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The influence of human resource synergy, project management, and logistics on the implementation of sustainable development in the new capital city

Degdo Suprayitno[1*]
[1]Institut Ilmu Sosial dan Manajemen STIAMI, Jakarta, Indonesia; degdosuprayitno@gmail.com (D.S.).

Abstract: Sustainable development serves as the primary objective in the development of Nusantara Capital City (IKN) as Indonesia's new capital. This study aims to analyze the influence of human resource (HR) synergy, project management, and logistics on the implementation of sustainable development, with operational efficiency acting as a mediating variable. A quantitative approach was employed, utilizing the Partial Least Squares Structural Equation Modeling (PLS-SEM) method to examine the relationships among variables. The findings reveal that logistics exerts a significant influence on operational efficiency (path coefficient = 0.788; $p < 0.001$) and the implementation of sustainable development (path coefficient = 0.406; $p < 0.05$). HR synergy also demonstrates a significant impact on sustainable development implementation (path coefficient = 0.396; $p < 0.001$), whereas project management and operational efficiency do not exhibit significant effects on the dependent variable. The analysis of indirect relationships indicates that operational efficiency does not mediate the relationship between the independent variables and sustainable development implementation. This study identifies logistics as the most dominant factor in supporting operational efficiency and sustainability outcomes. Additionally, HR synergy plays a crucial role in enhancing sustainability efforts. However, project management and operational efficiency require strengthened strategies to contribute more effectively.

Keywords: *Human Resources, Nusantara Capital City (IKN), Operational Efficiency, Sustainable Development.*

1. Introduction

The Indonesian government's commitment to the principles of sustainable development is critical to the successful implementation of the Nusantara Capital City (IKN) project. This initiative aligns with the Sustainable Development Goals (SDGs), emphasizing the need for inclusive economic growth that benefits all citizens through job creation and access to resources [1, 2]. The integration of green infrastructure is essential for addressing climate change and resource management challenges, thereby enhancing the livability of IKN [2]. Effective project management that prioritizes sustainability and inclusivity will be crucial for ensuring the long-term success of IKN [3]. A strong emphasis on human resource management is also vital, as it involves coordinating diverse teams and expertise needed to implement sustainable development principles effectively [4]. By fostering synergy among these elements, Indonesia can successfully navigate the complexities of sustainable development and create a resilient future for its capital city project.

The development of IKN as a smart and green city requires a multidimensional approach that integrates various critical elements for sustainability. Effective human resource management is essential, involving training and capacity-building programs aligned with the city's sustainability objectives to ensure that employees adopt sustainable practices and technologies [5]. Logistics and supply chain management play a crucial role in managing resources efficiently and minimizing waste,

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* Correspondence: degdosuprayitno@gmail.com

thereby reducing the city's environmental footprint [6]. The integration of natural resource management is vital, focusing on the conservation and efficient use of resources such as water and land to support sustainable growth [7]. By aligning these elements—human resources, logistics, and natural resource management—IKN can effectively address the complexities of large-scale development while achieving its sustainability goals [8, 9]. This comprehensive strategy is key to mitigating potential risks and ensuring the success of IKN's sustainable development initiatives.

Human resources serve as the foundation for successful development, as workforce skills and competencies are crucial for addressing both technical and non-technical challenges. Human capital development enhances these skills, leading to increased economic growth and sustainable development [10]. workforce competencies are vital for fostering innovation and adaptability, both of which are critical in navigating the complexities of development [11]. Equally important is stakeholder collaboration, which involves the active engagement of government bodies, the private sector, and public entities. Such collaboration promotes inclusive and sustainable development by integrating diverse perspectives and interests [12]. Effective stakeholder collaboration not only maximizes resource productivity but also creates conditions conducive to community-driven development [12]. the interaction between human resources, workforce competencies, and stakeholder collaboration establishes a strong framework for achieving sustainable development outcomes.

Effective project management is essential in construction to ensure that projects adhere to planned schedules, budgets, and quality standards. Integrating sustainability-based project management principles can significantly enhance this process by minimizing environmental impacts and promoting social responsibility throughout all project phases [13]. This approach not only assists in identifying potential risks but also facilitates effective resource management, which is crucial for achieving project objectives [14]. Comprehensive construction project planning is vital, as it defines the project scope and establishes clear objectives, timelines, and budgets, thereby reducing the likelihood of delays and cost overruns [15, 16]. Additionally, effective project schedule management is necessary to control timelines and mitigate risks, ensuring that projects are completed on time and within budget [17]. By integrating these elements, construction projects can achieve a balance between sustainability, cost efficiency, and quality outcomes.

Logistics play a critical role in the efficient distribution of resources and materials, significantly impacting supply chain management. By enhancing logistics efficiency, organizations can minimize operational costs while simultaneously reducing their environmental footprint, particularly regarding carbon emissions and waste generation. This dual benefit is achieved through strategic planning, process optimization, and the adoption of technology, which streamline logistics operations and promote sustainability [18, 19]. The implementation of green logistics practices, such as utilizing alternative fuels and optimizing delivery routes, is essential for mitigating environmental impacts [4]. Ultimately, a sustainable supply chain that incorporates these principles addresses not only economic concerns but also fosters social responsibility and environmental stewardship, aligning with the growing demand for corporate sustainability [20]. Effective logistics management is integral to achieving operational efficiency and environmental sustainability in today's business landscape.

The implementation of sustainable development in IKN is significantly hindered by the lack of integration among human resources (HR), project management, and logistics. This disconnection creates barriers to effective coordination, which is critical for achieving organizational goals and enhancing project efficiency [21, 22]. Effective project management is essential, as it ensures that resources are utilized efficiently while minimizing environmental impacts [23]. Moreover, logistics management plays a vital role in reducing waste and emissions, thereby supporting sustainable practices [24]. However, limitations in existing infrastructure further complicate these efforts, highlighting the necessity of analyzing how HR synergy, project management, and logistics can be better aligned to promote a more sustainable development model [25]. By addressing these challenges, this study aims to provide insights that could lead to development strategies that are not only efficient but also environmentally and socially beneficial [21, 25].

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The integration of human resource (HR) synergy, project management, and logistics is crucial for achieving the Sustainable Development Goals (SDGs) in IKN. However, the complexity and scale of the development pose significant challenges to this integration. Effective HR synergy ensures that the right skills are aligned with project needs, which is essential for the success of both project management and logistics operations [26, 27]. Furthermore, project management must incorporate sustainability principles to navigate the complex demands of development while closely collaborating with HR and logistics [27]. Logistics and supply chain management play a vital role in coordinating activities that support sustainable practices, thereby enhancing the overall effectiveness of development initiatives [28]. This study aims to assess how these elements can work synergistically to overcome challenges and provide actionable recommendations for stakeholders, ultimately facilitating the achievement of the SDGs in IKN [29, 30].

2. Literature Review

2.1. Sustainable Development

Sustainable development, as defined by the Brundtland Report, emphasizes the need to balance economic, social, and environmental considerations to meet present needs without compromising the ability of future generations to meet their own [31]. In the context of developing IKN, this balance is achieved through several key approaches. Efficient resource management is crucial to minimizing waste and optimizing resource use, thereby reducing the environmental footprint of development activities [32]. Additionally, social inclusivity ensures that all members of society benefit from development initiatives, promoting equity and reducing inequality [33]. Finally, environmental preservation is essential for protecting natural resources and maintaining biodiversity, which are critical for sustaining ecosystem services [34]. Together, these elements form a comprehensive framework for sustainable development that aligns with the principles outlined in the Brundtland Report and supports the Triple Bottom Line approach [35].

Sustainable development requires an integrated approach that actively engages diverse stakeholders, fostering collaboration among governments, businesses, and communities to achieve sustainability goals [36]. Stakeholder engagement is crucial for effective decision-making and planning, particularly in the context of emerging urban developments such as IKN [37]. The development of such cities must also prioritize the adoption of green technologies, which minimize environmental impacts and promote sustainability through innovative solutions [38]. Furthermore, implementing sustainability-based planning strategies is essential to ensure that urban growth maintains ecological balance and social equity, thereby safeguarding community well-being [39]. Additionally, integrating urban resilience into these planning efforts enhances a city's ability to withstand and recover from various challenges, ensuring long-term adaptability and sustainability [40]. Collectively, these elements underscore the importance of a holistic approach to sustainable urban development.

2.2. Human Resource Synergy

Human resources play a critical role in driving sustainable development, particularly in urban contexts where effective coordination among government entities, the private sector, and local communities is essential. HR competencies such as project management, communication, and stakeholder engagement facilitate collaboration, leading to improved project outcomes and enhanced sustainability [41, 42]. Moreover, HR innovation plays a significant role in developing new approaches to talent management and organizational design, which can improve the effectiveness of development projects [43]. The integration of the United Nations' Sustainable Development Goals (SDGs) into HR practices underscores the importance of cultivating skills that support sustainability, such as environmental management and social responsibility [44]. By fostering strong HR synergy and competencies, organizations can better align their efforts with sustainable development goals, ultimately contributing to more equitable urban development outcomes [28].

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Research indicates that enhancing HR competencies and involvement in development planning significantly influences sustainability outcomes. By integrating HR into planning and implementation processes, organizations can effectively leverage their expertise to promote sustainable practices [45]. Furthermore, the success of sustainability initiatives is closely linked to effective stakeholder collaboration. Engaging stakeholders throughout the project lifecycle ensures that their needs and expectations are addressed, which is critical for achieving project objectives [46]. This collaborative approach not only fosters a supportive environment for sustainability efforts but also aligns diverse interests toward a shared goal, thereby enhancing overall project success [47]. Thus, HR involvement and stakeholder collaboration are essential components in driving successful sustainability initiatives within organizations.

2.3. Project Management

Effective project management is essential for achieving specific objectives within designated timeframes and budgets. A structured risk management framework is critical for identifying and mitigating potential risks that could jeopardize project success, thereby minimizing the likelihood of failure [48]. Moreover, implementing robust quality control processes ensures that project outcomes meet established standards, which is vital for maintaining stakeholder satisfaction [27]. Performance monitoring and control play a crucial role in tracking project progress against planned objectives, enabling timely corrective actions to address any deviations [49]. Additionally, effective project schedule management is necessary to ensure that tasks are completed on time, while resource allocation is crucial for efficiently managing necessary resources to stay within budget [50]. Together, these elements create a comprehensive approach to project management that enhances the likelihood of successful project outcomes.

Effective project management in the context of sustainable development requires the integration of sustainability principles throughout the project lifecycle. This approach ensures that projects are designed and executed with minimal negative impacts on the environment and society [51, 52]. Research indicates that methodologies such as Agile and Lean project management enhance efficiency and adaptability, enabling project teams to respond effectively to environmental and social challenges [13, 53]. By focusing on flexibility and waste reduction, these methods align with the overarching goals of sustainability, addressing critical environmental challenges such as climate change and biodiversity loss [24]. Therefore, incorporating these sustainability-based project management strategies is essential for achieving responsible and resilient project outcomes in today's complex landscape [24, 51].

2.4. Logistics in Sustainable Development

Logistics play a crucial role in the efficient distribution of resources, encompassing the flow of materials and information. By optimizing logistics operations, organizations can enhance logistics efficiency, which is essential for minimizing costs and reducing environmental impacts [54]. Effective supply chain management integrates these logistics processes, ensuring that resources are sourced, produced, and delivered sustainably [55]. Furthermore, adopting green logistics practices, such as utilizing alternative fuels and optimizing transportation routes, directly contributes to achieving sustainability goals [19]. Sustainable transportation methods, including the use of electric vehicles, also play a significant role in reducing carbon emissions and improving air quality [31]. Additionally, effective inventory management ensures that the right products are available at the right time, further supporting logistics efficiency and sustainability efforts [56]. Collectively, these strategies underscore the importance of logistics in driving sustainable development processes.

Research by Arifin, et al. [2] highlights the critical role of technology in enhancing logistics efficiency and reducing the carbon footprint. The Internet of Things (IoT) facilitates real-time tracking and monitoring, which is essential for optimizing logistics operations [36]. Additionally, digital supply chain management improves visibility and collaboration among stakeholders, further contributing to operational efficiency and sustainability [57]. In the context of IKN development, integrated logistics systems are crucial, as they consolidate various logistics functions, support the effective distribution of

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environmentally friendly materials, and enhance waste management practices [5]. Moreover, implementing sustainable logistics practices is vital for minimizing environmental impacts while maintaining efficiency, aligning with the goal of reducing the logistics carbon footprint [58, 59]. Overall, leveraging these technologies and practices can lead to a more sustainable and efficient logistics framework for the development of IKN.

2.5. Synergy of Human Resources, Project Management, and Logistics

The integration of human resources (HR), project management, and logistics is crucial for achieving sustainable development goals. Competent HR practices ensure that organizations recruit and train individuals with the necessary skills to support effective project management and logistics operations, both of which are vital for sustainability initiatives [60]. Project management methodologies, such as Agile and PRINCE2, can be adapted to incorporate HR and logistics considerations, thereby enhancing sustainable project delivery [61]. Moreover, efficient logistics management plays a pivotal role in minimizing environmental impacts while ensuring the effective delivery of goods and services, thus promoting the implementation of sustainability policies [62]. By fostering synergy among these three elements, organizations can optimize resources, reduce waste, and contribute positively to social equity, economic efficiency, and environmental performance, which are the core principles of sustainable development [45].

A study by Ulucak [32] emphasizes the critical role of cross-functional synergy in enhancing the effectiveness of major development projects, particularly within the context of IKN development. By fostering collaboration across various departments, organizations can more effectively address project complexities and resource constraints [63, 64]. The integration of these elements not only streamlines operations but also significantly improves operational efficiency, enabling the timely and cost-effective delivery of projects[28, 65]. Furthermore, the emphasis on sustainability in these projects underscores the necessity of minimizing environmental, social, and economic impacts, which can be achieved through coordinated efforts [66]. Thus, adopting a synergistic approach is essential for overcoming the multifaceted challenges inherent in large-scale development initiatives, ensuring that both operational and sustainability goals are met [63, 66].

2.6. Hypotheses

H1: Human resource synergy has a positive and significant effect on the implementation of sustainable development in IKN.

H2: Project management has a positive and significant effect on the implementation of sustainable development in IKN.

H3: Logistics has a positive and significant effect on the implementation of sustainable development in IKN.

H4: Human resource synergy has a positive effect on operational efficiency in the implementation of sustainable development in IKN.

H5: Project management has a positive effect on operational efficiency in the implementation of sustainable development in IKN.

H6: Logistics has a positive effect on operational efficiency in the implementation of sustainable development in IKN.

H7: Operational efficiency mediates the effect of human resource synergy on the implementation of sustainable development in IKN.

H8: Operational efficiency mediates the effect of project management on the implementation of sustainable development in IKN.

H9: Operational efficiency mediates the effect of logistics on the implementation of sustainable development in IKN.

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3. Method

The research method designed to examine the influence of human resource synergy, project management, and logistics on the implementation of sustainable development in Nusantara Capital City (IKN) employs a quantitative approach. The quantitative approach is used to measure the relationships and impacts among the research variables, while a qualitative approach is utilized to explore in-depth information regarding the observed phenomena. The research design adopted is descriptive-correlational to identify the relationships among variables and explanatory to evaluate the influence of HR synergy, project management, and logistics on sustainable development.

The target population for this study consists of professionals involved in the IKN development project, including project managers, logistics experts, laborers, and relevant policymakers. A purposive sampling method was used to select respondents who are knowledgeable and directly engaged with the development of IKN. The sample size was determined using Slovin's formula with a 5% margin of error. It is estimated that a total of 140 respondents will be selected.

The variables used in this study include:

1. Independent Variables: Human Resource (HR) Synergy, Project Management, Logistics
2. Dependent Variable: Implementation of Sustainable Development
3. Intervening Variable: Operational Efficiency

4. Result & Discussion

4.1. Validity and Reliability Testing

4.1.1. Convergent Validity (Outer Loading)

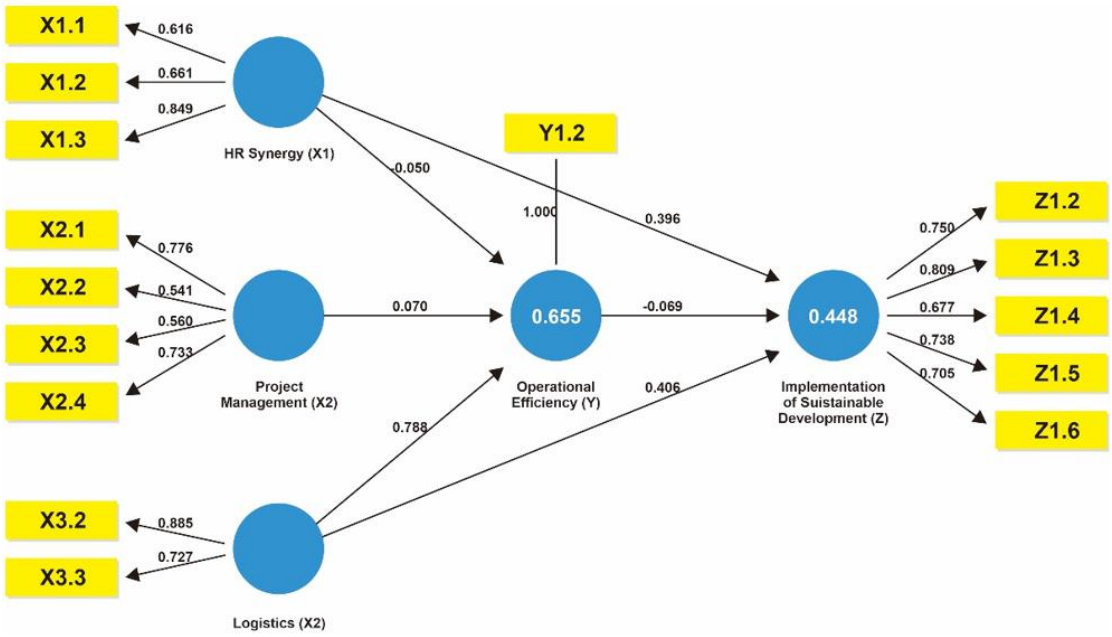

Figure 1.
Structural Model of the Influence of HR Synergy, Project Management, and Logistics on Operational Efficiency and Implementation of Sustainable Development in IKN.

Interpretation

All research items exhibited validity values greater than 0.500, indicating that the variable items in this study are considered valid and can proceed to the subsequent stages of analysis.

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4.1.2. Construct Validity

Table 1.
Construct Validity.

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Operational Efficiency (Y)	1.000	1.000	1.000	1.000
Implementation of Sustainable Development (Z)	0.789	0.794	0.856	0.544
Logistics (X3)	0.489	0.536	0.791	0.656
Project Management (X2)	0.560	0.588	0.751	0.436
Human Resource Synergy (X1)	0.516	0.560	0.756	0.513

Interpretation

1. Efisiensi Operasional (Y)

Cronbach's Alpha, rho_A, Composite Reliability, dan AVE = 1,000, This indicates that the variable has perfect validity and reliability. All indicators fully explain the latent variable. Although such results are rare in real-world data, they may occur if there is only one indicator or if the data has been manipulated to achieve perfection.

2. Implementasi Pembangunan Berkelanjutan (Z)

AVE = 0,544, The AVE value is 0.544, indicating that convergent validity is achieved as the AVE exceeds 0.5. The indicators for this variable are able to explain a substantial portion of the variance in the latent construct.

3. Logistik (X3)

AVE = 0,656, The AVE value is 0.656, demonstrating very good convergent validity, as the AVE is well above the 0.5 threshold.

4. Manajemen Proyek (X2)

AVE = 0,623, The AVE value is 0.623, reflecting good convergent validity with an AVE above the minimum threshold of 0.5.

5. Sinergi SDM (X1)

AVE = 0,513, The AVE value is 0.513, confirming that convergent validity is achieved, as it slightly exceeds the minimum threshold of 0.5. This indicates that the indicators are able to explain the variance in the latent variable, albeit with a narrow margin.

4.1.3. Discriminant Validity

Table 2.
Discriminant validity.

	Operational Efficiency (Y)	Implementation of Sustainable Development (Z)	Logistics (X3)	Project Management (X2)	Human Resource Synergy (X1)
Operational Efficiency (Y)	1.000				
Implementation of Sustainable Development (Z)	0.442	0.737			
Logistics (X3)	0.808	0.587	0.810		
Project Management (X2)	0.601	0.605	0.713	0.661	
Human Resource Synergy (X1)	0.463	0.606	0.598	0.609	0.716

Interpretation

1. Discriminant Validity (Fornell-Larcker Criterion)

- Operational Efficiency (Y): The square root of the AVE is 1.000, which is greater than all other correlation values. Discriminant validity is achieved.

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- Implementation of Sustainable Development (Z): The square root of the AVE is 0.737, which is greater than all other correlation values in its column (0.442, 0.587, 0.605, 0.606). Discriminant validity is achieved.
- Logistics (X3): The square root of the AVE is 0.810, which is greater than all other correlation values in its column (0.808, 0.587, 0.713, 0.598). However, the correlation with Operational Efficiency (Y) (0.808) is nearly as high, indicating that this variable requires attention for potential redundancy.
- Project Management (X2): The square root of the AVE is 0.661, which is greater than all other correlation values (0.601, 0.605, 0.713, 0.609). Discriminant validity is achieved.
- Human Resource Synergy (X1): The square root of the AVE is 0.716, which is greater than all other correlation values (0.463, 0.606, 0.598, 0.609). Discriminant validity is achieved.

4.1.4. Collinearity Model

Table 3.
Collinearity

	VIF
X1.1	1.117
X1.2	1.155
X1.3	1.277
X2.1	1.268
X2.2	1.057
X2.3	1.129
X2.4	1.260
X3.2	1.117
X3.3	1.117
Y1.2	1.000
Z1.2	1.644
Z1.3	1.784
Z1.4	1.441
Z1.5	1.512
Z1.6	1.503

Interpretation

- VIF ≤ 5: No multicollinearity issues are present.
- VIF > 5: Indication of multicollinearity that requires correction.
- VIF > 10: Serious multicollinearity issues, and indicators must be further examined.

The indicator items across all research variables showed VIF values within acceptable limits. This indicates that there are no serious multicollinearity problems, although the relationships among indicators are relatively strong. This test confirms that the data are free from serious multicollinearity issues, ensuring that the model has a stable structure and can be used for further analysis.

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4.1.5. Reliability

Table 4.
Construct Reliability dan Validity.

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Operational Efficiency (Y)	1.000	1.000	1.000	1.000
Implementation of Sustainable Development (Z)	0.789	0.794	0.856	0.544
Logistics (X3)	0.746	0.893	0.791	0.656
Project Management (X2)	0.853	0.885	0.751	0.623
Human Resource Synergy (X1)	0.790	0.760	0.756	0.513

Interpretation
Cronbach's Alpha:

- Higher values indicate better internal consistency.
- A value ≥ 0.7 indicates good reliability, while a value ≥ 0.8 indicates very good reliability.

Composite Reliability (CR):

- This value is considered superior to Cronbach's Alpha because it accounts for the indicator loadings.
- A value ≥ 0.7 indicates good reliability, while a value ≥ 0.8 indicates very good reliability.

1. *Operational Efficiency (Y)*

Cronbach's Alpha, rho_A, Composite Reliability = 1,000, Cronbach's Alpha, rho_A, and Composite Reliability are all 1.000, indicating perfect reliability. All indicators fully explain the latent variable without any error.

2. *Implementasi Pembangunan Berkelanjutan (Z)*

Cronbach's Alpha = 0,789; Composite Reliability = 0,856, Cronbach's Alpha demonstrates good internal reliability, and Composite Reliability indicates very good reliability.

3. *Logistik (X3)*

Cronbach's Alpha = 0,746; Composite Reliability = 0,791, Cronbach's Alpha reflects adequate reliability, and Composite Reliability, being slightly higher, demonstrates good reliability.

4. *Project Management (X2)*

Cronbach's Alpha = 0,853; Composite Reliability = 0,751, Cronbach's Alpha indicates very good internal reliability, while Composite Reliability reflects good reliability.

5. *Human Resource Synergy (X1)*

Cronbach's Alpha = 0,790; Composite Reliability = 0,756, Cronbach's Alpha shows good internal reliability, and Composite Reliability also indicates adequate reliability.

4.2. Model Structure Test
4.2.1. R Square

Table 5.
R Square.

	R Square	R Square Adjusted
Operational Efficiency (Y)	0.655	0.645
Implementation of Sustainable Development (Z)	0.448	0.430

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Interpretation

- R Square ≥ 0.75: Strong
- R Square between 0.50–0.75: Moderate
- R Square between 0.25–0.50: Weak
- R Square < 0.25: Very Weak

1. Operational Efficiency (Y)

The R Square value is 0.655, indicating that the independent variables contribute 65.5% to the variance in Operational Efficiency. This value suggests a moderate to strong relationship between the independent variables and Operational Efficiency.

2. Implementation of Sustainable Development (Z)

The R Square value is 0.448, indicating that the independent variables contribute 44.8% to the variance in the Implementation of Sustainable Development. This value suggests a weak to moderate relationship between the independent variables and the Implementation of Sustainable Development.

4.2.2. F Square

Table 6.
F Square.

	Operational Efficiency (Y)	**Implementation of Sustainable Development (Z)**
Operational Efficiency (Y)		0.089
Implementation of Sustainable Development (Z)		
Logistics (X3)	0.810	0.085
Project Management (X2)	0.092	
Human Resource Synergy (X1)	0.079	0.182

Interpretation

- F Square ≥ 0.35: Large effect
- F Square between 0.15–0.35: Medium effect
- F Square between 0.02–0.15: Small effect
- F Square < 0.02: No effect

4.2.2.1. Operational Efficiency (Y) on Implementation of Sustainable Development (Z)

F Square = 0,089**,** The F Square value is 0.089, indicating that the effect of Operational Efficiency (Y) on the Implementation of Sustainable Development (Z) falls within the small effect category. This suggests that while Operational Efficiency has a significant contribution, its impact on the Implementation of Sustainable Development is not substantial.

4.2.2.2. Logistics (X3)

The F Square value is 0.810, indicating a large effect of Logistics (X3) on Operational Efficiency (Y). This demonstrates that Logistics makes a highly significant contribution to enhancing Operational Efficiency.

The F Square value is 0.085, indicating a small effect of Logistics (X3) on the Implementation of Sustainable Development (Z). This suggests that although a relationship exists, its contribution to sustainability is relatively small compared to other variables.

4.2.2.3. Project Management (X2)

The F Square value is 0.092, indicating a small effect of Project Management (X2) on Operational Efficiency (Y). This suggests that while Project Management makes a significant contribution**, its** impact on Operational Efficiency is not substantial.

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4.2.2.4. Human Resource Synergy (X1)

The F Square value is 0.079, indicating a small effect of Human Resource Synergy (X1) on Operational Efficiency (Y). This suggests that while Human Resource Synergy contributes to Operational Efficiency, its impact is smaller compared to that of Logistics.

The F Square value is 0.182, indicating a medium effect of Human Resource Synergy (X1) on the Implementation of Sustainable Development (Z). This demonstrates that Human Resource Synergy is an important factor in supporting sustainability, with a fairly significant contribution.

- Hypothesis Testing

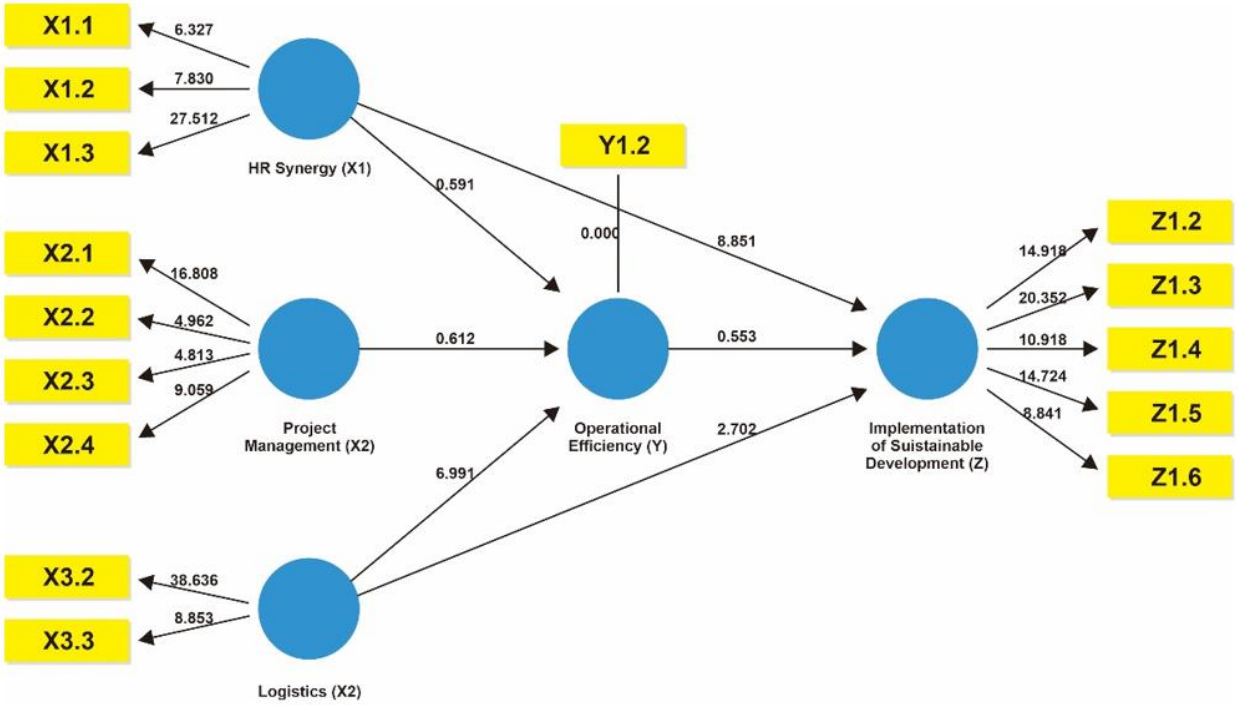

Figure 2.
Results of Structural Equation Model (SEM) Showing Path Coefficients and R^2 Values on the Influence of HR Synergy, Project Management, and Logistics on the Implementation of Sustainable Development in IKN.

4.3. Path Analysis

Table 7.
Without Intervening Variable.

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Operational Efficiency (Y) -> Implementation of Sustainable Development (Z)	-0.069	-0.077	0.125	0.553	**0.581**
Logistics (X3) -> Operational Efficiency (Y)	0.788	0.779	0.113	6.991	**0.000**
Logistics (X3) -> Implementation of Sustainable Development (Z)	0.406	0.413	0.150	2.702	**0.007**
Man.Project (X2) -> Operational Efficiency (Y)	0.070	0.083	0.114	0.612	**0.541**
HR Synergy (X1) -> Operational Efficiency (Y)	-0.050	-0.048	0.085	0.591	**0.555**
HR Synergy (X1) -> Implementation of Sustainable Development (Z)	0.396	0.408	0.103	3.851	**0.000**

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Interpretation

$H_{1:}$ Effect of Operational Efficiency (Y) on Implementation of Sustainable Development (Z)

Original Sample (O) = -0.069, indicating a small negative relationship between Operational Efficiency and Implementation of Sustainable Development. P-Value = 0.581, not significant ($p > 0.05$). This suggests that Operational Efficiency does not have a significant effect on the Implementation of Sustainable Development in this model.

$H_{2:}$ Effect of Operational Efficiency (Y) on Implementation of Sustainable Development (Z)

Original Sample (O) = -0.069, indicating a small negative relationship between Operational Efficiency and Implementation of Sustainable Development. P-Value = 0.581, not significant ($p > 0.05$). This suggests that Operational Efficiency does not have a significant effect on the Implementation of Sustainable Development in this model.

$H_{3:}$ Effect of Logistics (X3) on Implementation of Sustainable Development (Z)

Original Sample (O) = 0.406, indicating a moderate positive relationship between Logistics and Implementation of Sustainable Development. P-Value = 0.007, significant ($p < 0.05$). This shows that Logistics has a significant effect on the Implementation of Sustainable Development.

$H_{4:}$ Effect of Project Management (X2) on Operational Efficiency (Y)

Original Sample (O) = 0.070, indicating a small positive relationship between Project Management and Operational Efficiency. P-Value = 0.541, not significant ($p > 0.05$). This suggests that Project Management does not have a significant effect on Operational Efficiency in this study.

$H_{5:}$ Effect of Human Resource Synergy (X1) on Operational Efficiency (Y)

Original Sample (O) = -0.050, indicating a small negative relationship between Human Resource Synergy and Operational Efficiency. P-Value = 0.555, not significant ($p > 0.05$). This suggests that Human Resource Synergy does not have a significant effect on Operational Efficiency in this study.

$H_{6:}$ Effect of Human Resource Synergy (X1) on Implementation of Sustainable Development (Z)

Original Sample (O) = 0.396, indicating a moderate positive relationship between Human Resource Synergy and Implementation of Sustainable Development. P-Value = 0.000, significant ($p < 0.05$). This shows that Human Resource Synergy has a significant effect on the Implementation of Sustainable Development.

Table 8.
With Intervening Variables.

	Original Sample (O)	**Sample Mean (M)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	**P Values**
Logistics (X3) -> Operational Efficiency (Y) -> Implementation of Sustainable Development (Z)	-0.054	-0.064	0.105	0.516	0.606
Man.Project (X2) -> Operational Efficiency (Y) -> Implementation of Sustainable Development (Z)	-0.005	0.000	0.017	0.286	0.775
HR Synergy (X1) -> Operational Efficiency (Y) -> Implementation of Sustainable Development (Z)	0.003	0.002	0.013	0.267	0.789

Interpretation

H7. Effect of Logistics (X3) through Operational Efficiency (Y) on Implementation of Sustainable Development (Z)

Path Coefficient (O) = -0.054, indicating a small and negative indirect effect from Logistics to Sustainable Development through Operational Efficiency. T Statistics = 0.516; P Value = 0.606, not significant ($p > 0.05$). This relationship is not strong enough to support an indirect effect of Logistics on Sustainability through Operational Efficiency. Conclusion: The relationship is not significant, and the hypothesis is rejected.

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H8. Effect of Project Management (X2) through Operational Efficiency (Y) on Implementation of Sustainable Development (Z)

Path Coefficient (O) = -0.005, indicating a very small and negative indirect effect from Project Management to Sustainable Development through Operational Efficiency. T Statistics = 0.286; P Value = 0.775, not significant ($p > 0.05$). This relationship is too weak to indicate an indirect effect. Conclusion: The relationship is not significant, and the hypothesis is rejected.

H9. Effect of Human Resource Synergy (X1) through Operational Efficiency (Y) on Implementation of Sustainable Development (Z)

Path Coefficient (O) = 0.003, indicating a very small and positive indirect effect from Human Resource Synergy to Sustainable Development through Operational Efficiency. T Statistics = 0.267; P Value = 0.789, not significant ($p > 0.05$). This relationship is not strong enough to demonstrate an indirect effect. Conclusion: The relationship is not significant, and the hypothesis is rejected.

5. Conclusion

This study finds that logistics significantly enhances both operational efficiency and sustainable development, positioning it as the most influential factor. Human resource synergy also plays a vital role in advancing sustainability goals. However, project management and operational efficiency do not directly impact sustainability, and operational efficiency does not mediate the relationships among the studied variables. These results highlight the need to prioritize sustainable logistics strategies and strengthen human resource development to support large-scale projects like IKN.

Transparency:

The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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