

Leveraging Digital Technologies for Urban Resilience: Addressing Economic, Social, and Environmental Challenges in Developing Country Cities

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ABSTRACT

This study aims to explore urban resilience strategies in developing countries in addressing social, economic, and environmental challenges, especially in rapidly urbanizing cities such as Dhaka, Nairobi, Mumbai, and Manila. The study analyzes secondary data from government reports, international agencies such as UN-Habitat and the World Bank, and academic literature to evaluate the effectiveness of green infrastructure, adaptive technologies, and local-based policies in enhancing urban resilience using a case study approach. The results show that local-based policies that take into account the social, economic, and environmental characteristics of each city are more effective than generic approaches. Green infrastructure, such as mangrove parks and water channels, and simple technologies, such as early warning systems, have been shown to have significant impacts in enhancing resilience to climate change and natural disasters. In addition, collaboration with international agencies plays an important role in providing technical and financial support to cities with limited resources.

Keywords: Urban Resilience, Sustainable Development, Green Infrastructure, Developing Countries, Contextual Policies.

1. INTRODUCTION

Urban resilience plays a critical role in sustainable development, particularly in developing countries that face complex social, economic and environmental challenges (Kochskämper et al., 2024). Rapid urbanization often puts a strain on urban infrastructure, resources and public services, which are often unable to support the needs of a growing population (C. Wu et al., 2022; Y. Wu et al., 2024). A UN-Habitat report (2022) shows that cities in developing countries, such as Dhaka in Bangladesh, Nairobi in Kenya and Jakarta in Indonesia, are vulnerable to climate change, natural disasters and socio-economic instability that threaten their overall resilience (Kounani & Skanavis, 2021).

Limited financial and technical resources hamper efforts to create resilient and sustainable urban infrastructure in developing countries (Neuman, 2020; Roslan et al., 2021). Green infrastructure and adaptive technologies, along with international collaboration with organizations such as the World Bank and UNDP, have helped some cities adapt to these challenges (Huynh Thi Ngoc et al., 2024; Keita & Kourouma, 2023). The impact of local solution-based strategies that consider the social, economic, and environmental conditions of each city is now considered more effective in creating sustainable urban resilience (Zeng et al., 2022).

Rapid urbanization in developing countries poses major challenges for cities like Dhaka, Nairobi, Mumbai, and Manila. Basic infrastructure such as housing, transportation, clean water, and sanitation often cannot keep up with rapid population growth. Social inequalities are widening, with many residents forced into slums without adequate access to health services, education, and decent jobs. Unplanned urbanization exacerbates unemployment, expands the informal sector, and widens income disparities. Uncontrolled urban expansion contributes to deforestation, air and water pollution, and increases the risk of disasters due to climate change and poor urban planning from an environmental perspective. These cities face major challenges in balancing economic growth with environmental sustainability and social well-being. Adaptive and sustainable development strategies are needed for these cities to survive and thrive amidst the increasingly complex dynamics of urbanization:

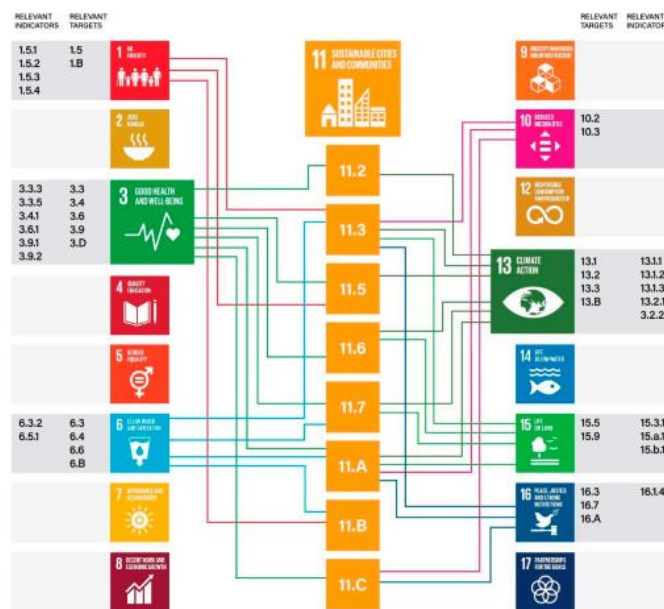


Figure 1. Sustainable Development Goals (SDGs)

Source: SDG Synthesis Report, 2018

This illustration shows the linkages between the Sustainable Development Goals (SDGs), specifically SDG 11 (Sustainable Cities and Communities), and the targets and indicators of other SDGs. SDG 11 emphasizes the importance of building inclusive, safe, resilient and sustainable cities. In this diagram, SDG 11 is linked to specific targets such as 11.2 (sustainable transport), 11.3 (inclusive urban planning), 11.6 (waste management and environmental quality), and 11.B (adoption of policies and plans for urban resilience). The diagram also shows the linkages between SDG 11 and several other SDGs that are directly relevant to urban development. For example, SDG 3 (Good Health and Well-being) relates to public health in cities through access to adequate health services, while SDG 6 (Clean Water and Sanitation) relates to the provision of clean water and adequate sanitation systems in cities. In addition, SDG 13 (Climate Action) has a close relationship with SDG 11 in terms of mitigation and adaptation to climate change in urban areas.

SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure) on the economic side, contribute to urban economic development and innovative and sustainable infrastructure development. SDG 16 (Peace, Justice, and Strong Institutions) also appears in this illustration, highlighting the role of governance and policies in creating safer and more inclusive cities. This image illustrates that achieving SDG 11 cannot be done in

isolation, but requires a cross-sectoral approach that is integrated with other development goals. This shows that urban sustainability depends heavily on policies that take into account social, economic, and environmental aspects simultaneously, thus building more resilient and livable cities for all.

Although urban resilience is frequently discussed in the global literature, the majority of previous studies have focused on cities in developed countries with more adequate resources and infrastructure (Rezvani et al., 2023). Research that specifically addresses the challenges in developing cities, such as Mumbai in India and Lima in Peru, is limited, as many existing studies tend to use a general approach that does not take into account local contexts, making the results less relevant to cities in developing countries (Edelman, 2018; Mahabir et al., 2016). This gap reflects the urgent need for more in-depth research on the effectiveness of locally tailored policies in enhancing urban resilience in developing countries.

Urban resilience strategies are increasingly gaining attention in academic research, particularly in the face of climate change, rapid urbanization, and environmental degradation. Green infrastructure, adaptive technologies, and locally driven policies have been identified as three key elements in enhancing urban resilience. Green infrastructure, as discussed by (Malalgoda & Amaratunga, 2015) plays a critical role in reducing environmental impacts by providing nature-based solutions, such as urban parks, green roofs, and green open spaces to enhance flood resilience and improve air quality. A study by (Cartalis, 2014) also showed that green spaces not only serve as a disaster mitigation tool but also improve social well-being and public health, especially in dense urban areas.

Adaptive technology has become an innovative solution in improving urban resilience. According to research by (Jaiswal et al., 2024) the application of technologies such as early warning systems, Internet of Things (IoT)-based infrastructure, and the use of renewable energy can improve city readiness in facing natural disaster risks. Another study by (Acuti & Bellucci, 2020) emphasized the importance of ecosystem-based technologies in building cities that are more resilient to climate change, such as sustainable drainage systems and urban design that is adaptive to extreme temperatures. Local-based approaches have proven effective in strengthening urban resilience from a policy perspective. For example, research by (Gargiulo et al., 2017) revealed that resilience strategies that involve community participation are more effective in improving disaster response compared to top-down policies. This is also reinforced in a study by (Díaz et al., 2024), which shows that community-based approaches in urban planning, such as the neighborhood-based resilience program in Bangkok, can increase community resilience in the face of climate change and socio-economic pressures.

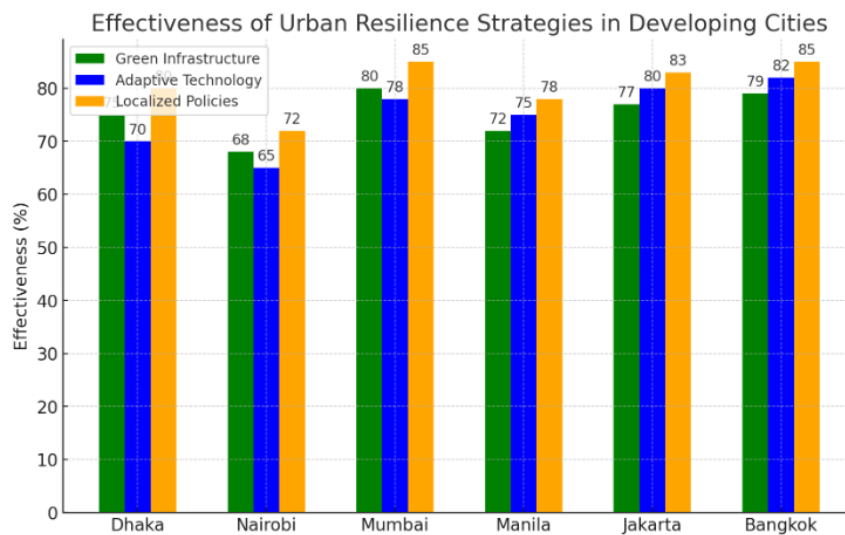


Figure 2. Effectiveness of Urban Resilience Strategies in Developing Countries

Source: data proceed

The bar chart above illustrates the effectiveness of three key urban resilience strategies—green infrastructure, adaptive technology, and localized policies—across six developing cities. The data show that localized policies tend to be the most effective strategy in enhancing urban resilience, particularly in cities like Mumbai, Jakarta, and Bangkok,

with effectiveness rates reaching 85%. Green infrastructure also plays a significant role, particularly in Mumbai (80%) and Bangkok (79%), supporting previous research that highlights nature-based solutions as vital components of sustainable urban development. Adaptive technology, although slightly lower in effectiveness compared to localized policies, remains crucial, especially in Bangkok (82%) and Jakarta (80%), demonstrating its role in improving urban risk response and infrastructure adaptation. Previous literature suggests that the combination of green infrastructure, adaptive technologies, and locally-based policies is a complementary approach to building urban resilience. Cities that implement all three strategies together tend to have greater resilience to social, economic, and environmental challenges, creating more sustainable and livable urban environments.

This study aims to explore various aspects of building urban resilience in developing countries, focusing on cities such as Dhaka, Nairobi, and Manila. Facing social, economic, and environmental challenges, these cities have developed diverse resilience strategies to ensure the sustainability and well-being of their citizens. One aspect examined is the role of green infrastructure and adaptive technologies in strengthening urban resilience to natural disasters and the impacts of climate change. The study also examines how resource constraints and international support affect the effectiveness of implemented resilience policies.

This study is expected to make a significant contribution to the literature on urban resilience in developing countries by presenting a local context-based perspective. The study highlights the importance of tailoring policies to the social, economic, and environmental characteristics of specific cities, using case studies such as Dhaka, Mumbai, and Lima. The findings of this study can help policymakers design more responsive and inclusive urban resilience strategies. This study provides a new perspective on integrating sustainable development approaches that consider economic, social, and environmental resilience holistically. A deeper understanding of the specific needs of cities in developing countries is essential amidst the increasing trend of urbanization globally. This study is expected to support the achievement of more resilient, sustainable, and locally-adapted urban development through empirical analysis and practical recommendations.

2. LITERATURE REVIEW

Urban Resilience in the Context of Developing Countries

In the context of sustainable development, the concept of urban resilience is becoming increasingly important, especially in developing countries. Urban resilience is defined as the ability of a city to withstand and recover from various economic, social, and environmental challenges (Zeng et al., 2022). (Burns & Machado Des Johansson, 2017) emphasize that disaster risk reduction is a critical approach in sustainable development, which requires integration between development policies and disaster risk management. This approach focuses not only on risk mitigation but also on creating community capacity to adapt to changes that occur (Cabello et al., 2021).

The concept of urban resilience also involves three main dimensions: economic, social, and environmental (Sharifi et al., 2017). The economic dimension relates to the city's ability to sustain inclusive economic growth, while the social dimension emphasizes the importance of social equity and community involvement in decision-making processes. The environmental dimension focuses on protecting ecosystems and managing natural resources sustainably. These three dimensions are interrelated and must be considered holistically to create a resilient city (Hariram et al., 2023).

Good urban planning is key to building resilience. (Dushkova & Ivlieva, 2024) show that inclusive and participatory planning can enhance urban resilience by ensuring that all voices, especially those of vulnerable groups, are heard and taken into account. This creates a sense of ownership among citizens and increases their capacity to face challenges. The main concept in building resilient cities includes the integration of economic, social, and environmental resilience. Economic resilience includes diversification of income sources and sustainable job creation (Bruzzzone et al., 2021). Economic resilience in urban areas can be achieved through the development of sectors that rely not only on traditional industries but also on innovation and technology (Khlystova & Kalyuzhnova, 2023).

Social resilience focuses on social justice and reducing inequality. (Echendu, 2023) emphasizes the importance of community involvement in urban planning to ensure that the needs of all groups in society are met. This is essential to creating an inclusive and supportive environment. Environmental resilience focuses on natural resource management and protection against the impacts of climate change. (Sokolova et al., 2024) show that green infrastructure, such as urban parks and open spaces, can increase urban resilience to climate change by providing essential ecosystem services.

Many studies have been conducted to understand how cities can be built to be more resilient. (Rezvani et al., 2023) conducted a systematic review of urban sustainability and resilience, which showed that cities that adopt sustainable practices are more likely to cope with external shocks. This study highlights the importance of collaboration between government, the private sector, and civil society in achieving resilience goals. (Mabon & Shih, 2021) examined the relationship between climate change and urban resilience. They found that cities with strong climate change adaptation strategies were more likely to survive natural disasters. This suggests that proactive and data-driven planning is critical in creating resilience. A study by (Chand, 2018) emphasized the importance of integrating social and environmental dimensions in urban resilience planning. They showed that social resilience can be enhanced through strengthening social networks and collaboration between communities. This creates the synergy needed to address complex challenges.

Sustainable Development and Urban Resilience

Sustainable development and urban resilience have been significant topics in the field of urban studies, with an increasing focus on strategies that address environmental, social, and economic challenges in developing countries. A key aspect of this is the role of green infrastructure in enhancing environmental resilience. Green infrastructure, such as urban parks, green roofs, and permeable surfaces, has been shown to provide multiple benefits, including flood mitigation, improved air quality, and reduced urban heat island effects (Chiroli et al., 2023; Mendizabal et al., 2018). In their study, (Patel & Nosal, 2016) argue that green spaces not only contribute to ecological sustainability but also improve urban residents' well-being by offering recreational areas and fostering community engagement. Some studies suggest that green infrastructure's effectiveness can be limited by spatial constraints and competing land uses in rapidly urbanizing areas (PITRENAITE-ZILENIENE & Torresi, 2014).

Adaptive technology has also gained attention as a critical tool in urban resilience, particularly in the context of climate change and disaster preparedness. Technologies such as early warning systems, smart infrastructure, and data-driven solutions are being increasingly used to mitigate urban risks. For instance, (Boeri et al., 2017) highlight how smart technologies, such as IoT-based systems for monitoring air quality and traffic flow, enhance the capacity of cities to respond to environmental and social risks. (Pickett et al., 2014) further discusses how adaptive technologies can integrate resilience-building efforts into urban planning processes. However, there are critiques about the high costs and technological barriers faced by cities in developing countries, which may limit the scalability of such solutions.

Localized policies grounded in the unique social, economic, and cultural contexts of cities in developing countries, are seen as essential for effective urban resilience. Research suggests that policies tailored to local needs, rather than one-size-fits-all solutions, are more likely to be successful in addressing the specific challenges faced by these cities (Spaans & Waterhout, 2017). Studies in cities like Dhaka and Nairobi highlight the importance of community participation and local knowledge in developing policies that are both practical and sustainable (Orsetti et al., 2022; Vale, 2014). Critics argue that localized approaches can sometimes face limitations due to the lack of political will or resources at the local level, leading to implementation challenges. Moreover, the fragmented nature of local governance can hinder coordinated efforts for resilience (Klein, 2023). Green infrastructure, adaptive technology, and localized policies hold promise for enhancing urban resilience, their effectiveness is contingent on various factors such as political support, resource availability, and spatial limitations, these strategies, when integrated into broader sustainable development frameworks, can contribute significantly to building resilient cities in the face of climate change and rapid urbanization.

Empirical Study

Empirical studies related to the implementation of urban resilience strategies can be seen through several case studies that illustrate the successes and challenges in designing and implementing urban resilience policies. For example, research by (Falcone, 2023) examines the resilience of cities in urban areas to climate change by highlighting the importance of ecosystem-based planning and community participation in decision-making. Another study by (Alamoudi et al., 2022) focuses on socio-economic resilience and how urban policies can improve infrastructure and reduce its vulnerability to global crises. A study by (Cao, 2023) explains the importance of community-based adaptation strategies, where local communities play an active role in designing and implementing disaster resilience solutions.

These studies provide a deeper understanding of how urban resilience can be achieved, emphasizing the role of integration between government policies, community involvement, and sustainable natural resource management.

Further analysis of the implementation of urban resilience strategies shows that despite the various studies that discuss it, the biggest challenge faced by many cities in developing countries is the lack of adequate resources and infrastructure to support these resilience policies. (Kochskämper et al., 2024) research focusing on ecosystem-based planning is very relevant, because this approach integrates environmental restoration and protection in resilience strategies, but is often constrained by limited funding and institutional capacity. The implementation of this policy requires greater support from the government and the private sector to build green infrastructure that can increase resilience to natural disasters.

(Malalgoda & Amaratunga, 2015) study, which focuses more on socio-economic aspects, suggests that in order to achieve effective resilience, the strategies implemented must be inclusive and consider the economic needs of the most vulnerable communities, and this includes increasing local economic capacity and reducing social inequality. Although this concept is ideal, its practice often faces obstacles in the form of unequal distribution of resources and the inability of local governments to allocate budgets fairly and efficiently.

(Boeri et al., 2017) research introduced the importance of the role of local communities in adaptation strategies. A community-based approach, which involves communities in the planning and implementation of policies, can increase resilience because communities better understand local needs and challenges. Implementing this approach also requires increasing community capacity, both in terms of knowledge and resources, which are not always available in cities with high levels of poverty and social inequality. A deeper analysis of the implementation of urban resilience strategies shows that although the concept of urban resilience has been increasingly accepted, the biggest challenge lies in the sustainability of these policies, both from a social, economic, and environmental perspective. A holistic approach is needed, involving multiple parties (government, community, private sector), and more flexible policy adaptation so that urban resilience can be achieved effectively and sustainably.

3. METHOD

Research Approach

This study uses a descriptive qualitative approach to deeply understand the challenges of urban resilience in various dimensions, including economic, social, and environmental. The descriptive qualitative approach was chosen because it allows researchers to explore complex phenomena in developing cities with different social and economic characteristics.

Secondary Data Collection

Secondary data is the main source of this research and is obtained from several types of documents, including:

- a. Government Reports and National Policies: Documents from governments of countries such as Indonesia, the Philippines, India, and Nigeria covering urban resilience strategies, climate change adaptation programs, and infrastructure planning.
- b. Reports from International Institutions: Reports from the United Nations Development Programme (UNDP), the World Bank, and the Asian Development Bank focusing on sustainable development, disaster mitigation, and supporting developing cities in the face of climate change.
- c. Previous Academic Journals and Case Studies: Articles and case studies examining urban resilience in developing countries to enrich the analysis. Research published in international journals such as *Cities and Sustainable Cities and Society* were used as primary references in confirming the findings and assessing the linkages between theory and field phenomena.

This data collection process was carried out through online searches on portals such as Google Scholar, JSTOR, and educational institution journal databases to ensure that the data used is relevant, valid, and supports contextual analysis in developing cities.

Data Analysis and Validation of Findings

The collected data was then analyzed using thematic analysis to identify key themes relevant to urban resilience. The analysis process began with data categorization, where data was divided into economic, social, and environmental themes. Each of these themes was then linked to relevant theories, such as Economic Resilience Theory and Urban Ecology Theory, to provide an in-depth framework for understanding the dynamics of urban resilience. The next step was pattern and relationship finding, where data from different cities were analyzed to find similarities or emerging patterns, such as the disaster mitigation approaches in Dhaka and Jakarta, or infrastructure adaptation in Mumbai and Manila. In this stage, researchers looked for similarities in how cities addressed resilience-related challenges, and to ensure the accuracy of the findings, the analysis results were then validated by comparing them to previous studies and reports. This validation aimed to reduce potential bias in data interpretation and strengthen the accuracy of the findings obtained, ensuring that the analysis provides a valid and relevant contribution to urban resilience studies.

4. RESULT AND DISCUSSION

Developing Urban Resilience in Developing Country Cities

Cities in developing countries such as Dhaka, Nairobi, and Manila face complex challenges in building sustainable urban resilience. The main challenges they face include high population pressure, environmental degradation, and significant socio-economic inequalities, as shown in the following data:

Table 1. Urban Resilience in Developing Country Cities

City	Challenge	Resolution Efforts
Dhaka, Bangladesh	Recurrent flooding is a major problem due to poor drainage systems and unplanned urbanization. A study by UN-Habitat shows that around 40% of Dhaka's population lives in densely populated areas with limited access to clean water and sanitation.	To address these challenges, programs such as Pro-Poor Urban Development have been implemented to improve access to basic services. These programs leverage local community management and the integration of simple technologies, such as flood early warning systems, to reduce disaster risk and improve community well-being.
Nairobi, Kenya	Facing unequal access to basic services, especially in slums like Kibera, where only 25% of the population has access to proper sanitation.	To address this issue, various international collaborations have been carried out, one of which is through the Kibera Transformation Project. This project aims to improve the condition of sanitation infrastructure by building new facilities and involving communities in planning and implementation to create more sustainable solutions that are in line with local needs.
Manila, Filipina	The risk of natural disasters such as typhoons and floods is a major threat, causing significant annual economic losses.	To improve disaster resilience, the local government implemented the Flood Management Master Plan project, which integrates green spaces with the urban drainage system. This approach not only

		helps reduce flood risks but also provides open spaces that can be used for recreation, thus providing dual benefits to the community.
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Source: data proceed

If we analyze the implementation of resilience strategies in Dhaka, Nairobi, and Manila, it is clear that each city faces unique challenges that require different approaches according to local social, economic, and environmental conditions. Dhaka, with its rapid urbanization and inadequate drainage system, relies on community-based approaches to improve flood resilience. Programs such as Pro-Poor Urban Development demonstrate that community involvement in resource management can help mitigate the impact of disasters, although challenges such as lack of funding and inter-agency coordination remain major obstacles. In Nairobi, for example, unequal access to basic services, especially in slums such as Kibera, is a major challenge in building urban resilience. Projects such as the Kibera Transformation Project highlight the importance of international collaboration in building sanitation infrastructure and improving the well-being of residents, these efforts still face obstacles in terms of project sustainability and limited government capacity to manage rapid urban growth.

Manila faces recurring natural disaster threats, such as typhoons and floods, which require infrastructure-based and ecological solutions. The implementation of the Flood Management Master Plan confirms that integrating green spaces with drainage systems can be an effective solution in reducing the impact of flooding while providing additional benefits to the community. However, the main challenges faced are the need for long-term investment and coordination between the national and local governments in implementing this program in a sustainable manner. The strategies implemented show that a community-based approach, investment in infrastructure, and collaboration with various stakeholders are key to building greater urban resilience, although each city has different challenges, the successful implementation of this strategy depends heavily on policy support, funding, and effective coordination between the government, private sector, and communities.

The Role of Green Infrastructure and Adaptive Technologies in Supporting Urban Resilience

Green infrastructure has become an innovative solution to improve the resilience of cities to environmental, social, and economic challenges. Various types and forms of green infrastructure have been implemented in many cities in developing countries, including urban parks, green roofs, urban forests, green open spaces, and natural drainage systems known as blue-green infrastructure. Urban parks and urban forests function as water catchment areas and air pollution filters, while green roofs on high-rise buildings can reduce the urban heat island effect and increase energy efficiency. Natural drainage systems based on green infrastructure, such as retention ponds and bioswales, also help control stormwater runoff and prevent flooding.

Several cities in developing countries have successfully implemented green infrastructure to address the challenges of urbanization. Dhaka, for example, has developed urban parks and retention ponds to address frequent flooding caused by poor drainage systems. Nairobi has initiated the Karura urban forest rehabilitation project, which not only improves air quality but also provides green space for urban communities. Jakarta, which faces the challenge of annual flooding, has implemented the concept of blue-green infrastructure by developing urban parks that serve dual functions as public spaces and water catchment systems.

The implementation of green infrastructure in developing countries still faces various challenges. Land constraints are one of the main obstacles, especially in cities with high population density, where open land is more often allocated for physical infrastructure development than green space. Budget constraints are also an obstacle, because the development and maintenance of green infrastructure require long-term investments that are often not prioritized in city planning. Conflicts of interest in urban planning also often occur, especially when economic interests and property development are prioritized over environmental sustainability. More supportive policies and active participation from various parties, including the government, private sector, and communities, are needed to ensure the sustainability of green infrastructure in supporting city resilience. A study by (Sokolova et al., 2024) showed that green open spaces, city parks, and mangroves have a positive impact on environmental quality and disaster resilience.

For example, mangrove parks in Mumbai not only protect the city from flooding but also provide habitat for biodiversity.

Table 2. Implementation of Green Infrastructure in Several Cities

City	Types of Infrastructure	Main Impact	Adaptive Technology	Main Impact
Dhaka	City Parks and Retention Ponds	Reducing the risk of flooding and increasing absorption capacity	Early Warning System	Enables rapid response to floods, reducing casualties and losses.
Nairobi	Green Roofs and Urban Forests	Lowering urban temperatures, improving air quality	Sistem Pemantauan Cuaca Real-Time	Helps predict extreme weather and respond faster.
Manila	Green Open Space and Ecological Corridor	Providing water catchment areas, recreation areas and natural ecosystems	Sistem Informasi Geospasial (GIS)	Monitor land use changes and support data-driven decisions.

Source: data proceed

Green infrastructure in cities plays a vital role in mitigating the negative impacts of urbanization such as flooding, air pollution, and rising temperatures. Cities like Dhaka and Jakarta are leveraging urban parks and retention ponds to address flooding, while Nairobi and Bangkok are leveraging green roofs to lower temperatures and improve air quality. Adaptive technologies provide innovation-based solutions to enhance urban resilience. Dhaka is using early warning systems to respond quickly to floods, while Addis Ababa is using GIS applications to map disaster-prone areas and support adaptive urban governance. The combination of green infrastructure and adaptive technologies is enabling cities in developing countries to sustainably strengthen resilience to environmental, social, and economic challenges.

The Influence of Resource Constraints and International Support on Urban Resilience Policies

Cities in developing countries often face resource constraints, whether financial, technical, or human, that directly impact the effectiveness of urban resilience policies. This challenge is evident in megacities such as Dhaka, Nairobi, and Manila, which are experiencing pressures from rapid urbanization but have limited capacity to build infrastructure that is resilient to disasters and climate change. One of the major obstacles to building urban resilience is budget constraints, which prevent many green infrastructure and climate adaptation projects from being fully implemented. In Dhaka, for example, lack of funding has left the city's drainage system underdeveloped, exacerbating flooding during the rainy season. Nairobi faces similar challenges, with over 60% of its population working in the informal sector, making it difficult for the government to collect taxes and fund large-scale projects (World Bank, 2022). These constraints not only impact physical infrastructure, but also hamper the development of early warning systems and adaptive technologies needed to improve a city's resilience to disasters.

In the face of these constraints, international support plays a critical role in helping developing cities build urban resilience. For example, the World Bank-funded Slum Revitalization Program in Nairobi has helped provide basic infrastructure such as clean water, sanitation, and road repairs, which were previously beyond the reach of local funding. Funding from organizations such as UN-Habitat has helped the city develop blue-green infrastructure projects to reduce flood risk in Jakarta. While external aid is helpful, (Falcone, 2023) research highlights that over-reliance on international funding can be challenging. Without a strong sustainability strategy, externally funded projects often lose their effectiveness after funding ends. Many experts recommend strengthening local capacities, such as improved governance, fiscal policy reform, and community participation in urban planning, as solutions to ensure the sustainability of urban resilience initiatives in developing countries.

Effectiveness of Contextually Based Resilience Policies compared to General Approaches

A contextual approach is more effective in addressing urban challenges in developing countries than a general approach due to its local relevance, at least this approach is rooted in two main points, namely as follows:

a. Community Participation

Policies that involve local communities, such as the program in Kibera, Nairobi, have been successful in creating a sense of ownership of the solutions implemented. This approach enhances long-term sustainability because communities are actively involved in maintaining project outcomes. Community participation is a key element in the sustainability of urban resilience policies, especially in developing countries that face multiple social, economic, and environmental challenges. Local communities play a key role in ensuring that implemented infrastructure policies and projects are effective in the long term. Without active citizen involvement, many government or international organization initiatives often lose their effectiveness after the initial implementation stage.

One of the main impacts of community participation is an increased sense of ownership and responsibility for the projects being implemented. When communities are involved in the planning, construction, and maintenance of infrastructure—whether it's a city park, a drainage system, or community-based housing—they feel more invested in the project. This reduces the risk of neglect, vandalism, or even rejection of government programs that often occur when policies are made top-down without consulting residents. A real-life example of successful community participation can be found in the Kibera slum revitalization program in Nairobi, where residents were involved in building and maintaining shared sanitation facilities. With community involvement, the project not only improved access to sanitation but also ensured that the facilities were well-maintained after the program ended. A similar study in Dhaka also showed that community-based sanitation systems were more effective than government approaches that did not take local customs and needs into account.

Policies based on community participation not only increase the sustainability of urban projects, but also strengthen social resilience, where citizens are better prepared and independent in facing environmental and economic challenges in their cities. The active role of the community must be a priority in every city development policy, in order to create solutions that are not only effective but also inclusive and sustainable.

Kibera, one of the largest informal settlements in Nairobi, has long faced serious sanitation challenges due to overcrowding, limited infrastructure, and inadequate waste management systems. To address these challenges, a community-based sanitation program was implemented that involved active community participation in every stage of planning, implementation, and maintenance of sanitation facilities. Local communities were involved from the beginning in the process of identifying needs and designing sanitation solutions that were appropriate to their social and economic conditions in this program. Residents participated in the construction of public sanitation facilities, including public toilets and locally-based wastewater management systems, they were also empowered to take responsibility for the maintenance of the infrastructure that had been built, by forming community groups that were tasked with collectively managing these facilities.

The results of this community-based approach have been very positive. Vandalism of public facilities has decreased significantly as the community feels a direct responsibility for the infrastructure they have built themselves. In addition, overall sanitation conditions have improved markedly, with access to more adequate toilets and improved waste disposal systems. These successes have not only impacted public health, but have also improved economic and social well-being by reducing sanitation-related diseases that have long been a burden on the local population.

In contrast to community-based approaches, the top-down approach often used in infrastructure projects in developing countries tends to fail in the long term. Sanitation programs designed without consulting residents often do not meet the needs of local communities. For example, government sanitation projects that implement standard infrastructure models often fail because they do not take into account the usage patterns and economic constraints of residents, resulting in facilities that are built that are not functional or underutilized. Projects that do not involve communities in their maintenance often experience degradation after the project ends. Many sanitation infrastructures end up being abandoned because there is no mechanism for sustainable management by local residents, which is different from community-based approaches, where the community has a strong sense of ownership and actively maintains the facilities.

b. Socio-Economic Relevance

Community-based policies that take into account local socio-economic patterns, such as in Dhaka, have proven to be more effective in providing access to sanitation than generic approaches that often ignore local needs. Urban resilience policies must be designed with the socio-economic conditions of communities in mind so that they can be implemented effectively and sustainably. Economic inequality and limited access to basic infrastructure are often major challenges in urban policy planning in developing countries, the strategies implemented must be adaptive to the social and economic realities of each community.

Adapting policies to the economic conditions of communities is crucial to ensuring their effectiveness. For example, many residents in informal settlements live on a daily basis, so policies that require upfront payments for infrastructure services are often difficult to implement. In addition, high levels of poverty and limited access to basic services such as clean water and sanitation make conventional approaches not always relevant. Social factors also play a role. For example, culture and patterns of community interaction determine how a policy is received and used. Sanitation policies that are designed without considering social customs regarding the use of sanitation facilities can face implementation difficulties, even if the infrastructure is technically in place. As a rapidly urbanizing and densely populated city, Dhaka faces significant challenges in providing adequate sanitation for its citizens. To address this issue, the Dhaka government is working with local communities to design a community-based sanitation system that is more flexible and in line with people's purchasing power.

One of the main strategies in this program is a graduated payment system that is adjusted to the income of the community. Rather than applying a standard tariff that is difficult for low-income groups to afford, this system allows for small payments at regular intervals, making access to sanitation facilities more inclusive. The impact of this approach has been very positive. The level of sanitation access has increased significantly, especially in areas that previously had limited sanitation infrastructure. Unlike international standard-based sanitation models that often do not take into account local economic conditions, this community-based program is more acceptable to the community, increases the use of facilities, and ensures the sustainability of their management.

Many sanitation projects based on a general approach also fail because they do not consider the purchasing power and needs of local communities. One example of this failure occurs when governments or international organizations build public toilets with standard models without considering operational costs and local customs. Sanitation infrastructure built in several developing cities is not used because people cannot afford the maintenance costs or because the design of the facility does not suit local culture. For example, the construction of sitting toilets in areas where the majority of residents are accustomed to using squat toilets causes the infrastructure to be underutilized, or even abandoned. This example certainly shows that urban resilience depends not only on the availability of infrastructure, but also on the relevance of policies to the socio-economic conditions of the community. Policies that are designed without understanding local dynamics risk experiencing implementation obstacles and losing long-term effectiveness. A community-based approach that considers economic and social aspects is a more sustainable strategy in building urban resilience in developing countries.

Discussion

Cities in developing countries like Dhaka, Nairobi, and Manila face complex social, economic, and environmental challenges. Dhaka, for example, struggles with extremely high population density and limited access to basic services like clean water and sanitation. Data shows that more than 50% of the city's population lives in slums with inadequate infrastructure. Nairobi faces significant social inequality, especially in settlements like Kibera, where only 25% of households have access to improved sanitation services. Manila, on the other hand, faces the risk of annual flooding due to a lack of drainage infrastructure and the increasing impacts of climate change.

Previous research (Zeng et al., 2022) highlighted the importance of integrating social and environmental dimensions in urban planning to enhance resilience. Examples of the application of this approach are seen in Dhaka and Nairobi, where social challenges such as unequal access to basic services are exacerbated by environmental pressures. The "Kibera Transformation Project" in Nairobi, for example, has focused on building community capacity by actively involving local communities in decision-making and implementation of sanitation solutions. This supports

the theory of (Cabello et al., 2021) which states that disaster risk reduction is not enough with technical mitigation, but also requires strengthening community capacity to adapt to changes that occur.

Responses to environmental challenges involve implementing ecosystem-based policies such as the integration of green spaces in the "Flood Management Master Plan." This project not only serves to mitigate flooding but also improves the quality of life of the community by providing green open spaces for recreation and environmental protection. These findings reinforce the importance of a multidimensional approach that considers social, economic, and environmental aspects simultaneously.

Integration of local communities in basic infrastructure management through programs such as "Pro-Poor Urban Development" has shown increased access to sanitation and clean water. This supports the view of (Mabon & Shih, 2021) that community-based adaptation strategies can increase the capacity of cities to cope with multidimensional challenges. Steps that can be taken include: a) identifying specific challenges faced by cities, b) incorporating social, economic, and environmental dimensions into urban planning, c) actively involving communities in decision-making processes and implementing solutions, d) implementing ecosystem-based solutions, such as the use of green spaces for flood management in Manila, which can simultaneously reduce the impact of climate change and improve the quality of life of the community, e) utilizing technical and financial assistance from international institutions such as UNDP and the World Bank to support large projects, such as the development of green infrastructure, and f) conducting regular monitoring to assess the effectiveness of programs and adjust them to remain relevant to changes in the city.

Green infrastructure and adaptive technologies play a critical role in supporting urban resilience to natural disasters and climate change. Green infrastructure, such as mangrove parks and green spaces, act as natural buffers that help mitigate the impacts of disasters, such as floods and heat waves, while providing sustainable ecosystem benefits. For example, the Mumbai Coastal Road Project in India demonstrates how the integration of mangrove parks not only helps prevent flooding but also improves air quality and provides public spaces that benefit communities. In Manila, green spaces have become part of the Flood Management Master Plan, which not only serves to mitigate flooding but also provides long-term environmental benefits.

Research by (Sokolova et al., 2024) supports the importance of green infrastructure as a provider of essential ecosystem services to address climate change. This example confirms that ecosystem-based approaches have a dual impact, increasing environmental resilience and supporting overall societal well-being. Adaptive technologies also play a key role in improving urban disaster preparedness. Early warning systems in Dhaka, for example, have been shown to be effective in minimizing loss of life during floods. This technology provides communities with sufficient time to respond to threats, especially in cities with inadequate infrastructure. GIS applications in Addis Ababa are being used to assist in more efficient spatial planning to accommodate rapid population growth. This technology enables better management of urban resources, such as the planning of flood-prone areas or the optimization of public spaces to address environmental risks.

According to (Rezvani et al., 2023), GIS-based technology and early warning systems can significantly increase a city's capacity to anticipate disaster risks. This approach is also in line with the findings of (Huynh Thi Ngoc et al., 2024) that simple but contextual technologies can be an effective solution, especially in developing countries with limited financial resources. Limited financial, technical, and human resources are major challenges in building urban resilience in developing countries. Cities such as Dhaka, Nairobi, and Manila often do not have sufficient budgets to build the basic infrastructure needed to deal with disaster risks or climate change impacts. For example, more than 50% of Dhaka's population lives in slums without access to adequate sanitation, reflecting the urgent need for significant infrastructure investment. In Nairobi, only 25% of slum households have access to basic sanitation services, indicating the structural constraints facing the city.

Collaboration with international agencies such as UNDP and the World Bank has played a significant role in addressing these local constraints. Slum revitalization projects in Nairobi and green infrastructure development in Dhaka demonstrate how international support can provide the funding, technology transfer, and training needed to build local capacity. For example, the Kibera Transformation Project in Nairobi, supported by the World Bank, has improved sanitation conditions and provided training to local communities in managing the infrastructure they build.

Research by (Falcone, 2023) underlines the importance of international support in overcoming resource constraints. The study shows that collaboration with global institutions enables the implementation of large-scale projects that would be difficult to implement with local resources alone. For example, the "Flood Management Master Plan" in Manila, funded by the Asian Development Bank (ADB), integrates green spaces with drainage systems to

reduce the risk of annual flooding, this approach not only provides technical solutions but also creates significant social and environmental benefits.

(Alamoudi et al., 2022) study added that international collaboration not only provides funding but also enhances local capacity through training and technology transfer. A concrete example is the use of GIS in Addis Ababa, Ethiopia, supported by the World Bank. This technology helps make spatial planning more efficient, enabling the city government to manage population growth more effectively. The results of this implementation show significant improvements in the city's ability to deal with environmental and social risks.

Resource constraints remain a constraint on the effectiveness of local policies. Dependence on international aid can create sustainability challenges if not accompanied by strengthening internal capacity. For example, a UNDP-supported green infrastructure project in Dhaka was successful in reducing flood risk, but its sustainability requires consistent local funding for maintenance and management. This is in line with findings from (Chand, 2018) who stated that urban resilience requires strengthening local capacity to ensure project sustainability after international intervention ends.

Findings suggest that contextually-based resilience policies are more effective than generic approaches, especially in addressing social, economic and environmental challenges in developing cities. The "Kibera Transformation Project" in Nairobi, which was designed with local socio-economic and cultural conditions in mind, is an example of successful contextually-based resilience policies. The program not only improved access to sanitation, but also involved local communities in planning and implementation, creating a greater sense of ownership over the solutions, generic approaches often fail to capture specific needs, making them less relevant and sustainable.

These results reinforce previous research conducted by Dushkova & Ivlieva (2024) who asserted that inclusive and participatory planning increases the relevance and effectiveness of resilience strategies. This is supported by (Mendizabal et al., 2018) who showed that strengthening social networks through local community involvement can create stronger social resilience. An example is seen in Dhaka, where a community-based approach has successfully improved sanitation in slums. This project reflects the importance of integrating social, economic, and environmental dimensions in resilience strategies, as outlined by Sharifi et al. (2017), who highlighted that urban resilience must be managed holistically.

Contextual resilience approaches also have advantages in responding to environmental risks. In Manila, policies designed to address flooding have included green spaces as part of the "Flood Management Master Plan." This policy is not only locally relevant but also creates long-term benefits for communities and the environment. In contrast, generic approaches applied in similar cities often fail to capture local nuances, such as geography, urbanization patterns, or local culture, which are key to the success of the policy.

Theory-based approaches further strengthen the argument that contextual resilience policies are more effective. (Chand, 2018) social resilience theory highlights that communities with limited access to basic services are more vulnerable to disaster impacts. Involving communities in decision-making can strengthen community resilience. A community-based sanitation program in Dhaka successfully created relevant and sustainable solutions, by strengthening local capacity and increasing citizen participation. The Brundtland Report's sustainable development theory also supports a contextual resilience approach, emphasizing that the needs of the present generation must be met without compromising future generations. This approach is evident in the Mumbai Coastal Road project, which not only serves to mitigate flood risks but also creates public spaces that benefit local communities. By integrating environmental, economic, and social aspects, this policy offers a relevant sustainability model for other developing cities.

5. CONCLUSION

The study highlights that developing cities such as Dhaka, Nairobi, Mumbai, and Manila face complex challenges that include resource constraints, social inequality, and environmental risks, requiring a cross-sectoral approach that integrates social, economic, and environmental aspects. Green infrastructure, such as mangrove parks and green spaces, have proven effective in reducing environmental impacts while improving quality of life, while simple technologies, such as early warning systems, help mitigate disaster risks in cities with limited high-tech capabilities. Collaboration with international agencies such as UN-Habitat and the World Bank has been instrumental in providing technical and financial support for the development of urban policies and infrastructure. Local context-

based policies are more effective than generic approaches because they enhance community engagement and create solutions that are more tailored to the specific conditions of cities. As a recommendation, the study encourages policymakers to adopt a framework that combines local-based policies, adaptive technologies, and international support to ensure sustainable urban resilience in the face of future challenges.

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