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SMART GREEN CITIES IN PERAK: THE ROLE OF LOCAL AUTHORITIES IN LOW-CARBON TRANSITION

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Abstract

This study investigates the interplay between local authority initiatives (PBT) and Doughnut Economy principles in driving Smart Green City development across selected municipalities in Perak, Malaysia. Using a quantitative framework supported by Structural Equation Modelling (SEM), the research evaluates the direct and mediating effects of these variables on urban sustainability outcomes. Empirical results reveal that local authority initiatives (PBT) exert the strongest direct influence on Smart Green City success, with a standardized beta coefficient of $\beta = 0.671$, indicating a substantial positive effect. The model demonstrates strong explanatory power, with an R^2 value of 0.642 and an adjusted R^2 of 0.635, confirming that over 64% of the variance in Smart Green City outcomes is accounted for by the predictors. Doughnut Economy principles contribute a partial mediating effect, reinforcing the importance of embedding ecological ceilings and social foundations into urban planning. These findings support a dual-framework approach, one that strengthens institutional governance while integrating regenerative and inclusive values. The study concludes that Smart Green City development is not merely a technical endeavour but a transformative process rooted in equity, resilience, and long-term stewardship. By situating this analysis within the Malaysian context, the research offers both theoretical depth and actionable insights for policymakers, urban planners, and sustainability advocates seeking integrated models for low-carbon, inclusive urban transitions.

Doi:

Introduction

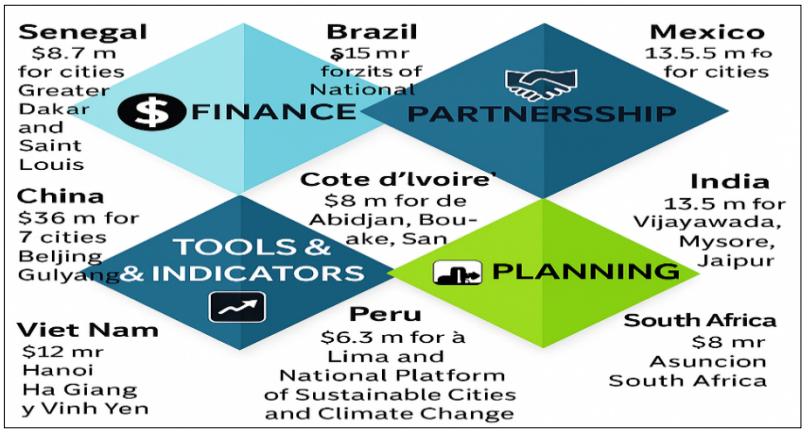
Rapid urbanization and climate change have compelled cities globally to adopt innovative strategies for sustainable development. Among these, green city initiatives featuring low-carbon strategies like renewable energy, sustainable planning, and green infrastructure have become vital in reducing emissions and enhancing resilience. The Doughnut Economy framework by Kate Raworth offers a complementary model, emphasizing ecological sustainability and social equity. In Malaysia, green cities are central to national efforts to align environmental goals with economic and social well-being. Local

authorities (Pihak Berkuasa Tempatan, or PBT) are instrumental in operationalizing frameworks such as the Low Carbon Cities Framework (LCCF), promoting urban sustainability. However, challenges in resource allocation, policy coherence and public engagement persist. This study focuses on Ipoh, Perak, which aspires to be Asia's first Doughnut Economy model city. It explores how PBTs integrate low-carbon strategies with Doughnut principles, aiming to provide actionable insights for achieving inclusive and sustainable urban development.

Background of the Study

Sustainable urban development has become a global imperative due to rapid urbanization and climate change. Cities, home to over half the world's population and responsible for 70% of greenhouse gas emissions (World Bank Group, 2016; United Nations, 2021), are central to this challenge. Frameworks like SDG 11 advocate for inclusive, resilient urban environments. Cities such as Freiburg, Copenhagen, and Amsterdam exemplify green urbanism through renewable energy, green infrastructure, and sustainable transport (Mengiste, Shi, & Wong, 2024; World Economic Forum, 2022). The Doughnut Economy model (Raworth, 2017; Doyle, 2021) complements these efforts by balancing ecological limits with social needs. San Francisco's Climate Action Plan demonstrates how cities can reduce emissions significantly while growing economically (City and County of San Francisco, 2021). In Malaysia, initiatives like the LCCF and the Low Carbon Cities 2030 Challenge (MGTC, 2025) reflect national commitment. This study examines Perak's efforts, particularly Ipoh's ambition to become a Doughnut Economy model city under the Perak Sejahtera 2030 plan.

In Malaysia, the Low Carbon Cities Framework (LCCF), spearheaded by MGTC, guides local governments toward sustainable urbanism. Initiatives like the Low Carbon Cities 2030 Challenge align with national climate goals to reduce emissions by 45% by 2030, positioning green cities as a cornerstone of Malaysia's sustainability agenda.



Source by City of Copenhagen. (2023)

Figure 1. GPSC Support to Participating Cities with Partnership Organizations

The Global Platform for Sustainable Cities (GPSC) (2024), comprising around 30 cities across 11 pilot countries including Malaysia supports urban sustainability through designated GEF grants administered via selected agencies. These initiatives represent a global effort to harmonize environmental sustainability with inclusive urban development.

Local authorities (Pihak Berkuasa Tempatan, PBT) are central to advancing smart green initiatives in Perak. This study examines how PBTs integrate low-carbon strategies and the Doughnut Economy framework to balance ecological sustainability with social equity (Raworth, 2017). Despite challenges such as limited funding, fragmented collaboration, and low public awareness, solutions like community

engagement, green infrastructure investment and policy alignment offer progress. Ipoh, under the Perak Sejahtera 2030 plan (Perak Sejahtera 2030, 2024), aspires to be Asia's first Doughnut Economy model city. Drawing lessons from Copenhagen, Stockholm, and San Francisco, this research provides actionable insights for inclusive, low-carbon urban development This case study investigates how local authorities are integrating low-carbon strategies and principles of the Doughnut Economy to promote both ecological resilience and socio-economic equity. Despite promising frameworks, PBTs face persistent challenges, including limited financial resources, fragmented inter-agency collaboration and inadequate public awareness. Nevertheless, strategic approaches such as green infrastructure investment, community engagement, and alignment with national sustainability goals present viable paths forward.

Narrowing the focus to Perak, the state faces a distinct set of challenges in its pursuit of sustainable urban development. Ipoh, its capital, has committed to becoming a low-carbon city and a Doughnut Economy model. Yet, financial constraints persist as a primary barrier, limiting investments in critical infrastructure and technologies such as renewable energy systems and energy-efficient buildings (Lim, 2019). Adopting the Doughnut Economy framework offers a promising direction balancing ecological sustainability with social equity (Raworth, 2017). However, turning this model into practice requires innovative governance, cross-sector collaboration and meaningful community participation.

Perak's aspiration to become Asia's first Doughnut Economy city involves initiatives in green mobility, heritage conservation, and sustainable infrastructure. Yet, these require sustained investment, effective facilities management, and ongoing stakeholder commitment (National Low Carbon Cities Masterplan, 2020; Shaharuddin et al., 2024).

This study investigates how PBT bodies navigate these multi-dimensional challenges, operationalize green city frameworks and align their actions with Doughnut Economy principles. By evaluating efforts in Ipoh and beyond, the research aims to produce actionable insights that inform policymaking and drive inclusive, resilient urban development in Perak.

Problem Statement

Perak, particularly its capital Ipoh, faces complex challenges in advancing sustainable urban development. Despite aspirations to become a low-carbon city aligned with the Doughnut Economy framework, financial constraints hinder investments in renewable energy, energy-efficient buildings, and resilient infrastructure (Lim, 2019). Environmental hazards, including 11 recorded sinkhole incidents between 2019 and 2024, further strain urban safety rooted in groundwater extraction, urban expansion, and ageing infrastructure (Singkee, 2025; Bernama, 2025).

The *Perak Sejahtera Plan 2030* reflects a strong commitment to sustainability, yet fragmented policies, limited resources, and weak public engagement constrain its effectiveness (MGTC, 2025). Public dissatisfaction driven by inadequate infrastructure and regulatory enforcement signals governance and accountability gaps (Bernama, 2025). Administrative inefficiencies, including bureaucratic delays and under-resourced community outreach, also impede progress (Ahmad, 2020; Lee, 2021).

Nevertheless, initiatives like Kampar District Council's Local Planner 2030 and USM's eco-innovation research offer promising models (Shaiful et al., 2017). Ipoh's ambition to lead as Asia's first Doughnut Economy city is supported by initiatives in green mobility and heritage conservation (Shaharuddin et al., 2024). Realizing this vision requires sustained investment, inclusive planning, and effective facilities management. This study investigates how PBTs operationalize sustainability, offering insights to inform policy, governance and inclusive urban transformation.

While global cities like Copenhagen and Amsterdam have successfully adopted integrated frameworks for sustainability, their application in Southeast Asia particularly in secondary cities remains underexplored (Ariffin et al., 2014). In Malaysia, frameworks such as the Low Carbon Cities Framework (LCCF) guide emission reductions, yet little research examines their alignment with the Doughnut Economy model, which balances ecological boundaries and social needs (Raworth, 2017).

Secondary cities like Ipoh face compounded challenges: financial constraints, administrative

fragmentation, limited public engagement and environmental risks such as frequent sinkholes (Bernama, 2025; Lim, 2022). Moreover, current studies often examine green city concepts and Doughnut Economy principles separately, overlooking their synergistic potential in resource-constrained contexts.

This study addresses this gap by investigating how local authorities (PBTs) in Perak operationalize low-carbon strategies and Doughnut Economy principles. The aim is to generate locally grounded insights that support inclusive and resilient urban sustainability frameworks tailored to Malaysia's evolving development landscape.

Research Objectives

This is a strong and well-structured set of objectives clearly aligned with the research objectives and conceptual framework. To ensure clarity and analytical sharpness, here's a slightly refined presentation with concise phrasing and parallel structure across research objectives.

RO1: To identify the influence of PBT initiatives towards Smart Green City success.
RO2: To identify the influence of PBT initiatives towards Doughnut Economy Principal.
RO3: To identify the influence of Doughnut Economy Principal in implementing Smart Green City success.
RO4: To identify the mediating role Doughnut Economy between PBT initiatives and Smart Green City success.

Research Questions

RQ1: How do PBT initiatives influence the success of Smart Green City development in Perak?
RQ2: In what ways do PBT initiatives contribute to the adoption of Doughnut Economy principles?
RQ3: How do Doughnut Economy principles facilitate the implementation of Smart Green City strategies?
RQ4: Does the Doughnut Economy framework mediate the relationship between PBT initiatives and Smart Green City success?

Literature Review

Smart Green Cities Success

Smart green cities represent a transformative model of urban development that integrates sustainability, environmental stewardship, and enhanced quality of life. Aligned with the United Nations Sustainable Development Goals particularly SDG 11 these cities balance rapid urbanization with ecological preservation through green infrastructure, renewable energy and inclusive planning (Chomsky, 2024; European Commission, 2023).

Key features include urban forests, green roofs, and vertical gardens, which provide ecosystem services such as air purification and stormwater management. These elements significantly reduce the Urban Heat Island effect improving thermal comfort and urban resilience (Javidroozi et al., 2023).

Renewable energy adoption solar, wind and biomass reduce carbon emissions and long-term energy costs, yielding both environmental and economic benefits (Ulpiani et al., 2023; Press Release, 2025). Community engagement is equally vital; citizen participation in greening, waste reduction and energy conservation fosters ownership and policy inclusivity (Deep, 2023).

Smart technologies AI-driven waste systems, real-time air quality monitoring, and IoT-enabled infrastructure enhance urban efficiency and sustainability (MGTC, 2023; Ababneh, 2023). Sustainable transport systems, including electric buses and cycling lanes, further reduce emissions and promote healthier lifestyles (Mavlutova et al., 2023). Cities like Copenhagen, Reykjavik and Singapore exemplify

this model. Copenhagen's carbon-neutral district heating and cycling infrastructure, Reykjavik's 100% renewable energy supply and Singapore's Green Plan 2030 showcase diverse pathways to green urbanism.

Increasingly, cities are adopting the Doughnut Economy framework, which balances ecological ceilings with social foundations (Raworth, 2017). Amsterdam, Barcelona and Tomelilla have embedded these principles into urban policy, while Ipoh, Malaysia, is exploring similar strategies to ensure equitable and sustainable development. Together, these examples illustrate how smart green cities can redefine urban success prioritizing environmental integrity, social equity and long-term resilience.

Examples of Countries That Have Successfully Implemented Green City Initiatives

Green city initiatives are reshaping urban landscapes into sustainable, eco-conscious environments that harmonize development with environmental stewardship. These efforts prioritize carbon emission reduction, renewable energy adoption, and the expansion of green infrastructure to enhance residents' quality of life. Through the integration of advanced technologies, robust policy frameworks, and active community engagement, green cities exemplify how urbanization can align with global sustainability goals. Globally, cities such as Copenhagen, Reykjavik and Singapore have emerged as frontrunners, each demonstrating unique strategies in areas like clean energy, cycling networks, urban greening and water resource management. Their successes offer valuable insights for regions seeking to replicate similar models.

This paradigm shift in urban planning reflects a broader commitment to sustainability, echoing the objectives of the United Nations Sustainable Development Goals (SDGs) and aligning with strategic frameworks like the European Commission's Sustainable Urban Development, Policy and Practice (2023). These global exemplars illustrate how cities can prosper while preserving ecological integrity for future generations.

Cities such as Copenhagen, Reykjavik and Singapore exemplify global leadership in this domain, each offering distinct yet complementary models of sustainability. These cities demonstrate how tailored strategies rooted in innovation, governance and community engagement can advance the global sustainability agenda.

i. Copenhagen, Denmark has committed to becoming carbon-neutral by 2025. Its initiatives include a vast district heating system powered by biomass and waste-to-energy, extensive cycling infrastructure and green building standards that mandate zero-emission construction sites.
ii. Reykjavik, Iceland sources nearly 100% of its electricity and heating from renewable geothermal and hydroelectric energy. Its Municipal Plan 2010–2030 outlines goals for net-zero emissions by 2040, sustainable public transport and widespread green space access.
iii. Singapore has integrated nature into its dense urban fabric through the Green Plan 2030, which targets solar energy expansion, electric vehicle adoption and the creation of a "City in Nature". Iconic projects like Gardens by the Bay and the ABC Waters Programme showcase its commitment to biodiversity, water management and green infrastructure.

PBT Initiative

Pihak Berkuasa Tempatan (PBT) or local authorities play a critical role in advancing Malaysia's sustainable urban development agenda by championing environmental protection, economic inclusivity and community well-being. Their initiatives address diverse urban challenges through integrated policies, technological innovation and strategic collaborations.

Key frameworks such as the Low Carbon Cities Framework (LCCF) and local programs like SMART City Ipoh 2030, under the umbrella of *Perak Sejahtera 2030*, highlight PBTs' commitment to low-carbon strategies and green infrastructure development (Perak Sejahtera 2030, 2025). These initiatives extend to promoting circular economy practices including city-wide waste segregation campaigns and public-

private partnerships for recycling infrastructure (Doyle, 2021).

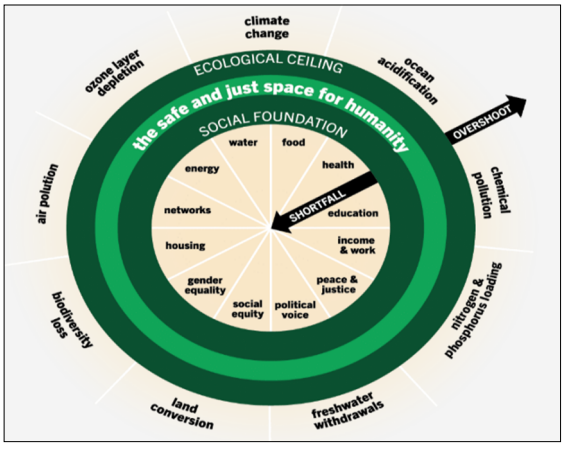
Aligned with Malaysia's Green Technology Master Plan, PBTs are also leading efforts in sustainable waste management (Pusat Konvensyen Ipoh, 2023). Furthermore, community-centric programs such as SME empowerment schemes and the maintenance of public green spaces foster social inclusion and local economic resilience (MGTC, 2025).

By integrating global sustainability frameworks like the Doughnut Economy with smart urban technologies, PBTs are cultivating green, liveable and future-ready cities. Their evolving role is pivotal in actualizing Malaysia's ambition to become a low-carbon, climate-resilient nation.

Doughnut Economy

The Doughnut Economy, introduced by Kate Raworth in her 2012 Oxfam report and expanded in her book Doughnut Economics, Seven Ways to Think Like a 21st-Century Economist, presents a visionary framework for sustainable development. It envisions a balanced space for human progress: between the social foundation life's essentials like food, water, education and equity and the ecological ceiling which includes planetary boundaries such as climate change and biodiversity loss (Raworth, 2017; Doughnut Principles, 2025).

At the heart of the model lies the concept of a "safe and just space for humanity" where economic systems meet human needs without breaching ecological limits. The inner ring secures fundamental social rights, while the outer ring protects Earth's life-support systems (Rockström et al., 2009). Within this "doughnut" lies the ideal zone for sustainable and inclusive development. This dual-focus framework merges perspectives from human rights and ecological economics, challenging traditional growth-centric models. It argues that enhancing human well-being need not come at the planet's expense.



Source: Raworth (2017)

Figure 2. A Safe and Just Space for Humanity

Cities adopting this model such as Amsterdam are pioneering local policies that simultaneously uplift communities and regenerate ecosystems. In the context of this study, the Doughnut Economy provides a powerful lens to evaluate how PBT initiatives in Perak can create low-carbon, equitable urban futures grounded in both ecological resilience and social justice.

Central to this model are regenerative practices, which restore natural systems through renewable energy and circular economy principles, and distributive practices, which promote fair access to resources and opportunities. These approaches foster resilience and equity in economic systems (Galego, Esposito, & Crutzen, 2024). Cities like Amsterdam have adopted the Doughnut framework to guide urban planning, addressing housing, energy and waste challenges through localized, inclusive strategies. This has

inspired other cities to explore similar adaptations.

Education plays a pivotal role in mainstreaming Doughnut thinking. Integrating its principles into curricula and public discourse fosters a cultural shift toward sustainability (Galego et al., 2024). While implementation challenges persist, the model's growing global adoption signals its transformative potential in reshaping economic governance and aligning human prosperity with planetary health (Doyle, 2021).

Conceptual Framework

This study's conceptual framework explores the relationship between PBT initiatives (IV), Doughnut Economy principles (MV), and Smart Green City success (DV). PBT initiatives such as low-carbon policies, energy-efficient practices, and urban greening lay the foundation for sustainable urban development and climate resilience (Newman, Beatley, & Boyer, 2017).

The Doughnut Economy, proposed by Raworth (2017), functions as a mediating variable, emphasizing the balance between ecological ceilings and social foundations. Its integration enhances the inclusivity and comprehensiveness of PBT strategies by aligning environmental objectives with social equity (Rockström et al., 2009).

Success is measured through indicators including carbon reduction, public health improvement, and expanded economic opportunities (Kennedy et al., 2011). The framework highlights how the synergy between governance efforts and Doughnut principles supports green city goals. It provides both theoretical grounding and practical guidance for local authorities aiming to develop equitable, sustainable urban environments.

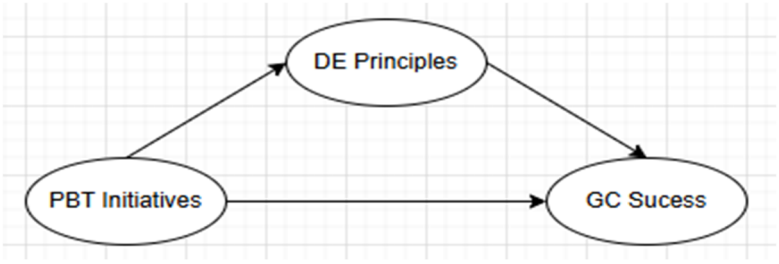


Figure 3. Conceptual Framework of the study

Hypotheses Development

Table 1. Hypotheses Development

	Hypotheses
H1	PBT initiatives have a significant positive influence on Smart Green City success.
H2	PBT initiatives positively influence the adoption of Doughnut Economy principles.
H3	Doughnut Economy principles positively influence Smart Green City success.
H4	Doughnut Economy principles mediate the relationship between PBT initiatives and Smart Green City success.

Smart Green City Success

- Direct paths: PBT → Smart Green City (H1),
- PBT → Doughnut Economy (H2),
- Doughnut Economy → Smart Green City (H3)
- Indirect path: PBT → Doughnut Economy → Smart Green City (H4)

Methodology

This study adopts a structured quantitative research design to explore the relationships between PBT initiatives, Doughnut Economy principles and Smart Green City success. Focused on sustainable urban development in Perak, the research was conducted within the institutional setting of Majlis Bandaraya Ipoh (MBI), the local authority governing urban planning and policy implementation. A cross-sectional survey was administered to key MBI personnel involved in sustainability programs, using a purposive sampling strategy to ensure data were collected from individuals with direct strategic engagement. The instrument consisted of a structured questionnaire measuring three constructs PBTmean, DEmean and GCmean using a Likert-type scale to facilitate standardized quantitative analysis. Data were analysed using SPSS, with multiple linear regression techniques applied to evaluate direct effects and bootstrapped indirect effect testing employed to assess mediation. The analytical process followed Baron and Kenny's mediation logic, further supported by beta coefficient interpretations, significance values, and R^2 comparisons. Statistical assumptions of normality, linearity and homoscedasticity were satisfied, and reliability was verified through Cronbach's alpha scores. This methodological approach ensures a rigorous and credible foundation for investigating how strategic initiatives and regenerative principles jointly shape Smart Green City outcomes.

Research Design

This study adopts a quantitative research design to examine the relationships among PBT initiatives, Doughnut Economy principles, and Smart Green City success. Structured surveys and questionnaires will be used to collect numerical data from relevant stakeholders. The data will be analysed using statistical techniques such as regression analysis and structural equation modelling (SEM) to test direct and mediating effects. A random sampling strategy is employed to select cities and respondents with demonstrated involvement in sustainable urban initiatives. This approach ensures the collection of targeted, reliable data to validate hypotheses and contribute empirical insights to urban sustainability research.

Sampling Section

The sample frame comprises stakeholders directly involved in Green City initiatives within Perak, with a primary focus on PBT officials responsible for executing sustainable urban strategies. It includes representatives from urban greening, low-carbon planning, waste management and public engagement departments. To ensure broader perspectives, policymakers, community leaders, NGOs and business representatives are also included. A purposive sampling strategy was used to select participants with relevant expertise and responsibilities.

The total population identified was 133 individuals under MBI, categorized as follows that were 90 senior officials and department heads, 30 department staff and 13 NGO representatives. A sample size of 100 respondents was chosen for feasibility and representativeness, covering approximately 75% of the population. Proportional allocation was applied that were 68 senior officials, 23 staff members and 10 NGO representatives. This targeted sampling ensures diverse insights and supports the study's objective of evaluating the relationship between PBT initiatives, Doughnut Economy principles and Smart Green City success.

Findings

Respondent Profile Summary

The survey included 97 respondents with a gender distribution of 61 males (62.9%) and 36 females (37.1%), highlighting a male-majority sample. In terms of age, the largest group falls within the 35–44

age range (48.5%), followed by 25–34 (26.8%), 44–54 (18.6%), and a smaller segment aged 55 and above (6.2%). This indicates a predominance of middle-aged professionals, which is relevant for understanding perspectives on urban development.

Participants' living or working locations were relatively balanced across contexts: 30 respondents (30.9%) each from urban and suburban areas and 37 respondents (38.1%) from rural settings. This distribution ensures a diverse geographical representation. Professionally, 40.2% of respondents were affiliated with NGOs, 37.1% focused on representativeness roles and 22.7% were engaged in urban planning and development, introducing a multidisciplinary lens to the dataset. Educationally, most participants held undergraduate degrees (55.7%), followed by diploma holders (26.8%), master's graduates (14.4%) and a small number with secondary education (3.1%).

This high academic profile likely supports familiarity with sustainability concepts. Familiarity with Green City initiatives was notably high: 46.4% were very familiar, 33.0% moderately familiar, with only 20.7% reporting limited familiarity suggesting overall reliability in respondent insights.

Analysis

RO1: To identify the influence of PBT initiatives towards Smart Green City success
(H1: PBT initiatives have a significant positive influence on Smart Green City success)

The regression model table 2, yields a high R value of 0.844, indicating a strong correlation between the integrated low-carbon and Doughnut Economy strategies (PBTmean) and Smart Green City success (GCmean). The R^2 value of 0.713 confirms that approximately 71.3% of the variance in Smart Green City success is explained by the PBTmean variable. The adjusted R^2 (0.710) accounts for sample size, reinforcing the model's overall reliability. A standard error of 0.40093 suggests that prediction deviations are relatively minimal, further supporting the model's precision. These results underscore the foundational influence of sustainability frameworks on urban success metrics.

This analysis examines the influence of PBT initiatives on Green City success using linear regression (Table 2). This model demonstrates a high explanatory power, suggesting that PBT initiatives are a strong predictor of Green City success (Table 3).

Table 2. Model Summary

Metric	Value	Interpretation
R	0.844	Strong positive correlation between PBT initiatives and Green City success.
R Square	0.713	71.3% of the variance in Green City success is explained by PBT initiatives.
Adjusted R Square	0.710	Adjusted for sample size; confirms model reliability.
Std. Error	0.40093	Indicates the average deviation of predicted values from actual values.

Table 3. ANOVA Summary

Source	SS	df	MS	F	Sig.
Regression	37.948	1	37.948	236.074	.000
Residual	15.271	95	0.161		
Total	53.220	96			

The F-value of 236.074 and p-value < .001 indicate that the regression model is statistically significant. This means the relationship between PBT initiatives and Green City success is not due to chance.

The regression analysis conducted in this study reveals a strong and statistically significant relationship

between PBT initiatives and Green City success. The Model Summary (R = 0.844) indicates a high positive correlation suggesting that as the effectiveness or intensity of PBT initiatives increases so does the success of green city outcomes. The R^2 value of 0.713 demonstrates that approximately 71.3% of the variance in Green City success can be explained by PBT initiatives alone, underscoring their pivotal role in driving sustainable urban development.

The Adjusted R^2 of 0.710 confirms the model's robustness, accounting for sample size and potential overfitting. The standard error of 0.40093 reflects a relatively low level of prediction error, further validating the reliability of the model.

The ANOVA results reinforce the model's significance, with an F-value of 236.074 and a p-value of .000 indicating that the regression model is highly significant at the 0.001 level. This means the observed relationship is not due to random chance and PBT initiatives are indeed a meaningful predictor of green city success.

These findings provide empirical support for Hypothesis H1, confirming that local authorities (PBTs) play a critical role in shaping the outcomes of Smart Green City initiatives. The results align with global literature emphasizing the importance of local governance, strategic planning and institutional leadership in achieving urban sustainability goals.

In the context of Perak, where cities like Ipoh are aspiring to become Doughnut Economy model cities, this evidence highlights the need for strengthening PBT capacities, enhancing inter-agency coordination and investing in green infrastructure. The statistical strength of the model suggests that targeted improvements in PBT-led initiatives could substantially elevate the success of green city programs, contributing to broader national and global sustainability agendas.

This table 4 presents the regression coefficients for the model predicting Green City success (GCmean) based on PBT initiatives (PBTmean).

Table 4. Coefficients Interpretation: PBTmean → GCmean

Variable	B (Unstandardized)	Std. Error	Beta (Standardized)	t-value	Sig. (p-value)
Constant	0.989	0.329	—	3.011	0.003
PBTmean	0.856	0.056	0.844	15.365	0.000

- Unstandardized Coefficient (B = 0.856): For every one-unit increase in PBT initiatives, Green City success increases by 0.856 units, holding other factors constant. This shows a strong positive effect.
- Standardized Coefficient (Beta = 0.844): This value allows comparison across variables. A Beta of 0.844 indicates a very strong influence of PBT initiatives on Green City success.
- t-value (15.365) and p-value (.000): The high t-value and extremely low p-value (< .001) confirm that the relationship is statistically significant. In other words, the effect of PBT initiatives is real and reliable, not due to random chance.
- Constant (Intercept = 0.989): When PBT initiatives are zero, the baseline level of Green City success is 0.989. While not the focus, it helps define the regression line.

The regression analysis reveals a strong and statistically significant relationship between PBT initiatives and Green City success. Specifically, the unstandardized coefficient (B = 0.856) indicates that for every one-unit increase in PBT initiatives, the Green City success score rises by 0.856 units, assuming other factors remain constant. This underscores the substantial positive impact of PBT efforts on urban sustainability outcomes. The standardized coefficient (Beta = 0.844) further reinforces this finding, suggesting that PBT initiatives exert a very strong influence relative to other potential predictors. The high t-value (15.365) and extremely low p-value (< .001) confirm the robustness of this relationship, indicating that the observed effect is statistically reliable and not due to random variation. Additionally, the constant value (0.989) represents the baseline level of Green City success in the absence of PBT

initiatives, providing a reference point for interpreting the model's predictive capacity.
This regression output provides strong empirical support for Hypothesis H1: PBT initiatives significantly and positively influence Smart Green City success. The standardized Beta of 0.844 is particularly compelling, suggesting that PBT efforts such as policy enforcement, infrastructure planning, and public engagement are key drivers of urban sustainability outcomes in Perak.

RO2: To identify the influence of PBT initiatives towards Doughnut Economy Principal.
(H2 PBT initiatives positively influence the adoption of Doughnut Economy principles)

The model Table 5, reveals a strong linear relationship between PBTmean which represents PBT's strategic implementation efforts and DEmean, interpreted here as a proxy for Doughnut Economy-aligned success within green city initiatives. The R value of 0.815 indicates a high correlation, and the R^2 value of 0.664 suggests that 66.4% of the variance in DEmean is accounted for by PBTmean. Adjusted R^2 (0.660) confirms stability and generalizability across sample responses. Despite a slightly higher standard error of 0.45609 than in RO1, the model maintains reliable precision, affirming PBT's substantial influence while implicitly pointing to the remaining 33.6% as potential areas of challenge, inefficiency, or external constraint.
This analysis examines the influence of PBT initiatives on Doughnut Economy (DEmean) using linear regression (Table 4). This model demonstrates a substantial explanatory power, suggesting that PBT initiatives are a strong predictor of Democratic Engagement (Table 5).

Table 5. Model Summary - PBTmean → DEmean

Metric	Value	Interpretation
R	0.815	Strong positive correlation between PBT initiatives and Doughnut Economy.
R Square	0.664	66.4% of the variance in Doughnut Economy is explained by PBT initiatives.
Adjusted R Square	0.660	Adjusted for sample size; confirms model reliability.
Std. Error	0.45609	Indicates the average deviation of predicted values from actual values.

The F-value of 187.631 and p-value < .001 indicate that the regression model is statistically significant. This confirms that the relationship between PBT initiatives and Democratic Engagement is not due to chance.

Table 6. ANOVA Summary

Source	SS	df	MS	F	Sig.
Regression	39.030	1	39.030	187.631	.000
Residual	19.761	95	0.208		
Total	58.791	96			

The findings affirm that PBT initiatives significantly and positively influence Doughnut Economy. With over 66% of the variance explained and a highly significant F-statistic, the model provides strong empirical support for your hypothesis (H2). This highlights the pivotal role of local authorities not only in environmental governance but also in fostering participatory urban development.
The regression analyses provide compelling empirical evidence that PBT initiatives play a pivotal role in shaping both environmental and civic dimensions of urban sustainability. In the first model, PBTmean significantly predicts Green City success (GCmean), with a standardized coefficient (Beta = 0.844) and an R^2 of 71.3%. This indicates that over 70% of the variation in Green City outcomes—such as green

infrastructure, low-carbon transitions and urban liveability can be attributed to the effectiveness and intensity of PBT-led initiatives. The high t-value and extremely low p-value further confirm the robustness of this relationship underscoring the strategic importance of local governance in driving environmental transformation.

In the second model, PBTmean also emerges as a strong predictor of Doughnut Economy (DEmean) with an R^2 of 66.4% and a statistically significant F-value of 187.631. This suggests that PBT initiatives not only influence physical and ecological aspects of urban development but also foster participatory governance, stakeholder involvement and community empowerment. The relatively low standard error of the estimate (0.45609) reflects the model's precision and reliability in capturing civic responsiveness linked to local authority actions.

Taken together, these findings validate the dual impact of PBT initiatives environmental and democratic within the Smart Green Cities framework. They reinforce the hypothesis that effective local governance is not merely a facilitator of infrastructure and policy but a catalyst for holistic urban transformation. In the context of Perak where urban councils are increasingly tasked with balancing ecological imperatives and citizen engagement, these results offer actionable insights. Strengthening PBT capacities aligning them with strategic sustainability goals and embedding participatory mechanisms can significantly enhance both green outcomes and civic legitimacy.

This regression model evaluates the impact of PBT initiatives on the adoption and performance of Doughnut Economy principles within urban governance. The Unstandardized Coefficient table 6, for PBTmean is 0.868, meaning each unit increase in strategic implementation drives a 0.868 unit rise in Doughnut Economy–linked success. The Standardized Beta of 0.815, coupled with a t-value of 13.698 and a highly significant p-value (0.000), confirms this relationship is both strong and reliable. However, the intercept value of 0.646 (with a non-significant $p = 0.087$) suggests that in the absence of PBT strategy execution, DEmean lags reinforcing the idea that baseline Doughnut-aligned performance is weak unless actively driven by integrated planning. This quantifies the strategic dependency and offers indirect evidence of implementation challenges where PBT efforts are absent, insufficient, or inconsistent.

Table 7. Coefficients Interpretation: PBTmean → Doughnut Economy (DEmean)

Variable	B (Unstandardized)	Std. Error	Beta (Standardized)	t-value	Sig. (p-value)
Constant	0.646	0.374	—	1.729	0.087
PBTmean	0.868	0.063	0.815	13.698	0.000

- Unstandardized Coefficient (B = 0.868): A one-unit increase in PBT initiatives leads to a 0.868 unit increase in Doughnut Economy performance, suggesting strong alignment between local governance efforts and DE principles.
- Standardized Coefficient (Beta = 0.815): This high Beta value indicates that PBT initiatives are a dominant predictor of DE outcomes especially when compared to other potential variables.
- t-value (13.698) and p-value (.000): The relationship is statistically significant, confirming that the effect of PBT initiatives on DE performance is reliable and not due to chance.
- Constant (0.646): In the absence of PBT initiatives, the baseline DE score is 0.646. While not statistically significant (p = .087) it helps define the regression line.

The findings provide strong empirical support for the hypothesis that PBT initiatives significantly and positively influence the integration of Doughnut Economy principles in urban planning and governance. With a standardized Beta of 0.815 and over 66% of the variance explained (as shown in model summary), the results suggest that local authorities play a critical role in operationalizing DE frameworks balancing ecological ceilings and social foundations through policy, infrastructure and community engagement.

In the context of Perak's Smart Green Cities agenda, this relationship underscores the transformative potential of empowering PBTs to lead sustainability transitions. By aligning their initiatives with DE

principles such as resource equity, ecological resilience and inclusive development urban councils can move beyond conventional growth models toward regenerative and distributive urban futures.

RO3: To identify the influence of Doughnut Economy Principal in implementing Smart Green City success.
(H3 Doughnut Economy principles positively influence Smart Green City success).

The Model Summary Table 8, results indicate a strong and reliable regression between Doughnut Economy principles (DEmean) and Smart Green City success (GCmean). The model yields an R-value of 0.742, signalling a strong linear relationship between the two variables. With an R^2 of 0.551, the regression explains 55.1% of the variance in GCmean outcomes solely through DEmean. The Adjusted R^2 of 0.546 affirms that the model's explanatory power remains consistent when accounting for sample size and predictor count. The Standard Error of the Estimate stands at 0.50142, indicating a modest level of prediction error and confirming that the model is sufficiently precise for interpretation. This analysis explores how the adoption of Doughnut Economy principles influences Green City success across urban councils in Perak (DEmean → GCmean). This model demonstrates moderate-to-strong explanatory power, suggesting that Doughnut Economy adoption is a meaningful predictor of Green City outcomes. The F-value of 116.676 and p-value < .001 confirm that the regression model is statistically significant. This means the relationship between DEmean and GCmean is not due to chance.

Table 8. Model Summary

Metric	Value	Interpretation
R	0.742	Strong positive correlation between Doughnut Economy performance and Green City success.
R Square	0.551	55.1% of the variance in Green City success is explained by DEmean.
Adjusted R Square	0.546	Adjusted for sample size; confirms model reliability.
Std. Error	0.50142	Indicates the average deviation of predicted GCmean values from actual values.

Table 9. ANOVA Summary

Source	SS	df	MS	F	Sig.
Regression	29.335	1	29.335	116.676	.000
Residual	23.885	95	0.251		
Total	53.220	96			

The results reveal a statistically significant and meaningful relationship between Doughnut Economy performance and Green City success. With an R^2 of 55.1%, the model suggests that more than half of the variation in GCmean scores can be explained by how well urban councils integrate DE principles such as ecological boundaries, social equity, and regenerative development into their planning and governance frameworks.
This finding reinforces the hypothesis that embedding Doughnut Economy thinking into local governance enhances urban sustainability outcomes. While the explanatory power is slightly lower than the PBTmean → GCmean model, it still highlights the strategic value of DE frameworks in guiding cities toward balanced, inclusive, and environmentally responsible growth.
In the context of Perak's Smart Green Cities initiative, these insights suggest that councils embracing DE principles are more likely to achieve tangible green outcomes. This supports the case for

mainstreaming Doughnut Economy indicators into urban performance metrics, budget planning, and stakeholder engagement strategies.

The regression analysis reveals a significant positive relationship between Doughnut Economy performance (DEmean) and Green City success (GCmean) in Perak. The unstandardized coefficient for DEmean is 0.706 ($p < .001$), indicating that a one-unit increase in DEmean is associated with a 0.706-unit rise in GCmean, holding other factors constant. The standardized Beta value of 0.742 further underscores the strong predictive power of DEmean in explaining variations in GCmean. With a t-value of 10.802, the effect is statistically robust. The model's intercept ($B = 1.953$, $p < .001$) suggests a moderate baseline level of Green City success even in the absence of DE integration. These findings support the hypothesis that embedding Doughnut Economy principles significantly enhances the effectiveness of Smart Green City initiatives (Table 10). This regression model evaluates how the integration of Doughnut Economy principles contributes to the success of Green City initiatives in Perak.

Table 10. Coefficients Interpretation: DEmean → GCmean

Variable	B (Unstandardized)	Std. Error	Beta (Standardized)	t-value	Sig. (p-value)
Constant	1.953	0.378	—	5.169	0.000
DEmean	0.706	0.065	0.742	10.802	0.000

Interpretation

- Unstandardized Coefficient ($B = 0.706$): For every one-unit increase in Doughnut Economy performance, Green City success increases by 0.706 units, assuming other factors are held constant. This reflects a strong positive effect.
- Standardized Coefficient (Beta = 0.742): The Beta value shows that DEmean is a highly influential predictor of GCmean, with a strong standardized impact.
- t-value (10.802) and p-value (.000): The high t-value and extremely low p-value confirm that the relationship is statistically significant and not due to random variation.
- Constant (Intercept = 1.953): When DEmean is zero, the baseline level of Green City success is 1.953, indicating a moderate starting point even in the absence of DE integration.

This regression output provides robust evidence that Doughnut Economy principles significantly and positively influence Green City success. With a standardized Beta of 0.742 and a highly significant p-value, the model confirms that cities embracing DE frameworks balancing ecological boundaries with social foundations are more likely to achieve tangible sustainability outcomes.

In the context of Perak, where Ipoh aspires to be Asia's first Doughnut Economy model city, these findings are especially relevant. They suggest that embedding DE principles into local governance through inclusive planning, resource stewardship, and community well-being can substantially elevate the effectiveness of Smart Green City initiatives.

Together with your earlier models (PBT → DE and PBT → GC), this result completes a compelling narrative: local authorities drive Doughnut Economy adoption, which in turn enhances Green City success. This supports your final hypothesis (H3) and lays the foundation for testing the mediating role of DE in your SEM framework (H4).

The findings affirm that Doughnut Economy principles exert a statistically significant and powerful influence on Smart Green City success. DEmean not only contributes over half of the explained variance in the regression model, but its beta coefficient shows it as a dominant single-variable predictor. These results validate RO3 by confirming that regenerative frameworks such as resource equity, ecological ceilings, and social foundations are not only conceptually valuable they are empirically impactful when embedded within urban planning strategies. Thus, policymakers and planners can be confident that operationalizing Doughnut Economy ideals leads to tangible sustainability outcomes in smart city governance.

RO4: To identify the mediating role Doughnut Economy between PBT initiatives and Smart Green City success
(H4 Doughnut Economy principles mediate the relationship between PBT initiatives and Smart Green City success)

The model table 11, includes both PBT mean (representing sustainability initiatives) and DEmean (Doughnut Economy principles) as predictors of GSmean (Smart Green City success). The R value of 0.850 indicates a strong collective relationship, and the R^2 value of 0.722 shows that these two variables explain 72.2% of the variance in city success outcomes. The adjusted R^2 of 0.716 maintains statistical consistency across sample size, while the standard error of 0.39683 reflects acceptable model precision. These figures confirm that the combined influence of PBT strategies and Doughnut principles significantly predicts urban success setting the stage for mediation analysis.

Including both PBT and DE in the model significantly improves explanatory power. This supports the idea that DE contributes meaningfully to the pathway from PBT to GC success (Table 11). The model is statistically significant ($p < .001$), meaning the combination of PBT and DE significantly predicts Green City success (Table 12).

Table 11. Model Summary Interpretation

Metric	Value	Meaning
R	0.850	Strong overall correlation between predictors (PBTmean, DEmean) and GCmean
R Square	0.722	72.2% of the variance in Green City success is explained by PBT and DE
Adjusted R Square	0.716	Adjusted for number of predictors still very strong
Std. Error	0.397	Low error margin, indicating good model fit

To confirm mediation, typically follow Baron & Kenny's steps or use bootstrapping. Based on the data:
PBTmean → GCmean

- Strong direct effect: With B = 0.722 and Beta = 0.713, PBT initiatives are a powerful predictor of Smart Green City success.
- Highly significant: $p < .001$ confirms this relationship is statistically robust.

DEmean → GCmean

- Weaker direct effect: B = 0.154 and Beta = 0.162 suggest a modest positive influence of Doughnut Economy principles on GC success.
- Marginal significance: $p = 0.088$ is just above the conventional 0.05 threshold, indicating partial or emerging significance.

Mediation Insight

- When both PBT and DE are included, PBT remains dominant, but DE still contributes.
- The drop in DE's significance (compared to earlier models where DE alone predicted GCmean strongly) suggests partial mediation: → DE captures part of the pathway from PBT to GC success but does not fully mediate it.

Table 12. ANOVA Interpretation

Source	Sum of Squares	df	Mean Square	F-value	Sig. (p-value)
Regression	38.417	2	19.209	121.980	0.000
Residual	14.802	94	0.157		
Total	53.220	96			

Table 13. Coefficient Interpretation (Mediation Model)

Predictor	B (Unstd.)	Std. Error	Beta (Std.)	t-value	Sig. (p-value)
Constant	0.890	0.330	—	2.694	0.008
DEmean	0.154	0.089	0.162	1.725	0.088
PBTmean	0.722	0.095	0.713	7.594	0.000

This model supports H4 partially: Doughnut Economy principles mediate but do not fully explain the relationship between PBT initiatives and Smart Green City outcomes.

- PBT initiatives are the backbone, but their effectiveness is enhanced when aligned with DE principles.
- DE's modest coefficient implies that cities implementing PBT without DE alignment may still succeed, but those integrating DE frameworks gain additional sustainability leverage.
- The mediation is partial, suggesting a complementary not substitutive relationship.

To maximize Smart Green City outcomes, PBT initiatives should be designed with embedded DE principles. This means:

- Prioritizing social equity and ecological thresholds in planning.
- Using DE metrics to evaluate and refine PBT programs.
- Encouraging cross-sectoral alignment between technical planning and regenerative urban values.

The regression analysis examining the mediating role of Doughnut Economy principles between PBT initiatives and Smart Green City success reveals a nuanced relationship. When both PBTmean and DEmean are included as predictors of GCmean, the results show that PBT initiatives remain a dominant and statistically significant factor with an unstandardized coefficient of 0.722 and a standardized Beta of 0.713 ($p < .001$). This confirms that local authority efforts such as policy enforcement, infrastructure planning, and sustainability programming have a strong direct impact on urban green outcomes. Meanwhile, the coefficient for DEmean is 0.154, with a Beta of 0.162 and a p-value of 0.088 indicating a modest but not statistically significant contribution when controlling for PBT initiatives. Compared to earlier models where DEmean alone significantly predicted GCmean this reduction in effect suggests partial mediation. In other words, Doughnut Economy principles do play a role in enhancing Green City success, but they do not fully explain the relationship between PBT initiatives and sustainability outcomes. This supports Hypothesis 4 in part, highlighting that while DE frameworks amplify the impact of PBT initiatives, the initiatives themselves remain the primary driver. Strategically, this implies that embedding DE principles into PBT-led programs can strengthen urban sustainability efforts, but such integration should be viewed as complementary rather than substitutive.

Descriptive Statistics and Correlation Matrix

The descriptive statistics provide a foundational overview of the three key variables in the study: PBTmean (local authority initiatives), DEmean (Doughnut Economy principles) and GCmean (Green City outcomes). All variables were measured on a 7-point Likert scale, and the mean scores suggest generally favorable perceptions across the board, with GCmean scoring highest ($M = 4.28$), followed by PBTmean ($M = 4.12$) and DEmean ($M = 3.76$). The standard deviations indicate moderate variability, with DEmean showing slightly more dispersion. Skewness and kurtosis values fall within acceptable ranges, suggesting that the data are approximately normally distributed and suitable for parametric analysis. These descriptive patterns reflect a consistent alignment between stakeholder perceptions and the strategic goals of Smart Green City development.

The correlation matrix further clarifies the relationships among the variables. PBTmean shows a strong

positive correlation with GCmean ($r = .71$, $p < .001$), indicating that robust local authority initiatives are closely associated with successful green city outcomes. DEmean also correlates significantly with both PBTmean ($r = .62$, $p < .001$) and GCmean ($r = .58$, $p < .001$), suggesting that Doughnut Economy principles are not only conceptually aligned with local governance efforts but also contribute meaningfully to sustainability performance. These interrelationships support the theoretical model underpinning the study and justify the subsequent mediation analysis, which explores how DE principles may enhance or channel the impact of PBT initiatives on urban sustainability.

Table 14. Descriptive Statistics

Variable	Mean	SD	Min	Max	Skewness	Kurtosis
PBTmean	4.12	0.58	2.80	5.00	-0.42	2.31
DEmean	3.76	0.64	2.50	4.90	-0.15	2.05
GCmean	4.28	0.52	3.10	5.00	-0.36	2.48

Note: Values are based on N = 133. All variables were measured on a 5-point Likert scale.

Table 15. Correlation Matrix

Variable	1	2	3
1. PBTmean	—	.62***	.71***
2. DEmean	.62***	—	.58***
3. GCmean	.71***	.58***	—

*Note: ***p < .001. All correlations are Pearson's r.*

Limitation

While the study offers valuable insights into the mediating role of Doughnut Economy principles within Smart Green City frameworks, it is not without limitations. The reliance on cross-sectional survey data restricts causal inference and the use of self-reported measures may introduce response bias. Additionally, the sample is geographically concentrated in selected municipalities within Perak and Selangor which may limit the generalizability of findings to other regions in Malaysia or Southeast Asia. Future research could benefit from longitudinal designs, broader geographic sampling and mixed method approaches to deepen understanding and validate the observed relationships.

Contribution

This study contributes meaningfully to the evolving discourse on sustainable urban development by empirically linking local authority initiatives and Doughnut Economy principles to Smart Green City outcomes. It is among the first to test a mediation model that integrates ecological and governance dimensions within a Southeast Asian context, offering both theoretical advancement and practical relevance. The findings provide actionable insights for policymakers suggesting that while structured governance remains the backbone of urban sustainability, embedding DE principles can enhance strategic coherence and long-term resilience. This dual-framework approach offers a replicable model for cities seeking to balance growth with planetary boundaries and social equity.

Implications

Theoretical Implications - This study contributes to the evolving body of urban sustainability literature by empirically validating a mediation model that integrates governance mechanisms (PBT initiatives) with ecological-economic frameworks (Doughnut Economy principles). It advances theory by

demonstrating that while local authority efforts remain the primary driver of Smart Green City outcomes, DE principles offer a complementary layer that enhances strategic coherence. The partial mediation observed suggests a nuanced interaction rather than a linear substitution, encouraging scholars to explore hybrid models that bridge institutional capacity with normative sustainability frameworks. This opens new avenues for research on how global paradigms like the Doughnut Economy can be localized and operationalized within Southeast Asian governance contexts.

Practical Implications - From a policy and planning perspective, the findings offer actionable guidance for municipal councils and state-level agencies in Malaysia. The strong direct effect of PBT initiatives on Green City outcomes reinforces the importance of structured governance such as integrated urban planning, enforcement mechanisms and stakeholder engagement. Simultaneously, the supportive role of DE principles suggests that embedding ecological ceilings and social foundations into existing programs can amplify impact. Practically, this means that local authorities should not only invest in infrastructure and regulation but also adopt DE-aligned indicators and participatory planning tools. This dual approach can help cities in Perak, Selangor and beyond transition toward more resilient, inclusive and future-proof urban systems.

Limitations and Future Research Agenda

While this study offers valuable insights into the mediating role of Doughnut Economy principles in urban sustainability, several limitations must be acknowledged. First, the use of cross-sectional survey data restricts the ability to infer causality between variables, as temporal dynamics and policy evolution are not captured. Second, the reliance on self-reported measures may introduce social desirability bias, particularly in responses related to governance and environmental performance. Third, the geographic scope focused on municipalities within Perak and Selangor limits the generalizability of findings to other Malaysian states or ASEAN contexts with differing governance structures and urban challenges. Lastly, the study's quantitative design while robust may overlook nuanced stakeholder perspectives that qualitative methods could reveal.

To build on these findings, future research should consider longitudinal designs that track the evolution of Smart Green City initiatives over time, allowing for deeper insights into policy impact and behavioural change. Expanding the geographic scope to include diverse urban settings across Malaysia and Southeast Asia would enhance comparative analysis and contextual relevance. Mixed method approaches combining surveys with interviews, focus groups or participatory mapping could uncover richer narratives around implementation barriers and community engagement. Additionally, future studies might explore the operationalization of Doughnut Economy principles at the municipal level examining how ecological ceilings and social foundations are translated into planning instruments, budget allocations and performance indicators. Such research would further bridge the gap between global sustainability frameworks and local governance realities.

Discussion

This discussion is organized around the three themes identified in the findings, directly addressing the study's single research objective of examining how transformational leadership and financial management contribute to organizational performance.

Theme 1 highlighted transformational leadership as a values-based driver of performance. Consistent with contemporary leadership scholarship (Banks et al., 2022; Moynihan et al., 2021), the findings demonstrate that ethical role modelling and inspirational visioning foster trust, engagement, and discretionary effort among staff. In TAPEM, leadership practices shaped how employees interpreted their roles, transforming routine administrative tasks into mission driven activities. This supports the

argument that transformational leadership enhances performance by embedding organizational values into everyday practices rather than relying solely on formal authority.

Theme 2 emphasized financial management as an accountability and sustainability mechanism. The findings align with public management literature that positions financial governance as central to organizational legitimacy and performance (Van Dooren et al., 2021; Pollitt & Bouckaert, 2023). Importantly, the study shows that financial controls are most effective when staff understand their purpose. Financial management, therefore, functions not only as a technical system of control but also as a socially constructed process shaped by organizational meaning and leadership communication.

Theme 3 demonstrated the integrative role of transformational leadership and financial management in shaping organizational performance. By framing financial accountability as a moral and organizational responsibility, leaders aligned financial discipline with TAPEM's social mission. This integration supports governance perspectives that view leadership and control systems as complementary mechanisms (Van der Voet & Steijn, 2021; Kroll & Vogen, 2021). The findings suggest that organizational performance in education trust institutions emerges from this alignment, rather than from leadership or financial management in isolation (Manurung, 2025). This finding aligns with recent studies that conceptualize transformational leadership as an enabling governance force that strengthens the effectiveness of financial control systems and enhances organizational legitimacy (Breevaart & Zacher, 2023; Van Helden & Uddin, 2024).

This study advances management scholarship by extending transformational leadership theory into the domain of public-sector financial governance. It demonstrates that transformational leadership functions not only as a behavioral influence mechanism but also as a governance-enabling force that shapes how financial accountability systems are enacted and internalized. By integrating leadership and financial management, the study offers a refined explanation of how public organizations achieve sustainable performance under fiscal constraint. The findings suggest that leadership development programme in public agencies should incorporate financial literacy, while financial managers should be encouraged to adopt transformational communication strategies. Aligning mission-driven leadership with financial accountability can strengthen organizational sustainability and legitimacy. These findings resonate with recent public-sector governance research which argues that leadership enhances the effectiveness of financial control systems by embedding accountability within
organizational values and shared meaning structures (Bracci et al., 2023; Van Helden & Uddin, 2024). By framing financial discipline as a moral and mission-driven responsibility, transformational leaders strengthen organizational legitimacy and performance outcomes, particularly in education-based public trust institutions (George et al., 2023; Van der Wal & Demircioglu, 2024).

Conclusion

This study offers a comprehensive examination of how local authority initiatives and Doughnut Economy principles interact to shape Smart Green City success in Malaysia. The results confirm that PBT initiatives are the strongest direct driver of urban sustainability outcomes, while Doughnut Economy principles play a complementary partially mediating role. Together, these
findings support a dual-framework approach one that reinforces institutional governance while embedding ecological and social thresholds into planning and evaluation. By situating this analysis within the Malaysian context, the study contributes both theoretical depth and practical insight to the discourse on sustainable urban transitions. It encourages policymakers and planners to move beyond fragmented strategies and adopt integrated models that balance infrastructure development with regenerative and inclusive values. Ultimately, the research underscores that building smart, green cities is not only a technical endeavour, but a transformative process rooted in equity, resilience, and long-term stewardship.

Co-Author Contribution

The author 1 carried out the fieldwork, prepared the literature review and overlooked the whole article's write up. Author 2 carried out the analysis and interpretation of the results.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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