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Multidimensional Perspectives on Temporary Architecture: Exploring the Social, Political, and Economic Impacts through the Case Study of Leishenshan Hospital

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ABSTRACT

This paper explores the use of temporary buildings in COVID-19 emergencies, focusing on Leishenshan Hospital in Wuhan. Data sources include literature, technical staff, and expert interviews. It highlights modular construction, BIM technology, adaptability, sustainability, and teamwork. The conclusion emphasizes modular construction and BIM technology's role in accelerating projects, while noting the importance of considering socio-cultural and environmental impacts.

KEYWORDS

Leishenshan Hospital; temporary buildings; modular construction; BIM technology

1. INTRODUCTION

In 2020, Wuhan, China, closed its city to combat the COVID-19 epidemic. Due to a shortage of beds, the Wuhan government decided to build Leishenshan Hospital. This dissertation analyzes Leishenshan Hospital to reveal the impact of temporary buildings in design, construction, and use. It explores how temporary buildings quickly respond to social needs, assessing their effectiveness in social, political, and economic dimensions [1]. Socially, it focuses on meeting public health requirements and promoting well-being, aligning with Sustainable Development Goal 3. Politically, it examines government decision-making and its impact on public trust, related to Goal 16. Economically, it assesses cost management and resource efficiency, reflecting Goals 9 and 11. The urgency to build these facilities under economic constraints highlights Goal 13. Limited to case studies, with a focus on Leishenshan Hospital, this review aims to establish a framework for future temporary building planning and implementation [2]. It raises questions about temporary buildings' roles, impacts, and challenges, exploring their multidimensional impact through Leishenshan Hospital and other literature. By comparing Leishenshan Hospital with other cases, this study provides a comparative analysis, highlighting temporary buildings' utility. It introduces the SDGs and their relevance, identifying research gaps and exploring how to fill them. Challenges in designing and implementing temporary buildings, such as material procurement and BIM technology use, are also discussed.

2. LITERATURE REVIEW

This paper explores the impacts of temporary buildings, focusing on disaster response, healthcare facilities, and COVID-19, considering procurement, transportation, and design team integration, with emphasis on BIM and modular buildings. The literature search used Manchester Metropolitan

University Library and Google Scholar, yielding 53 relevant studies on BIM in emergency medical buildings. After detailed review, 13 articles were analyzed. The Leishenshan Hospital exemplifies temporary construction, showcasing modular, standardized, and assembled buildings' impacts. Modularity enables rapid installation and shorter construction cycles by allowing simultaneous manufacturing in various locations, emphasizing planning to execution and infectious disease control. Standardized production ensures consistency and quality, facilitating BIM integration, improving efficiency, and promoting prefabricated construction's advantages like reduced labor, minimized waste, and enhanced quality control. Prefabricated modules seamlessly meet hospital requirements, aiding rapid health crisis response.

Research Goal and Future Directions

Leishenshan Hospital showcases the efficacy of modularity, standardization, and prefabrication in emergency medical construction, prompting further exploration of their scalability and adaptability in diverse contexts. Future research should assess these technologies' global potential in addressing viral crises [3].

2.1. Concluding Thoughts

Leishenshan Hospital sets a benchmark for innovative temporary building in healthcare, influencing future construction practices. This study raises questions about temporary buildings' roles in public health crises, their socio-political-economic impacts, and design/implementation challenges and opportunities [4]. Through the Mobile Cube Hospital case, it aims to explore these impacts, contributions, and limitations, guiding future urban planning and emergency responses.

2.2. Political and Economic Influence

Leishenshan Hospital's construction underscores the impact of modern construction techniques in rapid development projects, offering lessons on political and economic influences.

The Government's rapid mobilization of resources for Leishenshan Hospital reflects its commitment to public health, setting a benchmark for emergency response infrastructure. The modular, standardized, and prefabricated approach underscores political priority for innovation, efficiency, and scalability. This approach reduced construction time and costs, minimized site disruption, and stimulated economic activity across industries [5]. It also suggests a sustainable model for rapid infrastructure deployment in future emergencies. Discussion questions include optimizing this construction method for quicker deployment, exploring long-term economic benefits beyond immediate emergencies, and using Leishenshan's experience to streamline political decision-making for future rapid responses [6].

3. METHODOLOGY

This qualitative study examines the social, political, and economic impacts of temporary buildings, focusing on a "mobile cabin hospital." It uses a literature review and technical staff consultations to analyze temporary construction's effects. The literature review covers design, innovations, and impacts, while technical staff provided insights on BIM technology. Interviews with UCL scholars specializing in intelligent construction, Mr. Sun and Ms. Fan, who won a BIM modeling contest, further deepened understanding. They praised Leishenshan Hospital as a pivotal case and discussed BIM technology's pros and cons, citing China's New Infrastructure Cup competition as an example. These conversations enhanced understanding of BIM technology [7].

4. CASE STUDY ANALYSIS: LEISHENSHAN HOSPITAL

This study enriches understanding of temporary buildings' impact through literature reviews, technician consultations, and streaming interviews with temporary construction experts. Content analysis will identify themes from the literature, while critical insights from consultations and interviews will be compared to reveal the buildings' roles and impacts. The methodological framework explores temporary buildings' social, political, and economic effects, aiming to inform urban planning, emergency response, and temporary construction practices.

4.1. Case Study Introduction

Leishenshan Hospital in Wuhan, built in response to the COVID-19 epidemic, serves as a pivotal case study for evaluating temporary buildings' utility and impact globally. Constructed in Junyun Village, Jiangxia District, Wuhan, Leishenshan was the second temporary hospital decided on January 25, 2020, completed on February 6, and began operations on February 8, with a total of 1,600 beds. Named after the Chinese legend's god of thunder, the naming sparked debate but was later explained as symbolizing the restraint of evil through ancient myths.

Chosen as a case study due to its rapid emergency response, Leishenshan Hospital's construction and operation demonstrate temporary buildings' swift deployment capabilities. Built in just 12 days by the third Bureau of China Construction and other units, with central budget subsidies, it showcases efficiency and organization. This case study highlights temporary buildings' critical role in emergency responses and their feasibility for rapid deployment.

4.2. Establishment and Background of Leishenshan Hospital

Leishenshan Hospital's establishment highlights the role of temporary architecture in crisis management, particularly during the COVID-19 epidemic. As a rapid response, its completion showcased close cooperation between the Chinese government and various sectors, demonstrating the importance of temporary buildings in global health emergencies.

4.3. Social Impact of Temporary Medical Facilities

The Chinese government quickly responded, integrating resources from construction companies, medical suppliers, logistics firms, workers, and volunteers, while providing financial support. This multi-unit collaboration, involving multiple government departments, private enterprises, and civil society organizations, was unprecedented. Companies and volunteers worked tirelessly to complete the hospital swiftly, breaking doubts about the method's feasibility [8].

Government-private sector cooperation extended beyond funding and resources to sharing key technologies. Leading architecture firms shared expertise, accelerating construction and enhancing functionality and safety. Social mobilization and volunteerism were crucial, with thousands of local service workers contributing, fostering community solidarity and alleviating public anxiety.

Transparency and timely information updates from the government and media further increased public trust and support, effectively reducing panic over the epidemic.

Temporary medical facilities, exemplified by Leishenshan Hospital, significantly enhance public health emergency response. By swiftly providing additional medical space and resources, they ensure continued access to emergency services during crises like COVID-19. Innovations like modular construction accelerated facility setup, offering new strategies for future emergencies. These facilities boost public confidence and social stability by demonstrating crisis management capabilities and alleviating resource shortage fears. They also support long-term public health system resilience by adapting to evolving needs post-crisis. Cross-sectoral collaboration during construction and operation

improved crisis response and shared valuable lessons. In summary, temporary facilities are crucial for enhancing public health emergency capacity, showcasing the importance of innovation, collaboration, and flexibility.

4.4. Comparative Analysis of Leishenshan Hospital and Other Temporary Medical Facilities

A comparative analysis of makeshift hospitals, like Leishenshan, highlights the role of temporary buildings in public health crises. Evaluating the efficiency and effectiveness of different construction techniques is crucial. Modular buildings, prefabricated in factories and quickly assembled on site, played a key role in Leishenshan's construction, reducing on-site work, weather dependence, and allowing rapid installation. Italy also used modular technology during COVID-19, demonstrating its broad application. Modular buildings address industry challenges like high costs and labor shortages, and promote sustainable practices like green energy use. Sustainable building practices, including environmentally friendly materials and energy efficiency, have long-term environmental and economic benefits, as seen in disaster-related temporary housing projects in Japan.

The Leishenshan Hospital project showcases rapid assembly and disassembly through prefabricated buildings, simplifying construction and enabling quick setup and teardown post-crisis. This approach has been effective in temporary health facilities globally, like the Nightingale Hospital in the UK. However, despite high-level industrialization and assembly of prefabricated modules, integration with electromechanical equipment still relies heavily on on-site installation, with low medical equipment integration. Thus, Leishenshan achieved rapid construction, but not true rapid assembly and disassembly.

4.5. Integrated Application of BIM and Modular Technology

BIM technology and modular construction in temporary hospitals, exemplified by Leishenshan, showcase modern construction advancements. [9] BIM enhances design and planning efficiency, enabling 3D modeling, issue prediction, and information synchronization, thus accelerating construction. Modular technology, with factory-made components, reduces on-site construction time. Together, they improve construction quality by pre-analyzing building performance and minimizing errors, supporting UN's Sustainable Development Goals. BIM also optimizes resource use, reduces waste, and guides eco-friendly material selection, promoting sustainable building development. The integration of BIM and modular technology minimizes material waste, aligns with UN's SDG 11, and significantly boosts the sustainability of temporary hospital projects.

5. DISCUSSION

Analyzing temporary construction challenges in emergencies, we focus on Wuhan Leishenshan Hospital as a case study. This project offers practical experience and innovative strategies for rapid, sustainable green building through prefabricated methods. It highlights standardized design, industrial production, and close designer-engineer collaboration, significant for temporary construction and future projects. During COVID-19, it showed how to meet rapid construction needs while ensuring safety and managing supply chain disruptions. Using modular, standardized, prefabricated strategies, the project facilitated fast production, transportation, and reduced construction complexity, proving innovative methods can swiftly respond to emergencies.

BIM technology is crucial for construction safety, identifying risks via prefabricated design and process simulation. Fluid simulation optimizes airflow, enhancing safety. Leishenshan Hospital's supply chain management, via collaboration with multiple bases and technology, minimized supply disruption risks. Its success signifies an innovative leap in temporary construction, breaking traditional limits and demonstrating potential in rapid builds. Modular design and BIM technology

were pivotal: modular units and layouts expedited construction while BIM optimized processes, improved speed and quality, and facilitated information management. Leishenshan Hospital's experience underscores the importance of modular design, BIM, and effective supply chain management in rapid, safe, efficient temporary construction, offering valuable insights for future emergencies [10].

Temporary construction projects like Leishenshan Hospital face challenges in complying with building codes, health & safety standards, and environmental regulations under tight deadlines. Expediting the approval process is crucial, often requiring innovative workflows and special policy support. Adapting to different regulations across jurisdictions is another challenge, necessitating familiarity with both national and local requirements.

Environmentally, temporary projects must minimize waste and energy consumption. Modular and prefabricated components reduce on-site waste and energy use, while sustainably sourced and recyclable materials further mitigate environmental impact. Considering the building's lifecycle ensures dismantling and recycling at project end, enhancing sustainability.

Ensuring safety, durability, and cost-effectiveness were key challenges for the Leishenshan Hospital project. Steel structures and prefabricated lightweight medical wallboard were used to enhance stability and durability, with quality control measures like ultrasonic weld inspection in place.

Modular, standardized, and assembled construction methods were pivotal, speeding up construction, reducing costs, and ensuring safety and durability. BIM technology optimized design, simplified project management, improved cooperation, and enabled real-time monitoring, further enhancing efficiency and quality.

Cost management was addressed through modular design and BIM, which shortened design-to-material preparation cycles and optimized resource utilization. Leishenshan Hospital's construction showcased China's industrial modernization, design-construction integration, and medical manufacturer development.

Technological innovations like modularity and BIM shortened the construction period, reduced costs, and had minimal environmental impact, aligning with UN Sustainable Development Goals. The project's success offers valuable experience for future temporary hospital projects, with potential for wider application in public health events and natural disasters.

Adaptive reuse of structures and digital remote construction management were key in the Leishenshan Hospital project. Demolished buildings and components were sterilized and reused, saving resources and time while preserving history. Digital tools like BIM simplified project management, improved decision-making, and reduced the need for field personnel. The BIM-QR system monitored production and transportation, ensuring efficiency and quality. Drones for site inspections and remote monitoring further enhanced project efficiency and safety.

This project demonstrated that adaptive reuse and digital management improve construction efficiency, resource conservation, and quality. Their combined use had a synergistic effect. Technical cooperation was crucial for responding to public health emergencies and provides valuable experience for future projects.

The Leishenshan Hospital project highlighted the need for flexible regulatory frameworks during emergencies. Policymakers and regulators should develop policies to support rapid mobilization and construction. Future temporary construction projects should consider sustainable materials and practices, including modular and prefabricated components and BIM, to reduce waste and align with UN SDGs.

This study provides a multi-dimensional framework for understanding the impact of temporary buildings in emergencies, emphasizing the importance of an integrated approach. It contributes to urban planning and construction through analysis of BIM technology, modular construction, and

innovations in digital management. While focused on a Chinese case, it offers valuable lessons and challenges for future projects globally. The study emphasizes analyzing projects from social, political, and economic perspectives to understand broader implications.

6. CONCLUSION

Summary of Main Research Results:

This paper examines the use of temporary buildings in public health emergencies, using Leishenshan Hospital in Wuhan, China, as an example. The rapid construction of Leishenshan Hospital during the COVID-19 pandemic demonstrates the effectiveness of temporary structures in addressing emergency medical needs.

6.1. Key Findings Include

Modular construction and BIM technology expedite the construction of temporary projects while ensuring quality and safety.

Temporary structures show adaptability and sustainability through strategic planning and eco-friendly materials.

Multidisciplinary teamwork, including architecture, urban planning, public health, and engineering professionals, contributed to the hospital's success.

6.2. Future Guidance from Leishenshan Hospital Includes

Improved modular designs for flexibility and faster deployment.

Incorporation of BIM and other digital tools in planning, construction, and operation.

Development of adaptable policies and regulations.

Focus on sustainability with new materials and techniques.

Engagement with communities and stakeholders in decision-making.

6.3. Limitations and Future Research

The study is limited to one case, suggesting future research should include more cases for a comprehensive perspective.

Data accessibility is challenging due to the timeliness of temporary projects; future studies should cooperate closely with project stakeholders.

Sociocultural factors should be considered for successful implementation and integration.

Long-term environmental impact assessments are needed to explore sustainability.

Overall, the study highlights the importance of temporary hospital buildings in public health crises and suggests areas for further research to enhance understanding and future crisis management.

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