JRIIE Journal of Research Innovation and Implications in Education
Center for Research Implications & Practice

Website:www.jriiejournal.com ISSN 2520-7504 (Online) Vol.9, Iss.2, 2025 (pp. 298 - 305)

Smart City and Sustainable Urban Development in Rwanda: A Case Study of Nyarugenge District

Uwayo Goreth & Daniel Mburamatare
University of Kigali,
https://orcid.org/0009-0000-5599-8267
Email: uwayogoreth44@gmail.com

Abstract: *The general objective of this study is to assess the effect of smart city practices on sustainable urban development in Nyarugenge District, Rwanda. This study focused on 322 participants from Nyarugenge District. Using Slovin's formula, a sample size of 178 respondents ensured accurate representation. The study used simple random sampling. Data collection methods included questionnaires, interviews, and documentation reviews, with analysis conducted through SPSS version 25 to generate descriptive statistics, correlation coefficients, and regression models. The coefficient of Smart Technology Adoption is 0.457, indicating that sustainable urban development in Nyarugenge District increases by 0.457 units for every one-unit increase in smart technology adoption. The significance value (p = 0.000) confirms this effect is statistically significant. The coefficient of Smart Public Transport is 0.343 indicates a one-unit increase in smart public transport is associated with an increase of 0.343 units in sustainable urban development in Nyarugenge District. The significance value (p = 0.000) indicates a statistically significant relationship. The coefficient of Smart Utility Management is 0.163, suggesting a one-unit increase in smart utility management is associated with a 0.163-unit increase in sustainable urban development in Nyarugenge District. However, the significance value (p = 0.029) indicates this relationship is statistically significant at the 0.05 level. Substantial evidence demonstrates that smart technology adoption, smart public transport, and smart utility management each significantly influence sustainable urban development in Nyarugenge District. Nyarugenge District, in partnership with telecommunications companies and community organizations, should continue to invest in infrastructure to improve internet access in underserved areas further.*

Keywords: *Smart City Practices, Smart Technology Adoption, Smart Public Transport, Smart Utility Management and Sustainable Urban Development*

How to cite this work (APA):

Uwayo, G. & Mburamatare (2025). Smart city and sustainable urban development in Rwanda. A case study of Nyarugenge District. *Journal of Research Innovation and Implications in Education, 9*(2), 298 – 305. **https://doi.org/10.59765/vbtr2654r.**

1. Introduction

Rwanda's progress in this area highlights the importance of integrating smart city principles with local priorities and capacities. The Smart Kigali initiative, Kigali Innovation City, and the sustainable urban development efforts in Muhanga District demonstrate the country's commitment to creating livable, inclusive, and sustainable urban environments. Through the effective implementation of these initiatives, Rwanda continues to position itself as a model for sustainable urban development in Africa and beyond. The collective experiences of countries worldwide, regionally, and within Rwanda, underline the transformative potential of smart cities in creating a sustainable future for urban populations (Ntakirutimana *et al.*, 2020).

Kigali, the capital city, exemplifies this commitment through its Smart Kigali initiative. This program emphasizes the use of ICT to improve public services, urban mobility, and communication systems. Smart traffic management systems, cashless payment options in public transport, and city-wide Wi-Fi connectivity have enhanced the quality of urban life while addressing transportation and communication challenges. Additionally, Kigali has prioritized the development of green infrastructure and renewable energy systems, aligning with the national vision of achieving green growth and climate resilience (Tikoudi, 2023).

Additionally, the Urban green initiative in Rwanda focuses on creating green spaces within urban areas, enhancing biodiversity while improving the quality of life for residents. This initiative prioritizes environmentally friendly practices in urban development, ensuring that green architecture and open spaces are integrated into the city's landscape (Ndayisaba, 2023).

Despite the steps in technological adoption and urban planning, Rwanda faces persistent challenges in achieving smart cities and sustainable development goals. These include inadequate infrastructure, limited public transport integration, traffic congestion, and environmental concerns. Rwanda's urban population is rapidly increasing at a pace of 4.5% per year, similar to other African countries. The rapid growth of the country's cities presents challenges in providing safe and cost-effective infrastructure for residents to live, work, and contribute to the economy. Kigali, Rwanda's capital, has an annual population growth of over 100,000 people, which stresses the city's infrastructure, services, and resources (Gubić, 2022).

A significant challenge facing Kigali's transformation into a smart and sustainable city is financing and executing large-scale ecological projects. The Green City Kigali initiative, budgeted at $5 billion, aims to construct 1.7 million eco-friendly homes and install advanced water and internet infrastructure. However, progress remains slow, with limited pilot implementation on Kinyinya Hill. Additionally, Kigali's intelligent waste management system requires expansion to informal settlements, which account for a significant portion of its 1.8 million residents. These issues highlight financial, infrastructural, and inclusivity gaps hindering sustainable urban development in Rwanda (Afrik 21, 2024).

Moreover, Kigali struggles with poor road connectivity, inflexible work schedules, and inadequate public transport integration. With a road density of 0.53 km/km^2, only 15% of the city's 1,000 km of roads are paved, many in poor condition. Traffic congestion, centralized planning, and limited mixed land use hinder mobility, economic efficiency, and environmental sustainability. These issues challenge Rwanda's vision for smart cities by impeding technological integration, reducing livability, and exacerbating environmental impacts, underscoring the need for innovative and sustainable urban planning strategies (Bagenzi *et al.*, 2021).

Several studies have explored smart cities and sustainable urban development in Rwanda, focusing on challenges such as infrastructure, transport, and population growth. However, they failed to address the case of Nyarugenge District. To bridge the gap, the current study investigated the implications and proposed strategies to enhance urban sustainability and smart city development in Nyarugenge District.

The general objective of this study is to assess the effect of smart city on sustainable urban development in Nyarugenge District, Rwanda.

Specifically, the study is guided by the following objectives:

1. To assess the effect of smart technology adoption on sustainable urban development in Nyarugenge District.
2. To Evaluate the effect of smart public transport on sustainable urban development in Nyarugenge District.
3. To investigate the effect of smart utility management on sustainable urban development in Nyarugenge District.

The following null hypotheses were proposed by the researcher:

H_{01}: There is no significant effect of smart technology adoption on sustainable urban development in Nyarugenge District.
H_{02}: There is no significant effect of smart public transport on sustainable urban development in Nyarugenge District.
H_{03}: There is no significant effect of smart utility management on sustainable urban development in Nyarugenge District.

2. Literature Review

2.1 New Urbanism Theory

The roots of new urbanist theory are most evident in the works of Jane Jacobs and Leon Krier. Jacobs (1961) focused on ensuring a mix of uses and people in the city. It advocates pedestrian-friendly streetscapes, well-designed and connected street systems, and urban forms that facilitate urban living. New urbanism is the most important planning movement this century and is about creating a better future for us all. It is an international movement to reform the design of the built environment and is about raising our quality of life and standard of living by creating better places to live. New Urbanism is the revival of our lost art of place-making and is essentially a re-ordering of the built environment into the form of complete cities, towns, villages, and neighborhoods - the way communities have been built for centuries around the world. New Urbanism involves fixing and infilling cities, as well as the creation of compact new towns and villages (Talen, 2020).

New Urbanism seeks to create urban environments that are sustainable, socially inclusive, and conducive to a high quality of life, making cities more livable and connected. The principles of New Urbanism guide urban planning and policy development in contemporary communities, fostering integration and cohesion. The theory emphasizes a return to traditional neighborhood design principles and promotes sustainable practices that enhance the quality of life in urban contexts (Benfield & McGowan, 2018).

New Urbanism Theory promotes the integration of smart technologies within urban spaces to enhance the livability, walkability, and sustainability of neighborhoods, making it directly relevant to assessing technology adoption in Nyarugenge District.

2.2 Stakeholder Theory

Stakeholder Theory, introduced by R. Edward Freeman in 1984, highlights the importance of incorporating the perspectives and interests of all stakeholders in organizational decision-making processes. Stakeholders encompass individuals or groups that impact or are impacted by organizational activities, including employees, customers, suppliers, communities, and regulatory bodies. This theory emphasizes that addressing the needs of multiple stakeholder groups is vital for achieving long-term stability and success in any organizational context (Freeman *et al.*, 2021).

The theory advocates active stakeholder engagement to build trust and credibility while enhancing organizational effectiveness. It involves identifying relevant stakeholders, understanding their expectations, and harmonizing conflicting interests to align with broader goals. Mechanisms such as consultations, partnerships, and transparent communication channels are employed to maintain accountability and inclusivity. Stakeholder Theory has been widely applied in fields like corporate social responsibility, governance, and public policy, offering a comprehensive approach to managing relationships in complex systems (Bimpong & David, 2024).

Stakeholder Theory shows how smart utility management involves various stakeholders, including government bodies, utility providers, and the community. It emphasizes the need for engagement and collaboration among all parties to optimize resource management and sustainability in Nyarugenge District.

2.3 Empirical Review

Gubić (2022) examined Rwanda's smart city strategies for enhancing urban service delivery amidst rapid urbanization, with an annual population growth rate of 4.5%. Kigali, the capital city, serves as the main urban hub, attracting a significant number of migrants from rural areas. The study analyzed the integration of smart technologies, including digitized systems for property tax collection, electricity payments, and government communication, within Kigali's master planning processes. The focus on ICT and smart technologies was assessed in relation to their effectiveness in improving urban governance and service delivery. Key findings indicated that while technological advancements positively impacted service efficiency, achieving a comprehensive transformation required enhanced collaboration among national and local governments, civil society, and community-level stakeholders. The research recommended prioritizing deeper engagements with all stakeholders to align Rwanda’s smart city agenda with sustainable urbanization goals, leveraging tools such as sensors, mobile technology, and artificial intelligence effectively.

Bhorkar (2024) examined the transformative effects of public transportation on urban development and social equity, highlighting its influence on land use, economic growth, environmental sustainability, and accessibility. Transit-oriented development in cities like New York and Tokyo has enabled efficient land utilization, while London’s Elizabeth Line exemplifies the economic benefits through job creation and property value increases. Curitiba’s affordable bus rapid transit system ensures mobility for low-income populations, emphasizing public transport's role in social equity. Environmental benefits are observed in Amsterdam, where integrated public transportation reduces carbon emissions. A study by the American Public Transportation Association indicates that households in transit-accessible areas save over $10,000 annually, reducing financial burdens for low-income families. Public transport also promotes health through reduced accidents and active commuting, as seen in Paris’s Vélib’ program. Innovations like Shenzhen's electric fleets and Singapore’s AI-driven systems further demonstrate advancements in sustainable and efficient public transportation systems.

Wołek *et al.* (2021) conducted a case study on the trolleybus system in Gdynia and Sopot, Poland, examining factors influencing the development of electromobility in urban public transport. The study highlighted the economic viability of trolleybuses, particularly with in-motion charging (IMC) technology, which enables operations without overhead lines. Results indicated that when used intensively, trolleybuses are more cost-effective than diesel buses, with a minimum catenary length of 30% required for effective IMC operation. The study utilized an economic model to assess the lifecycle costs of trolleybuses, concluding that including external costs makes trolleybus transport economically efficient. The energy mix plays a significant role in enhancing economic benefits, with renewable energy diversification needed throughout the day. The research advocates for the adoption of in-motion charging trolleybuses as a balanced solution between capital costs and battery capacity, especially in cities with existing trolleybus infrastructure.

Makieła *et al.* (2022) explored the development of Metropolis GZM cities within the framework of Smart City 4.0 and 4T capitals, focusing on sustainable urban development and the integration of innovative strategies in local governance. The study analyzed how local authorities incorporate Smart City and 4T capitals concepts to enhance municipal services and engage citizens in urban decision-making. Data were collected through a systematic literature review, local document analysis, and interviews with local managers. The study identified the potential of academic entrepreneurship, citizen innovativeness, and entities supporting innovation in driving sustainable development in selected cities. The research also highlighted the importance of utilizing new models and tools for sustainable development to improve citizens' access to services. The findings revealed a growing emphasis on citizen participation and innovation in shaping the future of cities, with an increased focus on achieving sustainable urban living through collaborative approaches to policy and innovation management.

3. Methodology

This section outlines the methodology for conducting research to achieve the stated objectives. It emphasizes the importance of obtaining and utilizing accurate information to meet research goals effectively.

3.1 Research Design

This study employed descriptive and correlational research design. The descriptive aspect focused on illustrating smart city practices and sustainable urban development through descriptive statistics. The correlational aspect assessed the relationship between smart city practices and sustainable urban development. Correlation analysis was applied to determine the relationship between the variables.

3.2 Study Population and Sampling

This study focused on 322 participants from Nyarugenge District, including employees from Urban Planning and Development, Infrastructure, Transport and Mobility, Utilities Management, Local Government staff, and Citizen representatives per cell in Nyarugenge District. Their feedback was critical for assessing the effects of smart city practices on sustainable urban development.

When studying the entire population is impractical due to constraints such as time or resources, Slovin's formula is a reliable method for determining an appropriate sample size. The formula ensures that the sample accurately represents the population with acceptable error margins.

This is how the researcher determined sample size through Slovin's formula:

$$n = \frac{N}{1 + (Ne^2)}$$

n= Number of samples or sample size
N= Total population
e = Error tolerance

$$n = \frac{322}{1 + (322x0.05^2)}$$

$$n = \frac{322}{1+(322x0.0025)} = \frac{322}{1+0.805} = \frac{322}{1.805} = 178$$

The study used simple random sampling as every individual within the target population has an equal probability of being selected for inclusion in the sample. This random selection process ensured that each member of the population has an unbiased and equal chance of participation.

3.3 Data Collection Methods

The primary data was collected through questionnaires administered to 178 key stakeholders in Nyarugenge District. These individuals included representatives from the Department of Urban Planning, Department of Infrastructure, Department of Transport and Mobility, and Department of Utilities Management. Closed-ended questions assessed the quantitative impact of smart city practices on sustainable urban development, while open-ended questions explored perceptions regarding implementing smart city practices in Nyarugenge District.

3.4 Data Analysis

The data was analyzed using a combination of descriptive statistics, inferential statistics (Bivariate Correlation analysis), and a linear regression model. The researcher used Statistical Package for Social Science (SPSS) Version 25.0 to generate frequency, percentage, mean, and standard deviation.

Bivariate Correlation analysis was used for testing the validity of hypotheses; this ensures the test of one dependent variable to one independent variable. It is one of the simplest forms of statistical analysis, which was used to find out if there is a relationship between two sets of values. It usually involves the variables X and Y. Bivariate analysis is the analysis of exactly two variables. This generates Pearson Correlation (r), which ranges between ± 1, which may be positive or negative, strong or weak based on the test results, and which range fits from [-1; +1], and it also takes under consideration Sig.(2-Tailed) which tests the statistical significance of tested variables. This should be less or equal to 0.05 for being statistically significant.

Multiple regression model was evaluated to all indicators as stated in the conceptual framework.

$$Y= \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + e$$

Where:

Y = Sustainable Urban Development,
β_0 = Constant (intercept),
X_1 = Smart Technology Adoption,
X_2 = Smart Public Transport,
X_3 = Smart Utility Management,
e = Error term.

This equation helped to assess the effect of the three independent variables on sustainable urban development in Nyarugenge District.

3.5 Ethical Considerations

Participants were asked for their consent prior to completing the surveys, and all data gathered kept strictly confidential. To facilitate the process, an official letter of acceptance for data collection from the educational institution, as well as a letter from the relevant authorities at Nyarugenge District presented to all participants prior to the study. The questionnaires were not requiring participants to provide their names or titles, ensuring their privacy and anonymity are preserved throughout the research process.

4. Results and Discussion

According to the research, 155 of the 178 questionnaires distributed were completed and returned, providing a response rate of around 87.07%. This high response rate indicates that individuals actively participated, indicating that the questionnaire was well-received and relevant to them. Inferential statistics were used for drawing conclusions or making inferences about a population based on a sample of data. Two key methods in inferential statistics are correlation and regression analysis.

4.1. Correlation Analysis

Correlation analysis assesses the strength and direction of a relationship between two quantitative variables. It indicates whether and how strongly pairs of variables are related.

Table 1: Correlations matrix

		Smart Technology Adoption	Smart Public Transport	Smart Utility Management	Sustainable Urban Development
Smart Technology Adoption	Pearson Correlation	1	.725**	.707**	.848**
	Sig. (2-tailed)		.000	.000	.000
	N	155	155	155	155
Smart Public Transport	Pearson Correlation	.725**	1	.896**	.847**
	Sig. (2-tailed)	.000		.000	.000
	N	155	155	155	155
Smart Utility Management	Pearson Correlation	.707**	.896**	1	.819**
	Sig. (2-tailed)	.000	.000		.000
	N	155	155	155	155
Sustainable Urban Development	Pearson Correlation	.848**	.847**	.819**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	155	155	155	155

**. Correlation is significant at the 0.01 level (2-tailed).
Source: Field data, 2024

The correlation matrix Table 1 displays the relationships between four key variables: Smart Technology Adoption, Smart Public Transport, Smart Utility Management, and Sustainable Urban Development in Nyarugenge District.

Smart Technology Adoption and Sustainable Urban Development in Nyarugenge District: The Pearson correlation coefficient is 0.848, indicating a very strong positive correlation. The significance of value (p = 0.000) confirms that this relationship is statistically significant at the 0.05 level. Smart Public Transport and Sustainable Urban Development in Nyarugenge District: The correlation coefficient is 0.847, also indicating a very strong positive correlation. The significance value (p = 0.000) suggests this relationship is statistically significant. Smart Utility Management and Sustainable Urban Development in Nyarugenge District: The Pearson correlation here is 0.819, indicating a strong positive correlation. The significance of value (p = 0.000) confirms this strong relationship is statistically significant.

In line with Bibri (2021) mentioned that the concept of smart city integrates advanced technologies and data-driven approaches to enhance urban living, improve sustainability, and promote efficient resource management. Across different countries, the adaptation of smart city principles demonstrates varied strategies and outcomes, influenced by regional contexts, economic statuses, and technological capabilities.

4.2. Regression Analysis

Regression Analysis is used when you are interested in predicting the value of a dependent variable based on one or more independent variables. It allows for insights into the nature of relationships and provides a means of forecasting.

Table 2: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.916[a]	.838	.835	.26655

a. Predictors: (Constant), Smart Utility Management, Smart Technology Adoption, Smart Public Transport

Source: Field data, 2024

The regression analysis model summary Table 2 indicates an R value of 0.916, signifying a strong positive correlation between the independent variables (Smart Technology Adoption, Smart Public Transport, Smart Utility Management) and the dependent variable (Sustainable Urban Development of Nyarugenge District). The R-squared value of 0.838 suggests that approximately 83.8% of the variance in sustainable urban development Nyarugenge District can be explained by the independent variables included in the model, demonstrating a strong explanatory power.

Ntakirutimana *et al.* (2020) stated that Rwanda's progress in this area highlights the importance of integrating smart city principles with local priorities and capacities. Through the effective implementation of these initiatives, Rwanda continues to position itself as a model for sustainable urban development in Africa and beyond. The collective experiences of countries worldwide, regionally, and within Rwanda underline the transformative potential of smart cities in creating a sustainable future for urban populations.

Table 3: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	55.616	3	18.539	261.11	.000b
	Residual	10.728	151	.071		
	Total	66.345	154			

a. Dependent Variable: Sustainable Urban Development
b. Predictors: (Constant), Smart Utility Management, Smart Technology Adoption, Smart Public Transport
Source: Field data, 2024

Table 3 of ANOVA shows the results of the regression analysis. The F-value of 261.11 with a significance level ($p = 0.000<0.05$) indicates that the overall model is statistically significant, indicating that all combined predictors reliably predict sustainable urban development in Nyarugenge District. Supported by Shava and Vyas-Doorgapersad (2023), Johannesburg and other South African cities are examples of cutting-edge urban planning. Collaborations between local government and technology companies promote public-private partnerships to enhance infrastructure and strengthen community involvement in urban governance.

Table 4: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.274	.119		2.303	.023
	Smart Technology Adoption	.457	.047	.473	9.723	.000
	Smart Public Transport	.343	.074	.356	4.635	.000
	Smart Utility Management	.163	.074	.165	2.203	.029

a. Dependent Variable: Sustainable Urban Development
Source: Field data, 2024

Table 4 presents the unstandardized coefficients and provides the effect size of each predictor, holding all other variables constant:

$Y= \beta_0+ \beta_1X_1 + \beta_2X_2 + \beta_3X_3 +e$
Where:
Sustainable Urban Development = 0.274+ is 0.457 (Smart Technology Adoption) + 0.343 (Smart Public Transport) + 0.163 (Smart Utility Management) +0.119

The intercept is 0.274; this is the expected mean value of sustainable urban development in Nyarugenge District when all predictors are zero.
Smart Technology Adoption: The coefficient is 0.457, indicating that for every one-unit increase in smart technology adoption, sustainable urban development in Nyarugenge District increases by 0.457 units. The significance value ($p = 0.000$) confirms this effect is statistically significant.

Smart Public Transport: The coefficient of 0.343 indicates a one-unit increase in smart public transport, which is associated with an increase of 0.343 units in sustainable urban development in Nyarugenge District. The significance value ($p = 0.000$) indicates a statistically significant relationship. Smart Utility Management: The coefficient is 0.163, suggesting a one-unit increase in smart utility management is associated with a 0.163-unit increase in sustainable urban development in Nyarugenge District. However, the significance value ($p = 0.029$) indicates this relationship is statistically significant at the 0.05 level. Mehmood *et al.* (2024) examined the role of smart technologies in achieving sustainable urban and regional development. The study identified specific technologies such as the Internet of Things (IoT), artificial intelligence, and big data analytics as transformative tools enabling efficient resource management and enhancing urban infrastructure. The research emphasized their impact on reducing carbon emissions, improving energy efficiency, and optimizing transportation systems.

4.3 Hypotheses Decision

Based on the results of the correlation and regression analyses presented in the tables, there is the decision regarding each null hypothesis proposed by the researcher:

H_{01}: There is no significant effect of smart technology adoption on sustainable urban development in Nyarugenge District.

The significance value ($p = 0.000<0.05$) confirms this effect is statistically significant. Therefore, the study rejected the null hypothesis (H_{01}); there is indeed a significant effect of smart technology adoption on sustainable urban development in Nyarugenge District.

H_{02}: There is no significant effect of smart public transport on sustainable urban development in Nyarugenge District.

The significance value ($p = 0.000<0.05$) reinforces the conclusion that this effect is statistically significant. Therefore, the researcher rejected the null hypothesis (H_{02}); there is a significant effect of smart public transport on sustainable urban development in Nyarugenge District.

H_{03}: There is no significant effect of smart utility management on sustainable urban development in Nyarugenge District.

The significance value ($p = 0.029<0.05$) indicates that this effect is statistically significant at the 0.05 level. Thus, the researcher rejected the null hypothesis (H_{03}); smart utility management has a significant effect on sustainable urban development in Nyarugenge District.

The results of the correlation and regression analyses support the rejection of all three null hypotheses. There is significant evidence that smart technology adoption, smart public transport, and smart utility management each have a statistically significant effect on sustainable urban development in Nyarugenge District.

5. Conclusion and Recommendations

5.1 Conclusion

The significant relationship underscores the effect of smart technology on advancing sustainable urban development goals, highlighting the importance of continued investment in technology to enhance urban living conditions in Nyarugenge District.

The analysis reveals a robust relationship between smart public transport initiatives and sustainable urban development in Nyarugenge District. Community members have expressed a positive sentiment towards smart public transport offerings, reflecting their recognition of the benefits associated with these initiatives. This strong correlation indicates that further improvements and enhancements in public transport can significantly contribute to the district's sustainable development objectives, facilitating better mobility and access for residents.

The results demonstrate a meaningful connection between smart utility management and sustainable urban development in Nyarugenge District. The community displays a generally positive view toward smart utility management practices, emphasizing the importance of these initiatives in improving service efficiency and reliability. While individual experiences may vary, the significant relationship suggests that advancements in utility management can play a vital role in supporting sustainable urban development efforts, paving the way for enhanced infrastructure and resource management in Nyarugenge District.

Substantial evidence demonstrates that smart technology adoption, smart public transport, and smart utility management each significantly influence sustainable urban development in Nyarugenge District.

5.2 Recommendations

Based on the findings regarding smart technology adoption, smart public transport, smart utility management, and sustainable urban development in Nyarugenge District, the following practical recommendations can be made for addressing the needs of the community and enhancing urban development initiatives:

1. Urban transport authorities must invest in expanding smart transport solutions, such as e-ticketing systems and real-time information displays at bus stops. Conduct public awareness campaigns to inform residents about these services and their benefits.

2. Nyarugenge District, in partnership with telecommunications companies and community organizations, should continue to invest in infrastructure to improve internet access in underserved areas further. Initiatives should ensure that all residents have affordable and reliable internet connectivity regardless of income level.
3. Nyarugenge District should regularly review and improve government e-services based on user feedback to enhance accessibility and user-friendliness. Providing training sessions about these services can help users become more comfortable and proficient in using them.
4. Housing authorities are recommended to strengthen policies that promote affordable housing development, ensuring that low-income families can secure safe and adequate housing.

5.3. Area for Further Research

Here are some specific suggestions for future researchers, including proposed topics related to smart technology adoption, public transport, utility management, and sustainable urban development: Exploring the effect of Smart Technologies in Enhancing Citizen Engagement in Urban Development, Investigating the Effectiveness of Renewable Energy Integration in Urban Utility Management and Evaluating the Effectiveness of Smart Waste Management Systems in Enhancing Urban Cleanliness.

References

Afrik 21. (2024, January 17). Rwanda: Challenges facing Samuel Dusengiyumva, new mayor of the green city of Kigali. Afrik 21. https://www.afrik21.africa.

Bagenzi, L., Alade, T., & Muramira, S. (2021). The Influence of Inflexible Work Schedules and Land Use Design on Traffic Congestion in Kigali City. *Rwanda Journal of Engineering, Science, Technology and Environment, 4*(1).

Benfield, F. W., & McGowan, J. (2018). The New Urbanism. In our defense of our communities. *Journal of Urbanism, 11*(1), 63-79.

Bibri, S. E. (2021). Data-driven smart sustainable cities of the future: An evidence synthesis approach to a comprehensive state-of-the-art literature review. *Sustainable Futures, 3, 100047.*

Bimpong, H., & David, A. (2024). Analysing the role of stakeholder engagement in determining the effectiveness of communication and public relations strategies: ghana highway authority in perspective. *Project Management and Scientific Journal, 7*(9), 51-67.

Makieła, Z. J., Stuss, M. M., Mucha-Kuś, K., Kinelski, G., Budziński, M., & Michałek, J. (2022). Smart City 4.0: Sustainable urban development in the metropolis GZM. *Sustainability, 14, 3516.*

Mehmood, R., Yigitcanlar, T., & Corchado Rodríguez, J. (2024). Smart technologies for sustainable urban and regional development. *Sustainability, 16*(3), Article 1171.

Ndayisaba, J. (2023). Ecological sustainability in urban landscapes and smart cities: Case study Kigali City, Rwanda.

Ntakirutimana, T., Aguirre-Bastos, C., & Mugabo, L. R. (2020) Home-grown initiatives for sustainable development in Rwanda.

Shava, E., & Vyas-Doorgapersad, S. (2023). Inclusive participation in information and communication technologies (ICTs) processes for smart services in the city of Johannesburg. *Insights into Regional Development,* 5(1), 26-40.

Talen, E. (2020). The evolution of New Urbanism: From principles to practices. In *Urban Design: Policy, Planning, and Management* (pp. 25-46). Routledge.

Tikoudi, A. (2023). *ICT-based Social Innovation in Africa: the case of Rwanda* (Master's thesis, Norwegian University of Life Sciences).

Wołek, M., Wolański, M., Bartłomiejczyk, M., Wyszomirski, O., Grzelec, K., & Hebel, K. (2021). Ensuring sustainable development of urban public transport: A case study of the trolleybus system in Gdynia and Sopot (Poland). *Journal of Cleaner Production,* 279, 123807.