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The implementation of green construction in IKN development by integrating sustainable triangle concept into sustainable development goals

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This study examines the integration of green construction in the development of Indonesia's new capital city, *Ibu Kota Nusantara* (IKN), by applying the Sustainable Triangle Concept within the framework of Sustainable Development Goals (SDGs). The research addresses critical issues such as environmental sustainability, economic viability, and social inclusivity in developing IKN. Employing a quantitative descriptive approach, the study collected data through a purposive sampling method from 100 stakeholders, including environmental experts, community members, and contractors involved in IKN projects. Structural Equation Modeling (SEM) analysis, performed with PLS software, revealed significant relationships between green construction and sustainable development, with the environmental, economic, and social aspects serving as mediating variables. Findings indicate that green construction practices positively impact sustainable development by fostering energy efficiency, utilizing sustainable materials, and enhancing community welfare. The study highlights that sustainable urban development in IKN can serve as a model for balancing economic growth with environmental preservation and social equity, supporting Indonesia's broader sustainability goals. This research contributes to theoretical and practical knowledge, offering a replicable model for policymakers and stakeholders seeking to implement sustainable practices in urban development. Future research is suggested to further explore the replicability of this model in other regions, addressing broader challenges and opportunities in sustainable urban planning.

KEYWORDS

green construction, sustainable triangle, sustainable development goals, national development, new capital city

1 Introduction

The development of *Ibu Kota Nusantara* (IKN) faces substantial challenges, including environmental degradation, social displacement, and resource management, emphasizing the critical need for sustainability. This approach aims to fulfil present demands while safeguarding future generations' resources and opportunities (Rifaid et al., 2023). Considering these challenges, integrating the Sustainable Triangle Concept with the Sustainable Development Goals (SDGs) offers a promising pathway for promoting green construction practices.

In crafting development strategies, a balanced emphasis on economic, social, and environmental dimensions is crucial to minimizing environmental degradation, stimulating long-term economic growth, and improving community quality of life. This holistic approach aligns with the Sustainable Development Goals (SDGs), which strive to enhance living standards globally by integrating sustainability into local development agendas. Through these principles, sustainable development becomes essential for raising living standards and preserving resources for future generations.

Numerous countries, including Malaysia, Nigeria, Myanmar, and Kazakhstan, have successfully relocated their capitals, yielded various outcomes and highlighted the critical role of the sustainable triangle concept, which integrates economic, environmental, and social sustainability. Achieving this balance requires careful planning and innovative implementation to support economic growth, protect the environment, and improve social welfare (Purvis et al., 2019; Ruhulessin, 2023).

Amidst these dynamics, Indonesia's *Ibu Kota Nusantara* (IKN) project exemplifies a strategic response to urban density challenges, particularly on Java Island. This new capital, situated on Kalimantan Island, is designed to connect Indonesia to global markets by promoting international trade, strengthening logistics, and attracting investments through advanced technological infrastructure (Puspitaningrum et al., 2023). Additionally, the IKN initiative prioritises logistics enhancement to support efficient supply chains, reduce costs, and position Indonesia competitively in the regional economy.

The IKN project also aims to attract both local and international investment by integrating smart city solutions to create an appealing, sustainable environment for businesses and residents. As investors increasingly value eco-conscious practices, IKN's focus on green, sustainable development will likely bolster investment interest. Through a balanced approach encompassing international trade, supply chain strength, and investment appeal, IKN has the potential to become a regional model for sustainable urban development, demonstrating the role of technology in achieving economic growth and societal benefit.

IKN's overarching mission aligns with Indonesia's national development objectives as outlined in the *Indonesia Emas* 2045 framework, aiming not just to develop a new capital but to pioneer a model for sustainable urban living that elevates residents' well-being. Incorporating the sustainable triangle, IKN addresses critical issues such as forest degradation and water scarcity to support a healthy environment for future residents (Saputra and Widiansyah, 2022).

Ensuring social inclusivity is another key focus, with the project aiming to improve access to housing, healthcare, and education to promote equitable growth (Seghezzo, 2009). Economically, IKN seeks to stimulate regional development by creating jobs, reducing Jakarta's population strain, and expanding green investment opportunities. Enhanced collaboration among stakeholders and improved policy coordination are essential for addressing water and land management challenges within the sustainable triangle framework (Laksono, 2024; Hermansyah et al., 2024; Duran et al., 2015).

Green construction is central to IKN's sustainability goals, addressing environmental concerns while fostering economic resilience. Energy-efficient technologies and eco-friendly designs will reduce carbon emissions and lower environmental impact, thereby improving urban living standards and supporting SDGs on sustainable cities (SDG 11) and economic growth (SDG 8). This balanced approach establishes IKN as a forward-thinking model for sustainable urbanization, integrating economic, social, and environmental priorities into Indonesia's long-term development strategy (Indraini, 2024).

2 Research methods

The study employed a quantitative descriptive approach to obtain in-depth insights into green construction practices within the IKN development project. This approach was chosen to elucidate the role of integrating the sustainable triangle concept within the Sustainable Development Goals (SDGs) to advance sustainable development in the IKN area. According to Taherdoost (2022), quantitative research leverages empirical data on specific research topics through mathematical methods, thereby generating dependable information that can shape policy decisions and support the formulation of standardized programs.

Purposive sampling was utilized to specifically target stakeholders most relevant to the study. Questionnaires were distributed to 100 participants, comprising environmental experts, community representatives, regional stakeholders, and contractors involved in IKN development projects. The data collected were then analyzed using SEM PLS software (version 4.1.0.6), providing a comprehensive evaluation of the ongoing projects' implementation and effectiveness within the IKN context.

The research is guided by several key hypotheses based on the context provided:

> *First Hypothesis:* Green construction significantly contributes to sustainable development.
>
> *Second Hypothesis:* The relationship between green construction and sustainable development is notably influenced by environmental aspects.
>
> *Third Hypothesis:* The relationship between green construction and sustainable development is notably influenced by social aspects.
>
> *Fourth Hypothesis:* The relationship between green construction and sustainable development is notably influenced by economic aspects.

3 Results

3.1 Characteristic of respondent

After collecting the questionnaires, a total of 95 responses were obtained. This data was subsequently processed and analyzed using SEM PLS software, taking into account various respondent characteristics such as role, place of residence, area of origin, and length of involvement in the IKN development project, as shown in Figure 1.

Figure 1 illustrates that most respondents involved in IKN development projects are local indigenous individuals, with 32 respondents (34%) from surrounding communities and 39 respondents (41%) from the IKN area itself. Additionally, 11 respondents (12%) are specifically based in *Penajam Paser Utara*

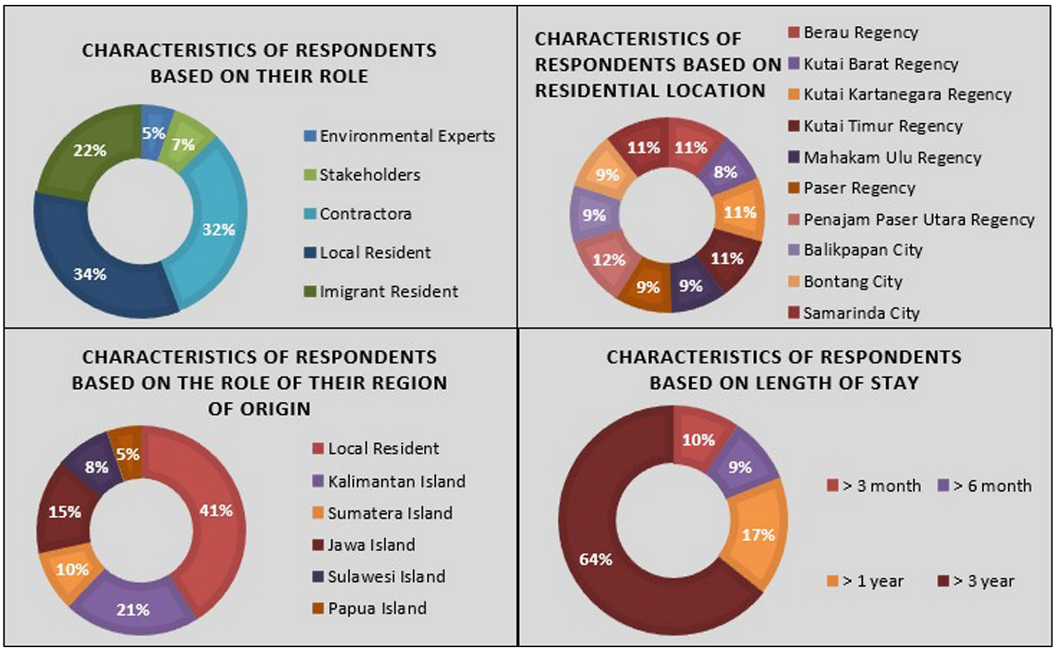

FIGURE 1
Characteristic of respondent. Source: Questionnaire from 95 respondent.

Regency. Furthermore, 61 respondents (64%) have been present in the IKN area for over 3 years, indicating a significant level of local engagement and long-term involvement.

3.2 Data analysis results

The research employed the Partial Least Squares (PLS) method using SEM PLS 4.1.0.6 software to analyze three variable types: independent, dependent, and mediating. Green construction served as the independent variable, evaluated through 8 questionnaire items rooted in the theoretical frameworks established by Abdel-Basset et al. (2021), Qaemi and Heravi (2012), and Ali and Al Nsairat (2009). These items focused on four primary dimensions—energy efficiency, water efficiency, materials, and indoor air quality—coded with the GC indicator.

The dependent variable, sustainable development, was assessed using 7 items derived from Da Silva et al. (2020), which examined factors such as economics, infrastructure systems, population, institutional aspects, human relations, information systems, and resources, coded with the SD indicator.

Additionally, three mediating variables were examined: environmental, social, and economic factors, represented by the codes EV, SC, and EC, respectively. These mediators were integrated into the study via the sustainable triangle concept and the Sustainable Development Goals (SDGs), with each mediator comprising three sub-indicators in the questionnaire. The research framework utilized in the outer model test is depicted in Figure 2.

For the EV (environmental) indicator, the study focused on three core factors: water supply and sanitation, utilization of affordable energy, and promotion of environmentally friendly lifestyles. The SC (social) indicator examined aspects of human resources management, community and societal development, and the maintenance of a healthy lifestyle. Similarly, the EC (economic) indicator analyzed three focal areas: poverty reduction, reduction of inequalities, and the advancement of innovative planning. These dimensions were incorporated to reflect the sustainable triangle's goals, aligning with the broader Sustainable Development Goals framework.

3.2.1 Outer model analysis

The outer model is an output of SEM PLS used to evaluate the validity and reliability of the correlations among each tested indicator. This assessment involves three key aspects: convergent validity, discriminant validity, and composite reliability (Luscia et al., 2023). Convergent validity is assessed through the outer loading value and the Average Variance Extracted (AVE) value, with a criteria of values above 0.5 to ensure data validity, as illustrated in Figure 2. The details of this evaluation are described as follows in Table 1.

Table 1 indicates that each indicator meets the validity requirements for the research, with all values exceeding 0.5. Among these, the SD3 indicator exhibits the highest value, while the SD2 indicator has the lowest. Additionally, the Cronbach's Alpha and Composite Reliability values, which are components of convergent validity, assess the reliability of the research data. The acceptable criteria are a Cronbach's Alpha value greater than 0.6 and a Composite Reliability value greater than 0.8. The specific values for AVE, Cronbach's Alpha, and Composite Reliability in this study are as follows in Table 2.

Table 2 demonstrates that each indicator meets the reliability standards for the research. Specifically, the Average Variance Extracted (AVE) values exceed 0.5, Cronbach's Alpha values surpass 0.6, and Composite Reliability values are greater than 0.8. The table also indicates that the highest Average Variance Extracted (AVE) value is from variable Y, which is 0.615, while the lowest is from variable X, at 0.510.

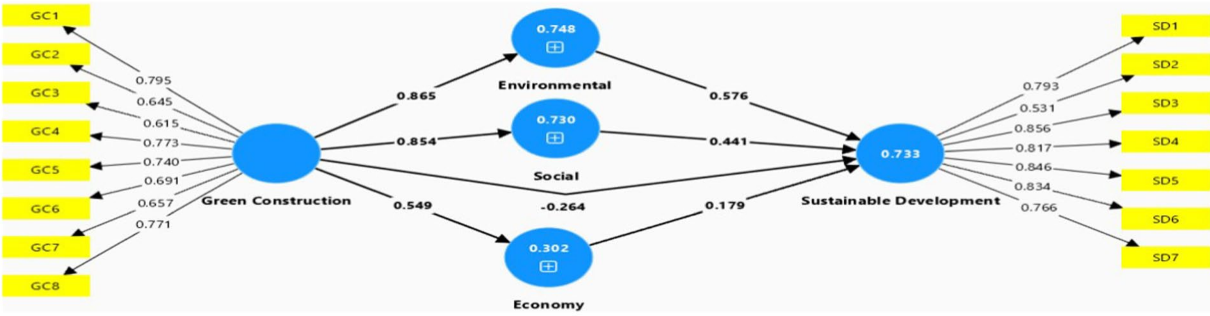

FIGURE 2
Outer model graphical output. Sources: SEM PLS.

TABLE 1 Outer loading results.

Code	Outer loading	Kode	Outer loading	Code	Outer loading
GC1	0.795	EV23	0.731	EC22	0.690
GC2	0.645	EV31	0.719	EC23	0.671
GC3	0.615	EV32	0.735	EC31	0.688
GC4	0.773	EV33	0.710	EC32	0.720
GC5	0.740	EV41	0.722	EC33	0.709
GC6	0.691	EV42	0.673		
GC7	0.657	EV43	0.704		
GC8	0.771	SC11	0.739		
SD1	0.793	SC12	0.754		
SD2	0.531	SC13	0.716		
SD3	0.856	SC21	0.731		
SD4	0.817	SC22	0.752		
SD5	0.846	SC23	0.728		
SD6	0.834	SC31	0.770		
SD7	0.766	SC32	0.646		
EV11	0.736	SC33	0.641		
EV12	0.729	EC11	0.766		
EV13	0.692	EC12	0.772		
EV21	0.763	EC13	0.733		
EV22	0.731	EC21	0.760		

Sources: SEM PLS.

In terms of Cronbach's Alpha, the highest value is observed in variable Z, specifically the Environmental sub-indicator, with a value of 0.916, whereas the lowest is found in variable X, with a value of 0.861. Similarly, the highest Composite Reliability value is associated with variable Z, again the Environmental sub-indicator, at 0.928, while the lowest is recorded for variable X, at 0.892.

3.2.2 Inner model analysis

In addition to analyzing the outer model, it is essential to conduct tests on the inner model to gain a deeper understanding of the significant relationships between variables. This involves assessing both direct influences through path coefficients and indirect effects, such as those mediated by variable Z. The following presents the research framework derived from the inner model analysis.

TABLE 2 Construct reliability results.

Variabel	AVE	Cronbach's alpha	Composite reliability
Green construction (X)	0.510	0.861	0.892
Environmental (Z)	0.519	0.916	0.928
Social (Z)	0.520	0.884	0.907
Economy (Z)	0.524	0.888	0.908
Sustainable development (Y)	0.615	0.891	0.917

Sources: SEM PLS.

Figure 3 illustrates that Green Construction, as a variable, meets the assessment criteria for the inner model, where a significant influence between variables is indicated by a p-value of less than 0.05. For a more comprehensive understanding, the results of the inner model test are detailed in Table 3.

Table 3 reveals that the most substantial influence is observed in the relationship between green construction and the environment, with a t-statistic value of 34.451, significantly exceeding 1.96, and a p-value of 0.000, indicating a strong and significant relationship between these variables. Conversely, the relationship between green construction and sustainable development shows a smaller effect, with a t-statistic value of 2.114 and a p-value of 0.035, both exceeding the significance threshold. This suggests a notable influence, though the addition of a mediating variable may be necessary to enhance the relationship between these two variables.

Table 4 shows that the Environmental indicator has the highest R-squared value of 0.748. This indicates that 74.8% of the variation in the mediating variables can be explained by the independent variables, while the remaining 25.2% is attributable to factors outside the scope of this research.

In addition to the direct effects indicated by the path coefficient values, this research also explores indirect effects using mediating variables, which can either enhance or diminish the direct relationship between the independent and dependent variables. Table 5 shows that the economic indicator within the mediating variables has a t-statistic value of 2.954, exceeding the threshold of 1.96, and a p-value of 0.003, which is below 0.05. This suggests that the economic indicator serves as a partial mediator, providing a

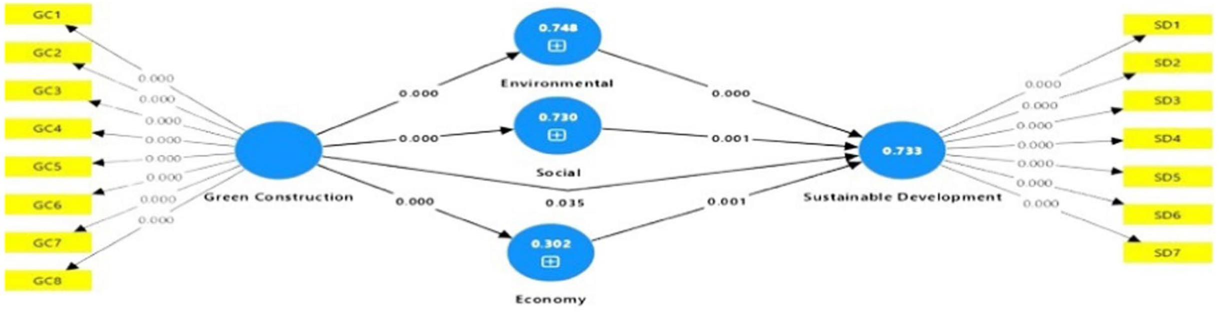

FIGURE 3
Inner model graphical output. Sources: SEM PLS.

TABLE 3 Path coefficient results.

	T statistics	*P* values
Green construction - > Sustainable development	2.114	0.035
Green construction - > Environmental	34.451	0.000
Green construction - > Social	27.779	0.000
Green construction - > Economy	7.397	0.000
Environmental - > Sustainable development	4.813	0.000
Social - > Sustainable development	3.399	0.001
Economy - > Sustainable development	3.256	0.001

Sources: SEM PLS.

TABLE 4 Coefficient determinant.

	R-square (R^2)
Environmental	0.748
Social	0.730
Economy	0.302
Sustainable development	0.733

Sources: SEM PLS.

significant indirect influence and strengthening the direct effect between variable X and variable Y.

4 Discussion

The IKN Development Project, as delineated in the IKN Master Plan attached to the IKN Law, was formulated by the Ministry of National Development Planning and formally established on March 14, 2022, under Law No. 3 of 2022. This strategic framework initiates a five-phase development plan, aiming for project completion by 2045. The IKN initiative intends to improve community welfare while advancing the vision of "Golden Indonesia 2045," integrating diverse programs across economic, social, and ecological dimensions.

A key pillar of this sustainable framework is ecological preservation, which aligns with several SDGs, including Climate Action, Life Below Water, and Life on Land. These goals emphasize urgent action to mitigate climate change, conserve marine and terrestrial ecosystems, and halt biodiversity loss. The sustainable

TABLE 5 Specific indirect effect results.

	T statistics	*P* values
Green construction - > Environmental - > Sustainable development	4. 643	0.000
Green construction - > Social - > Sustainable development	3.334	0.001
Green construction - > Economy - > Sustainable development	2.954	0.003

Sources: SEM PLS.

triangle framework reinforces the view that environmental health is fundamental for sustainable development. Any achievements in economic or social sectors would be fleeting without robust environmental protection. Thus, the IKN project must prioritize harmonized land use, integrating both cultivation and conservation within green zones (Evelyn et al., 2022), ensuring resource sustainability and ecosystem resilience.

Social well-being, another critical component of the sustainable triangle, resonates with SDGs targeting No Poverty, Good Health and Well-being, and Quality Education (Murni et al., 2024). This pillar underscores the need for equitable development, community empowerment, and enhanced quality of life, especially for vulnerable populations. Through improved access to education, healthcare, and social justice, the IKN initiative promotes an inclusive approach to development, correcting past imbalances that prioritized economic growth over social welfare. This direction contrasts with the New Order period's focus, which often overlooked social issues like poverty and inequality (Muhammad et al., 2023). Emphasizing social resilience prepares communities to withstand challenges like climate impacts and economic disruptions, fostering a more equitable and sustainable society.

The final pillar, economic viability, aligns with SDGs aimed at fostering sustained, inclusive growth and reducing inequalities. This dimension emphasizes the long-term economic feasibility of development projects, striving to create jobs, stimulate local economies, and provide opportunities across all social sectors. In IKN's context, this pillar is reflected in green investments, support for the creative economy, and initiatives to generate quality employment beyond Java, addressing regional disparities (Ristanto et al., 2022). By embedding economic sustainability within the green construction agenda, policymakers can ensure resource distribution equity alongside environmental goals.

Collectively, these dimensions position IKN as a transformative model for sustainable development. This holistic approach goes beyond physical infrastructure, embedding environmental, economic, and social considerations that reflect the Indonesian government's commitment to sustainability (Kalalinggi et al., 2023). By interweaving green construction and sustainability objectives, the IKN project exemplifies a development model poised to set a new standard in sustainable urban planning and help meet the SDGs.

Supporting this concept, recent studies echo the integration of the sustainable triangle in green construction practices. Liu et al. (2022) discuss how green building strategies effectively reduce environmental footprints while securing long-term economic benefits, emphasizing the need for government and stakeholder engagement. Similarly, highlight sustainability's role in construction efficiency, waste reduction, and enhanced outcomes, further underscoring its importance for sustainable urban growth.

Countries like Brazil, India, and Kenya, facing challenges akin to Indonesia's, exemplify the complex balance between sustainability and economic growth in construction. Brazil advances smart city frameworks while balancing economic demands, India prioritizes sustainable building designs with renewable energy, and Kenya focuses on circular economy principles in urban planning. Each example showcases distinct approaches to integrating sustainable practices, despite facing financial and technological hurdles.

However, implementing the sustainable triangle in IKN's development reveals challenges. Balancing environmental preservation, economic growth, and social equity often leads to conflicting priorities. For example, economic growth may compromise environmental integrity, while stringent environmental regulations can limit job opportunities. Integrated policies are needed, combining systems-thinking with a focus on long-term trade-offs among the three pillars. Furthermore, fragmented frameworks and insufficient data for social and economic sustainability metrics hinder balanced progress. Enhanced metrics and frameworks, such as Life Cycle Assessments (LCAs), can address these gaps.

Other obstacles include economic limitations and social resistance, as initial costs for sustainable practices remain high in developing regions, and communities may resist changes perceived to threaten job security. Financial incentives, international support, and community engagement are essential to overcome these challenges, ensuring the transition to sustainable development is both financially viable and socially inclusive.

Collaborative efforts across public and private sectors, and international cooperation, will be crucial for embedding the sustainable triangle within IKN and achieving long-term SDG goals. Such partnerships can foster innovation, resource sharing, and knowledge transfer, creating a solid foundation for sustainable and resilient development.

4.1 Hypothesis analysis

Following the completion of the sample determination, data collection, and data processing stages, a comprehensive analysis of the research hypotheses and their corresponding results has been conducted using the SEM PLS 4.1.0.6 application. The following sections provide a detailed examination of these relationships, and the insights derived from the data analysis.

4.1.1 First hypothesis: green construction significantly contributes to sustainable development

The data analysis indicates a significant relationship between the two variables, evidenced by a path coefficient with a t-statistic of 2.114 and a *p*-value of 0.035. To begin with, it means that green construction mitigates environmental degradation using sustainable materials, eco-friendly designs, and energy-efficient technologies. The t-statistics suggest a significant impact on reducing carbon emissions and conserving natural resources. Additionally, the p-value supports this, indicating that the environmental benefits of green construction are unlikely to occur by chance.

Moreover, green construction enhances economic viability by fostering growth in renewable energy, sustainable technologies, and green industries. This shift creates jobs and promotes long-term cost savings, as the *t*-statistics underscores the economic advantages tied to these practices. The p-value further confirms that these economic benefits are statistically significant, proving that green construction is a financially sustainable approach.

Lastly, green construction promotes social well-being by improving urban living conditions. The incorporation of sustainable building techniques reduces pollution and enhances public health, contributing to more resilient communities. Statistical measures reinforce the importance of these social benefits, highlighting how green construction aligns with the Sustainable Development Goals (SDGs), particularly SDG 11, which emphasizes the creation of sustainable cities and communities.

These interconnected factors demonstrate that green construction effectively advances sustainability through environmental stewardship, economic growth, and improved social well-being. Achieving this influence requires the integration of recyclable building materials, optimal utilization of green spaces, and effective management of construction waste. Additionally, it is essential to monitor changes in land use with a focus on sustainability principles to ensure that the development aligns with sustainable practices.

4.1.2 Second hypothesis: the relationship between green construction and sustainable development is notably influenced by environmental aspects

The analysis results show a significant relationship between the two variables, evidenced by a path coefficient with a t-statistic of 4.643 and a *p*-value of 0.000. The relationship between green construction and sustainable development is deeply shaped by environmental considerations, starting with carbon emission reduction Green construction reduces the carbon footprint through energy-efficient designs, renewable energy, and low-carbon materials, aligning with climate action goals and contributing to global sustainability targets. Additionally, resource efficiency plays a key role. By utilizing sustainable materials, conserving water, and managing waste, green construction addresses the depletion of natural resources and pollution, promoting responsible consumption and long-term environmental stewardship.

Lastly, biodiversity conservation and health are integral. Green construction minimizes ecosystem disruption, promotes native species, and improves indoor environmental quality, ensuring healthier living conditions while preserving natural habitats. This comprehensive approach ties environmental health, resource management, and human well-being within sustainable development. This indicates a strong influence between the variables. Achieving this influence involves implementing measures such as optimizing energy and water use, conserving green spaces and natural habitats, and incorporating renewable energy sources into development practices.

4.1.3 Third hypothesis: the relationship between green construction and sustainable development is notably influenced by social aspects

The data analysis indicates a notable relationship between the two variables, as evidenced by a path coefficient with a t-statistic of 3.334 and a *p*-value of 0.001. The relationship between green construction and sustainable development is strongly influenced by social aspects in several key ways. Firstly, green construction enhances public health and well-being by using non-toxic materials, improving indoor air quality, and providing access to natural light. This creates healthier living and working environments, particularly in urban areas, directly supporting sustainable development goals related to health. Moreover, green construction contributes to social equity and inclusivity by promoting affordable, sustainable housing and engaging local communities in the decision-making process. This ensures that development projects address the needs of all social groups, fostering social cohesion and aligning with sustainable urban development goals.

Additionally, green construction supports economic and social stability by creating jobs in sustainable industries and preserving cultural heritage. By boosting local economies and integrating traditional architectural practices, it ensures that sustainable development benefits the broader community, promoting social resilience and cultural preservation. This substantial effect underscores the importance of expanding educational and healthcare facilities, implementing self-development and counseling initiatives, and advancing the quality of community life as key strategies for achieving the desired outcomes.

4.1.4 Fourth hypothesis: the relationship between green construction and sustainable development is notably influenced by economic aspects

The analysis of the data indicates a significant relationship between the two variables, as evidenced by a path coefficient with a t-statistic of 2.954 and a *p*-value of 0.003. The relationship between green construction and sustainable development, shaped by economic aspects, can be explained in three key sections. To begin with, economic feasibility and long-term benefits are crucial. Although green construction has higher upfront costs due to sustainable materials and technologies, these costs are balanced by long-term savings from reduced energy and maintenance expenses. Moreover, green construction promotes job creation and economic growth. By fostering industries such as renewable energy and sustainable architecture, it supports employment opportunities and contributes to economic resilience, aligning with SDG 8 (Decent Work and Economic Growth).

Lastly, economic incentives and local economic impacts are significant. Government support, such as subsidies and tax incentives, encourages investment in green construction. Furthermore, using locally sourced materials strengthens local economies and integrates social equity into the sustainability model. This significant influence underscores the importance of utilizing local materials to support regional businesses, enhancing trade opportunities in remote areas, and ensuring the development of adequate infrastructure and accessibility to meet sustainability goals effectively.

5 Research implications

5.1 Managerial implication

The managerial implications drawn from this research, as highlighted by Pujiati (2024), provide practical guidance for addressing context-specific challenges and evaluating the effectiveness of sustainable solutions in the IKN development project. These implications are particularly relevant for key stakeholders involved in the project.

For government bodies, their primary role involves establishing regulatory frameworks that support sustainable construction practices, such as green building codes, energy efficiency, and carbon reduction standards. By offering incentives like tax benefits, subsidies, or grants for green projects, governments can set a clear path for developers and builders. Additionally, their involvement in urban planning is essential to ensuring that development aligns with broader Sustainable Development Goals (SDGs) such as SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action).

Stakeholders also play a vital liaison role between the government and communities, advising on sustainable strategies that reflect local needs and ensuring that development is cohesive and effective. Private developers and builders, who implement green construction practices, adopt the Sustainable Triangle concept to design structures that are environmentally friendly, cost-effective, and socially responsible. Their efforts include sourcing sustainable materials, integrating renewable energy, and reducing waste, while also engaging with financiers and investors to secure green funding aligned with SDG projects.

Architects and engineers bring technical expertise to meet the Sustainable Triangle's demands by designing buildings that emphasize environmental sustainability through energy efficiency, water conservation, and renewable materials. In accordance with SDG 9 (Industry, Innovation, and Infrastructure), these professionals innovate in passive design, green roofs, and energy-smart systems, considering accessibility, safety, and comfort to foster social cohesion and well-being within communities.

Financiers and investors are essential in providing capital for green construction, aligning investment goals with SDGs such as SDG 8 (Decent Work and Economic Growth) and SDG 12 (Responsible Consumption and Production). Green finance mechanisms encourage investors to consider long-term impacts, focusing on community development and environmental sustainability over short-term gains.

Lastly, community and civil society involvement is critical for social sustainability, as local residents, NGOs, and advocacy groups have a vested interest in how construction affects their environment, health, and quality of life. Participatory planning and open dialogs ensure that projects reflect local priorities, particularly in areas like public housing, access to green spaces, and inclusivity. These practices align with SDGs focused on social equity, including SDG 1 (No

Poverty), SDG 10 (Reduced Inequalities), and SDG 3 (Good Health and Well-being), placing social well-being at the core of development efforts.

5.2 Theoretical implication

The theoretical implications presented in this study, following Pujiati (2024), offer essential insights that can refine and extend existing theoretical models. These implications are vital for advancing academic understanding and provide actionable guidance for the development of sustainable policy frameworks. The research findings are particularly valuable for informing policies that aim to mitigate environmental and social impacts associated with development projects. By incorporating these insights, policymakers can better safeguard natural ecosystems and enhance community well-being, thereby promoting the core objectives of sustainable development.

Additionally, this study contributes to sustainable development scholarship by introducing innovative concepts, theories, and methodologies pertinent to the environmentally sustainable growth of IKN. These insights enrich existing theoretical frameworks on sustainable development, particularly within the IKN context, allowing for the creation of more holistic and effective models. Such theoretical advancements are crucial for the successful implementation of green construction practices in IKN, ensuring that these efforts align with broader sustainability goals.

6 Conclusion

The *Ibu Kota Nusantara* (IKN) development project in Indonesia offers a unique model for implementing green construction principles within the framework of the Sustainable Development Goals (SDGs). This study highlights that by integrating the Sustainable Triangle Concept—balancing economic, environmental, and social dimensions—IKN exemplifies a comprehensive approach to sustainable urban planning. The analysis confirms that green construction significantly influences sustainable development outcomes, particularly through enhancing environmental conservation, social welfare, and economic resilience. Findings from Structural Equation Modeling (SEM) indicate a strong, positive relationship between green construction practices and sustainability across key mediating factors such as resource efficiency, community engagement, and economic viability. This integration supports Indonesia's broader objectives for equitable growth, environmental stewardship, and technological innovation, aligning with the national vision for 2045.

Through this framework, IKN is positioned as a benchmark for sustainable urbanization, presenting an adaptable model for similar global contexts. The study emphasizes the need for strategic alignment among government entities, private sector stakeholders, and local communities to ensure the longevity and adaptability of sustainable practices in urban development (Pasaribu, 2024). Future research could explore the applicability of this model in other regions, potentially enriching the discourse on green construction and sustainable urbanization within varied sociopolitical and environmental landscapes.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

YY: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. RS: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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