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Influence of Modern Technology in Cultural Buildings

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Abstract: *Cultural buildings, from museums and libraries to theaters and historical sites, are embracing modern technology to enhance the visitor experience, broaden accessibility, and breathe new life into their collections. technology is transforming cultural buildings in several key ways like Enriched Engagement (Interactive exhibits, virtual reality experiences, and multimedia displays are fostering deeper connections between visitors and cultural artifacts). Accessibility Expansion (accessible to people with disabilities and geographically dispersed audiences. Sustainable Design (Building Information Modeling (BIM) and other innovations are optimizing construction processes and promoting energy efficiency in cultural buildings.) Striking a balance between embracing technological advancements and preserving the authenticity of cultural identity is crucial in navigating the evolving landscape of cultural building in the modern era.*

Keywords: *Cultural buildings, Modern technology, Enrich engagement, Accessibility, Sustainable Design*

I. INTRODUCTION

In today's world, technology has integrated in every aspect of our lives and architecture is no exception. The role of technology in modern architecture has been revolutionary, driving innovation, creativity, and efficiency in the way Cultural buildings are designed, constructed, and experienced. Advanced materials, construction techniques and sustainable building technologies, have expanded the possibilities to create innovative and environmentally friendly structures. Smart technologies have introduced a new dimension to cultural architecture, enabling buildings to be more responsive, efficient, and interactive, enabling individuals and communities to share their unique traditions, art forms, and narratives with the world. Museums and cultural institutions now incorporate cutting-edge technologies like virtual reality and augmented reality to enhance visitor experiences, providing immersive journeys through history, art, and culture. Here we find out how effective this construction technique in amalgamation with modern architecture style to climatic conditions like tropical climate. What is it about modern technology that attracts people? What role does incorporate modern technology into cultural building have? Modern technology reveals a compelling intersection between sustainability, technology, and heritage preservation. Through the incorporation of innovative strategies such as passive design, energy-efficient systems, renewable energy integration, and adaptive reuse, cultural buildings can minimize their environmental footprint while maintaining their historical and cultural significance. In the other instance, this technological influence also brings challenges, such as the potential loss of traditional practices and the risk of cultural appropriation. Striking a balance between embracing technological advancements and preserving the authenticity of cultural identity is crucial in navigating the evolving landscape of cultural building in the modern era.

II. LITERATURE STUDY

In today's rapidly evolving world, technology has permeated every aspect of our lives, and architecture is no exception. The role of technology in modern architecture has been revolutionary, driving innovation, creativity, and efficiency in the way Cultural buildings are designed, constructed, and experienced. The literature review delves into how modern techniques influence the design, aesthetics and functionality of cultural buildings.

A. Introduction

1) Culture and Its Elements

- ❖ It is the shared way of life for a group.
- ❖ It includes behaviors, beliefs, values and symbols.
- ❖ Passed down through generations via communication and imitations.
- ❖ Serves as Symbolic communication.
- ❖ Shapes the identity of a community.
- ❖ Cultural diversity reflects the richness of human experience, with each culture contributing unique perspectives.

2) Cultural Architecture

- ❖ It is the embodiment of a society's values, beliefs, and traditions in the design and construction of buildings and spaces.
- ❖ It plays a vital role in shaping social interactions, fostering a sense of belonging, and preserving cultural heritage.
- ❖ It evolves over time, blending traditional elements with modern design principles to create structures that resonate with both the past and the present, ultimately enriching society and promoting cultural diversity and understanding.

3) Cultural buildings

- ❖ Cultural buildings are structures that reflect the traditions, beliefs, and values of a specific culture or society.
- ❖ They serve as the tangible manifestation of a culture's intangible aspects
- ❖ Examples of cultural buildings include libraries, schools, auditoriums, and government offices that may benefit people and their communities via healthy design and shared use.

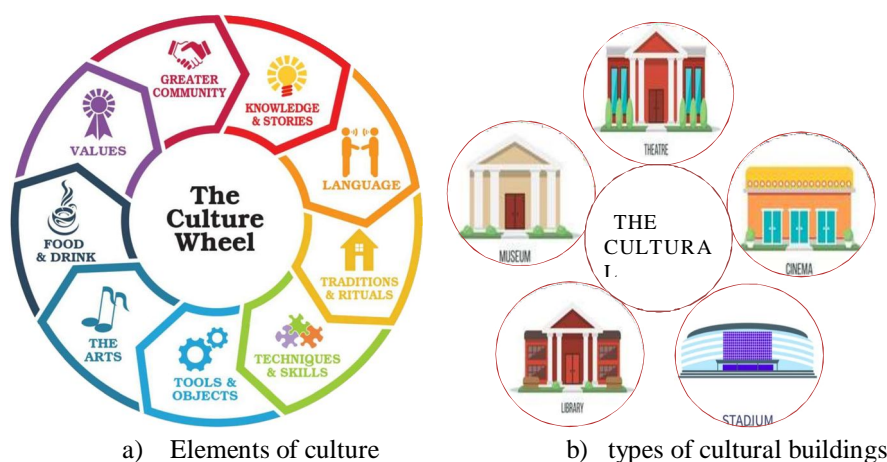


Figure 1 About cultural building

(Source a- <https://rachelelepac.com/>, b- <https://www.shutterstock.com/>)

4) Modern Techniques

- ❖ Design techniques includes Parametric design and Responsive design techniques.
- ❖ Modern construction technique includes prefabrication and modular construction
- ❖ Sustainability is also one of the important aspects of modern technique which includes Green building techniques, Smart building system, universal Accessible principles.
- ❖ Cultural representation is another aspect that include incorporation of local material and have interactive exhibits.

5) Role of Modern Technology

- ❖ Modern techniques can play a significant role in designing cultural buildings
- ❖ Incorporating modern techniques in designing cultural buildings can also help in creating a sustainable environment.
- ❖ For instance, the use of green roofs, solar panels, and rainwater harvesting systems can help reduce the building's carbon footprint.
- ❖ In conclusion, modern techniques can help in designing cultural buildings that are sustainable, energy-efficient, and sensitive to local culture and traditions.

B. Historical context

The evolution of modern techniques in cultural buildings reflects not only advancements in construction technology but also shifting aesthetic preferences, socio-economic contexts, and environmental considerations.

- 1) 19th Century (Industrial revolution): The Industrial Revolution introduces new materials and construction techniques, such as iron and steel framing, enabling the construction of larger and more complex cultural buildings. Ex: - Crystal place, London (1851) as Exhibition hall

- 2) Early 20th Century (Modernist movement): Modernist architects like Le Corbusier and Ludwig Mies van der Rohe prioritize functionalism, simplicity, and innovation in design. Cultural buildings begin to embrace minimalist aesthetics and utilize reinforced concrete for structural integrity. Ex: - Museum of contemporary Art (1929)
- 3) Mid to late 20th Century (Postmodernism and technological advancements): Historical references and eclectic design elements in cultural buildings. Technological advancements: - computer-aided design (CAD) and structural engineering. Ex: - Guggenheim Museum Bilbao (1997)
- 4) 21st Century (Sustainability and Digital innovations): Integration of green building practices and renewable energy technologies in cultural buildings. Digital design tools: - Building Information Modelling (BIM) and parametric modelling. Ex: - Copenhagen Opera House (2005)

C. Design Techniques

1) Parametric Design

Parametric design tools enable architects to create complex, adaptive, and aesthetically pleasing structures that reflect cultural nuances and symbolism. Algorithm-based method merging the design intent with the design outcome. There are different ways by which parametric design is utilized in cultural buildings: -

- ❖ Form exploration and optimization: - enables to create unique, innovative shapes and spatial configurations that reflect the cultural identity or narrative of the project. Ex: - The Louvre Abu Dhabi, UAE
- ❖ Adaptive facades and envelopes: - respond dynamically to environmental conditions such as sunlight, wind, and temperature and enhances energy efficiency and occupant comfort. Ex: - The Museum of the Future
- ❖ Structural optimization and material efficiency: - structurally robust, lightweight, and resource-efficient, while still meeting aesthetic and functional requirements. Ex: - Pradhanmantri Sangrahalaya, India.



- a) The Louvre Abu Dhabi, UAE
- b) The museum of Future
- c) Pradhanmantri Sangrahalaya, India

Figure 2 Example of parametric design utilize in cultural building
(Source a- www.archdaily.com, b- Killa Design | Dezeen, c- Author)

2) Responsive Design

This involves designing structures that can adapt to different environmental conditions. For example, buildings with responsive facades that adjust based on sunlight or temperature. Responsive design in architecture involves creating buildings that adapt to various factors such as environmental conditions, user needs, and cultural context. There are different ways by which Responsive design is utilized in cultural buildings: -

- ❖ Climatic responsive: - respond to local climate conditions, optimizing energy efficiency and user comfort., passive cooling, natural ventilation, and shading devices tailored to the specific climate zone. Ex: - The sheikh zayad learning centre, UAE
- ❖ Interactive facades and envelopes: - respond to environmental stimuli or user interactions, creating dynamic and engaging architectural expressions. Ex: - The museum of tomorrow, Rio de janerio
- ❖ Flexible and adaptable spaces: - This approach allows for the evolution and reconfiguration of spaces to suit changing cultural activities and community requirements. Ex: - The Tate moderns switch house extension, London
- ❖ Cultural sensitivity and contextual design: - integrating local materials, vernacular architectural elements, and cultural symbols to create buildings that resonate with the community and reflect its identity. Ex: - The national museum of African American history and culture, Washington, D.C.



a) The sheikh zayed learning centre, UAE
b) The museum of tomorrow, Rio de janerio
c)The Tate moderns switch house extension, London
d)The national museum of African American history and culture, Washington, D.C

Figure 3 Example of Responsive design utilize in cultural building

(Source: a) [Sheikh Zayed Desert Learning Centre | Al Ain Zoo](#) b) [Welcome | Museu do Amanhã \(museudoamanha.org.br\)](#) c) [The Tate Modern Project — KollektiveLand | KLA](#) d) [National Museum of African American History and Culture - African American Design Nexus \(harvard.edu\)](#))

D. Modern Construction Technique

The study will take into account smaller architectural objects in order to generate an adequate comparison. The conflict is between local and universal, similar to Frampton's pairs, which will assist examine the myth of efficiency between the vernacular house and the modernistic house. The modern house chosen is the most common in today's housing estate developments, whether private or public.

The housing estate home is a typical structure with CMU block or prefabricated concrete walls and a zinc gable roof that is regarded a building industry reference. This modernistic structure was placed on the Coast Region with few adjustments, resulting in unpleasant living conditions. This architectural style, according to the study, is the product of dishonest house developers who prioritise profit over habitability.

1) Prefabrication and Modular Construction

These techniques enhance efficiency, reduce construction time, and minimize environmental impact. They are particularly useful for cultural buildings, ensuring precision and quality while preserving the surrounding environment. Prefabrication involves constructing building components off-site in a controlled factory environment, allowing for simultaneous on-site preparation and assembly. Modular construction utilizes standardized modules that are manufactured off-site and then assembled on-site like building blocks.

- ❖ Efficiency and speed: - These methods can significantly reduce construction time, as site work and building fabrication can occur concurrently, resulting in faster project delivery.
- ❖ Cost-effectiveness; - can lead to cost savings through economies of scale, reduced labour costs, and minimized material waste.
- ❖ Sustainability: - often result in less construction waste and reduced environmental impact compared to traditional building methods.
- ❖ Design flexibility: - accommodate changing programmatic needs or site conditions, offering adaptability and longevity to cultural building projects.



Figure 4 The Board Art Museum, Los Angeles, USA

(Source: [New landmark: The Broad contemporary art museum by Diller Scofidio + Renfro opens in LA | Architecture and design news | CLADglobal.com](#))

2) Insulating Concrete Framework (ICF) Technique

Insulating concrete formwork (ICF) is a construction method that use lightweight formwork (made of insulating material) to support concrete walls while they are being cast in place and then uses the formwork as insulation.

Material used in insulated_concrete_form (ICF); -

Insulating concrete forms are manufactured from any of the following materials:

- ❖ Polystyrene foam (most usually expanded or extruded)
- ❖ Polyurethane foam (most commonly expanded or extruded)
- ❖ Wood fiber bound to cement
- ❖ Polystyrene beads bonded to cement
- ❖ Concrete with a cellular structure

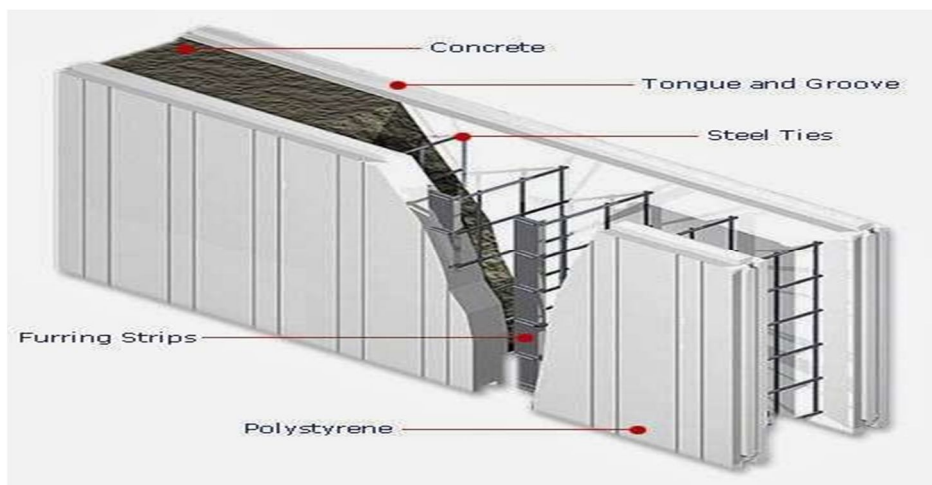


Figure 5 Construction detail of ICF technique

(Source: [2 Insulated formwork system component and application \(Source:... | Download Scientific Diagram \(researchgate.net\)\)](#))

E. Sustainable Technique

Through the incorporation of innovative strategies such as passive design, energy-efficient systems, renewable energy integration, and adaptive reuse, cultural buildings can minimize their environmental footprint while maintaining their historical and cultural significance

1) Green Building Techniques

Modern cultural buildings increasingly incorporate integrating green building technologies, such as solar panels, rainwater harvesting, and energy-efficient designs, such as energy-efficient HVAC systems, renewable energy sources, and eco-friendly materials to minimize environmental impact.

Green building techniques in cultural buildings involve incorporating sustainable design principles, materials, and technologies to reduce environmental impact while preserving cultural heritage

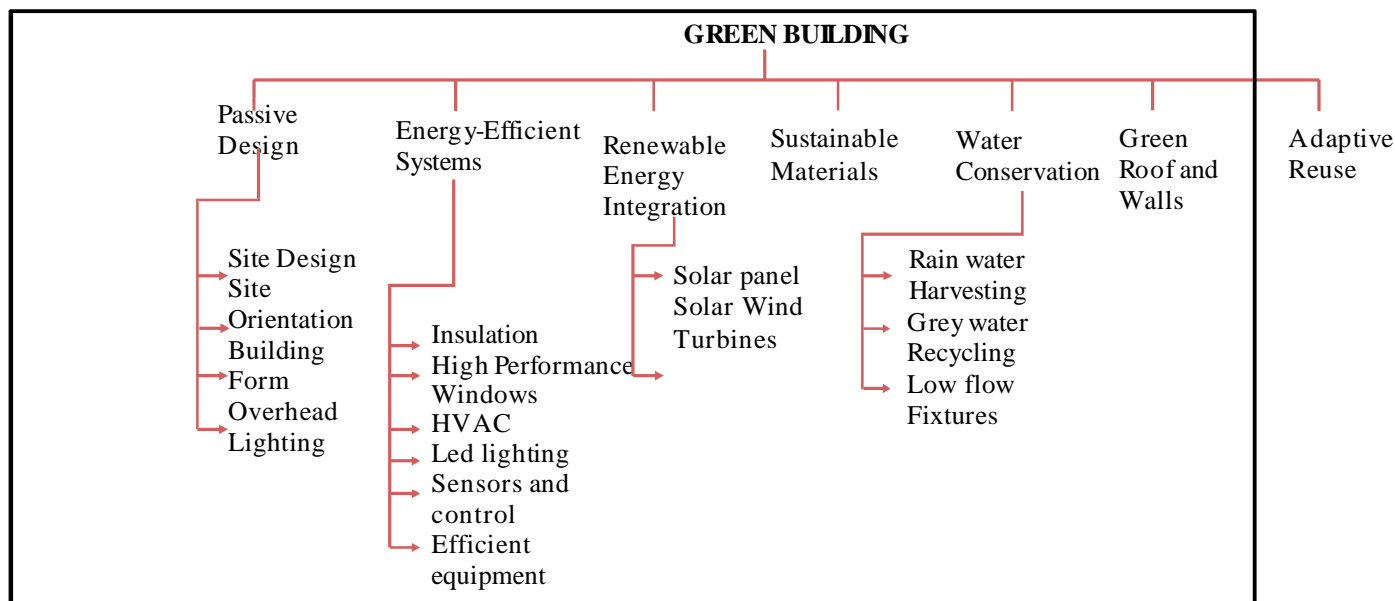


Figure 6 Flow chart of different green building techniques that can be used in cultural buildings

2) Passive design

- ❖ Site design - Site obstructions such as neighboring buildings, trees, and landforms will determine the maximum available daylight on a site Maximize perimeter to daylight.
- ❖ Site orientation: - Orient the majority of the glazing north-south, with a maximum exposure to more easily controllable daylight.
- ❖ Building Form: - Long and narrow footprints are better than square one for access to daylight

Implementing passive design strategies such as orienting the building to maximize natural light and ventilation, thus reducing the need for artificial lighting and mechanical cooling/heating systems.

Sancaklar Mosque in Turkey incorporates passive design principles with its minimalist architecture and use of natural light and ventilation

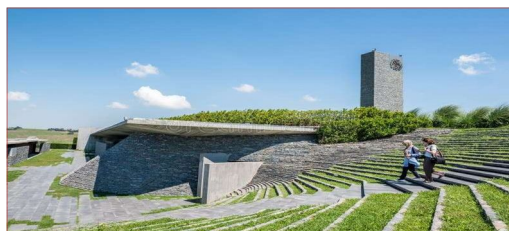


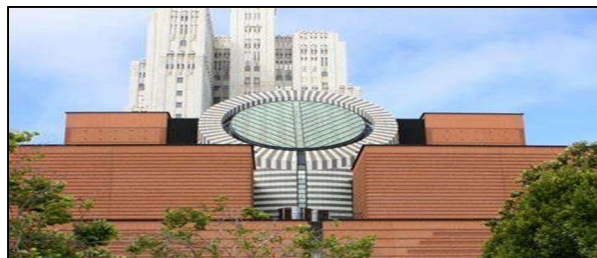
Figure 7 Sancaklar mosque, turkey

(Source: [Exterior view of famous Sancaklar Camii mosque, TURKEY, ISTANBUL,30 JULY 2017 Stock Photo - Alamy](#))

3) Energy Efficient Systems

Installing energy-efficient HVAC (heating, ventilation, and air conditioning) systems, lighting fixtures, and appliances to minimize energy consumption.

- ❖ Insulation: - Proper insulation of walls, floors, and roofs helps to minimize heat transfer between the interior and exterior of the building, reducing the need for heating and cooling.
- ❖ High performance Windows: - Energy-efficient windows with low-emissivity coatings, multiple panes, and insulated frames help to reduce heat loss in winter and heat gain in summer, improving comfort and energy efficiency.
- ❖ Energy-efficient HVAC systems: - utilize advanced technologies such as variable speed drives, energy recovery ventilation, and zoned controls to optimize comfort while minimizing energy consumption
- ❖ Led Lighting: - consume less electricity and lasting longer



The **San Francisco Museum of Modern Art (SFMOMA)** in the United States renovated its building with energy- efficient systems, including LED lighting and a high- efficiency HVAC system.

Figure 8 San Francisco museum of modern art

(Source: [10 architectural things to look for at SFMOMA \(sfchronicle.com\)](https://www.sfchronicle.com))

4) Renewable Energy Integration

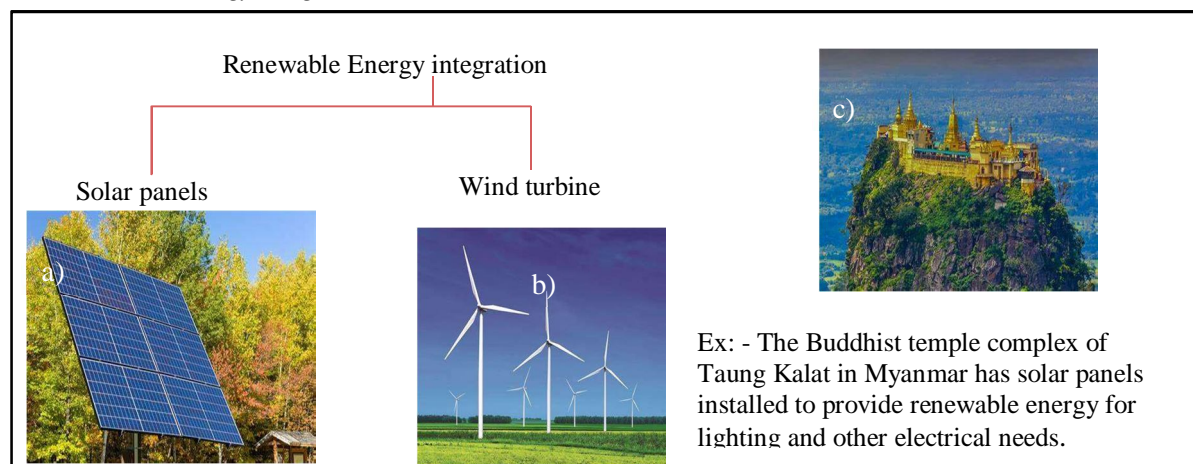
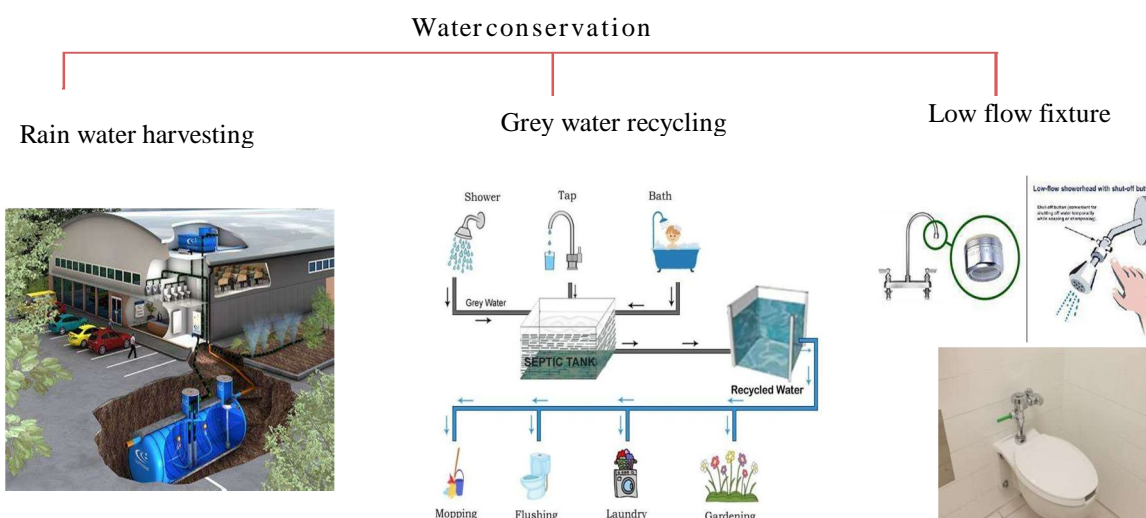


Figure 9 Different Renewable Energy Integration with Example

(Source: a) [PolyCrystalline Solar Panels: Cheap yet efficient long lasting solar panels - The Economic Times \(indiatimes.com\)](https://www.economictimes.com) b) [Energia odnawialna w Polsce - ambitne plany do 2020 roku | zmianynaziemi.pl](https://www.zmianynaziemi.pl) c) [Nature of Myanmar. Photos of the most beautiful places \(sitekid.ru\)](https://www.sitekid.ru))

5) Water Conservation



b) Figure 10 Different water conservation methods

(Source: a) <https://www.renewableenergyhub.co.uk> b) [Are you searching for grey Water Treatment solutions \(netsolwater.com\)](https://www.netsolwater.com) c) <https://th.bing.com/th>)

F. Conclusion

The literature study on modern techniques in cultural buildings reveals a compelling intersection between sustainability, technology, and heritage preservation.

Through the incorporation of innovative strategies such as passive design, energy-efficient systems, renewable energy integration, and adaptive reuse, cultural buildings can minimize their environmental footprint while maintaining their historical and cultural significance. These techniques not only contribute to reducing energy consumption and mitigating climate change but also enhance the overall performance and resilience of cultural structures.

By leveraging green building principles and cutting-edge technologies, cultural buildings can serve as exemplars of sustainable architecture, demonstrating a harmonious balance between tradition and modernity. Overall, the literature study highlights the transformative potential of modern techniques in cultural buildings, offering a roadmap for creating resilient, environmentally responsible, and culturally vibrant spaces for generations to come.

By integrating modern techniques such as parametric design and responsive design with historical insights and sustainable practices, cultural buildings can not only reflect the cultural identity of a society but also achieve enhanced functionality, efficiency, and environmental performance. This holistic approach ensures that cultural architecture remains relevant, resilient, and responsive to the evolving needs of communities while preserving cultural heritage and promoting sustainable development.

III. CASE STUDY

The primary aspects of current modern technology used in cultural buildings are generalised through this case study. To demonstrate them, I chose two museums in two completely different country and one convention centre. One of the museums is in Delhi, India, which is my live case study, another museum is in Dubai

A. Pradhanmantri Sangrahalaya

The Pradhanmantri Sangrahalaya, is a remarkable tribute to every Prime Minister of India since Independence.

Some of the remarkable features or modern technology uses are:

- ❖ Digital Museum - The museum is spread across two buildings. Building 1: the gallery of Shri Jawaharlal Nehru, Constitution galleries, Toshakhana. Building 2: This building showcases the personal lives, along with the social, political, and economic reforms of the succeeding Prime Ministers from Shri Lal Bahadur Shastri to Dr. Manmohan Singh.
- ❖ Engaging Experience: -Light and Sound Show: The Sangrahalaya features an epic saga titled 'Veeranganaon Ki Mahagatha', which celebrates valiant women warriors who upheld the nation's pride. 'Navya Ki Udaan': This program provides visitors with a glimpse of India's technological advances in space exploration over the last 75 years.
- ❖ Visitor Engagement Zone - Anubhuti: Visitors can choose to: Take a 'Selfie with Prime Minister' 'Walk with Prime Minister'. Receive a 'Letter from Prime Minister' Experience a virtual helicopter ride showcasing the architectural and technological marvels of the nation.
- ❖ Interactive Features: Inspirational Messages: Visitors can leave their inspirational messages on the vision feedback wall. Unity Chain: Visitors can record their presence on a big wall in groups. The Sangrahalaya also provides golf carts, wheelchairs, guides/audio guides, a Cafeteria, and a Souvenir shop.



Figure 11 Pradhanmantri Sangrahalaya with two building

(Source: Author)

B. Bangalore International Convention Center

The Bangalore Convention Centre leverages modern technologies to create a dynamic and efficient space for events of all sizes. This likely includes:

- ❖ Smart Building Systems: Integrated controls for lighting, heating, ventilation, and air conditioning (HVAC) to optimize energy use and comfort.
- ❖ High-Speed Connectivity: Robust Wi-Fi and wired internet access to facilitate presentations, information sharing, and real-time communication.
- ❖ Audio-Visual Technology: State-of-the-art sound systems, high-definition displays, and flexible configurations to cater to diverse event needs.
- ❖ Digital Signage: Interactive displays for wayfinding, event information, and dynamic content delivery.
- ❖ Building Management Systems: Centralized control for security, access, and facility management.

By employing these and potentially other advanced technologies, the Bangalore Convention Centre strives to provide a world-class platform for conferences, exhibitions, and events, fostering innovation and collaboration in the heart of India's tech hub.

The modern technology integrated into the Bangalore Convention Centre has significantly enhanced its functionality and efficiency, making it a premier venue for various events and gatherings. With state-of-the-art audio-visual systems, high-speed internet connectivity, advanced lighting, and sound management solutions, the convention centre offers a seamless experience for organizers and attendees alike.

The use of modern technology has transformed the convention centre into a dynamic hub for conferences, exhibitions, seminars, and other events, enabling seamless communication, collaboration, and engagement among participants. From interactive digital displays to virtual reality experiences, the centre leverages cutting-edge technologies to create immersive and memorable experiences for visitors.

Moreover, the integration of smart building systems and sustainability features underscores the centre's commitment to environmental responsibility and resource efficiency. Through energy-efficient lighting, climate control systems, and waste management solutions, the convention centre minimizes its ecological footprint while maximizing comfort and convenience for guests.

In conclusion, the adoption of modern technology in the Bangalore Convention Centre has revolutionized the way events are hosted and experienced. By harnessing the power of innovation, the centre continues to set new standards for excellence in the event industry, attracting both local and international audiences to participate in meaningful exchanges of knowledge, ideas, and expertise.



Figure 12 Bangalore International Convention Centre

(Source: [Photo Gallery - Bangalore International Centre](#))

C. The Museum of the Future

The Museum of the Future in Dubai isn't just a showcase for future technologies, it embodies them within its very structure. Here's a possible conclusion about the modern technology used in this building. The Museum of the Future transcends its role as a museum by using cutting-edge technologies in its design and construction.

These advancements contribute to its functionality, sustainability, and impact:

- ❖ **Parametric Design:** The museum's unique, torus-shaped structure utilizes parametric software to optimize its form for both aesthetics and structural integrity.
- ❖ **Sustainable Materials:** Treated steel cladding minimizes environmental impact while creating a visually striking exterior.
- ❖ **Building Information Modeling (BIM):** BIM likely played a crucial role in the planning and construction phases, ensuring efficiency and minimizing waste.
- ❖ **Renewable Energy Integration:** The museum might utilize solar panels or other renewable energy sources to contribute to its power needs.

By serving as a testament to these technologies, the Museum of the Future becomes an exhibit itself, blurring the lines between showcasing innovation and being an innovative structure. This approach positions the museum as a leader in sustainable and forward-thinking design.

The Museum of Future stands as a testament to the extraordinary possibilities of modern technology, offering visitors a glimpse into what lies ahead. Through its innovative use of cutting-edge advancements such as augmented reality, virtual reality, artificial intelligence, and interactive exhibits, the museum provides an immersive and enlightening experience unlike any other.

By harnessing the power of virtual reality, visitors can explore distant worlds, witness historical events, and even interact with lifelike simulations of future scenarios. Augmented reality overlays digital information onto the physical world, bringing exhibits to life and providing deeper insights into the subject matter.

Artificial intelligence plays a pivotal role in personalizing the visitor experience, adapting exhibits to individual preferences and interests. From intelligent tour guides to interactive installations, AI enhances engagement and facilitates deeper understanding of complex concepts.

Moreover, the museum serves as a hub for innovation, showcasing ground-breaking technologies and inspiring the next generation of creators and inventors. Through interactive workshops, educational programs, and collaborative projects, it fosters a culture of curiosity, exploration, and discovery.

In conclusion, the Museum of Future demonstrates the transformative potential of modern technology in shaping our understanding of the past, present, and future. By pushing the boundaries of imagination and ingenuity, it invites visitors to embark on a journey of exploration and enlightenment, fostering a deeper appreciation for the wonders of science, technology, and human creativity.



Figure 13 The Museum of Future (calligraphy on window)

IV. COMPARATIVE ANALYSIS

S.No.	Parameters	Literature case study	Live case study	National case study	International case study
1.	Concept	Nil	contributions of each Prime Minister to India's development over the last 75 years.	A platform that reflects the <u>ethos and culture of Bangalore</u> as a dynamic, futuristic, aspirational and growing metropolis. A premier, "go-to" place for informed conversations, arts and culture	it seeks to foster solutions to the challenges that future cities face
2.	Space and Functions	Galleries, museums, auditoriums, Library	Gallery of Jawahar all Nehru and Indian constitution Gallery of contribution of each Prime Minister of India	Auditorium, seminar rooms, a library, an art gallery, meeting rooms, and a cafe	exhibition space, seat auditorium, restaurant, café, and lobby.
3.	Architectural style	Nil	Building-i: - colonial architecture Building- ii: - modern architecture	Contemporary architecture	Futuristic
4.	Design	<ul style="list-style-type: none"> • Responsive design • Parametric design 	Responsive design	Responsive design	Parametric design
5.	Construction techniques	Prefabricated Augmented Reality-Assisted Building	Augmented Reality-Assisted Building	Vernacular	Prefabrication

6.	Green building techniques	<ul style="list-style-type: none"> • Passive design • Energy Efficient system • Renewable energy integration • Sustainable materials • Water conservation • Green Roof and walls • Adaptive reuse 	Energy efficient system: - Efficient HVAC system Lighting: - LED lighting Renewable Energy integration: - Solar panel Water Conservation: - Rain water Harvesting Green Roof and walls: - Green roof	submitted for a GRIHA 5 Star certification	attained the LEED Platinum certification in terms of its green rating.
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V. CONCLUSION

Conclusion of Case Study 1: The integration of modern technology within museums not only aids in preserving history but also enhances visitor experiences through features like laser shows and interactive elements such as Unity Chain.

These technological advancements not only enrich the space but also make the museum-going experience more engaging and immersive.

Conclusion of Case Study 2: Cultural buildings can serve multiple purposes beyond their traditional roles. By incorporating mixed-use elements and utilizing energy-efficient systems, they can become vibrant hubs for art performances while also promoting sustainability and resource efficiency.

Conclusion of Case Study 3: Museums can adopt futuristic designs featuring innovative elements such as voids, dynamic facades, and calligraphy while still prioritizing energy efficiency and sustainability. Achieving LEED ratings showcases their commitment to environmental stewardship while embracing contemporary architectural trends.

In conclusion, the case studies underscore the transformative potential of modern technology in museums, highlighting how it not only preserves history but also elevates visitor engagement.

Additionally, they demonstrate the versatility of cultural buildings, illustrating how they can evolve into dynamic spaces that promote sustainability and community interaction.

Moreover, the futuristic designs showcased in the third case study emphasize the harmonious coexistence of innovation and environmental consciousness in contemporary architectural practices.

Together, these conclusions advocate for a holistic approach to cultural and architectural design that prioritizes both heritage preservation and forward-thinking sustainability measures.

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