LOCAL AUTHORITY ROLES IN GREEN CITY IMPLEMENTATION: LOW-CARBON PATHWAYS AND EQUITABLE URBAN ECONOMIC OUTCOMES IN LABUAN FINANCIAL CENTRE

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The role of Pihak Berkuasa Tempatan (PBT) in advancing green city implementation within the Labuan Financial Centre, focusing on low-carbon pathways and equitable urban economic outcomes. Positioned at the nexus of sustainability and governance, the study employs a mixed-methods design to evaluate how local authorities operationalise policy intentions into strategies balancing ecological integrity and socio-economic inclusivity. Findings reveal a strong relationship between PBT interventions and green city performance ($R = 0.815$, $R = 0.663$), underscoring the importance of institutional capacity and regulatory coherence. Equitable urban economic principles, operationalised through an alternative planning framework, contribute moderately yet substantively ($R = 0.742$, $R = 0.551$), with mediation analysis confirming their role in enhancing sustainability outcomes. Despite structural challenges, the thesis proposes an integrated strategic framework emphasising stakeholder engagement, adaptive policies, and capacity-building. The study highlights broader socio-economic and environmental benefits, offering practical guidance for inclusive, resilient urban governance

Keywords: Low-Carbon Pathways; Equitable Urban Economy; Sustainable Urban Development; Local Authority Governance; Stakeholder Engagement; Green Cities

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INTRODUCTION

River systems are among the most critical socio-ecological infrastructures, providing water for domestic consumption, agriculture, industry, and sustaining biodiversity. In Malaysia, rivers have historically been central to economic development and community livelihoods. However, rapid industrialization, urban expansion, and agricultural intensification have placed immense pressure on river ecosystems. Pollution, sedimentation, and habitat degradation are now common features of many Malaysian rivers, undermining their ecological integrity and threatening long-term sustainability (Mokhtar, Idris, Kenway, & Pikaar, 2026). Governance of river systems is inherently complex, involving multiple institutions at federal, state, and local levels. Malaysia's water governance framework is characterized by overlapping jurisdictions, fragmented responsibilities, and limited coordination among agencies. While regulatory mechanisms exist—such as the Environmental Quality Act 1974 and the National Water Resources Policy—implementation gaps persist, leading to inconsistent enforcement and weak accountability (Springer Nature, 2026). This institutional fragmentation has become a major barrier to effective river management.

Much of the existing scholarship on river governance in Malaysia has focused on technical and ecological dimensions, such as pollution control, hydrological modeling, and biodiversity conservation. While these studies provide valuable insights, they often overlook the institutional arrangements that underpin governance outcomes. For instance, regulatory frameworks are well documented, but the interplay between institutions, stakeholder participation, and accountability mechanisms remains underexplored (Young, 2002; Folke, Hahn, Olsson, & Norberg, 2005). This gap is significant because institutional dynamics—such as coordination across scales, enforcement capacity, and stakeholder engagement—directly influence the effectiveness of governance. Without addressing these institutional weaknesses, technical solutions alone cannot ensure sustainable river management. Recent studies highlight persistent water pollution despite comprehensive regulatory frameworks, underscoring the need for a more proactive, participatory, and institutionally coherent approach (Mokhtar et al., 2026).

Against this backdrop, the present study seeks to address the institutional dimension of river governance in Malaysia. The objectives are fourfold: first, to examine the institutional frameworks governing river systems, including legal, regulatory, and administrative structures; second, to identify structural and procedural gaps that hinder effective governance, particularly in enforcement and coordination; third, to assess stakeholder perceptions of policy effectiveness, institutional accountability, and governance legitimacy; and fourth, to propose evidence-based recommendations for strengthening governance structures and advancing sustainable river management. By integrating institutional analysis with environmental governance, the study aims to provide a holistic understanding of river management challenges and opportunities.

The significance of this research lies in its dual contribution to theory and practice. Theoretically, the study extends institutional analysis into the domain of environmental governance, applying concepts such as fit, scale, and interplay (Young, 2002) to river systems. It highlights how institutional fragmentation undermines adaptive governance and resilience, thereby enriching scholarly debates on socio-ecological systems. Practically, the findings provide policymakers and stakeholders with actionable insights to reform governance structures. Recommendations will emphasize enhancing coordination, strengthening enforcement, and fostering stakeholder participation. These reforms are crucial for achieving Malaysia's sustainability goals, including those outlined in the National Policy on Climate Change and the Sustainable Development Goals (SDGs). Ultimately, the study bridges academic inquiry with policy relevance, offering pathways for institutional reform that align with national and global sustainability agendas.

Institutional analysis has long been recognized as central to understanding environmental governance. Ostrom's (1990) work on collective action and common-pool resources underscore the importance of institutional design in managing shared resources. Similarly, Young (2002) emphasizes the institutional dimensions of environmental change, particularly the need for governance systems to achieve "fit" with ecological processes. In the context of river governance, adaptive governance frameworks highlight the importance of multi-level learning, stakeholder engagement, and institutional flexibility (Folke et al., 2005; Pahl-Wostl, 2009). These frameworks suggest that governance systems must evolve in response to ecological and social feedbacks, requiring institutions that are both robust and

adaptive. Malaysia's governance challenges resonate with these theoretical insights. Despite comprehensive regulatory frameworks, enforcement remains inconsistent, and institutional coordination is weak (Mokhtar et al., 2026). This misalignment between institutional structures and ecological realities exemplifies the "fit" problem identified in institutional theory.

Recent studies highlight persistent water pollution in Malaysia, particularly from industrial and agricultural sources. Regulatory mechanisms exist, but compliance is uneven, and enforcement capacity is limited (Mokhtar et al., 2026). For example, while the Department of Environment (DOE) is tasked with monitoring and enforcement, resource constraints and overlapping mandates with state agencies often lead to inefficiencies. Moreover, stakeholder participation remains limited. Communities affected by river degradation often lack meaningful avenues for engagement in governance processes. This exclusion undermines legitimacy and reduces the effectiveness of policy interventions. A more participatory approach—integrating local knowledge and stakeholder perspectives—is essential for sustainable governance (Folke et al., 2005).

Addressing these challenges requires institutional reform that enhances coordination, strengthens enforcement, and fosters stakeholder participation. Key pathways include clarifying institutional mandates to reduce overlap and fragmentation, enhancing enforcement capacity through resource allocation and capacity building, promoting stakeholder engagement by institutionalizing participatory mechanisms, and integrating adaptive governance principles to ensure flexibility and responsiveness to ecological feedbacks. These reforms would align Malaysia's river governance with international best practices, contributing to both national sustainability goals and global environmental governance debates.

METHODOLOGY

This study adopted a mixed-methods research design to capture both the structural dimensions of institutional frameworks and the experiential perspectives of stakeholders involved in river governance. The rationale for employing a mixed-methods approach lies in the complexity of environmental governance, which requires integration of quantitative rigor with qualitative depth to generate actionable insights (Creswell & Plano Clark, 2018). The research was conducted in two phases. The first phase involved a quantitative survey administered to stakeholders across federal, state, and local institutions, as well as community representatives. The survey was designed to measure perceptions of governance effectiveness, accountability, and institutional coordination, with constructs operationalized based on established frameworks in institutional analysis and adaptive governance (Ostrom, 1990; Pahl-Wostl, 2009). The second phase consisted of qualitative interviews with key informants, including policymakers, enforcement officers, and community leaders. Semi-structured interviews allowed for exploration of institutional dynamics, enforcement challenges, and stakeholder experiences, providing contextual depth and triangulating findings from the survey (Yin, 2018).

For the quantitative survey, a stratified sampling technique was employed to ensure representation across different institutional levels and geographic regions. Respondents included officials from the Department of Environment, state water authorities, municipal councils, and community organizations. A total of 250 valid

responses were collected, exceeding the minimum threshold for structural equation modeling (Hair, Hult, Ringle, & Sarstedt, 2017). For the qualitative interviews, purposive sampling was used to identify 20 key informants with direct involvement in river governance. This approach ensured that participants possessed relevant expertise and experience, thereby enhancing the credibility and richness of qualitative data (Patton, 2015). Survey instruments were distributed both electronically and in person, depending on institutional accessibility, with items measured using a five-point Likert scale ranging from "strongly disagree" to "strongly agree." The interview protocol was developed to probe issues of institutional fragmentation, enforcement capacity, and stakeholder participation. Interviews were conducted in Malay and English, recorded with consent, and transcribed verbatim for analysis.

Quantitative data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM), which is particularly suitable for exploratory research and complex models involving latent constructs (Hair et al., 2017). This technique allowed for testing relationships between institutional structures, enforcement capacity, and governance outcomes. Reliability and validity were assessed through composite reliability, average variance extracted (AVE), and discriminant validity measures. Qualitative data were analyzed using thematic analysis, following Braun and Clarke's (2006) six-phase framework. Codes were generated inductively from the data and organized into themes reflecting institutional gaps, enforcement challenges, and stakeholder perspectives. NVivo software was used to facilitate coding and ensure systematic analysis. Triangulation was achieved by integrating quantitative and qualitative findings, thereby enhancing the robustness of conclusions. For instance, survey results on perceived enforcement gaps were cross-validated with interview narratives describing resource constraints and overlapping mandates. Methodological rigor was further ensured through pilot testing of survey instruments, member checking of interview transcripts, and peer debriefing during data analysis (Creswell & Plano Clark, 2018).

Ethical approval was obtained from the relevant university research ethics committee. Participants were informed of the study's objectives, assured of confidentiality, and provided with consent forms prior to participation. Data were anonymized to protect identities, and findings were reported in aggregate to avoid attribution of sensitive information. These methodological choices ensured that the study was both scientifically rigorous and ethically sound, providing a robust foundation for analyzing institutional dimensions of river governance in Malaysia.

RESULTS AND DISCUSSIONS

An analysis of the respondents' demographic profile reveals important contextual insights into the institutional and governance perspectives captured in this study. The gender distribution indicates that male participants constitute the majority of the sample, with 61 individuals (62.9%) identifying as men and 36 individuals (37.1%) identifying as women (Table 1). This predominance of male respondents reflects the existing gender composition commonly observed within decision-making, managerial, and technical roles in local authorities and related urban governance institutions, particularly within infrastructure development,

planning, and environmental management sectors (Guest, MacQueen, & Namey, 2012).

Table 1 Gender Distribution of Respondents

Gender	Frequency	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
Male	61	62.9	62.9	62.9
Female	36	37.1	37.1	100.0
Total	**97**	**100.0**	**100.0**	—

While male perspectives dominate, the inclusion of female respondents ensures that diverse viewpoints are represented, contributing to a more balanced understanding of governance practices and institutional dynamics within the Labuan Financial Centre (Creswell & Plano Clark, 2018). Understanding this gender composition is essential for interpreting how local authority roles are shaped by organizational structures, leadership patterns, and professional cultures, thereby enhancing the credibility of the findings by situating respondents' views within the broader socio-institutional landscape influencing equitable urban economic outcomes and sustainability transitions (Yin, 2018; Saunders, Lewis, & Thornhill, 2019).

Table 2 Age Distributions of Respondents

Age Group	Frequency	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
25–34 years	26	26.8	26.8	26.8
35–44 years	47	48.5	48.5	75.3
45–54 years	18	18.6	18.6	93.8
55 years and above	6	6.2	6.2	100.0
Total	**97**	**100.0**	**100.0**	**-**

The age distribution of respondents further contextualizes the sample. The majority of participants fall within the 35–44 years' age group, accounting for 47 individuals (48.5%), followed by 26 participants (26.8%) aged 25–34 years, and 18 participants (18.6%) aged 45–54 years. Only 6 respondents (6.2%) are aged above 55 years (Table 2). This distribution highlights that the sample is predominantly composed of middle-aged professionals, a demographic often associated with active involvement in managerial and policy implementation roles. Their professional maturity and experience are likely to influence perspectives on sustainability transitions and urban governance.

Respondents' living or working locations are relatively balanced across geographical contexts. Thirty participants (30.9%) live or work in urban areas, an equal number (30 participants, 30.9%) in suburban areas, and the largest group, 37

participants (38.1%), in rural areas (Table 3). This distribution ensures that perspectives from diverse geographical settings are represented, allowing the study to capture governance dynamics across urban, suburban, and rural contexts. Such balance is particularly relevant in analyzing green city initiatives, as sustainability challenges and opportunities often vary significantly across spatial categories.

Table 3 Residential or Work Location of Respondents

Location Category	Frequency	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
Urban	30	30.9	30.9	30.9
Suburban	30	30.9	30.9	61.9
Rural	37	38.1	38.1	100.0
Total	**97**	**100.0**	**100.0**	**-**

Professional roles of respondents reveal further diversity. The largest group comprises non-governmental organization (NGO) representatives, with 39 individuals (40.2%), followed by 36 respondents (37.1%) engaged in public sector or local authority implementation roles, and 22 participants (22.7%) involved in urban planning and development (Table 4). This composition reflects the multi-stakeholder nature of urban governance, where NGOs, public authorities, and planning professionals collectively shape sustainability strategies. The predominance of NGO representatives underscores the growing role of civil society in advocating for low-carbon development and participatory governance.

Table 4 Primary Role or Professional Affiliation of Respondents

Primary Role / Profession	Frequency	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
Urban Planning and Development	22	22.7	22.7	22.7
Public Sector / Local Authority Implementation Roles	36	37.1	37.1	59.8
Non-Governmental Organisation (NGO) Representative	39	40.2	40.2	100.0
Total	**97**	**100.0**	**100.0**	**-**

Educational attainment among respondents is relatively high, with the majority holding undergraduate degrees (54 participants, 55.7%). A further 26 respondents (26.8%) possess diplomas, 14 (14.4%) hold master's degrees, and only

3 (3.1%) reported secondary education as their highest qualification (Table 5). This high level of educational attainment suggests that respondents are well positioned to engage with complex sustainability concepts and policy frameworks, thereby enhancing the reliability of their perspectives on green city initiatives.

Table 5 Educational Attainment of Respondents

Highest Educational Qualification	Frequency	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
Secondary Education	3	3.1	3.1	3.1
Diploma / Technical Qualification	26	26.8	26.8	29.9
Bachelor's Degree	54	55.7	55.7	85.6
Master's Degree	14	14.4	14.4	100.0
Total	**97**	**100.0**	**100.0**	**-**

The relationship of respondents with green city initiatives reveals that 59 participants (60.8%) identify as community members, while 38 participants (39.2%) are business owners (Table 6). This mix of community-level and private sector perspectives provides a balanced view of governance practices, reflecting both grassroots engagement and market-driven approaches to sustainability. Finally, respondents' familiarity with green city initiatives is relatively strong. Forty-five participants (46.4%) reported being very familiar, 32 (33.0%) moderately familiar, 15 (15.5%) not familiar at all, and 5 (5.2%) slightly familiar (Table 7). This distribution indicates that most respondents possess substantial awareness of green city initiatives, which strengthens the credibility of their responses and ensures that the findings are grounded in informed perspectives.

Table 6 Respondents' Relationship with Green City Initiatives

Relationship with Green City Initiatives	Frequency	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
Business Owner	38	39.2	39.2	39.2
Community Member	59	60.8	60.8	100.0
Total	**97**	**100.0**	**100.0**	**-**

Taken together, the demographic profile of respondents situates the study within a socio-institutional context characterized by male predominance in governance roles, middle-aged professional representation, balanced geographical

distribution, strong NGO involvement, high educational attainment, and substantial familiarity with sustainability initiatives. These demographic characteristics enhance the interpretive depth of the study, ensuring that the findings reflect the realities of institutional dynamics and stakeholder engagement in the Labuan Financial Centre's pursuit of green city and low-carbon development strategies.

Table 7 Respondents' Level of Familiarity with Green City Initiatives

Level of Familiarity with Green City Initiatives	Frequency	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
Not Familiar at All	15	15.5	15.5	15.5
Slightly Familiar	5	5.2	5.2	20.6
Moderately Familiar	32	33.0	33.0	53.6
Very Familiar	45	46.4	46.4	100.0
Total	**97**	**100.0**	**100.0**	**-**

This section presents the quantitative analysis of the data collected, applying statistical techniques to address the research objectives and hypotheses. The analysis begins with descriptive statistics to provide an overview of the dataset, followed by reliability and validity testing to ensure the robustness of the measurement instruments. Exploratory Factor Analysis (EFA) was conducted to identify latent dimensions and uncover the underlying structure of the variables. Inferential statistical methods, including regression and hypothesis testing, were then employed to investigate relationships and validate the proposed framework. Collectively, these findings offer a comprehensive understanding of the quantitative aspects of the study, laying the groundwork for informed discussions and interpretations.

Interpretation guidelines were established to ensure consistency in evaluating correlation and regression results. For correlation analysis, coefficients ranging from 0.90–1.00 were categorized as very strong, 0.70–0.89 as strong, 0.50–0.69 as moderate, 0.30–0.49 as weak, and 0.00–0.29 as negligible. Statistical significance was determined at $p < 0.05$ (Field, 2013). For regression analysis, model fit was assessed using the coefficient of determination (R^2), with values $\geq$ 0.70 considered good in natural sciences and 0.30–0.69 accepted in social science research due to behavioral variability. Model significance was again determined at $p < 0.05$, while accuracy was evaluated through standard error values, with lower values indicating greater precision (Bhandari, 2024).

The first hypothesis (H1) posited that the systematic implementation of low-carbon strategies by local authorities (Pihak Berkuasa Tempatan, PBT) significantly enhances Green City Success. To test this hypothesis, a simple linear regression analysis was conducted using PBT1mean (representing low-carbon strategy implementation) as the independent variable and GCmean (representing Green City Success) as the dependent variable.

The regression output demonstrates a strong positive relationship between low-carbon strategies and Green City Success. The correlation coefficient (R=

0.833) indicates a high degree of association between the two variables, suggesting that improvements in low-carbon initiatives are closely linked to enhanced green city outcomes. The coefficient of determination (R^2= 0.694) reveals that approximately 69.4% of the variance in Green City Success can be explained by the implementation of low-carbon strategies undertaken by local authorities (Table 8). This level of explanatory power is considered substantial within social science and urban governance research, particularly in studies involving complex institutional and behavioral factors. The adjusted R^2 value of 0.690 further confirms the robustness of the model by accounting for potential overfitting, while the standard error of the estimate (0.41422) reflects a relatively small average deviation between observed and predicted values, suggesting satisfactory predictive accuracy and model stability.

Table 8 Model Summary for the Relationship between Low-Carbon Strategies (PBT1) and Green City Success

Model	R	R^2	Adjusted R^2	Standard Error of Estimate
1	0.833	0.694	0.690	0.41422

The statistical significance of the regression model was validated through Analysis of Variance (ANOVA). The model recorded a high F-statistic (F = 215.178) with a significance level of $p < 0.001$, well below the conventional 0.05 threshold (Table 9). This confirms that the regression model is statistically significant and that low-carbon strategies implemented by PBT meaningfully explain variations in Green City Success within the Labuan context. The regression sum of squares (36.920) indicates a substantial proportion of explained variance, while the residual sum of squares (16.300) represents unexplained variance attributable to other external or contextual factors.

Table 9 ANOVA Results for the Effect of Low-Carbon Strategies (PBT1) on Green City Success

Model	**Source of Variation**	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	36.920	1	36.920	215.178	0.000
	Residual	16.300	95	0.172		

Collectively, these findings provide strong empirical support for H1, confirming that low-carbon strategies adopted by local authorities play a decisive role in driving green city success. Within the Labuan Financial Centre, this underscores the importance of policy instruments such as carbon-efficient infrastructure, sustainable mobility, energy optimization, and emissions reduction initiatives as core mechanisms for advancing sustainable urban outcomes. The results align with established methodological approaches to hypothesis testing in applied policy research and reinforce the central role of local governance in

translating sustainability frameworks into measurable urban performance outcomes (Guest, MacQueen, & Namey, 2012).

Finally, the regression coefficients provide detailed insights into the relationship between the variables. The unstandardized coefficient (B = 0.822) indicates that for every one-unit increase in PBT1mean, GCmean increases by 0.822 units. The constant (B = 0.849) represents the predicted value of GCmean when PBT1mean equals zero. The standardized coefficient (β = 0.833) reinforces the strong influence of PBT1mean on GCmean. Both coefficients are statistically significant, as evidenced by the t-values (2.402 for the constant and 14.669 for PBT1mean) and their corresponding p-values (0.018 and 0.000, respectively) (Table 10). Overall, this analysis highlights a strong and statistically significant positive relationship between low-carbon strategy implementation and Green City Success.

Table 10 Regression Coefficients for Low-Carbon Strategy Implementation (PBT1) and Green City Success

Model	Predictor	Unstandardized Coefficient (B)	Std. Error	Standardized Coefficient (β)	t-value
1	Constant	0.849	0.354	-	2.402
	Low-Carbon Strategy Implementation (PBT1mean)	0.822	0.056	0.833	14.669

The findings of this study demonstrate that low-carbon strategies implemented by local authorities play a decisive role in enhancing green city performance while simultaneously contributing to equitable urban economic outcomes. Quantitative regression results revealed strong and statistically significant relationships between PBT-led initiatives and green city success indicators, reinforcing the central role of local governance in sustainability transitions. These results underscore the importance of institutional capacity and local implementation in translating sustainability frameworks into measurable urban outcomes, a theme consistently highlighted in the sustainability transition literature (Raworth, 2017; Lim, 2022).

Low-carbon interventions such as renewable energy deployment, waste-to-energy systems, sustainable mobility initiatives, and urban greening have collectively reduced environmental externalities while generating economic and social co-benefits. Respondents emphasized that these initiatives not only mitigated ecological impacts but also created synergies across economic and social domains. This aligns with broader scholarship on sustainability transitions, which argues that urban decarbonisation initiatives can act as catalysts for economic restructuring and social inclusion when supported by appropriate governance mechanisms (Raworth, 2017; Lim, 2022).

From an environmental perspective, initiatives including solar installations on public buildings, energy-efficient infrastructure upgrades, and the introduction of electric and hybrid public transport systems have contributed to measurable reductions in greenhouse gas emissions. Respondents highlighted that these measures reduced operational costs for public institutions while serving as demonstration projects that encouraged adoption by private firms and households.

Such diffusion effects are consistent with findings from Malaysian and regional urban sustainability studies, which report similar patterns of institutional leadership fostering broader societal uptake of low-carbon practices (Ariffin et al., 2014; Azizi & Kouddane, 2024).

Economically, low-carbon strategies have stimulated new employment opportunities in renewable energy, waste management, eco-tourism, and environmental services. Interview data revealed that job creation was particularly evident in sectors linked to waste management and clean energy, reflecting the emergence of a "green economy" that integrates environmental protection with economic growth (Meadows, 2008). However, respondents also noted that these economic benefits were more pronounced in urban areas, suggesting persistent spatial inequalities. This uneven distribution highlights the need for targeted policy interventions to ensure that rural and suburban communities also benefit from sustainability transitions, thereby addressing equity concerns within green city frameworks.

Socially, low-carbon initiatives contributed to improved public health outcomes through cleaner air, enhanced sanitation, and increased access to green spaces. These improvements were widely perceived by community members as enhancing overall quality of life. Such outcomes align with the social sustainability dimension of green city frameworks, which emphasize human well-being alongside environmental performance (Lee, 2021). The integration of environmental and social benefits underscores the multidimensional nature of sustainability transitions, where ecological improvements are inseparable from social outcomes.

Despite these positive outcomes, the findings reveal that the integration of low-carbon strategies with explicit equity-oriented economic planning remains uneven. While some social equity programmes exist, they are often implemented in isolation rather than as part of a coherent strategy linking decarbonisation with inclusive economic development. This disconnect underscores the need for a more integrated planning approach that explicitly embeds equity considerations into green city strategies. Without such integration, sustainability transitions risk reinforcing existing inequalities rather than alleviating them.

Overall, the study contributes to the literature by empirically demonstrating that low-carbon strategies not only enhance environmental performance but also generate economic and social co-benefits. However, the uneven integration of equity considerations highlights a critical area for policy reform. Future research should explore mechanisms for embedding social equity into low-carbon planning, ensuring that sustainability transitions are both environmentally effective and socially inclusive.

CONCLUSIONS

The findings of this study confirm that low-carbon strategies implemented by local authorities significantly enhance green city performance while generating environmental, economic, and social co-benefits. Initiatives such as renewable energy deployment, waste-to-energy systems, sustainable mobility, and urban greening have reduced emissions, lowered operational costs, and improved public health outcomes. These results reinforce the central role of local governance in sustainability transitions, aligning with broader literature that emphasizes the

transformative potential of urban decarbonisation when supported by effective institutional mechanisms (Raworth, 2017; Lim, 2022).

Beyond environmental gains, low-carbon strategies have stimulated economic opportunities in renewable energy, waste management, and eco-tourism, contributing to the emergence of a green economy (Meadows, 2008). Socially, cleaner air, improved sanitation, and expanded access to green spaces have enhanced quality of life, consistent with social sustainability frameworks that prioritize human well-being alongside ecological performance (Lee, 2021). However, the study also reveals uneven integration of equity considerations, with economic benefits more pronounced in urban areas, underscoring persistent spatial inequalities that require targeted policy intervention.

To strengthen outcomes, several recommendations are proposed. First, equity must be embedded into low-carbon planning by linking decarbonisation with inclusive economic development. Second, institutional capacity should be enhanced through clearer mandates, resource support, and participatory governance mechanisms. Third, scaling up renewable energy and sustainable infrastructure via public-private partnerships can accelerate adoption, while monitoring and evaluation frameworks should ensure accountability and continuous improvement. By implementing these measures, local authorities can consolidate environmental gains, expand economic opportunities, and ensure that sustainability transitions are socially inclusive and equitable.

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