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Sustainability-Driven Innovation in Engineering Project Governance Models

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Abstract: Due to the unprecedented rate of global economic and social development, the conflict between mankind, natural resources and the environment has increased. Major infrastructure projects provide significant benefits to regions. On the other hand, these projects often consume substantial resources and can create lasting, hidden ecological burdens, posing long-term sustainability challenges. This paper adopts the sustainable management practices by Skanska, which has been officially published in LaGuardia Airport Terminal B redevelopment project, which won the world's first Envision Platinum award. The paper frames sustainability as a collaborative governance effort among stakeholders, analyzing governance measures for major projects and implemented through local policy. The results are impressive, showing a 99.92% waste recycling rate, 19% energy savings, and a 40% reduction in water consumption, demonstrating a tangible impact of governance innovation. The paper gives us useful information and ways to make certain that Public-Private Partnerships (PPPs) projects continue over the long-term. It offers fresh experience in managing these partnerships so they are not weak or unprofitable in the future, and so people working on projects will be more confident in their operations, achieving positive outcomes and providing valuable management experience for other types of PPP project construction.

Keywords: Sustainability concept, PPP projects, governance measures.

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1. Introduction

With the development of science and technology and the acceleration of urbanization, human society has encountered serious problems associated with major environmental and developmental issues. Rapid population growth, resource depletion, climate anomalies, environmental pollution, and ecological destruction are all problems that threaten human existence and development. Thus, how to save resources, reduce carbon emissions and achieve sustainable development during the process of urbanization has become a hot topic in the field of architecture. Traditional governance has always emphasized costs and timelines while ignoring the environment and people. It also causes high energy consumption, high pollution, and high waste in the process of building and operation. The short lifespan, poor quality, and poor performance of residential buildings often result in huge demolition, followed by reconstruction that destroys the harmony among people, the natural environment, and human living spaces. Green buildings comprehensively consider environmental factors during the planning and implementation stages, enhance indoor environmental quality and comfort, and embody a people-oriented design philosophy (Valencia, et al, 2022). With global resources and climate crisis the sustainable development of urban architecture has become a key topic in architecture.

The operation and management of major projects can strongly support social and economic stability. Public-Private Partnership (PPP), a collaboration between government and private capital, is an effective way to finance and manage large projects. It provides a financial solution to fiscal constraints and funding problems by incorporating private capital into the creation of infrastructure and public services. It is widely used in infrastructure construction. It can help ease the tension between investment sources, increase the supply of projects, improve service efficiency, and improve service quality. With the full implementation of the concept of higher-quality development, new demands for the operation of significant projects have been created: namely, safety, quality, efficiency and sustainable value. However, long operating cycles, complex

environments, and the slow improvement of operating capacity mean that the real needs for sustainable operations in major projects have not been met. Therefore, creating an effective and sustainable operations management system through systematic and scientific research methods is becoming an urgent need in major project operation management. This paper references the sustainable success stories that Skanska released for the official record of LaGuardia Airport Terminal B redevelopment project, which received the world's very first Envision Platinum certification. As a government-private capital cooperation project, it studies the project's sustainable management practice, analyzing the governance methods adopted with consideration of the local policy environment to improve the post-completion outcome. The result is a scientific basis that meets the true needs of major operational requirements for continuous improvement in safety, quality, efficiency, and value. The research provides a foundation for integrating sustainability into public-private partnership projects, serving as a way for all stakeholders to collaborate more effectively. It also demonstrates valuable management experience for enhancing sustainability in terms of resilience, lasting worth, and making people trust it more when it comes to engineering projects.

2. Current Situation Analysis

Traditional construction project management models mainly focus on cost, schedule, and quality control, while lacking concern for environmental and social sustainability (Rendtorff, 2020). "Sustainability" refers to the ability of a social system, ecological system, or any other system that is constantly developing to keep functioning without being weakened by the depletion of key resources. The concept of sustainable development has become a consensus of humankind. Informed by this principle, ecological values and environmental ethics have been established, forming the fundamentals of these new aspects: architectural aesthetics, technical vision, environmental perspective, and cultural perception. As mentioned, these elements constitute the theoretical foundation of architecture underlying ecological technology and aesthetics. However, problems persist in project management, such as a lack of innovation in green technology, incorrect treatment of pollutants, and damage to local ecosystems. The use of non-environmentally friendly building materials, high energy consumption, environmental pollution, and cost overruns in construction, installation, operation, management, and ecological restoration will not contribute to the local economy. Other risks are associated with the contract, a lack of management ability, an inability to coordinate between managers, the possibility of safety accidents, and employment impacts (Xue, 2025; Wang et al., 2021; Liu et al., 2021).

The implementation of sustainable operation management can be achieved through a scientific sustainable operation management system (Li et al., 2021). At present, a variety of studies on sustainable engineering practices have been conducted, including stakeholder participation, environmental impact assessment, and green procurement. In terms of stakeholder participation, achieving sustainable management practices requires not only adequate financial investment but also depends on the motivation, commitment, and capacity building of project owners, as well as the establishment of collaborative mechanisms with internal and external strategic partners. Such partnerships help integrate resources, attract investment, and create a synergistic force for sustainable governance (Jia et al., 2022). Research has shown that the timely collection of project-related data and information can help stakeholders clearly understand project progress, reduce information asymmetry, and enhance the ability to identify and predict potential risks. This enables project managers to take preventive measures to cope with uncertainties, thereby protecting stakeholders' interests, increasing mutual trust among relevant parties (Kar et al., 2021), improving engineering management efficiency, and enhancing project sustainability. In terms of environmental impact assessment, with the continuous advancement of urbanization, real estate development and other construction projects have been rapidly increasing. Due to their large area, high quantity, wide distribution, intense activity, and significant dust emissions, construction sites have become a main contributor to air pollution (Thakor and Merton, 2023). The disorderly accumulation and landfilling of construction waste not only occupy land resources but also cause multi-medium pollution through heavy metal leaching, PM2.5 dust, and the release of organic pollutants, severely disrupting the balance of soil, water, and air systems (Tao et al., 2022). During the treatment process, green methods such as recycling and reuse of construction waste can significantly reduce environmental pollution, though transportation may still have negative environmental impacts. A comprehensive evaluation of environmental, social, and economic benefits can be conducted through Life Cycle Assessment (LCA) (Bisciotti et al., 2022). In terms of green procurement, in the construction market, green procurement refers to project owners purchasing and reselling green building products produced by construction enterprises. Green procurement is not only a key pathway for achieving the "dual carbon" goals but also a pivotal point for systemic transformation in the highway engineering sector. The entire industry must build consensus to provide strong support for the construction of sustainable and modern transportation infrastructure. Khan et al. used the Pakistani construction industry as a case study to verify the effect of green supply chain practices on the sustainable transformation, emphasizing the need to formulate green strategies based on localized policies and enterprise capabilities (Bai et al., 2025). Orfanidou et al. (2023) pointed out that to achieve cost-effectiveness, environmental standards must be fully considered during the procurement process, accompanied by detailed market research, planning, and coordination. Gao et al. (2024) studied the supply chain of prefabricated buildings in China under the Engineering, Procurement, and Construction (EPC) model, exploring influencing factors at each stage, to reduce supply chain costs and improve efficiency through green management.

Although environmental protection is an important pillar of sustainable development, some of the project risk management practices do not take the importance of environmental protection and sustainability into consideration and do not conduct the appropriate ecological impact assessment. This could expose the enterprise to legal risk, lead to opposition and complaints from the public and stakeholders, and increase other project risks (Bai, 2023). Green construction

technology has made great progress in building projects, but many challenges remain. These include the high cost of sustainable materials and equipment, lack of clear standards, inefficient use of resources, environmental pollution, contract disputes, communication errors, the owner's lack of experience with sustainable construction management, inadequate management methods, and poor government oversight of construction (Khaddour et al., 2021). Chuba et al. (2025) focused on the risks of green supply chain procurement in construction projects and, through an investigation of procurement practices in the construction industry of Gauteng Province, South Africa, identified several key risk factors, such as delivery uncertainty during the planning stage and insufficient risk identification capability during the implementation stage. Therefore, sustainable development still suffers from fragmented governance and non-innovative mechanisms, which are incompatible with long-term goals. McKinsey Global Institute has set the 360° framework for achieving sustainable transformation of transport infrastructure, which encourages effective operational management to promote the environmental and socially sustainable benefits of transport infrastructure. It stresses turning infrastructure into sustainable assets, ensuring financial sustainability, and getting economic value beyond the expected return (Milani et al., 2021). Project management has been integrated with sustainability in order to achieve sustainability goals at the development level.

In the past few decades, research on major project management has put quite a lot of focus on sustainable project management concerning practices, risks, barriers, drivers, and evaluation (He et al., 2020). Previous works mainly focused on large construction projects to evaluate sustainability, which formed basic frameworks and goals for evaluating sustainable management (Chen et al., 2020). This paper draws from the sustainable practices officially documented by Skanska in the LaGuardia Airport Terminal B Redevelopment Project, which received the first Envision Platinum certification. It studies the sustainability practices of a key project through its project management process, to understand governance measures within the local policy context and improve post-completion performance. It embeds sustainability as a driving factor for governance innovation. It can provide a scientific reference to support the sustainable development of large-scale projects. This project is a physical example of a PPP that embodies the concept of sustainability and demonstrates how it can initiate collaboration between different entities. It also provides new, practical governance experience in how to make projects more resilient, valuable in the long term, and trusted by stakeholders.

3. Research Methods

3.1. Research Approach

Conceptual Analysis Method: This method involves collecting, organizing, analyzing, and synthesizing relevant literature on sustainable engineering projects to identify established research and gaps in the literature, thus determining a feasible and innovative research direction.

Case Study Method: This method selects representative cases for in-depth, systematic investigation to verify the validity of relevant viewpoints through empirical evidence. This analysis will present a case demonstrating the significant impact on modern engineering projects. Showing us its importance for engineering works.

In this study, I analyzed the successful implementation of sustainability in the LaGuardia Airport Terminal B redevelopment project, a case officially released by Skanska that received the first Envision Platinum certificate. The findings from the case study will form a basis for evaluating performance indicators and generating recommendations for improving PPP projects.

3.2. Governance Model Design

To establish an indicator system, the first step is to define a concept for identifying indicators. The core dimensions of sustainable development are social, economic, and environmental (Rendtorff, 2020). When building a performance evaluation system for project management, two aspects must be considered simultaneously: the project's entire lifecycle and sustainable development. The reasons are as follows:

1. Large PPP projects tend to have complex governance, long lifespans, and many subprojects. Therefore, performance management should cover the entire process from construction to handover and ensure all critical factors are included in the assessment.

2. Sustainability must be integrated into the strategic goals of PPP projects to serve the public interest. This ensures private partners adhere to sustainability principles in their actions, thereby securing the public interest.

Based on a literature review and the LaGuardia Airport Terminal B redevelopment project case study, this study combines sustainability dimensions (environmental, economic, and social) with governance mechanisms to build a performance indicator system for redevelopment projects.

3.3. Construction of Indicators

Hypothesis 1: Carbon emission reduction contributes to project sustainability. As an internationally recognized climate governance goal, carbon neutrality has gained increasing strategic significance. Globally, many leading cities, including Amsterdam, Adelaide, Copenhagen, and New York, have successively formulated comprehensive carbon reduction strategies and detailed implementation roadmaps. Their core focus lies in key areas such as improving energy efficiency and promoting green building design, with the ultimate aim of achieving carbon neutrality (Hosseinzade et al., 2023). Carbon emission reduction is positively related to financial performance through carbon performance. Although short-term

emission reductions can create financial pressure for a company, they are beneficial for business performance in the long run. Furthermore, reducing emissions can improve non-financial performance by enhancing corporate environmental standing and reputation.

Hypothesis 2: Resource utilization supports project sustainability. It has a positive correlation with environmental pillars, such as resource utilization efficiency and pollution control. It also relates to economic pillars, including cost reduction and higher output. Hu (2022), Xie (2023) and Dong and Wang (2021) use the number of green patent applications as a proxy indicator for green innovation output, as green patents represent tangible results of innovation. In this study, green innovation is defined as innovation during the construction process intended to conserve resources and protect the environment, with results often presented as patents.

Hypothesis 3: Stakeholder satisfaction leads to a positive effect on the project's sustainability. Research on PPP rail transit projects faces social risk factors and concludes that using a human-centered sustainable approach can promote stakeholder interactions and reduce the risks. Onishi and Miyamoto (2023) found through experimental research that investors' risk preferences are affected by emotional fluctuations, resulting in a 30% decision-making bias. This indicates a correlation between risk perception and behavioral intervention. For infrastructure PPP projects to be sustainable, the partnerships themselves must be sustainable.

Table 1. Selection of sustainability evaluation indicators based on literature and the LaGuardia terminal B project

Primary Indicator	Secondary Indicator	Indicator Description	Source
Environmental	Reduction of major pollutant emissions	Evaluate local pollutant emissions after project implementation	Saka and Oshika (2014)
Social	Stakeholder satisfaction	Evaluate satisfaction of stakeholders with project quality and outcomes	Ye Xiaosu et al. (2014)
Economic and Environmental	Resource utilization	Evaluate efficiency of resource use and improvements in environmental sustainability	Hu (2022); Xie (2023); Dong and Wang (2021)

3.4. Data Source

This study draws on the LaGuardia Airport Terminal B redevelopment project, officially released by Skanska, which was awarded the first Envision Platinum certification for its sustainability practices.

3.5. Selection of Evaluation Indicators

Based on research conducted on the LaGuardia Airport Terminal B redevelopment project, sustainability performance indicators for PPP project governance are proposed. Based on the three dimensions of sustainability (the environment, economics, and society) shown in Table 3-1, the selected indicators are reduction of major pollutant emissions, efficiency of resource utilization, and stakeholders satisfaction. These indicators collectively form an evaluation model for evaluating the sustainability of PPP projects, and hold both theoretical and practical significance.

4. Case Study and Results

4.1. Project Description

LaGuardia Terminal B project had a total investment of USD 5.1 billion (USD 4 billion of which was construction value) making it the largest PPP project in US aviation history. The redevelopment works had a new terminal (35 gates), a central hall, a parking garage, roads and supporting works.

4.2. Practices of Sustainability-Oriented Governance Innovation

(1) As the first transportation agency to sign the Paris Climate Agreement, the port authority commits to adopting best practices for carbon reduction at the new LaGuardia airport and any other facilities. (2) Two pedestrian bridges span active taxiways. This is a world first for a main terminal connecting to two island concourses, and the island and bridge designs add more taxiway space. (3) Innovative phased construction was utilized, which included building on top of existing operating facilities so that construction could continue throughout the terminal's operation. (4) Sustainability was fully integrated during the design phase of new facilities so that long-term savings on energy and water and reductions of emissions could be achieved after the project's completion. (5) During the demolition of the old structures and the building of the new terminal B and auxiliary buildings, Skanska-Walsh performed many measures to prevent waste and to recycle and reuse materials. (6) Evacuated groundwater was extracted and repurposed, rather than tapped municipal water for concrete production. (7) Skanska–Walsh created the Connect Committee, whose members started and furthered many community activities, ranging from cultural events to relationships with neighborhood shelters and food banks, and an eight-week virtual 3D design fundamentals class for local kids. (8) One outcome of the collaboration with the community was the formation of a new partnership with the Elmjack Little League right near the airport. As a part of the partnership, Skanska spent $1.8 million on a complete renovation of the ballpark, redoing the grading and leveling, upgrading the drainage and irrigation systems, and building new dugouts, fences, and so forth. (9) Acknowledging the significance of modern and interlinked public transport for long-term urban economic and environmental welfare, arrangements were made within the project structure to allow for the AirTrain to connect with Terminal B in the future.

4.3. Comparative Results

The Port Authority is the first transportation agency to sign the Paris Climate agreement. This commitment obligates them to enhance carbon reduction at and around LaGuardia Airport. The project's sustainable design and construction enhanced air quality and lowered greenhouse gas emissions, and received the Envision Platinum certification, which sets a high benchmark. The new terminal provides a world-class passenger experience without impacting the environment. Skanska Walsh demonstrated that their planning, design, and construction techniques could deliver significant social, environmental, and financial advantages to the community throughout all parts of the project phases and beyond.

4.4. Research Findings (see Table 2 and Fig. 1)

Table 2. Research findings

Project Name	Governance Measures	Performance Outcomes	Performance Indicators
Demolition of old structures and construction of the new Terminal B and auxiliary facilities	Extensive measures to minimize waste and maximize recycling	99.92% of demolition waste from the old parking garage was recycled	Significant improvement in resource utilization efficiency
Installation of advanced building management systems in new facilities	Design included a new baggage handling system, optimized building envelope, solar water heaters, large skylights, and floor-to-ceiling windows to reduce lighting demand	19% net energy savings achieved after project completion	Significant improvement in resource utilization efficiency
Water supply and drainage engineering	Adoption of high-efficiency water-saving devices and rainwater harvesting systems	40% reduction in water use	Significant improvement in resource utilization efficiency
Project design	New island concourses and roadway systems optimized aircraft taxiing routes	Reduced local road traffic, lowered fuel consumption of planes and vehicles	Significant reduction in pollutant emissions
	Incorporation of flood control measures and placement of critical infrastructure above predicted sea-level rise	Enhanced resilience	Significant improvement in stakeholder satisfaction
	Two pedestrian bridges spanning active taxiways	Delivered a world-class passenger experience while minimizing environmental footprint	Significant improvement in stakeholder satisfaction
Establishment of the Connect Committee to lead dozens of community activities	From cultural events and partnerships with shelters and food banks to eight-week virtual 3D design courses for local children	Enhanced social benefits for the community	Significant improvement in stakeholder satisfaction
Partnership with Elmjack Little League near the airport	USD 1.8 million invested in full-scale renovation of the ballpark	Improved local economic benefits	Significant improvement in stakeholder satisfaction

Source: Official press release from Skanska.

In summary, the results show that, under otherwise unchanged conditions, applying sustainable planning, design, and construction methods throughout the entire life cycle of a project can significantly enhance its environmental benefits, including a waste recycling rate of 99.92%, energy savings of 19%, a 40% reduction in water consumption, and improved building performance and functionality. Investing in surrounding facilities with a sustainable development perspective can effectively enhance the project's socio-economic benefits.

5. Discussion and Conclusion

5.1. Main Research Findings and Theoretical Contributions to Project Governance

The study mainly used a case study method to understand the management of PPP projects and obtain performance results.

This indicates that large projects related to public goods have an improvement in performance when driven by sustainability innovation. New infrastructure PPP projects are characterized by large investment scale, long construction cycle, and high uncertainty. Due to their complexity and dynamism, sustainable development is a challenge (Liu & Li, 2022). Traditional management models have their own limitations and are not suitable for effective PPP project management. Sustainable development requires evaluation of economic, social and environmental conditions in order for projects to develop in a regulated way (Liu, 2020). PPP projects generally face complex risks, including management risks such as hidden debts, engineering quality issues, and market fluctuations, as well as unforeseeable risks such as natural constraints and policy adjustments. These factors often cause the actual operational performance of projects to deviate from their original management objectives. For example, the failure of the Delhi Airport Express PPP project in India was mainly due to risks encountered in construction, operation, and revenue generation, as well as the breakdown of the partnership between the collaborating parties when facing these risks.

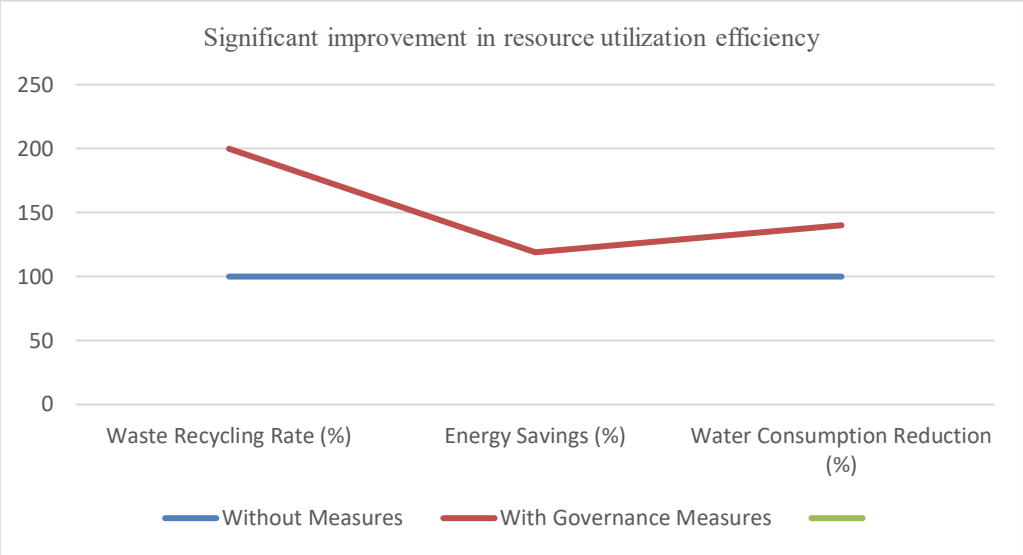

Fig. 1. Performance results.

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As PPP projects involve a partnership characterized by benefit sharing, risk sharing, and full-process cooperation, they are often established in regions where investment and public utilities are in urgent need of improvement. This study further verifies that organically integrating sustainability elements (environmental, economic, and social) with governance structures in PPP projects can significantly enhance project performance. It not only helps improve the operational quality and management efficiency of airport PPP projects but also provides a valuable theoretical foundation and practical reference for the life-cycle performance monitoring and continuous improvement of other PPP projects, such as highways, railways, urban subways, and hospital or building construction projects.

5.2. Practical Implications:

How Sustainability-Driven Innovation Enhances Project Resilience, Long-Term Value, and Stakeholder Trust.

(1) If green building design is used for construction projects, it can successfully solve problems related to resource usage, environmental security, and society. These pathways can help cut long-term costs, increase competitiveness, reduce negative environmental impacts, and promote positive social development.

(2) Building a green management framework is of great significance for construction projects. From an environmental perspective, it can effectively reduce energy consumption and pollutant emissions during both construction and operation

while protecting the surrounding ecosystem. From a conservation perspective, significantly reducing waste and maximizing recycling can greatly boost resource use efficiency.

(3) By improving surrounding infrastructure and providing skills training for local residents, projects can enhance social benefits, strengthen corporate image, increase public recognition, and foster harmonious development. In terms of economics, it can reduce long-term operating costs, improve resource use efficiency, and achieve economic, environmental, and social benefits to realize a win-win situation for the integrated and sustainable development of construction projects.

5.3. Research Limitations

This study focuses on the LaGuardia Airport Terminal B redevelopment project, which was officially documented by Skanska and was the first to receive an Envision Platinum certificate for its sustainable practices. However, it does not cover all types of construction projects. In this case, its sustainability dimensions are limited and are related to the project type or the stakeholder categories. Due to the limited scope and constantly evolving nature of governance standards, more research is needed on this topic by increasing the number of case studies and analyzing them more deeply.

5.4. Future Research Directions

More focus should be given to the R&D and application of green construction technology and cross-disciplinary sustainability, encouraging future academic-research cooperation. Establishing an AI-based governance decision-making system, solving key technical problems, and improving technological performance are also necessary. Universities and vocational institutions should strengthen the cultivation of green construction technical talent through dedicated courses. Projects using these technologies should be encouraged and subsidized. As PPP projects generally have many stakeholders, smart management platforms must be employed to manage and use the data resources of the entire project life cycle so that the connections between construction and operation are seamless. It allows for full collaboration throughout the design, construction, operation and maintenance of a project using digitalized management (Whyte and Nussbaum, 2020). Therefore, it is necessary to adopt a digital governance platform for cost reduction and to improve management. With the continuous advancement of theory and practice, green and sustainable management will continue to expand and deepen in the construction industry, providing theoretical support for achieving harmonious coexistence between human society and the natural environment.

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Declaration of Artificial Intelligence (AI) Tools

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