# Assessing the Role of Green Spaces in Enhancing Pandemic Resilience a Case Study of Jos Metropolis

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## ABSTRACT

The COVID-19 pandemic underscored the necessity for resilient built environments, emphasizing the role of Green Spaces in mitigating the impacts of pandemics within urban settings. This study evaluates the effectiveness of Green Spaces in fostering pandemic resilience within Jos Metropolis, Nigeria, through the lens of architectural composition within urban design. The objectives include: examining the relationship between Green Spaces of architectural composition and sustainable urban design, investigating their role in pandemic resilience, and assessing the mediating effects of Green Spaces in this context. A positivist approach was adopted, using a quantitative methodology on a sample of 384 residents, calculated with Cochran's formula (Cochran, 1977). Findings reveal significant interconnections between architectural composition in the built environment and pandemic resilience, mediated by Green Spaces. These results highlight the necessity for robust urban planning policies prioritizing green infrastructure and active community engagement. The study recommends targeted investment in green technologies and comprehensive education initiatives to enhance urban resilience and sustainability.

**Keywords:** Green Spaces, Architectural Composition, Pandemic Resilience, Sustainable Urban Design, Jos Metropolis, Quantitative Methodology

## INTRODUCTION

The rapid urbanization and environmental challenges exacerbated by climate change and public health crises, such as the COVID-19 pandemic, have catalysed interest in architectural composition of the built environment and urban design. Green Spaces, encompassing parks, green roofs, urban forests, and other vegetative systems, are pivotal to urban resilience (Hansen et al., 2018). Specifically, Green Spaces contribute to balance public health, and social cohesion, making it indispensable for pandemic resilience (Green Spacesll et al., 2007).

In the Nigerian context, cities like Jos grapple with environmental degradation and inadequate green infrastructure, which intensifies vulnerabilities during pandemics (Akande et al., 2020). By integrating Green Spaces, architects and urban planners can enhance community well-being and mitigate the adverse effects of public health crises. Research indicates that accessible Green Spaces reduce stress and foster social interaction, which are critical during periods of isolation (Ibrahim et al., 2022). The present study focuses on evaluating these benefits within Jos Metropolis, aiming to provide actionable insights into green space integration for sustainable urban resilience.

Sustainable architectural composition in urban design aims to create urban environments that are not only livable and equitable but also resilient to various shocks and stresses (Kabisch, Korn, Haase, & Strohbach, 2019). It involves the integration of natural systems into the built environment to enhance ecological functions, improve public health, and foster social cohesion. In the context of the COVID-19 pandemic, sustainable architectural composition in urban design has become increasingly important as cities strive to mitigate the impacts of the virus and adapt to new societal norms. Green Spaces is a critical component of architectural composition, offering multiple benefits that contribute to urban resilience. It enhances environmental sustainability by improving air and water quality, reducing urban heat island effects, and supporting biodiversity (Green Spacesll, Handley, Ennos, & Pauleit, 2018). Additionally, Green Spaces provide social

benefits by offering spaces for recreation, promoting mental health, and fostering social interactions, which are essential during times of social distancing and isolation (Ibrahim & Suleiman, 2020).

The COVID-19 pandemic has highlighted the importance of Green Spaces in enhancing urban resilience. Studies have shown that access to Green Spaces can mitigate the negative impacts of lockdowns and restrictions on physical and mental health. For instance, Ibrahim and Suleiman (2020) found that Green Spaces in Jos Metropolis offered residents essential areas for outdoor activities, which helped reduce stress and anxiety levels during the pandemic. Moreover, Musa and Bello (2021) demonstrated that Green Spaces contributed to maintaining air quality and reducing pollution levels, which are critical for respiratory health during a health crisis.

Jos Metropolis, a growing urban area in Nigeria, provides a valuable case study for evaluating the effectiveness of Green Spaces in pandemic resilience. The city's unique socio-economic and environmental context offers insights into how Green Spaces can be leveraged to enhance urban resilience. Research by Okeke and Nwankwo (2022) explored the role of community gardens and urban parks in Jos Metropolis, highlighting their contribution to social cohesion and food security during the pandemic. These findings underscore the importance of integrating Green Spaces into urban planning frameworks to build resilient cities. Effective policy measures are essential for maximizing the benefits of Green Spaces. Aliyu and Yakubu (2019) emphasized the need for policies that incentivize the incorporation of Green Spaces into new urban developments and retrofit existing urban areas. Their research suggested that policy interventions, such as green roof mandates and the creation of urban green belts, can significantly enhance the resilience of cities to future pandemics and other crises.

The primary aim of this research is to evaluate the effectiveness of Green Spaces in enhancing pandemic resilience within Jos Metropolis. The specific objectives include: To assess the current state of Green Spaces in Jos Metropolis, to analyze the role of Green Spaces in mitigating the impacts of the COVID-19 pandemic, to identify the challenges and opportunities in implementing Green Spaces in Jos and to provide recommendations for enhancing urban resilience through Green Spaces. The question of concern is how effective is Green Spaces in enhancing pandemic resilience within Jos Metropolis?

Urban areas worldwide have faced unprecedented challenges during the COVID-19 pandemic, exposing vulnerabilities in public health, infrastructure, and social systems. Jos Metropolis, with its rapid urbanization and environmental challenges, has not been exempt from these impacts. The lack of adequate Green Spaces has exacerbated the city's vulnerability to environmental hazards and public health crises (Adedeji, Oduduwa & Adebayo, 2020). Therefore, there is an urgent need to evaluate the effectiveness of Green Spaces as a strategy to enhance urban resilience in Jos Metropolis.

While there is a growing body of literature on the benefits of Green Spaces, there is a paucity of quantitative studies specifically focusing on its effectiveness in pandemic resilience within African urban contexts, including Jos Metropolis (Kabisch et al., 2021). This research aims to fill this gap by providing empirical data on the role of Green Spaces in mitigating pandemic impacts. Another gap identified is the lack of comprehensive studies on the policy and implementation challenges of Green Spaces in Nigerian cities. Existing studies often focus on developed countries, leaving a gap in understanding the unique socio-political and economic barriers faced in cities like Jos (Adegun, 2018). This research will explore these challenges and provide context-specific recommendations.

# THEORETICAL FRAMEWORK

## Ecological Modernization Theory

Ecological Modernization Theory (EMT), conceptualized by Huber (1985) and further developed by Mol and Spaargaren (1993), emphasizes the role of technological innovation and institutional reforms in addressing environmental challenges. EMT posits that economic growth and environmental sustainability are not mutually exclusive but can be synergistic through deliberate policy and innovation (Mol & Spaargaren, 1993). While the theory highlights the potential of green technologies, it has been critiqued for its reliance on Western contexts

and underestimation of socio-political barriers in developing countries (Mol & Spaargaren, 1993). In this study, EMT provides a framework to assess the integration of Green Spaces into urban design as a technological and institutional response to pandemic resilience.

EMT is often criticized for its over-reliance on technological innovations for solutions, while underestimating the social and political barriers to environmental sustainability. The theory has been primarily developed and tested in Western contexts, which may limit its applicability to developing countries with different socio-economic and political conditions. However, the theory's emphasis on the role of technological innovation and institutional reforms in addressing environmental challenges aligns with the research objectives of evaluating the effectiveness of Green Spaces in mitigating pandemic impacts.

### Supporting Theory: Biophilia Hypothesis

The Biophilia Hypothesis, introduced by Wilson (1984) and inspired by Fromm (1964), suggests that humans possess an innate affinity for nature, which fosters well-being. Exposure to Green Spaces is linked to reduced stress and improved mental health, making it a crucial component of urban resilience during pandemics (Wilson, 1984). While empirical evidence supports these claims, cultural differences in perceiving nature remain underexplored. This hypothesis underpins the study's focus on the psychological and social benefits of Green Spaces in Jos Metropolis.

# CONCEPTUAL REVIEW

### The Role of Green Spaces in Sustainable Urban Development

Green Spaces are increasingly recognized as critical components of architectural composition within any sustainable urban design, due to their ecological, social, and economic benefits (Semeraro, 2021). Hansen et al. (2018) emphasize that integrating Green Spaces within urban areas can enhance ecological balance and mitigate the urban heat island effect. Akande et al. (2020) similarly highlight their importance in managing flood risks in Nigerian cities. These findings align with those of Gill et al. (2007), who assert that vegetative systems, such as green roofs, contribute to carbon sequestration and improved air quality. Collectively, these studies underscore the multifaceted role of Green Spaces as foundational elements of sustainable urban environments.

Sustainable Urban Drainage Systems (SUDS) further demonstrate the importance of Green Spaces. Roy et al. (2008) discuss their effectiveness in managing water resources, mitigating flood risks, and improving public health. Within the Nigerian context, Ibrahim et al. (2022) reveal that Green Spaces in Jos Metropolis provided significant physical and mental health benefits during the COVID-19 lockdown. However, Okeke and Nwankwo (2022) advocate for comprehensive policy frameworks to maximize these benefits, emphasizing the need for structured approaches to urban green space management.

### Pandemic Resilience and Urban Green Spaces

The COVID-19 pandemic has underscored the importance of pandemic resilience in urban areas, including Jos Metropolis. Pandemic resilience refers to the capacity of communities to adapt, recover, and thrive in the face of pandemics (Kuntz, 2020). According to Adamu and Mohammed (2020), the capacity of health infrastructure significantly affects the ability of the built environments to respond to pandemics. Their study highlighted the challenges of inadequate resources and staffing in Jos Metropolis, emphasizing the urgent need for infrastructural strengthening. Community responses also play a pivotal role, as evidenced by Nwosu and Okafor (2021), who note that community-based interventions, such as awareness campaigns and support networks, were instrumental in mitigating COVID-19's impact in the metropolis.

Green Spaces have been identified as a key component of pandemic resilience, (Pamukcu-Albers et al., 2021). Ibrahim et al. (2022) found that Green Spaces in Jos Metropolis provided residents with opportunities for physical activity and mental relaxation during the pandemic, thereby enhancing overall well-being and resilience. These findings highlight the dual role of Green Spaces as ecological assets and social sanctuaries

during crises. Additionally, Ayuba and Hassan (2023) examined socio-economic disparities in Jos Metropolis during the COVID-19 pandemic, revealing that lower-income communities were disproportionately affected. This underscores the need for equitable access to Green Spaces to bolster pandemic resilience across diverse demographic groups.

**Effectiveness of Green Spaces in Jos Metropolis**

Green Spaces in Jos Metropolis deliver a wide range of ecological, social, and economic benefits. From an environmental perspective, Ibrahim et al. (2022) report that Green Spaces reduce urban heat islands and mitigate flood risks through improved water infiltration and storage. Similarly, Musa and Yakubu (2020) highlight their role in enhancing air quality and reducing pollution levels, with areas rich in Green Spaces exhibiting significantly lower concentrations of airborne pollutants. Biodiversity conservation is another critical function of Green Spaces. Nwankwo and Adeyemi (2021) emphasize the importance of urban parks and green corridors as habitats and migration routes for wildlife in Jos Metropolis. Their findings underline the need to integrate biodiversity considerations into urban planning to sustain ecological balance.

From a social perspective, Green Spaces provide recreational opportunities and mental health benefits. Okeke and Aliyu (2019) observed that access to Green Spaces in Jos Metropolis correlates with higher physical activity levels, reduced stress, and improved mental health. These benefits enhance community well-being, particularly during periods of stress such as pandemics. Economically, Green Spaces contribute to urban development by increasing property values and attracting tourism. Bello and Umar (2023) found that properties near Green Spaces in Jos Metropolis had higher market values compared to those in less green areas, demonstrating the economic advantages of investing in green infrastructure.

**Policy and Planning for Effective Green Space Management**

Effective implementation of Green Spaces in urban areas requires supportive policies and planning frameworks. John and Yusuf (2021) argue that integrating Green Spaces into urban planning is essential for maximizing their benefits. Their study recommends policy measures such as zoning for Green Spaces and incentives for green roof installations. Similarly, John and Bello (2021) discuss the role of government policies during the COVID-19 pandemic, noting that targeted interventions, such as lockdown measures and support for vulnerable populations, were critical to managing the crisis. These findings emphasize the importance of robust policy frameworks in enhancing the effectiveness of Green Spaces.

In summary, the literature highlights the multifaceted benefits of Green Spaces in urban areas, particularly in enhancing pandemic resilience. By improving ecological balance, supporting biodiversity, and fostering community well-being, Green Spaces serve as essential components of sustainable urban development. In the context of Jos Metropolis, targeted investments in Green Spaces, coupled with supportive policies and equitable access, can significantly enhance urban resilience. Continued research and policy innovations are crucial for harnessing the full potential of Green Spaces in mitigating the impacts of future pandemics and advancing sustainable urban growth.

# METHODOLOGY

This research adopts a positivist approach, positing that reality is objective, measurable, and quantifiable. Within the scope of this study, the effectiveness of Green Spaces in enhancing pandemic resilience is assessed through empirical evidence and statistical analysis, enabling hypothesis testing and conclusion drawing. A quantitative research design is employed, incorporating both descriptive and explanatory methods. Data collection will be conducted using a cross-sectional survey, capturing information at a single point in time.

The study population comprises residents, urban planners, and policymakers from the Rayfield and Lamingo areas of Jos Metropolis, specifically individuals with direct experience or involvement in Green Spaces projects. To ensure representation across diverse demographic groups, stratified random sampling was applied. The sample size calculation was done using Cochran's formula for sample size determination in large populations:

$n = \{Z^2 . \ p \ (1-p)\} \ \{e^2\}]$

Where:

- (Z) = Z-value (e.g., 1.96 for a 95% confidence level)

- (p) = estimated proportion of the population

- (e) = mar Green Spacesn of error (e.g., 5%)

For a population where the estimated proportion (p) is 0.5, the sample size (n) would be:

$n = \{(1.96)^2 \ 0.5(1-0.5)\} \ \{(0.05)^2\}$ approximately, 384 respondents

Structured questionnaires featuring closed-ended questions were employed, focusing on respondents' perceptions regarding the effectiveness of Green Spaces in mitigating pandemic impacts, their accessibility, usage patterns, and overall satisfaction. The collected data was analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM), a method particularly well-suited for complex models and small-to-medium sample sizes. This approach offers a systematic framework for quantitatively assessing the role of Green Spaces in enhancing pandemic resilience, grounded in a positivist research philosophy and underpinned by rigorous statistical techniques.

## RESULTS AND DISCUSSION

**This study section focuses on the significant relationship between evaluation of sustainable urban design and Green Spaces.**

**Table 1. Significant Relationship between evaluation of sustainable urban design and Green Spaces**

| Sustainable urban design | Green Spaces | | |
|---|---|---|---|
| | Vegetative system | Water Management System | Urban Drainage System |
| Environmentally Sustainable design | .529** | .511** | .525** |
| Economic Sustainability | .680** | .620** | .674** |
| Social Sustainability | .676** | .629** | .626** |

**\*\*. Correlation is significant at the 0.01 level (2-tailed).**

**Table 1** highlights the interconnected relationship between sustainable urban design and Green Spaces, emphasizing their shared objective of fostering resilient, efficient, and livable urban environments. This discussion examines how the three pillars of sustainable urban design environmental, economic, and social sustainability align with the core components of Green Spaces: vegetative systems, water management systems, and urban drainage systems.

### Environmental Sustainability

Environmental sustainability aims to minimize the ecological footprint of urban development while enhancing ecosystem health. Green Spaces play a central role in these efforts through their vegetative systems, water management systems, and urban drainage solutions. Features such as urban forests, green roofs, and parks contribute to biodiversity enhancement, carbon sequestration, and mitigation of the urban heat island effect.

They also improve air quality and provide habitats for wildlife (Gill, Handley, Ennos, & Pauleit, 2007). Additionally, rain gardens, bioswales, and constructed wetlands naturally manage stormwater, reducing runoff and improving water quality. These systems deliver vital ecosystem services like filtration and groundwater recharge (Roy, Wenger, Fletcher, et al., 2008). Sustainable Urban Drainage Systems (SUDS), including retention ponds and permeable pavements, further reduce flooding risks and enhance water quality by simulating natural hydrological processes (Ellis, 2013).

**Economic Sustainability**

Economic sustainability in urban design focuses on cost-efficiency, resilience, and the long-term financial benefits of sustainable practices. Green Spaces significantly contribute to economic sustainability through diverse benefits. Urban forests and green spaces can increase property values and attract businesses and tourism. Green roofs and walls reduce energy costs by enhancing insulation (Wolf, 2004). Moreover, Green Spaces often present cost-effective alternatives to traditional grey infrastructure, reducing the need for expensive stormwater management systems and mitigating flood-related damage (USEPA, 2010). SUDS provide additional cost savings by decreasing the demand for extensive drainage networks and lowering maintenance expenses, while also enhancing urban resilience to climate change-induced flooding (Ashley, Brown, & Farrelly, 2012).

**Social Sustainability**

Social sustainability focuses on improving urban residents' quality of life, health, and well-being. Green Spaces support social sustainability by offering recreational opportunities, promoting mental health, and fostering community cohesion. Access to parks, gardens, and green streets encourages physical activity, reduces stress, and enhances mental well-being. These spaces also serve as social hubs, fostering community interaction (Maas, Verheij, Groenewegen, de Vries, & Reisenberg, 2006). Furthermore, elements like rain gardens and bioswales not only manage water effectively but also enhance neighbourhood aesthetics, making them more attractive and livable (Lennon, Scott, & O'Neill, 2014). SUDS can be seamlessly integrated into public spaces, creating multifunctional landscapes that offer recreational opportunities and enhance urban aesthetics. These features contribute to a sense of place and community identity (CIRIA, 2015).

In conclusion, the synergy between sustainable urban design and Green Spaces lies in their mutual goals of environmental health, economic efficiency, and social well-being. By integrating vegetative systems, water management systems, and urban drainage solutions into urban planning, cities can achieve sustainable development that benefits both people and the planet.

**This study section focuses on the significant relationship between Sustainable urban design and pandemic resilience.**

**Table 2. Significant Relationship between sustainable urban design and pandemic resilience**

| Sustainable urban design | Pandemic Resilience | |
|---|---|---|
| | Healthcare System Preparedness and response | Community and Social Resilience |
| Environmentally Sustainable design | .538** | .523** |
| Economic Sustainability | .653** | .670** |
| Social Sustainability | .652** | .674** |

**\*\*. Correlation is significant at the 0.01 level (2-tailed).**

As indicated in Table 2, a significant relationship exists between sustainable urban design and Green Spaces are intricately linked, with both aiming to create resilient, livable, and healthy urban environments. The relationship between these two concepts can be explored through the lenses of environmentally sustainable design, economic sustainability, social sustainability, and pandemic resilience, particularly healthcare system preparedness and community and social resilience.

Environmentally sustainable design emphasizes reducing environmental impacts through energy efficiency, waste reduction, and the protection of natural resources. Green Spaces, such as green roofs, urban forests, and permeable pavements, plays a critical role in achieving these goals. Implementing Green Spaces helps mitigate urban heat island effects, reduces stormwater runoff, and improves air quality (Benedict & McMahon, 2006). These environmental benefits contribute to overall urban resilience by reducing the strain on healthcare systems during heatwaves and improving respiratory health, which is crucial during respiratory pandemics (Green Spacesll et al., 2007). Green Spaces enhances urban areas' ability to adapt to climate change, thereby supporting sustainable urban design's environmental goals. This adaptability is essential for pandemic resilience, as climate change can exacerbate the spread of diseases (Pataki et al., 2011).

  These savings can be redirected to enhance healthcare system preparedness, such as investing in medical supplies and health infrastructure. Implementing and maintaining Green Spaces creates jobs in landscaping, construction, and environmental management sectors (Young, 2011). This economic activity can enhance community resilience by providing stable employment and supporting local economies, which are vital during pandemics when economic disruptions are common (Xie et al., 2020). Social sustainability aims to create inclusive, healthy, and equitable communities. Green Spaces supports social sustainability by providing recreational spaces, enhancing mental well-being, and promoting social cohesion.

Access to Green Spaces has been shown to improve mental health and reduce stress, which is crucial during pandemics when anxiety and isolation are prevalent (Kuo, 2015). Well-designed Green Spaces can support healthcare system preparedness by promoting public health and reducing the burden on healthcare facilities. Green Spaces projects often involve community participation, fostering a sense of ownership and social cohesion (Hartig et al., 2014). Strong social networks are essential for community resilience, as they facilitate support and resource sharing during crises (Aldrich & Meyer, 2015).

The relationship between sustainable urban design and Green Spaces is strongly positive, with each supporting the other's goals. Environmentally sustainable design benefits from Green Space's ability to mitigate climate impacts and improve urban environments. Economic sustainability is enhanced through cost savings and job creation associated with Green Spaces. Social sustainability is supported by the health benefits and social cohesion fostered by Green Spaces. Furthermore, these elements contribute to healthcare system preparedness and community resilience, which are crucial components of pandemic resilience. Therefore, integrating Green Spaces into sustainable urban design is essential for creating resilient and sustainable urban environments.

**This study section focuses on the significant relationship between Pandemic Resilience and Green Spaces**

**Table 3. Significant Relationship between pandemic Resilience and Green Spaces**

| Pandemic Resilience | Green Spaces | | |
|---|---|---|---|
| | Vegetative System | Water Management System | Urban Drainage System |
| Healthcare System preparedness and response | .725[**] | .677[**] | .709[**] |
| Community and social resilience | .779[**] | .727[**] | .789[**] |

**\*\*. Correlation is significant at the 0.01 level (2-tailed).**

As indicated in Table 3, a significant relationship exists between pandemic resilience, specifically healthcare system preparedness and community and social resilience and Green Spaces is multifaceted and profound. Green Spaces components such as vegetative systems, water management systems, and urban drainage systems significantly contribute to enhancing resilience during pandemics. Vegetative systems, including urban forests, green roofs, and community gardens, play a crucial role in improving air quality and reducing urban heat islands (Nowak et al., 2006). Better air quality and moderated urban temperatures can reduce respiratory and heat-related illnesses, thereby lessening the strain on healthcare systems, particularly during pandemics when healthcare facilities are overburdened (Tzoulas et al., 2007). Effective water management systems help ensure clean and safe water supplies, which are vital for public health. Green Spaces approaches such as rain gardens and constructed wetlands can filter pollutants and provide clean water, supporting healthcare system preparedness by reducing waterborne diseases (Fletcher et al., 2015). During a pandemic, access to clean water is essential for Hy Green Spacemen and reducing the transmission of infections.

Green Spaces elements like permeable pavements and bioswales enhance urban drainage systems by reducing surface runoff and preventing flooding (Ahiablame et al., 2012). By mitigating flood risks, these systems protect healthcare facilities and maintain their operational integrity during extreme weather events, which is crucial for pandemic resilience. Community gardens and Green Spaces foster social interaction and provide mental health benefits, enhancing social resilience (Hartig et al., 2014). During pandemics, these spaces offer safe areas for physical activity and socialization, which are critical for maintaining mental health and community cohesion (Bratman et al., 2019).

Implementing green water management systems can involve community participation, fostering a sense of ownership and collective responsibility (Cohen-Shacham et al., 2016). This community engagement enhances social resilience by building stronger social networks and support systems, which are vital during crises. Green urban drainage systems can be designed to include aesthetic and recreational elements, such as water features and parks, that enhance urban livability and provide spaces for community gatherings (Muller & Marsalek, 2014). These spaces support social resilience by offering venues for community activities and fostering a sense of place and belonGreen Spacesng.

The relationship between components of pandemic resilience and Green Spaces is strongly positive. Vegetative systems improve air quality and reduce heat stress, supporting healthcare system preparedness. Water management systems ensure clean water supplies, essential for Hy Green spacemen and health during pandemics. Urban drainage systems prevent flooding and protect healthcare infrastructure. Additionally, these Green Spaces components enhance community and social resilience by fostering social interaction, community engagement, and providing mental health benefits. Therefore, integrating Green Spaces into urban planning is crucial for enhancing pandemic resilience.

**This study section focuses on the significant relationship between sustainable Urban green Design and Pandemic Resilience as Mediated by Green Spaces.**

**Table 4. Mediation Analysis on the Effects of Green Spaces on the Relationship between Sustainable urban Design and Pandemic resilience**

|  | B | SE | T | P | LLCI | ULC |  |  |
|---|---|---|---|---|---|---|---|---|
| Direct | 0.324 | 0.06 | 5.259 | 000 | 0.203 | 0.446 | Significant |  |
| Indirect | 0.515 | 0.07 | 7.543 | 000 | 0.343 | 0.556 | Significant | Complementary Partial Mediation |
| Total | 0.840 | 0.06 | 15.029 | 000 | 0.729 | 0.950 | Significant |  |
| SUD-PR | 0.878 | 0.06 | 14.394 | 000 | 0.757 | 0.998 | Significant |  |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SUD- GREEN SPACES | 0.324 | 0.06 | 5.259 | 000 | 0.203 | 0.446 | Significant | |
| PR- GREEN SPACES | 0.587 | 0.05 | 11.656 | 000 | 0.488 | 0.686 | Significant | |

**(SUD- Sustainable Urban Design, PR- Pandemic Resilience, GREEN SPACES- Green Spaces)**

Table 4 indicates a significant relationship exists among Sustainable Urban design, Pandemic Resilience, and Green Spaces. The findings highlight the interconnectedness of sustainable urban design, pandemic resilience, and Green Spaces, demonstrating how sustainable urban design influences these elements. These interrelationships provide a strong foundation for enhancing urban sustainability and public health outcomes. As a mediator, sustainable urban design facilitates the integration of Green Spaces into urban areas, strengthening pandemic resilience. It encompasses the strategic planning and development of urban environments to promote environmental sustainability, social equity, and economic viability. This approach incorporates key elements such as vegetative systems, water management strategies, and urban drainage systems into the urban framework (Beatley, 2020).

Sustainable urban design leverages vegetative systems like urban forests, green roofs, and community gardens, which offer critical ecosystem services, including improved air quality and mitigation of urban heat (Lovell & Taylor, 2022). These features are vital for creating livable urban spaces and are fundamental to sustainable urban design. Another critical aspect is water-sensitive urban design (WSUD), which integrates water management solutions such as rain gardens and constructed wetlands to manage stormwater and enhance water quality (Wong & Brown, 2020). These measures contribute not only to environmental sustainability but also to public health by ensuring access to clean water.

Additionally, green urban drainage systems, including permeable pavements and bioswales, play a key role in managing runoff and preventing flooding (Zhang et al., 2021). These systems enhance urban resilience to extreme weather events, which are increasingly common. By reducing environmental stressors like air pollution and heat stress, sustainable urban design that incorporates Green Spaces can improve public health outcomes and bolster healthcare system preparedness (Kabisch et al., 2021). Furthermore, by creating inclusive and accessible Green Spaces, sustainable urban design fosters social interaction and mental well-being, contributing to community and social resilience (Jennings & Bamkole, 2019). During pandemics, these spaces serve as safe areas for physical activity and social engagement, essential for mental health and community cohesion.

Sustainable urban design serves as a critical mediator by integrating Green Spaces into urban environments, thereby enhancing pandemic resilience. Through the inclusion of vegetative systems, water management solutions, and urban drainage infrastructure, sustainable urban design creates urban landscapes better equipped to handle public health crises (Xie et al., 2022). This mediating role strengthens the synergies between Green Spaces and pandemic resilience. For instance, Green Spaces intentionally designed to support public health can provide venues for physical distancing and outdoor activities during pandemics, directly contributing to public health resilience (Russo & Cirella, 2021). The evidence underscores the importance of sustainable urban design in creating resilient and sustainable urban areas. By integrating essential ecological systems into urban environments, sustainable urban design not only enhances healthcare system preparedness but also fosters community and social resilience, making cities more capable of withstanding public health emergencies

# CONCLUSINON

The study reveals a significant and strong correlation between Green Spaces and pandemic resilience. Integrating vegetative systems, water management solutions, and urban drainage infrastructure into urban planning has proven effective in improving public health outcomes and strengthening community resilience.

These findings underscore that Green Spaces not only support environmental sustainability but also play a pivotal role in preparing urban areas for public health crises, affirming the critical importance of sustainable urban design.

The role of Green Spaces in fostering pandemic resilience is particularly evident in areas with well-maintained Green Spaces and effective water management systems. These infrastructures provide essential services, including improved air quality, mitigation of urban heat, and flood control—services that become especially critical during pandemic situations. Additionally, the availability of accessible and inclusive Green Spaces has supported social distancing measures and facilitated outdoor activities, which are vital for maintaining mental and physical health during lockdowns and other restrictive periods. This highlights the diverse benefits of Green Spaces in enhancing urban resilience.

The findings from Jos metropolis emphasize the importance of incorporating sustainable urban design principles into urban planning to achieve comprehensive pandemic resilience. Policymakers and urban planners should prioritize the development and upkeep of Green Spaces as a strategic approach to enhancing urban sustainability and public health. Such measures can better prepare cities to manage future public health crises while simultaneously promoting environmental sustainability and social equity. This study provides compelling evidence for the global adoption of sustainable urban design practices in urban areas.

# RECOMMENDATION

**Enhance Policy Frameworks for Sustainable Urban Design and Green Spaces Integration**

To strengthen the relationship between sustainable urban design and Green Spaces, it is imperative to establish and implement comprehensive policy frameworks that seamlessly integrate these concepts. Policymakers in Jos metropolis should prioritize developing guidelines and regulations that mandate the inclusion of Green Spaces in all urban development projects. Such policies will ensure the consistent application of sustainable urban design principles, fostering environmental sustainability and enhancing the resilience of urban communities.

**Promote Community Engagement and Education on Sustainable Urban Design and Pandemic Resilience**

Active community involvement is essential for reinforcing the connection between sustainable urban design and pandemic resilience. Educational initiatives and public awareness campaigns should be launched to inform residents about the benefits of sustainable urban design and the role of Green Spaces in promoting resilience during pandemics. Involving community members in the planning, development, and maintenance of Green Spaces can cultivate a sense of ownership and responsibility, ultimately leading to improved upkeep and utilization of these critical assets.

**Invest in Research and Development of Green Spaces Technologies**

To further advance the understanding and effectiveness of Green Spaces in enhancing pandemic resilience, increased investment in research and development (R&D) is crucial. Allocating funds to explore innovative Green Spaces technologies such as advanced vegetative systems, efficient water management techniques, and resilient urban drainage solutions will help improve urban resilience during public health crises. These R&D efforts should prioritize creating scalable, cost-effective solutions that can be easily implemented in urban areas like Jos metropolis.

**Implement Pilot Projects to Demonstrate the Mediating Role of Green Spaces**

Pilot projects across various neighbourhoods in Jos metropolis can offer valuable insights into the mediating role of Green Spaces in sustainable urban design and pandemic resilience. These projects should incorporate diverse Green Spaces elements, including parks, green roofs, and rain gardens, designed in accordance with sustainable urban design principles. By monitoring and evaluating the outcomes of these projects, urban

planners can assess the effectiveness of Green Spaces in enhancing resilience, providing data-driven guidance for future urban development initiatives.

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