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COMPARISON OF TRADITIONAL AND MODERN CONSTRUCTION EFFICIENCY IN TRANSPORTATION INFRASTRUCTURE DEVELOPMENT PROJECTS

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Abstract

In recent decades, the development of construction technology has produced two main approaches in the implementation of transportation infrastructure projects, namely traditional and modern construction methods. The selection of an efficient construction method affects the project's duration and impacts the construction's cost, quality, and environmental impact. It aims to analyze and compare the efficiency of the implementation time of transportation infrastructure projects between traditional and modern construction methods and identify differences in the cost of implementing transportation infrastructure projects using traditional and contemporary construction methods. Evaluate the quality of construction results and the environmental impact of traditional and modern construction methods in transportation infrastructure projects. This research method is by reviewing journals, books, reports, and scientific articles related to the efficiency of traditional and modern construction, conducting case studies on transportation infrastructure development projects, both conventional and contemporary, involving experts, contractors, or project managers to gain in-depth insight into the construction efficiency of the two methods, using questionnaires to collect data from various transportation development projects, comparing traditional and modern construction methods. From all that, it produces real examples of contemporary construction efficiency, which can be seen in the construction of toll roads or bridges with advanced Technology, where technologies such as drones, IoT sensors, and BIM (Building Information Modeling)-based design software significantly increase work effectiveness. On the other hand, traditional construction is still used in remote areas or low-complexity projects that do not require advanced Technology. Therefore, choosing the right construction method must consider the scale of the project, its complexity, and the final goal to be achieved.

Kata Kunci : Konstruksi, Tradisional, Modern, Efisiensi

INTRODUCTION

Transportation infrastructure development plays a crucial role in driving economic growth, enhancing regional connectivity, and facilitating the efficient movement of people and goods. The continuous advancements in construction technology have led to two dominant approaches in transportation infrastructure projects: traditional and modern construction methods. The selection of an appropriate method significantly influences not only the duration of the project but also its overall cost, quality, and environmental impact.

Traditional construction methods, which primarily rely on manual labor and conventional techniques, remain widely used, especially in developing countries. This approach is often preferred due to its relatively low initial costs and the availability of a workforce familiar with conventional

techniques. However, it faces several challenges, including a high dependence on human labor, extended project durations, and inconsistent quality outcomes, which can lead to increased maintenance costs in the long run. Additionally, traditional methods may have a greater environmental impact due to inefficient resource utilization and higher material waste.

On the other hand, modern construction methods leverage the latest technological advancements, such as automation, prefabrication, and digital project management tools. These technologies enhance efficiency by reducing construction time, minimizing errors, and optimizing resource allocation. Despite these advantages, modern construction requires a substantial initial investment in machinery, skilled labor, and infrastructure readiness. The transition from traditional to modern construction also demands a well-trained workforce capable of operating advanced technology.

Therefore, selecting the most suitable construction method depends on various factors, including project scale, budget constraints, workforce availability, and environmental considerations. A hybrid approach that integrates both traditional and modern methods may provide a balanced solution, ensuring cost-effectiveness while maintaining efficiency and quality in transportation infrastructure development.

Research conducted by Li et al. (2020) revealed that using modern technology in transportation infrastructure projects can reduce project implementation time by up to 30% compared to traditional methods. This efficiency is achieved through automation, improved project monitoring, and optimized resource allocation. However, the study also highlighted that the application of modern technology requires a level of readiness of human resources and adequate supporting infrastructure, which can be a challenge in regions with limited technical expertise and financial constraints.

In a different context, Singh and Jain (2019) showed that traditional methods are still relevant for small projects or areas with limited access to advanced technology. These methods, while slower, often require lower initial investment and can be implemented using locally available resources. Therefore, the choice between modern and traditional methods depends on project scale, budget, and the availability of technological infrastructure, making a hybrid approach a practical solution in certain cases.

This study examines the efficiency of traditional and modern construction methods in transportation infrastructure projects by evaluating key factors such as time, cost, quality, and environmental impact. Traditional methods, while often requiring lower initial investment, may result in longer project durations, whereas modern technology-driven methods can significantly enhance efficiency but demand higher resource readiness. By analyzing these aspects, this study aims to provide valuable insights for decision-makers and industry practitioners in selecting the most suitable construction approach based on project scale, budget, and available infrastructure. The findings are expected to support informed decision-making and promote sustainable infrastructure development.

LITERATURE REVIEW

Production Efficiency Theory

Production efficiency theory explains how resources can be optimally utilized to produce output with minimal cost and time. According to Farrell (1957), production efficiency can be divided into **technical efficiency** and **allocative efficiency**. In the context of transportation infrastructure construction, modern methods tend to have higher technical efficiency due to the use of advanced technologies such as Building Information Modeling (BIM), prefabrication, and automation. In contrast, traditional methods rely heavily on manual labor, which can lead to inefficiencies in project execution.

Project Management Theory

Project management theory, as proposed by Kerzner (2017), emphasizes the importance of **planning, organizing, execution, and control** in construction projects to achieve efficiency in terms of time, cost, and quality. Modern construction methods facilitate better project management through the use of digital technologies and real-time data management systems. On the other hand, traditional methods often face challenges in project control due to limited monitoring tools and reliance on workers' experience.

Sustainable Construction Theory

The sustainable construction theory (Hill & Bowen, 1997) highlights the environmental, social, and economic aspects of the construction process. Modern construction methods align more closely with sustainability principles by reducing material waste, improving energy efficiency, and incorporating environmentally friendly technologies. In contrast, traditional construction methods often generate higher waste and have a more significant environmental impact due to the uncontrolled use of materials.

METHOD

The method used to conduct this research is with the following stages:

1. Literature Studi

   This literature study provides valuable insights into the analysis to be conducted, helping researchers understand the appropriate methods and frameworks. Additionally, it serves as a reference by comparing previous studies, identifying research gaps, and strengthening the theoretical foundation. This process ensures that the research is well-informed and contributes to existing knowledge.

2. Data Collection

Data collection is conducted to obtain both theoretical and empirical data relevant to the research field. This process involves various methods, such as observations, interviews, surveys, or document analysis, to ensure comprehensive and accurate information. The collected data serves as a foundation for analysis, interpretation, and drawing meaningful research conclusions.

3. Analyzing

   The next stage involves analyzing the collected data to extract meaningful insights and identify patterns or relationships. This process may include qualitative or quantitative methods, such as statistical analysis, thematic coding, or comparative evaluation. The results of this analysis help in drawing conclusions and making informed research decisions.

RESULTS AND DISCUSSION

Traditional Construction

Traditional construction refers to building methods that use old techniques that have proven reliable over time. These methods usually involve significant manual labour, simple tools, and more conventional materials.

1. Advantages of Traditional Construction
   a. Lower Initial Costs: Traditional construction often requires a smaller initial investment than modern methods, as it relies more on manpower than expensive equipment.
   b. Flexibility in small-scale or low-complexity projects and traditional construction allows greater flexibility in field design adjustments.
   c. Risk control of human labour provides better control over technical details and possible construction errors that can be more easily corrected.
2. Weaknesses of Traditional Construction
   a. Longer Time The construction process tends to take longer because of the amount of work that is done manually.
   b. Limited Efficiency Lower productivity capabilities compared to modern methods result in less-than-optimal efficiency.

Risk of Human Error Human error is more likely to occur in traditional construction, which can lead to additional costs for repairs and material replacement.

Modern Construction

Modern construction refers to using advanced technology and innovation to construct transportation infrastructure. Automation, advanced equipment, and data-driven processes are central to higher efficiency.

1. Advantages of Modern Construction
   a. Higher Efficiency: Modern construction can complete projects faster and with a higher degree of precision through automation and modern equipment.

b. Lower Operating Costs Although the initial investment costs are higher, modern Technology often results in greater efficiencies in the long term, reducing waste of materials and labour.
c. Better Quality integration of advanced Technology improves the quality of construction results, reducing the possibility of structural failure or premature damage.

3. Weaknesses of Modern Construction
   a. Higher Initial Costs Initial investment in modern Technology, such as heavy equipment, sophisticated software, and skilled labour, can hinder some small or medium-scale projects.
   b. Dependence on Technology In some cases, dependence on Technology can lead to the risk of system failure if the tools or systems used are disrupted.
   c. Complexity Project management with modern methods tends to require more complex management, including real-time data management, system integration, and coordination between various disciplines.

Efficiency Comparison

1. Construction Completion Time

   Modern construction has a significant advantage when it comes to project completion time. Heavy equipment, automation technology, and data-driven project management make the construction process more time-efficient, especially for large-scale projects requiring high accuracy.

2. Cost

   Although the initial cost of modern construction tends to be higher, the resulting efficiencies can reduce operational and maintenance costs in the long run. On the other hand, traditional construction has a lower initial cost but a longer completion time and a higher risk of budget overruns.

3. Quality and Precision

   Modern Technology allows for a high degree of precision in construction, reducing the likelihood of construction errors that can increase time or cost. In contrast, traditional construction relies more on the expertise of manual labour, which can be challenging to maintain consistent quality.

4. Risks

   Technology-based controls lower the risk of human error and material failure in modern construction. However, the risk of technological system failure remains, although it is rare. Meanwhile, traditional construction faces a higher risk of human error and technical inaccuracy.

Implementation

A real example of modern construction efficiency can be seen in the construction of toll roads or bridges with advanced Technology, where technologies such as drones, IoT sensors, and BIM (Building Information Modeling) based design software significantly increase work effectiveness. In

contrast, traditional construction is still used in remote areas or low-complexity projects that do not require advanced Technology.

CONCLUSION

A comparison of traditional and modern construction efficiency in transportation infrastructure development projects reveals significant differences in various aspects. Modern construction methods, which utilize advanced technologies such as Building Information Modeling (BIM), prefabrication, and automation, provide higher efficiency in terms of time, quality, and precision. These methods allow for faster project completion, reduce human error, and enhance overall construction accuracy. However, their implementation requires higher initial investment costs, advanced technical expertise, and complex management strategies. On the other hand, traditional construction methods remain relevant, particularly in small-scale projects or areas with limited access to modern technology. These methods offer greater flexibility and adaptability, especially in environments where skilled labor is abundant but technological resources are scarce. Although traditional methods may require longer construction times and pose quality control challenges, they often come with lower initial costs and are easier to implement in remote or underdeveloped areas.

Therefore, choosing the appropriate construction method should be based on project scale, complexity, budget, and final objectives. A hybrid approach that integrates traditional and modern construction techniques may also be a viable solution, allowing for optimized efficiency while addressing cost and management concerns. Effective decision-making in method selection can significantly impact the success of transportation infrastructure projects.

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