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PARAMETRIC MODELING OF MULTIFUNCTIONAL BUILDINGS IN THE BIM SYSTEM

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Abstract:
This article analyzes the design and architectural features of multifunctional buildings, particularly exhibition centers, and explores the integration of parametric modeling within the Building Information Modeling (BIM) system. The study focuses on the evolution of exhibition spaces, their key functions, and the role of advanced technologies in improving design efficiency. Special attention is paid to the significance of physical and functional requirements for exhibition buildings and how parametric modeling in BIM can address these needs. The article highlights the advantages of using BIM for multifunctional exhibition centers, emphasizing its impact on flexibility, efficiency, and sustainability.

Keywords: Exhibition buildings, BIM, parametric modeling, design process, multifunctional spaces, building efficiency, sustainability.

INTRODUCTION

Exhibition buildings play a significant role in modern society, acting as hubs for communication, information exchange, and business development. These buildings serve as venues for various events, from global exhibitions to local trade fairs, and provide platforms for presenting innovations, technologies, and cultural heritage. They are not only places for showcasing products and ideas but also foster communication between professionals, consumers, and organizations. Today, exhibition centers are more than just spaces for displaying items; they are dynamic environments for conferences, workshops, and interactive experiences.

The concept of exhibition buildings is broad, with different classifications based on their purpose, operational period, and the content they host. These buildings can be categorized into universal exhibition centers, which host a wide range of events, or thematic centers dedicated to specific industries such as art, design, education, or science. Exhibition centers may also be global, international, national, regional, or local, and their functions extend beyond merely showcasing products to facilitating business deals, academic discussions, and the exchange of knowledge.

The growth of exhibition spaces in Uzbekistan reflects their increasing importance in the economic and cultural landscape. These venues contribute to the country's international recognition and economic development by supporting trade, innovation, and regional cooperation. Despite these advancements, Uzbekistan's exhibition industry faces challenges related to legislative frameworks, organizational infrastructure, and regional disparities. These issues limit the potential for the exhibition sector to fully thrive and meet international standards.

With the increasing complexity of exhibition center design, traditional approaches often struggle to address the diverse and evolving needs of these spaces. The integration of parametric modeling in BIM systems provides an innovative solution that enhances design flexibility, reduces errors, and optimizes construction processes. This article examines how parametric modeling within BIM can be applied to the design of multifunctional exhibition buildings, focusing on the advantages it offers to architects, engineers, and developers.

METHODS

This research employs a combination of qualitative and quantitative methods, including literature review, case studies, and technical analysis of BIM applications in the design of multifunctional buildings. The study analyzes the design processes involved in the creation of exhibition centers, exploring how parametric modeling tools are integrated into the BIM system to optimize building performance, reduce costs, and improve communication among stakeholders.

Design Framework and BIM Integration

The study explores the application of BIM and parametric modeling at each stage of the design and construction of an exhibition center. The key stages identified include:

1. **Conceptual Design**: Establishing the initial parameters, such as spatial configuration, layout, and basic functionality. At this stage, parametric tools are used to test different

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configurations and identify the most effective design solution.

2. **Detailed Design**: Further defining the building's functional requirements, including exhibition hall dimensions, circulation paths, lighting systems, and interactive spaces. Parametric modeling enables designers to quickly adjust and modify elements based on evolving needs.
3. **Construction**: During construction, BIM models provide detailed data for material procurement, scheduling, and coordination among contractors. Parametric modeling supports the creation of efficient construction plans, minimizing waste and optimizing material usage.
4. **Operation and Maintenance**: BIM's role extends beyond the construction phase to include facility management and long-term operation. Parametric modeling assists in optimizing energy consumption, maintenance scheduling, and system efficiency throughout the building's lifecycle.

Parametric Design Methods

The parametric design methods utilized in the study involve defining specific building parameters that control various aspects of the building's form and function. These include:

- **Geometric Parameters**: Dimensions, form, and spatial relationships are treated as adjustable parameters within the model. These allow for dynamic alterations to the design without compromising the integrity of the model.
- **Functional Parameters**: These relate to the building's purpose and usage, such as room sizes, layouts, and accessibility requirements. Parametric models can be adjusted based on the changing needs of different events or exhibitions.
- **Material and Structural Parameters**: Materials, construction systems, and structural elements are modeled parametrically to ensure the building is both functional and sustainable. This approach allows for the optimization of material costs and environmental impact.
- **Economic and Time Parameters**: Cost estimation, time schedules, and resource allocation are calculated through BIM models, allowing for a comprehensive understanding of project scope and budget.

By employing these methods, the study demonstrates how parametric modeling in BIM can address complex design challenges while maintaining flexibility, precision, and efficiency.

RESULTS

The integration of parametric modeling in BIM for the design of multifunctional exhibition buildings has demonstrated several key benefits, including:

Increased Flexibility and Adaptability

Parametric modeling allows designers to easily modify the building's parameters to accommodate changing requirements. Whether adjusting spatial configurations for different events or optimizing energy-efficient systems, parametric tools provide the flexibility needed to respond to evolving demands. For example, the layout of exhibition halls can be adjusted depending on the scale and type of event, while maintaining optimal visitor flow and functionality.

Enhanced Collaboration and Communication

BIM's centralized data system ensures that all stakeholders—architects, engineers, contractors, and clients—have access to the same up-to-date information. This enhances collaboration by providing a clear, shared vision of the project and minimizing misunderstandings. The visual nature of BIM models also facilitates communication with clients, allowing them to better understand design proposals and make informed decisions.

Improved Efficiency and Cost-Effectiveness

Parametric modeling automates many repetitive tasks, such as material quantity calculations and cost estimations. By integrating these tasks into the BIM system, the design process becomes more efficient, saving both time and money. Additionally, parametric tools allow for more accurate cost forecasting, helping to prevent budget overruns.

Sustainability and Energy Optimization

Parametric modeling enables the analysis and optimization of energy-efficient systems within the building. From lighting to HVAC systems, BIM models allow for simulations that optimize performance and reduce environmental impact. These tools can also help in selecting sustainable materials and incorporating renewable energy solutions, such as solar panels and rainwater harvesting systems.

Error Reduction and Accuracy

Because BIM models are dynamically linked to parameters, any change made in one part of the design automatically updates the entire model. This ensures that all aspects of the design remain coordinated,

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reducing the likelihood of errors and inconsistencies during construction.

DISCUSSION

The application of parametric modeling within BIM systems significantly enhances the design and construction of multifunctional exhibition centers. By providing a dynamic and flexible design environment, BIM enables designers to explore multiple design options and make adjustments quickly. This is particularly valuable in the context of exhibition spaces, where layout and functionality must adapt to a wide range of events and visitor requirements.

Challenges and Opportunities

Despite the clear advantages, the adoption of BIM and parametric modeling faces several challenges. In some regions, the technology remains underutilized due to a lack of trained professionals and the high initial costs associated with setting up a BIM system. Additionally, the integration of BIM into traditional construction practices requires a shift in industry culture and processes.

However, the long-term benefits—such as improved efficiency, reduced costs, and enhanced sustainability—present compelling reasons for adopting these technologies. As BIM continues to evolve, its potential to revolutionize the design of exhibition buildings becomes increasingly evident.

Future Research Directions

Future studies should explore the integration of advanced simulation tools within BIM models, particularly in terms of environmental performance and energy modeling. Additionally, research could focus on the development of BIM standards and guidelines specifically tailored to exhibition centers, ensuring that all stakeholders adhere to consistent and effective practices.

CONCLUSION

Parametric modeling within the BIM system represents a powerful tool for the design and construction of multifunctional exhibition buildings. By allowing for flexibility, efficiency, and sustainability, it transforms how exhibition centers are planned and built. As the adoption of BIM grows in the architectural and construction industries, the integration of parametric design will continue to shape the future of exhibition space design, providing more adaptable, cost-effective, and environmentally responsible solutions.

The ongoing development of BIM and parametric modeling technologies will play a crucial role in advancing exhibition buildings, helping them meet the diverse and changing needs of the global community while supporting economic, cultural, and technological growth.

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