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INNOVATIVE ARCHITECTURAL ENVIRONMENTAL DESIGN

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This paper reviews three pivotal trends in Architectural Environmental Design: sustainable materials and energy systems, IoT-enabled smart buildings, and biophilic, user-centric spaces, through landmark projects like Bosco Verticale, the Bullitt Center, The Edge, and Khoo Teck Puat Hospital etc. These examples illustrate how green technologies, automated climate control, and nature-inspired design reduce environmental impact, boost occupant well-being, and spur industry innovation. The study highlights the field's critical role in forging a resilient, healthy, and economically vibrant built environment.

Key words: architectural design, environmental design, sustainable design, environmental protection, renewable energy, innovations, smart buildings.

INTRODUCTION

In the modern era, Architectural Environmental Design is emerging as a field with a remarkably promising future. This discipline seamlessly fuses the art and science of architecture with a deep-seated concern for the environment. It goes beyond traditional architectural design by explicitly incorporating ecological factors. Professionals in this area strive to create structures that are energy-efficient, using passive strategies like proper orientation to capture natural light and ventilation, and focus on selecting sustainable materials, reducing construction waste, and enhancing the overall environmental quality of the built environment.

As environmental awareness grows worldwide, the demand for Architectural Environmental Design is surging. It will play a pivotal role in shaping a more sustainable and livable future, making it an exciting and dynamic field full of potential.

PURPOSE

The purpose of this study is to analyze the emerging trends: sustainability, smart technology integration, and user-centered design, that are shaping the future of Architectural Environmental Design. Through key case studies, it seeks to demonstrate how these innovations can reduce environmental impact, enhance occupant well-being, and drive economic growth.

RESULTS AND DISCUSSION

Architecture Environment Design holds profound significance for a promising future.



- **Environmental Sustainability.** By integrating green technologies and sustainable materials, this approach dramatically reduces buildings' energy consumption and carbon emissions, it's an essential step in combating climate change.
- **Enhanced Quality of Life.** Well-designed environments with ample natural light, fresh air, and green spaces improve occupants' physical and mental well-being. For instance, office buildings that incorporate interior gardens or biophilic elements often see measurable boosts in employee productivity and job satisfaction.
- **Economic Development.** The expansion of this field creates new job opportunities in design, construction, and research. It also spurs innovation in building materials and construction techniques, making Architectural Environmental Design an indispensable driver of a prosperous and sustainable economy.

Sustainable Design

Sustainability has become a cornerstone of architectural environmental design. As the world grapples with climate change, architects and designers are increasingly adopting practices that minimize environmental impact and promote resource efficiency. For example, the Bosco Verticale (Vertical Forest) in Milan, Italy (fig. 1), features towers covered with trees and shrubs that absorb CO₂, produce oxygen, and help regulate indoor temperatures. Similarly, the Bullitt Center in Seattle, USA (fig. 2), is renowned as one of the "greenest commercial buildings" due to its net-zero energy consumption, rainwater harvesting systems, and use of FSC-certified wood.



Fig. 1. Bosco Verticale (Vertical Forest), Milan, Italy



Fig. 2. Bullitt Center, Seattle, Washington, USA

Smart Architecture Integration

The rise of smart technologies is revolutionizing architectural environmental design. Smart buildings employ IoT sensors and AI to adjust lighting, temperature, and ventilation based on real-time occupancy and environmental data. For instance, The Edge in Amsterdam, Netherlands (fig. 3), uses an IoT-based system to optimize energy use: sensors monitor occupancy, automatically dim lights in unoccupied spaces, and adjust climate control. In Abu Dhabi, the Al Bahr Towers



(fig. 4) feature dynamic facades that open and close in response to sunlight, reducing cooling demands by up to 50%.



Fig. 3. The Edge, Amsterdam, Netherlands



Fig. 4. Al Bahr Towers, Abu Dhabi, UAE

Enhanced User Experience

Future architectural environmental design will place greater emphasis on user experience by addressing the psychological and physiological needs of occupants. Biophilic elements, such as natural light, indoor greenery, and views of nature, have been shown to reduce stress and improve well-being. The Khoo Teck Puat Hospital in Singapore (fig. 5) integrates extensive greenery, natural ventilation, and healing gardens to accelerate patient recovery. Likewise, the Googleplex Headquarters in Mountain View, USA (fig. 6), offers flexible workspaces with abundant daylight (fig. 7), outdoor meeting areas, and biophilic design features to enhance employee satisfaction and productivity.



Fig. 5. The Khoo Teck Puat Hospital, Singapore, Republic of Singapore



Fig. 6. Googleplex Headquarters exterior, Mountain View, California, USA



Fig. 7. Googleplex Headquarters interior, Mountain View, California, USA

CONCLUSIONS

By examining real-world examples, it is clear how sustainable practices, smart technologies, and user-centric design are shaping the future of Architectural Environmental Design. These innovations not only address environmental challenges but also improve the health, comfort, and productivity of building occupants. In short, the future of the built environment is bright: the combination of sustainable design principles, advanced technology integration, and a focus on user experience will yield more innovative and functional buildings. Architects and designers must continue to embrace these trends to meet the needs of present and future generations.

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ШМЕЛЬОВА-НЕСТЕРЕНКО О., ЛЮ Сінчжао

ІННОВАЦІЙНИЙ ДИЗАЙН АРХІТЕКТУРНОГО СЕРЕДОВИЩА

У цій статті розглянуто три ключові тенденції в дизайні архітектурного середовища: сталий вибір матеріалів і енергетичних систем, «розумні» будівлі на базі IoT та біофільні, орієнтовані на користувача простори, які проілюстровані такими знаковими проектами, як Bosco Verticale, Центр Буллім, The Edge та лікарня Khoo Teck Puat. Ці приклади демонструють, як зелені технології, автоматизований контроль клімату та натхненний природою дизайн знижують навантаження на довкілля, підвищують комфорт і добробут мешканців та стимулюють інновації в галузі. Дослідження підкреслює вирішальну роль цієї сфери в побудові стійкого, здорового та економічно динамічного життєвого середовища.

Ключові слова: архітектурний дизайн, дизайн середовища, сталий розвиток, захист довкілля, відновлювані джерела енергії, інновації, «розумні» будівлі.