key measures is the use of water-efficient fixtures such as low-flow toilets, faucets, and showerheads. These fixtures are designed to minimize water consumption by reducing flow rates while maintaining satisfactory performance [31]. Low-flow toilets, for example, use significantly less water per flush compared to traditional toilets, effectively reducing water usage without compromising functionality. In addition to water-efficient fixtures, green buildings often incorporate rainwater harvesting systems. These systems collect and store rainwater from rooftops, which can then be used for non-potable purposes such as landscape irrigation, toilet flushing, and cooling tower makeup water. By capturing and utilizing rainwater on-site, green buildings reduce the demand for freshwater resources, particularly during periods of drought or water scarcity [32]. Rainwater harvesting systems also help mitigate stormwater runoff, which can contribute to urban flooding and water pollution [33].

Greywater recycling systems are another water-saving feature commonly found in green buildings. Greywater refers to wastewater generated from sources such as sinks, showers, and laundry. Rather than being discharged into the sewage system, greywater can be treated and reused for purposes that do not require potable water, such as toilet flushing or irrigation. By treating and recycling greywater on-site, green buildings reduce the strain on municipal water supply and decrease the amount of wastewater that needs to be treated at wastewater treatment plants [34].

Moreover, green buildings often incorporate landscaping strategies that promote water efficiency. This may include the use of native or drought-tolerant plants, which require less irrigation compared to non-native species. Additionally, green roofs and permeable pavements are implemented to minimize stormwater runoff and facilitate groundwater recharge [35]. These sustainable landscaping practices not only conserve water but also enhance the overall ecological performance of green buildings, promoting biodiversity and mitigating the urban heat island effect [36]. Through the implementation of water-efficient fixtures, rainwater harvesting systems, greywater recycling, and sustainable landscaping, green buildings significantly reduce water consumption, promote sustainable water management, and alleviate the strain on municipal water supply. By adopting these measures, green buildings play a crucial role in conserving water resources, mitigating the environmental impact of urban areas, and building a more sustainable future [37].

Sustainable Materials

Green buildings place a strong emphasis on the selection and use of sustainable and eco-friendly materials throughout the construction process. These materials are chosen based on their low embodied energy and reduced environmental impacts, contributing to the overall sustainability of the building. One aspect of sustainable material selection is the incorporation of recycled content. Green buildings prioritize the use of materials that are made from recycled materials or have a high percentage of recycled content. This includes materials such as recycled steel, recycled glass, and recycled plastic. By utilizing recycled content, green buildings help reduce the extraction of virgin resources, conserve energy, and minimize waste going to landfills [38].

Responsibly sourced timber is another key element in green building materials. Sustainable forestry practices, such as certification programs like the Forest Stewardship Council (FSC), ensure that timber is harvested in a manner that maintains the health and biodiversity of forests while also considering the social and economic aspects of local communities. By selecting responsibly sourced timber, green buildings contribute to the conservation of forests and promote sustainable forest management practices [39].

Furthermore, green buildings prioritize the use of low VOC (volatile organic compound) paints and coatings. VOCs are chemicals that can be released into the air, contributing to indoor air pollution and negative health effects. Low VOC paints and coatings have significantly reduced levels of these harmful chemicals, promoting better indoor air quality for occupants. By selecting low VOC products, green buildings create healthier and more comfortable indoor environments while minimizing the impact on human health and the environment. In addition to recycled content, responsibly sourced timber, and low VOC paints, green buildings consider a range of other environmentally friendly construction materials [40]. This may include the use of insulation made from renewable or recycled materials, such as cellulose insulation or recycled fiberglass. Green buildings also explore alternative materials that have lower environmental impacts, such as natural and bio-based materials like bamboo, cork, or straw bales. These materials offer renewable and sustainable alternatives to conventional construction materials [41].

By prioritizing the use of sustainable and eco-friendly materials, green buildings reduce the environmental footprint associated with the construction industry. These materials contribute to the conservation of natural resources, promote responsible sourcing practices, minimize indoor air pollution, and support the transition to a more sustainable and circular economy [42]. As the demand for green buildings continues to grow, the use of sustainable materials will play a pivotal role in achieving sustainable development and reducing the environmental impact of the built environment [43].

Indoor Environmental Quality

Green buildings prioritize the creation of a healthy and comfortable indoor environment by implementing various strategies that enhance the indoor environmental quality (IEQ). One key aspect is the integration of natural daylighting strategies. Green buildings are designed to maximize the penetration of natural light into interior spaces, reducing the reliance on artificial lighting during daylight hours. This not only reduces energy consumption but also provides occupants with access to natural light, which has been linked to improved mood, productivity, and overall well-being [44].

Efficient air filtration systems are another important feature of green buildings. These systems are designed to remove pollutants, allergens, and contaminants from the indoor air, ensuring a healthy and clean environment for occupants. High-efficiency air filters capture and trap particulate matter, including dust [45], pollen, and airborne pollutants, reducing the risk of respiratory problems and allergies. By maintaining high indoor air quality, green buildings create a comfortable and healthy space for occupants to live, work, and thrive [46].

Optimal thermal comfort control is also a priority in green buildings. They employ advanced HVAC systems that allow for precise temperature regulation and individual control over thermal comfort [47]. These systems utilize zoning and occupancy sensors to adjust heating and cooling based on occupancy and thermal demand. By providing occupants with the ability to customize their thermal settings and maintaining optimal comfort levels, green buildings enhance occupant satisfaction, productivity, and overall well-being. Moreover, green buildings prioritize the use of low-emitting materials and furnishings [48]. These materials have low levels of volatile organic compounds (VOCs) and other harmful chemicals that can off-gas and contribute to indoor air pollution. By selecting low-emitting materials, such as low VOC paints, adhesives, and furniture, green buildings reduce the exposure to indoor pollutants and create a healthier indoor environment for occupants [49].

By focusing on providing a healthy and comfortable indoor environment, green buildings create spaces that promote occupant well-being, productivity, and satisfaction. The integration of natural daylighting, efficient air filtration, optimal thermal comfort control, and low-emitting materials collectively contribute to improving the indoor environmental quality [50]. As the understanding of the importance of indoor environmental quality grows, green buildings play a vital role in ensuring that occupants have access to spaces that foster their health, happiness, and overall quality of life [51].

Waste Management

Green buildings prioritize waste management strategies as a crucial component of their sustainability efforts [52]. They implement various practices to minimize waste generation, divert materials from landfills, and embrace a circular economy approach. One key waste management strategy in green buildings is the incorporation of recycling facilities [53]. These buildings provide designated areas or systems for the collection and sorting of recyclable materials such as paper, cardboard, plastic, and glass. By promoting recycling practices within the building, occupants are encouraged to separate their waste and contribute to the recycling process. This not only reduces the volume of waste going to landfills but also conserves resources by enabling the reuse of materials [54].

Composting systems are another important aspect of waste management in green buildings. These systems facilitate the decomposition of organic waste materials, such as food scraps and plant trimmings, into nutrient-rich compost. The compost can then be used for on-site landscaping or donated to local agricultural projects. By diverting organic waste from landfills and converting it into a valuable resource, green buildings reduce greenhouse gas emissions associated with landfill decomposition and contribute to soil fertility and regenerative agriculture [55].

During the construction phase, green buildings prioritize the use of recycled materials. Recycled content materials, such as recycled concrete, steel, or plastic, are incorporated into the building's structure, finishes, and furnishings. These materials are sourced from post-consumer or post-industrial waste, reducing the demand for virgin resources and minimizing the environmental impact of extraction and manufacturing processes. By utilizing recycled materials, green buildings contribute to the circular economy by closing the loop on material flows and reducing waste generation. Furthermore, green buildings encourage waste reduction and source separation through educational programs and awareness campaigns. Occupants and building users are educated about the importance of waste management practices, including reducing waste at the source, reusing materials, and making conscious purchasing decisions. By fostering a culture of waste reduction and responsible consumption, green buildings promote sustainable behaviors beyond their physical infrastructure [56]. Green buildings embrace waste management strategies that encompass recycling facilities, composting systems, and the use of recycled materials during construction. These practices minimize waste generation, divert materials from landfills, and foster a circular economy approach by promoting resource conservation and material reuse [57].

Urban Heat Island Effect

Green buildings play a significant role in combating the urban heat island effect by implementing various strategies that focus on mitigating temperature rise in urban areas, improving air quality, and reducing the energy demand for cooling. These strategies include the incorporation of green roofs, vertical gardens, and permeable surfaces [58].

One effective measure is the installation of green roofs. Green roofs consist of vegetation and growing medium layered on rooftops, providing multiple benefits. They act as insulators, reducing heat transfer between the building and the outdoor environment. By absorbing and retaining rainfall, green roofs also minimize stormwater runoff and help regulate the urban water cycle [59]. Additionally, they enhance biodiversity, promote urban agriculture, and improve the aesthetic appeal of buildings. Overall, green roofs contribute to lowering the ambient temperature in urban areas, mitigating the urban heat island effect, and creating a more sustainable and pleasant living environment [60].

Vertical gardens, or living walls, are another feature incorporated in green buildings to combat the urban heat island effect. These gardens are comprised of plants grown vertically on the exterior walls of buildings, utilizing vertical space and providing numerous benefits. Vertical gardens enhance insulation by shading the building facade and reducing heat gain. They also improve air quality by absorbing pollutants and releasing oxygen, contributing to a healthier and more enjoyable urban environment. Additionally, vertical gardens add aesthetic value, enhance biodiversity, and create a sense of connection with nature in urban settings [61].

Permeable surfaces are essential components of green buildings that contribute to the mitigation of the urban heat island effect. Traditional paved surfaces, such as roads, sidewalks, and parking lots, contribute to heat buildup due to their high heat absorption and minimal capacity to release heat. Green buildings incorporate permeable surfaces, such as permeable pavements or porous materials, which allow water to infiltrate into the ground, promoting natural drainage and reducing stormwater runoff. By reducing the extent of impervious surfaces, green buildings help cool the urban environment and prevent the formation of heat islands [62].

Collectively, the integration of green roofs, vertical gardens, and permeable surfaces in green buildings offers a holistic approach to combating the urban heat island effect. These features contribute to reducing ambient temperatures, improving air quality, enhancing urban aesthetics, and promoting sustainable urban development. As cities continue to grapple with the challenges of urbanization and climate change, green buildings and their innovative strategies will play a pivotal role in creating more resilient and livable urban environments [63].

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Conclusion

The widespread adoption of green building practices holds tremendous potential for achieving substantial energy savings, reducing greenhouse gas emissions, preserving natural resources, and enhancing the overall sustainability of urban areas. By prioritizing energy efficiency, green buildings significantly decrease energy consumption and lower the demand for fossil fuel-based power generation. This not only helps combat climate change but also reduces reliance on non-renewable energy sources and supports the transition to a more sustainable energy future.

Furthermore, green buildings contribute to the reduction of greenhouse gas emissions. Through advanced building envelope design, high-performance insulation, and efficient HVAC systems, these buildings minimize the need for heating and cooling, thereby reducing carbon emissions associated with energy use. Moreover, the incorporation of renewable energy technologies, such as solar panels and wind turbines, allows green buildings to generate clean, on-site energy, further mitigating greenhouse gas emissions and promoting a low-carbon economy.

In addition to energy conservation, green buildings prioritize the efficient use of water resources. By implementing water-efficient fixtures, rainwater harvesting systems, and greywater recycling, these buildings minimize water consumption, alleviate strain on municipal water supplies, and contribute to sustainable water management in urban areas. This helps address water scarcity concerns, reduce the energy required for water treatment and distribution, and protect ecosystems that depend on water resources.

The adoption of green building standards and certifications plays a pivotal role in promoting industry best practices and driving continuous improvement in sustainable building design and operation. Certifications such as LEED, BREEAM, and WELL Building Standard provide frameworks and guidelines that encourage green building strategies and reward buildings that meet rigorous sustainability criteria. These standards incentivize the implementation of energy-efficient systems, renewable energy integration, water conservation measures, indoor environmental quality enhancements, and sustainable material selection. They foster innovation, knowledge sharing, and collaboration among professionals in the construction industry, driving the development of more sustainable buildings and influencing the broader market to embrace sustainable practices [64].

By embracing green building practices, cities can transform their built environment into more sustainable, resilient, and livable spaces. Green buildings offer a pathway to reduce energy consumption, decrease greenhouse gas emissions, conserve natural resources, and enhance the overall quality of life for residents. As governments, organizations, and individuals recognize the environmental and economic benefits of green buildings, the momentum toward sustainable construction continues to grow, shaping a more sustainable future for urban areas worldwide.

References

[1] A. GhaffarianHoseini, N. D. Dahlan, U. Berardi, A. GhaffarianHoseini, N. Makaremi, and M. GhaffarianHoseini, “Sustainable energy performances of green buildings: A review of current theories, implementations and challenges,” *Renewable Sustainable Energy Rev.*, vol. 25, pp. 1–17, Sep. 2013.

[2] C. J. Kibert, “GREEN BUILDINGS: AN OVERVIEW OF PROGRESS,” *J. Land Use Environ. Law*, vol. 19, no. 2, pp. 491–502, 2004.

[3] Y. Lu, Z. Wu, R. Chang, and Y. Li, “Building Information Modeling (BIM) for green buildings: A critical review and future directions,” *Autom. Constr.*, vol. 83, pp. 134–148, Nov. 2017.

[4] V. S. R. Kosuru and A. K. Venkitaraman, “Developing a deep Q-learning and neural network framework for trajectory planning,” *European Journal of Engineering and Technology Research*, vol. 7, no. 6, pp. 148–157, 2022.

[5] M. Alam, “Reconstructing anti-capitalism as heterodoxa in Indonesia’s youth-led urban environmentalism Twitter account,” *Geoforum*, 2020.

[6] Q. Li, R. Long, H. Chen, F. Chen, and J. Wang, “Visualized analysis of global green buildings: Development, barriers and future directions,” *J. Clean. Prod.*, vol. 245, p. 118775, Feb. 2020.

[7] A. K. Venkitaraman and V. S. R. Kosuru, “Resilence of Autosar-Complaint Spi Driver Communication as Applied to Automotive Embedded Systems,” *EJECE*, vol. 7, no. 2, pp. 44–47, Apr. 2023.

[8] J. Pitts, “Green Buildings: Valuation Issues and Perspectives,” *Appraisal J.*, vol. 39, no. 4, pp. 115–118, Oct. 2008.
[9] B. Wen *et al.*, “The role and contribution of green buildings on sustainable development goals,” *Build. Environ.*, vol. 185, p. 107091, Nov. 2020.
[10] von P. Paul, “The business case for high performance green buildings: Sustainability and its financial impact,” *Journal of Facilities Management*, vol. 2, no. 1, pp. 26–34, Jan. 2003.
[11] Z. Gou, S. S.-Y. Lau, and D. Prasad, “MARKET READINESS AND POLICY IMPLICATIONS FOR GREEN BUILDINGS: CASE STUDY FROM HONG KONG,” *Journal of Green Building*, vol. 8, no. 2, pp. 162–173, Apr. 2013.
[12] M. Alam, “Young People as Transformative Citizens Fighting Climate Change,” *Political Identity and Democratic Citizenship in*, 2020.
[13] C. Debrah, A. P. C. Chan, and A. Darko, “Green finance gap in green buildings: A scoping review and future research needs,” *Build. Environ.*, vol. 207, p. 108443, Jan. 2022.
[14] A. Steinemann, P. Wargocki, and B. Rismanchi, “Ten questions concerning green buildings and indoor air quality,” *Build. Environ.*, vol. 112, pp. 351–358, Feb. 2017.
[15] M. Sharma, “Development of a ‘Green building sustainability model’ for Green buildings in India,” *J. Clean. Prod.*, vol. 190, pp. 538–551, Jul. 2018.
[16] A. K. Venkitaraman and V. S. R. Kosuru, “A review on autonomous electric vehicle communication networks-progress, methods and challenges,” *World J. Adv. Res. Rev.*, vol. 16, no. 3, pp. 013–024, Dec. 2022.
[17] J. C. Howe, “Overview of green buildings,” *Envtl. L. Rep. News & Analysis*, vol. 41, p. 10043, 2011.
[18] M. Alam, “Young People as Transformative Citizens Fighting Climate Change,” in *Political Identity and Democratic Citizenship in Turbulent Times*, IGI Global, 2020, pp. 230–254.
[19] H. Gabay, I. A. Meir, M. Schwartz, and E. Werzberger, “Cost-benefit analysis of green buildings: An Israeli office buildings case study,” *Energy Build.*, vol. 76, pp. 558–564, Jun. 2014.
[20] W. A. Shanika and T. Ramachandra, “Economic sustainability of green buildings: a comparative analysis of green vs non-green,” *Built Environment Project and Asset Management*, vol. 8, no. 5, pp. 528–543, Jan. 2018.
[21] V. S. R. Kosuru and A. K. Venkitaraman, “Advancements and challenges in achieving fully autonomous self-driving vehicles,” *World Journal of Advanced Research and Reviews*, vol. 18, no. 1, pp. 161–167, 2023.
[22] V. S. Rahul, “Kosuru; Venkitaraman, AK Integrated framework to identify fault in human-machine interaction systems,” *Int. Res. J. Mod. Eng. Technol. Sci*, 2022.
[23] A. Sinha, R. Gupta, and A. Kutnar, “Sustainable Development and Green Buildings,” *Drv. Ind.*, vol. 64, no. 1, pp. 45–53, 2013.
[24] I. Akomea-Frimpong, A. S. Kukah, X. Jin, R. Osei-Kyei, and F. Pariafsai, “Green finance for green buildings: A systematic review and conceptual foundation,” *J. Clean. Prod.*, vol. 356, p. 131869, Jul. 2022.
[25] M. Alam, P. Nilan, and T. Leahy, “Learning from Greenpeace: Activist habitus in a local struggle,” *Electron. Green J.*, 2019.
[26] G. R. Newsham *et al.*, “Do ‘green’ buildings have better indoor environments? New evidence,” *Build. Res. Inf.*, vol. 41, no. 4, pp. 415–434, Aug. 2013.
[27] K. V. Ashwin, V. S. R. Kosuru, S. Sridhar, and P. Rajesh, “A Passive Islanding Detection Technique Based on Susceptible Power Indices with Zero Non-Detection Zone Using a Hybrid Technique,” *Int J Intell Syst Appl Eng*, vol. 11, no. 2, pp. 635–647, Feb. 2023.
[28] J. Zuo and Z.-Y. Zhao, “Green building research–current status and future agenda: A review,” *Renewable Sustainable Energy Rev.*, vol. 30, pp. 271–281, Feb. 2014.
[29] V. S. R. Kosuru and A. K. Venkitaraman, “Evaluation of Safety Cases in The Domain of Automotive Engineering,” *International Journal of Innovative Science and Research Technology*, vol. 7, no. 9, pp. 493–497, 2022.
[30] J. Heerwagen, “Green buildings, organizational success and occupant productivity,” *Build. Res. Inf.*, vol. 28, no. 5–6, pp. 353–367, Sep. 2000.
[31] V. S. R. Kosuru and A. Kavasseri Venkitaraman, “A Smart Battery Management System for Electric Vehicles Using Deep Learning-Based Sensor Fault Detection,” *World Electric Vehicle Journal*, vol. 14, no. 4, p. 101, Apr. 2023.

[32] M. Alam and I. A. N. Azalie, “Greening the Desert: Sustainability Challenges and Environmental Initiatives in the GCC States,” in *Social Change in the Gulf Region: Multidisciplinary Perspectives*, Springer Nature Singapore Singapore, 2023, pp. 493–510.
[33] B. Edwards and E. Naboni, *Green buildings pay: Design, productivity and ecology*. Routledge, 2013.
[34] R. Ries, M. M. Bilec, N. M. Gokhan, and K. L. Needy, “The Economic Benefits of Green Buildings: A Comprehensive Case Study,” *Eng. Econ.*, vol. 51, no. 3, pp. 259–295, Sep. 2006.
[35] M. Alam, “Environmental Education and Non-governmental Organizations,” in *The Palgrave Encyclopedia of Urban and Regional Futures*, R. C. Brears, Ed. Cham: Springer International Publishing, 2023, pp. 495–502.
[36] A. K. Venkitaraman and V. S. R. Kosuru, “Hybrid deep learning mechanism for charging control and management of Electric Vehicles,” *European Journal of Electrical Engineering and Computer Science*, vol. 7, no. 1, pp. 38–46, Jan. 2023.
[37] S. J. Robinson and A. R. Sanderford, “Green Buildings: Similar to Other Premium Buildings?,” *J. Real Estate Fin. Econ.*, vol. 52, no. 2, pp. 99–116, Feb. 2016.
[38] O. A. Olubunmi, P. B. Xia, and M. Skitmore, “Green building incentives: A review,” *Renewable Sustainable Energy Rev.*, vol. 59, pp. 1611–1621, Jun. 2016.
[39] Z. Gou, D. Prasad, and S. Siu-Yu Lau, “Are green buildings more satisfactory and comfortable?,” *Habitat Int.*, vol. 39, pp. 156–161, Jul. 2013.
[40] V. S. R. Kosuru and A. K. Venkitaraman, “Preventing the False Negatives of Vehicle Object Detection in Autonomous Driving Control Using Clear Object Filter Technique,” *2022 Third International*, 2022.
[41] D. C. Matisoff and D. S. Noonan, “Policy monitor—Green buildings: Economics and policies,” *Economics and Policy*, 2016.
[42] V. S. R. Kosuru and A. K. Venkitaraman, “Automatic Identification of Vehicles in Traffic using Smart Cameras,” *and Informatics (IC3I …*, 2022.
[43] A. Leaman, L. E. Thomas, and M. Vandenberg, “‘Green’ buildings: What Australian users are saying,” *EcoLibrium (R)*, Jan. 2007.
[44] J. Teng, X. Mu, W. Wang, C. Xu, and W. Liu, “Strategies for sustainable development of green buildings,” *Sustainable Cities and Society*, 2019.
[45] V. S. R. Kosuru and A. Kavasseri Venkitaraman, “Trends and Challenges in Electric Vehicle Motor Drivelines-A Review,” *International journal of*, 2023.
[46] M. P. Deuble and R. J. de Dear, “Green occupants for green buildings: The missing link?,” *Build. Environ.*, vol. 56, pp. 21–27, Oct. 2012.
[47] M. Alam, “Activists’ heterodoxic beliefs in fostering urban environmental education in Indonesia,” *Local Development & Society*, pp. 1–18, Apr. 2022.
[48] V. S. R. Kosuru, A. K. Venkitaraman, V. D. Chaudhari, N. Garg, A. Rao, and A. Deepak, “Automatic Identification of Vehicles in Traffic using Smart Cameras,” in *2022 5th International Conference on Contemporary Computing and Informatics (IC3I)*, 2022, pp. 1009–1014.
[49] L. Zhang, J. Wu, and H. Liu, “Turning green into gold: A review on the economics of green buildings,” *J. Clean. Prod.*, vol. 172, pp. 2234–2245, Jan. 2018.
[50] M. Alam, “Mental health impact of online learning: A look into university students in Brunei Darussalam,” *Asian J. Psychiatr.*, vol. 67, p. 102933, Jan. 2022.
[51] M. Alam, S. Mahalle, and D. H. Suwarto, “Mental distress among Indonesian academic mothers during enforced remote working,” *Journal of Further and Higher Education*, pp. 1–13, May 2023.
[52] P. Eichholtz, N. Kok, and J. M. Quigley, “The economics of green building,” *Rev. Econ. Stat.*, 2013.
[53] M. Alam, *Freshmen orientaton program: Circle of violence, moral crisis, and pseudo-altruism*. Nas Media Pustaka, 2023.
[54] L. N. Dwaikat and K. N. Ali, “Green buildings cost premium: A review of empirical evidence,” *Energy Build.*, vol. 110, pp. 396–403, Jan. 2016.
[55] G. B. Guy, *Construction Ecology: Nature as a Basis for Green Buildings*. London, England: Routledge, 2003.
[56] A. K. Venkitaraman and V. S. R. Kosuru, “Electric Vehicle Charging Network Optimization using Multi-Variable Linear Programming and Bayesian Principles,” *2022 Third International*, 2022.
[57] J. Yudelson, *The Green Building Revolution*. Island Press, 2007.

[58] A. Leaman and B. Bordass, “Are users more tolerant of ‘green’ buildings?,” *Build. Res. Inf.*, vol. 35, no. 6, pp. 662–673, Nov. 2007.
[59] M. Alam, “Indonesian educated middle-class fathers’ preferences in pregnancy services at a private hospital,” *Int. Rev. Sociol. Sport*, vol. 30, no. 3, pp. 539–560, Sep. 2020.
[60] A. Chegut, P. Eichholtz, and N. Kok, “Supply, demand and the value of green buildings,” *Urban Stud.*, 2014.
[61] V. S. R. Kosuru and A. K. Venkitaraman, “CONCEPTUAL DESIGN PHASE OF FMEA PROCESS FOR AUTOMOTIVE ELECTRONIC CONTROL UNITS,” *International Research Journal of Modernization in Engineering Technology and Science*, vol. 4, no. 9, pp. 1474–1480, 2022.
[62] N. Miller, D. Pogue, and Q. Gough, “Green buildings and productivity,” *Journal of Sustainable*, 2009.
[63] A. Singh, M. Syal, S. C. Grady, and S. Korkmaz, “Effects of green buildings on employee health and productivity,” *Am. J. Public Health*, vol. 100, no. 9, pp. 1665–1668, Sep. 2010.
[64] J. G. Allen, P. MacNaughton, J. G. C. Laurent, S. S. Flanigan, E. S. Eitland, and J. D. Spengler, “Green Buildings and Health,” *Curr Environ Health Rep*, vol. 2, no. 3, pp. 250–258, Sep. 2015.