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Research Article

Advancing SDGs-Driven Urban Resilience Pathways in the Global South: An Integrated PSR–VIKOR Evaluation of Sustainability, Equity, and Governance

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Abstract

The paper examines how SDG-aligned sustainability, governance, and socio-spatial equity shape pandemic resilience in Cairo and Alexandria cities, two major urban centres in the Global South facing compounded pressures from environmental stressors, institutional fragmentation, and systemic health vulnerabilities. The research underscores how gaps in housing conditions, mobility accessibility, data interoperability, and coordinated governance, exposed during COVID-19, directly intersect with SDGs 3, 10, 11, 13, and 16. A four-phase sequential mixed-methods design was employed. The paper synthesizes global knowledge on sustainability and resilience; conducts an SDG-coded qualitative review of Egyptian urban policies; applies statistical association tests to evaluate structural relationships among pressures, state variables, and resilience responses; and uses the *VlšeKriterijumska Optimizacija I Kompromisno Rešenje* (VIKOR) method to prioritise resilience drivers. Findings show that technology plays a critical role across these phases, particularly through reliance on data-driven analytical tools, metropolitan-scale information systems, and decision-support methodologies. The paper highlights the importance of interoperable data platforms, digital governance infrastructure, and computational decision models for strengthening SDG-oriented planning. Environmental Sustainability and Climate Co-benefits are the strongest drivers of pandemic resilience, followed by Governance and Institutional Coordination. Mobility and Social-Spatial Inclusivity emerge as key mediating factors influencing urban resilience, while housing inequality maintains a weaker but significant role. These results validate the need for technologically enabled, risk-informed, and equity-centred planning. The paper demonstrates that integrated analytical frameworks and enhanced urban data systems can support transformative, SDG-aligned resilience strategies, informing policymakers seeking socially just, technologically supported, and environmentally responsive urban futures.

Keywords: Environmental sustainability; Governance coordination; Socio-spatial inclusivity; Housing informality; Mobility accessibility

Highlights

- PSR–VIKOR reveals SDG-aligned pathways for resilient urban systems.
- Governance and climate co-benefits drive metropolitan resilience outcomes.
- Inclusivity and mobility shape equitable, future-ready urban transformations.

1 Introduction

1.1 Global Urban Challenge

Cities in the Global South are experiencing unprecedented urban transformation driven by rapid population growth, spatial expansion, and increasing socio-economic complexity. These dynamics have intensified challenges related to infrastructure provision, environmental degradation, housing shortages, and socio-spatial inequality. Sustainable urban development has emerged as a key policy framework aimed at balancing environmental protection, economic viability, and social equity to ensure long-term urban resilience and intergenerational well-being (UN-Habitat, 2020), thus aligning with the United Nations Sustainable Development Goals (SDGs), particularly SDGs 3, 10, 11, 13, and 16, emphasising health resilience, equity, sustainable urbanisation, climate responsiveness, and effective governance as foundational pillars of contemporary urban policy.

Strategies for urban resilience in the Global South are increasingly associated with the SDGs. Nevertheless, these initiatives frequently prioritise economic considerations over social and ecological goals, thereby impeding the significant changes needed for sustainable progress. The 100 Resilient Cities initiative has demonstrated how cities can align resilience strategies with global agendas such as the SDGs, but equity and justice are inconsistently addressed in these strategies (Croese, Green, & Morgan, 2020; Fitzgibbons & Mitchell, 2019; Kochskämper, Glass, Haupt, Malekpour, & Grainger-Brown, 2025).

Challenges in governance, including insufficient institutional strength, disjointed strategic planning, and restricted stakeholder participation, impede the adoption of resilience principles in the Global South (Cobbinah, 2021; Das, 2025). Equitable social considerations and justice are often neglected in urban resilience frameworks, leading to insufficient attention to inclusive planning and the needs of marginalised communities (Fitzgibbons & Mitchell, 2019; Nazmul Haque & Sharifi, 2024).

Addressing the vulnerabilities of urban systems, particularly in water, energy, and transit, requires implementing infrastructure that withstands climate-related impacts, adopting solutions inspired by natural processes, and establishing alliances between government and commercial entities (Das, 2025). The integration of urban green infrastructure and urban agriculture is gaining traction to improve sustainability and resilience. However, adopting these strategies in the Global South faces limitations due to governance and equity concerns (Pauleit, Vasquéz, Maruthaveeran, Liu, & Cilliers, 2021; Senthamizh & Anbarasan, 2025).

The concept of urban resilience has gained increasing prominence in urban research and policy debates. Urban resilience refers to the capacity of cities and their socio-ecological systems to anticipate, absorb, adapt to, and recover from shocks and stresses, including natural hazards, economic crises, and public health emergencies(Meerow, Newell, & Stults, 2016). Contemporary research increasingly recognises that sustainability and resilience are deeply interconnected. Resilience strategies that ignore equity risks and reinforce structural vulnerabilities, while sustainability initiatives that overlook adaptive capacity may underestimate the systemic nature of urban risks.

Resilience highlights the inherent ability of interconnected socio-ecological and institutional systems to adapt, whereas Disaster Risk Reduction (DRR) is primarily concerned with pinpointing and mitigating the root causes of risk. Resilience underscores the adaptive potential of intertwined urban systems, encompassing social, environmental, infrastructural, and institutional components, whereas DRR prioritises the identification and reduction of the inherent risks that lead to disasters. Recent global assessments emphasise that disaster risks are inherently systemic, emerging from complex interactions between development trajectories, governance structures, environmental degradation, and socio-economic inequalities (SDG Knowledge Hub, 2025; United Nations Office for Disaster Risk Reduction, 2025).

1.2 Pandemic Urban Vulnerabilities

Urban centres in the Global South are vulnerable to these interconnected risks. Rapid urbanisation, high population densities, informal settlements, and limited institutional capacity often increase exposure to environmental hazards and public health crises (Mamba & Ncube, 2025; Shekhar et al., 2022). Financial constraints further limit governments' ability to invest in long-term risk reduction strategies (Levine et al., 2023; Mamba & Ncube, 2025). A substantial share of the urban workforce operates in the informal sector, where workers often lack access to healthcare services, financial security, and social protection. These structural conditions amplify vulnerability during crises and complicate response and recovery efforts (Munishi, Kirumirah, & Lwoga, 2021).

The COVID-19 pandemic highlighted the critical intersection between public health emergencies and urban disaster risk governance. The pandemic exposed underlying vulnerabilities associated with housing inequality, informal economic activity, infrastructure limitations, and fragmented governance systems. Various cities in the Global South experienced disproportionate health and socio-economic impacts, due, in part, to constrained healthcare capacity, dense urban environments, and limited social protection mechanisms. The crisis generated innovative responses, including digital governance tools, community-based support systems, and expanded social protection programmes. These experiences indicated that effective DRR must integrate public health preparedness with inclusive planning and coordinated governance systems (IFHV, 2025).

1.3 Research Gaps

Despite the rapid expansion of urban research during the pandemic, the literature remains conceptually fragmented, particularly in integrating sustainability, governance, and socio-spatial equity. This inquiry advances the field by explicitly integrating three contributions:

- A combined Pressure–State–Response (PSR)–*VlseKriterijumska Optimizacija I Kompromisno Resenje* (VIKOR) analytical framework linking causal interpretation with decision prioritisation.
- An empirical application to Cairo and Alexandria as representative Global South metropolitan systems, and
- An SDG-aligned interpretation connecting resilience outcomes with goals 3, 10, 11, 13, 16, and 17.

Environmental studies frequently employ quantitative tools such as GIS and remote sensing to analyse environmental changes during lockdown periods. However, these studies often interpret sustainability improvements as temporary outcomes of behavioural changes rather than as results of structural planning reforms. Conversely, resilience-orientated research commonly emphasises emergency preparedness and institutional response capacity while giving comparatively limited attention to socio-spatial inequality and distributive justice. Research focusing on inequality provides critical insights into housing precarity, gendered vulnerabilities, and informal labour dynamics, but often remains disconnected from broader sustainability and governance frameworks (Bambra, Riordan, Ford, & Matthews, 2020; Hamidi, Sabouri, & Ewing, 2020; Muhammad, Long, & Salman, 2020; Sharifi & Khavarian-Garmsir, 2020).

Sustainability, resilience, and inclusivity are frequently examined as parallel rather than integrated dimensions of urban development. This fragmentation limits the ability of existing research to explain how governance systems, environmental pressures, and socio-spatial inequalities interact to shape urban resilience outcomes.

A second major gap concerns mainstreaming global conceptual frameworks into local policy and planning contexts. While international scholarship proposes several models of sustainable and resilient urban development, few studies systematically examine how these frameworks are operationalised within the institutional environments of cities in the Global South. Governance structures,

administrative capacity, and resource limitations often shape how resilience policies are interpreted and implemented in practice.

Empirical research on African and Middle Eastern metropolitan contexts remains limited, particularly at the city level. Although global resilience research frequently references megacities, coastal cities, and national capitals, detailed analyses of how resilience frameworks are applied in these contexts remain scarce (Parnell & Robinson, 2012). This gap is evident in Egyptian metropolitan regions, where national strategies such as Egypt Vision 2030 promote sustainable development, yet the practical integration of sustainability, resilience, and inclusivity within urban planning systems has received limited scholarly attention.

Several studies emphasise the need for integrated evaluation frameworks, such as the Pressure–State–Response (PSR) model, to assess urban resilience and sustainability. These frameworks can help identify critical factors and pathways for improvement (Senthamizh & Anbarasan, 2025). The use of participatory approaches and localised strategies is essential for addressing the unique socio-economic and environmental contexts of cities in the Global South (Ariza-Montobbio, Carrión, & Delgado-Ramos, 2022; Mngumi, 2021).

1.4 Cairo and Alexandria Contexts

A scholarship in Egypt studied COVID-19. It found a connection between city design, health system management, and patient outcomes. This connection was studied at different levels. In Cairo, researchers used GIS mapping. They combined various factors to predict outbreak "hotspots". These factors included demographics, housing, environment, and land features. They used a method called AHP weighting. This helped them prioritise different indicators. The study found that crowded areas with high economic activity and poor infrastructure were most vulnerable. These areas were often identified as outbreak hotspots. This shows that epidemic risk is linked to urban structure. This understanding can help with public health and planning solutions. These solutions can be specifically designed for affected areas (Ramadan & Ramadan, 2022).

Complementing this spatial lens, paediatric evidence on SpringerLink situates Egypt's first officially reported case in Cairo in February 2020. It characterises paediatric presentations through multi-centre clinical reporting, highlighting fever and respiratory/GI symptom clusters, laboratory inflammatory patterns, and age-stratified severity (notably elevated risk among infants), which together underscore the need for differentiated paediatric surveillance and care pathways (El Houchi et al., 2025). In Alexandria, downstream morbidity becomes visible through large-scale hospital-based follow-up, which estimates a substantial burden of post-COVID conditions and identifies correlates such as hospitalisation history and comorbidity profiles, emphasising that the pandemic's impact persists as chronic symptomatology requiring rehabilitation and longitudinal service planning (Ashmawy et al., 2024). At the level of service delivery, early containment research documents how repurposed "isolation hospital" dormitories for mild cases in Smouha achieved favourable short-term outcomes (low mortality and declining transfers), illustrating adaptive, surge-capacity governance under constrained resources (Wahdan, Abdou, & El-Nimr, 2020). Urban design and policy responses in Alexandria register the pandemic's socio-spatial imprint through redesigned public spaces designated for social interaction, such as restaurant–café interfaces and outdoor seating logics, that translate distancing guidance into site-scale spatial protocols. Meanwhile, national-level commentary simultaneously problematises the integrity of early reported figures by weighing undercount claims against contextual explanations, indicating that "epidemic knowledge" in Egypt is co-produced by measurement, medical practice, and spatial regulation (Abdel Gawad, Abdel Salam, & Raslan, 2022; Medhat & El Kassas, 2020).

1.5 Research Contribution and Questions

The paper endeavours to close these conceptual and empirical voids by embedding global resilience discourse in a locally informed, methodologically unified framework. It also investigates the assimilation of global knowledge on sustainable, resilient, and inclusive urban development within

metropolitan governance and planning methodologies. The research focuses on Cairo and Alexandria, two major Egyptian cities representing distinct urban conditions. Cairo exemplifies challenges associated with high density, governance complexity, and socio-spatial inequality, while Alexandria represents a coastal metropolitan system exposed to environmental vulnerability and pandemic-related stresses. Three research questions guide the inquiry:

RQ1 (Knowledge Production) What are the dominant concepts, themes, and analytical frameworks shaping global academic discourse on sustainable, resilient, and inclusive urban development in the Global South during the COVID-19 pandemic?
RQ2 (Policy Translation) To what extent do urban development and recovery policies in the cities of Cairo and Alexandria reflect, operationalise, or diverge from these global frameworks?
RQ3 (Planning Implications) What planning gaps, institutional constraints, and strategic opportunities emerge from comparing global knowledge frameworks with local policy practice?

By systematically linking bibliometric mapping of global scholarship with qualitative policy analysis and quantitative evaluation, this research helps bridge the gap between global resilience discourse and local urban governance practice. The inquiry also provides empirically grounded insights to support the development of more integrated and context-sensitive urban planning strategies in cities confronting overlapping environmental, social, and public health challenges.

2 Research Design

The inquiry employs a sequential mixed-methods research design comprising four analytical phases to address the research questions. This design integrates bibliometric analysis, qualitative document review, statistical association testing, and multi-criteria decision analysis to examine how global conceptual frameworks on sustainability, resilience, and inclusivity are translated into metropolitan governance practices. The methodological approach stems from the data and governance dimensions of SDGs. Integrating the Pressure–State–Response (PSR) framework with the VIKOR method operationalises these targets by strengthening data-driven analysis and enhancing policy coherence across sustainability, resilience, and urban governance domains. Recent studies, such as Moayedfar, Mohebbi, Mozaffaree Pour, and Sharifi (2025) and Chen, Guo, Zhou, Qian, and Zhang (2022), demonstrate the relevance of VIKOR in urban sustainability assessment, infrastructure prioritisation, and resilience evaluation, providing a robust basis for its integration with PSR in this inquiry.

The PSR framework originates from environmental systems analysis and has been widely used to structure causal relationships between drivers, system conditions, and policy responses. Its application in urban sustainability and resilience research enables the interpretation of systemic interactions across environmental, institutional, and socio-spatial dimensions. Similarly, Multi-Criteria Decision Analysis (MCDA), specifically the VIKOR method, is frequently applied to prioritise competing criteria in complex planning environments where trade-offs among sustainability, equity, and governance objectives are required.

The methodological framework connects global academic knowledge production with local urban policy analysis. The four phases of the research design, which Figure 1 exhibits, are summarised as follows:

Phase I Bibliometric Analysis: A large-scale analysis of publications indexed in Scopus and the Web of Science Core Collection identifies dominant conceptual themes and knowledge clusters within global scholarship on sustainable, resilient, and inclusive urban development during the COVID-19 pandemic.
Phase II Qualitative Document Review: The thematic domains identified in the bibliometric analysis inform a qualitative analysis of policy frameworks, planning strategies, and academic studies related to urban development in Cairo and Alexandria.

Phase III Statistical Analysis: Statistical association tests are applied to the coded dataset to evaluate the strength and significance of relationships among thematic domains identified during the qualitative analysis.
Phase IV Multi-Criteria Decision Analysis: The VIKOR method is used to prioritise the relative influence of the identified thematic domains on pandemic-related urban resilience outcomes.

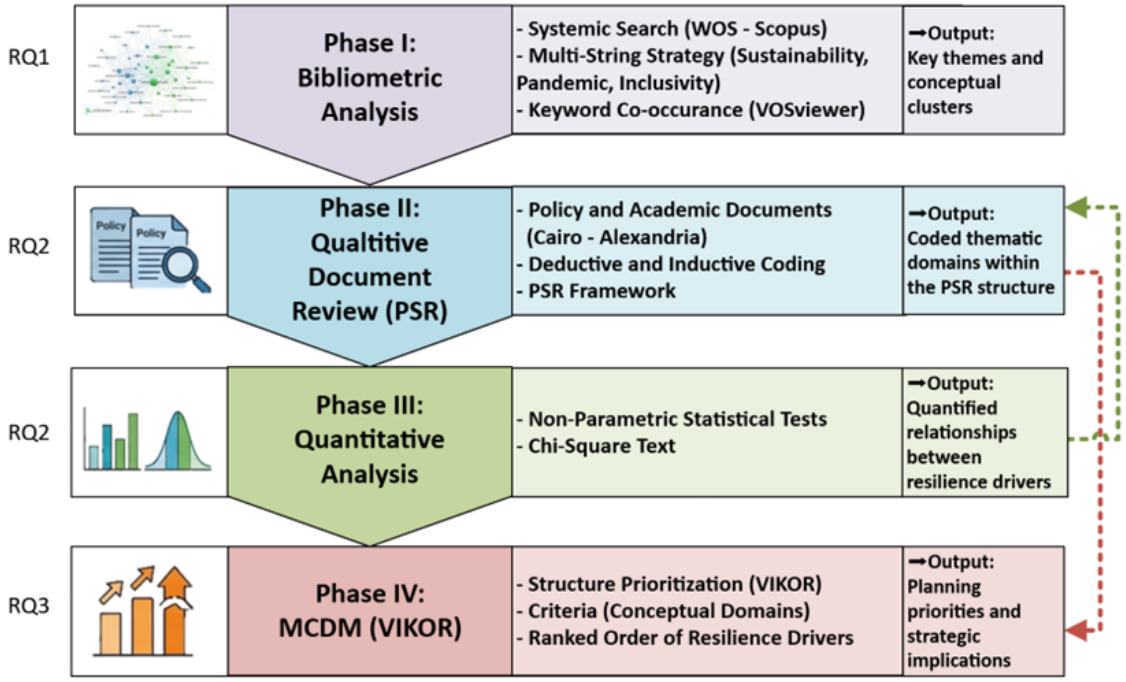

Figure 1. Integrated workflow combining bibliometric analysis, qualitative policy review, PSR framework interpretation, statistical association testing, and VIKOR prioritisation.

The research applies the PSR framework to interpret relationships among environmental pressures, urban conditions, and policy responses. The PSR framework conceptualises urban systems through three interrelated components:

Pressures: structural drivers influencing urban systems, such as environmental stressors, governance structures, and institutional capacity.
State: socio-spatial conditions resulting from these pressures, including housing inequality, infrastructure accessibility, and environmental quality.
Responses: policy interventions and adaptive strategies implemented to address these conditions and enhance urban resilience.

The PSR framework provides a systemic lens for understanding causal relationships, though it lacks a method to prioritise resilience drivers. The research integrates the VIKOR analysis, a popular multi-criteria decision-making method frequently applied in sustainability and urban planning studies.

3 Methodology

The research uses a sequential mixed-methods design with four phases. Methodology: bibliometrics first maps global knowledge. This sequential linkage ensures conceptual continuity and avoids methodological fragmentation (Figure 1). The method links global academic talk to city policy. The integrated design contributes to the implementation of the SDGs by strengthening knowledge generation and data integration through bibliometric analysis, advancing SDG 11.b through the application of risk-informed analytical frameworks, and supporting evidence-based and transparent

decision-making processes under SDG 16.6. Bibliometric mapping, the Pressure–State–Response framework, and VIKOR method provide a unified approach to knowledge, system analysis, and policy.

3.1 Bibliometric Analysis

The first phase involved a systematic bibliometric review of peer-reviewed publications. To ensure reproducibility, a multi-string search protocol was designed using predefined keyword sets and Boolean operators and was applied uniformly across Scopus and Web of Science. These databases were chosen for their extensive coverage of international scholarly journals and their frequent use in bibliometric research on sustainability and urban studies.

Studies were included if they met the following criteria:

1. Peer-reviewed journal articles or review papers
2. Published between 2020 and 2026
3. Contained an explicit focus on urban sustainability, resilience, inclusivity, or the impacts of COVID-19.

After retrieval, duplicate records were removed using DOI matching supplemented by manual screening.

Given the limited number of studies that integrate sustainability, resilience, inclusivity, and pandemic conditions within a single analytical lens, a multi-string approach was adopted to capture the broader intellectual structure of the field. Three complementary queries were formulated to identify literature addressing:

1. Sustainable urban development and urban resilience
2. Pandemic-related urban research (including COVID-19)
3. Urban inclusivity and socio-spatial inequality

Searches were conducted across titles, abstracts, and author keywords, and results were restricted to peer-reviewed journal articles and review papers published between 2020 and 2026.

To support mapping in VOSviewer, the bibliometric workflow proceeded as follows:

- Step A: "Sustainable urban development" or "urban sustainability" combined with "urban resilience" or "resilience" produced 548 records.
- Step B: Urban/city terms combined with pandemic/COVID-19 terms yielded 7,925 records.
- Step C: Inclusion, inequality, or social equity terms within urban/city contexts returned 9,000 records.
- Step D: After merging the three datasets and removing overlaps, 16,930 unique documents remained.

The consolidated dataset was then analysed using VOSviewer (v1.6.20) to generate keyword co-occurrence networks, enabling the identification of dominant thematic clusters and relationships within the literature.

3.2 Qualitative Document Review

The second phase involves a qualitative thematic analysis of policy documents, planning frameworks, and academic studies addressing urban development and resilience in the cities of Cairo and Alexandria.

The final corpus consisted of 17 policy documents and 200 peer-reviewed studies selected through purposive sampling. Selection criteria included relevance to Cairo and Alexandria, publication during or after COVID 19, and explicit engagement with governance, sustainability, or socio-spatial dynamics. A combined deductive–inductive coding approach was applied.

First, deductive coding categories were derived from the thematic clusters identified in the bibliometric analysis. These categories correspond to major analytical domains: sustainability, resilience, governance, and socio-spatial inequality.
Second, inductive codes were introduced to capture context-specific dynamics within Egyptian urban governance systems.

The coded dataset was analysed using co-occurrence analysis, which examines how frequently thematic codes co-occur within the same textual segments. The strength of relationships between codes was calculated using the following co-occurrence coefficient, Equation 1 (Friese, 2019):

Equation 1

$$C = \frac{(n_{1-2})}{((n_1 + n_2) - n_{1-2})}$$

- where c is the coefficient per co-occurrence between the two codes.
- $n_{1\text{-}2}$ is the commonly shared quotation from the texts between the two codes.
- n_1 is the number of quotations from the texts per Code 1.
- n_2 is the number of quotations from the texts per Code 2.

3.3 Quantitative Analysis

The third phase evaluates statistical relationships among thematic domains identified during qualitative coding. Because the dataset consists of categorical variables derived from textual frequencies, non-parametric statistical methods were used.

The Pearson Chi-Square test was used to assess statistically significant associations among thematic variables. The Chi-Square statistic is calculated as in Equation 2.

Equation 2

$$\chi^2 = \sum \frac{O_i - E_i}{E_i}$$

- where χ2 = chi squared
- Oi = observed value
- Ei = expected value

Measures of association strength were evaluated using Phi (ϕ) and Cramer's V, which provide normalised indicators of the strength of relationships between categorical variables.

These statistical measures enable empirical testing the proposed relationships within the PSR conceptual framework, thereby allowing the identification of interactions among governance pressures, socio-spatial conditions, and resilience responses.

3.4 Multi-Criteria Decision Analysis Using the VIKOR Method

The final phase applies the VIKOR multi-criteria decision-making method to prioritise resilience drivers using three indicators, driven from Equations 3, 4 and 5:

Equation 3

- **S (group utility measure**)
    - For the benefit attribute

$$S_i = \sum_{i=1}^{n} W_i \left(\frac{(f_{ij})_{max} - (f_{ij})}{(f_{ij})_{max} - (f_{ij})_{min}}\right)$$

    - or for a non-benefit attribute

$$S_i = \sum_{i=1}^{n} W_i \left(\frac{(f_{ij}) - (f_{ij})_{min}}{(f_{ij})_{max} - (f_{ij})_{min}}\right)$$

Equation 4

- **R (individual regret measure)**
  - For the benefit attribute

$$R_i = Max\left(W_i\left(\frac{(f_{ij})_{max} - (f_{ij})}{(f_{ij})_{max} - (f_{ij})_{min}}\right)\right)$$

  - or for a non-benefit attribute
- $R_i = Min\left(W_i\left(\frac{(f_{ij}) - (f_{ij})_{min}}{(f_{ij})_{max} - (f_{ij})_{min}}\right)\right)$

Equation 5

- **Q (compromise index)**
- $\boldsymbol{Q_i} = \nu\left(\frac{S_i - S^*}{S - S^*}\right) + (1 - \nu)\left(\frac{R_i - R^*}{R - R^*}\right)$

- where: Q_i (compromise index)
- $S*$ and S represent the best and worst group utility values
- $R*$ and R represent the best and worst individual regret values
- v is the decision weight reflecting the importance of group utility (commonly set at 0.5)

The evaluation criteria correspond to the thematic domains resulting from the bibliometric and qualitative analyses. Normalised relational strengths, determined through co-occurrence coefficients and statistical association measures, were utilised in the development of the decision matrix. The resulting Q values provide a ranked prioritisation of resilience drivers, allowing the identification of domains with the greatest influence on pandemic-related urban resilience outcomes in Cairo and Alexandria.

4 Results

The results demonstrate that urban resilience in Cairo and Alexandria emerges as a systemic outcome rather than an isolated policy objective, with environmental and governance pressures structuring the urban system, while mobility and inclusivity mediate their effects on resilience outcomes. Across all analytical phases, a consistent pattern emerges specifically: structural pressures (environmental and governance) shape system conditions, while socio-spatial variables mediate access and distribution, ultimately influencing resilience capacity.

4.1 Results from Bibliometric Analysis

The authors examined the evolution and structure of scholarly discourse on sustainable, resilient, and inclusive urban development in the Global South. A four-step bibliometric analysis was conducted using VOSviewer, based on peer-reviewed publications indexed in Scopus and Web of Science. The analysis sequentially captures (1) urban sustainability and resilience debates, (2) pandemic-driven urban research, (3) inclusivity and inequality-focused urban scholarship, and (4) an integrated bibliometric synthesis of urban research in the Global South.

4.1.1 Urban Sustainability and Resilience Debates

Figure 2 (upper right) presents the foundational literature on urban sustainability and resilience before the COVID-19 pandemic. The network is structured around core keywords such as urban sustainability, urban resilience, sustainable urban development, and climate change, with strong linkages to green infrastructure, ecosystem services, nature-based solutions, and urban planning. Methodological terms (GIS, spatial analysis, remote sensing) also emerge, showing the prominence of spatial approaches in Global South urban research. The stage reveals the following themes:

- Environmental Sustainability and Climate Co-benefits (Strong Alignment (i)), evidenced by dense clusters around climate adaptation, biodiversity, and green infrastructure.
- Urban Resilience to Health Crises (Moderate Alignment), as resilience is framed primarily in relation to climate and ecological stressors rather than public health crises.
- Governance-related terms (urban governance, planning, policy) appear as secondary nodes, suggesting an enabling but not dominant role at this stage.

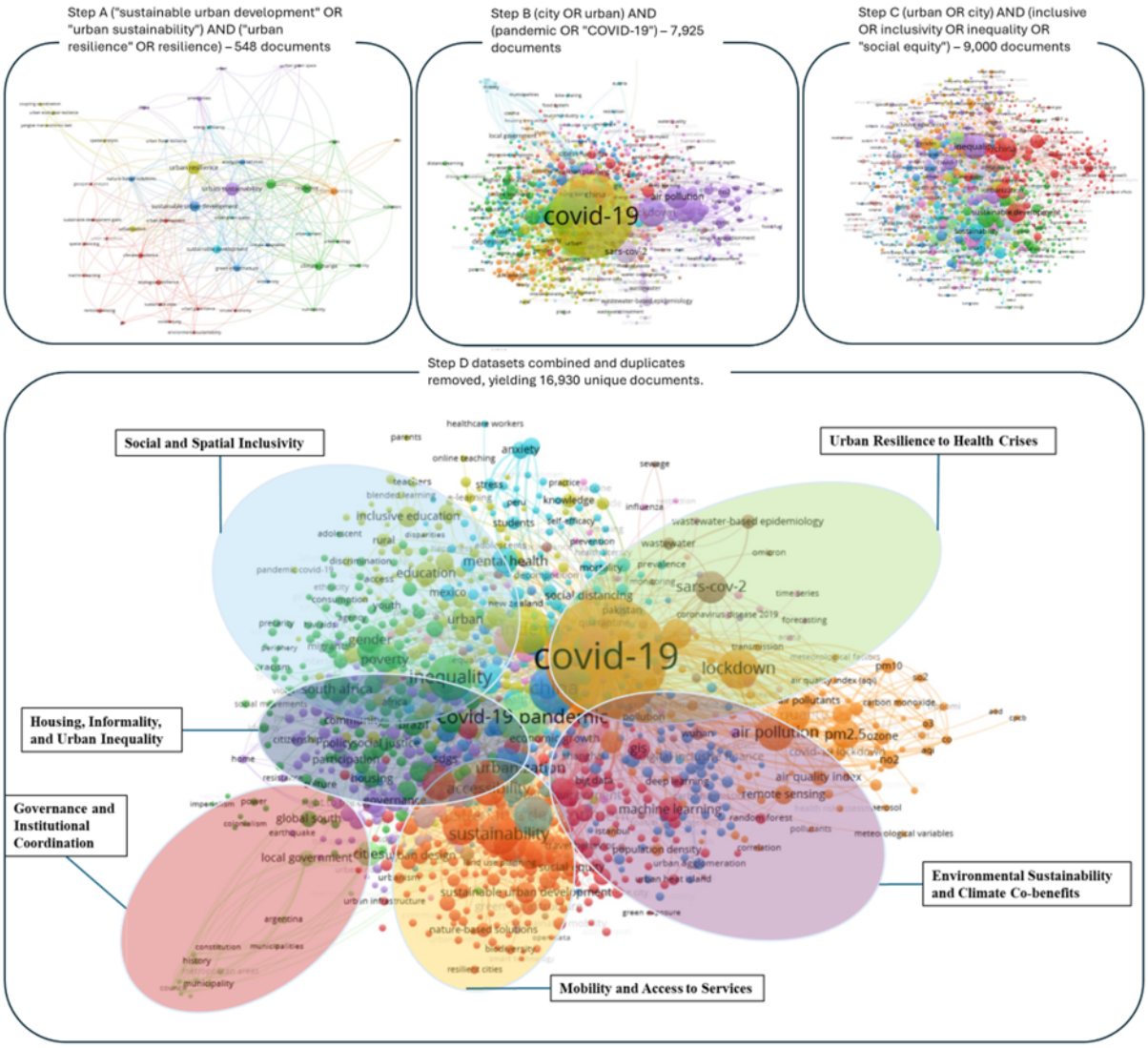

Figure 2. Bibliometric search workflow used for mapping in VOSviewer: Step A ("sustainable urban development" OR "urban sustainability") AND ("urban resilience" OR resilience) – 548 documents; Step B (city OR urban) AND (pandemic OR "COVID-19") – 7,925 documents; Step C (urban OR city) AND (inclusive OR inclusivity OR inequality OR "social equity") – 9,000 documents; Step D datasets combined and duplicates removed, yielding 16,930 unique documents.

4.1.2 Pandemic-Driven Urban Research

Figure 2 (upper middle) captures the rapid reconfiguration of urban research agendas during the COVID-19 pandemic. The network is dominated by COVID-19, the pandemic, lockdown, and SARS-CoV-2, which form a highly central and dense cluster. This cluster is directly connected to air pollution, PM2.5, NO_2, mobility, quarantine, and wastewater-based epidemiology, reflecting an intensified focus on urban health risks and environmental exposure. The stage shows:

- Urban Resilience to Health Crises (Strong Alignment), as pandemic-related keywords occupy the network's structural core.

- Environmental Sustainability and Climate Co-benefits (Strong Alignment) through strong links between lockdowns, air quality improvements, and environmental indicators.
- Mobility and Access to Services (Moderate Alignment), with transport, travel behaviour, and accessibility appearing as bridging nodes linking health, environment, and governance discussions.
- Governance and institutional terms (local government, municipalities, restrictions) are gaining visibility, indicating growing attention to institutional response capacity, though they still primarily serve as connectors.

4.1.3 Inclusivity and Inequality-Focused Urban Scholarship

Figure 2 (upper left) shows a shift toward structural and social aspects of urban vulnerability, which is relevant to contexts in the Global South. Dominant nodes include inequality, poverty, urbanisation, gender, inclusive education, the digital divide, and housing. These are linked to COVID-19 and sustainability, showing an integrated framing of health crises and long-standing socio-spatial inequalities. The stage shows alignment with:

- Social and Spatial Inclusivity (Strong Alignment), as inclusivity-related keywords form dense, high-frequency clusters.
- Housing, Informality, and Urban Inequality (Strong Alignment), evidenced by the co-occurrence of housing, informality, access, and vulnerability.
- Governance and Institutional Coordination (Moderate Alignment), as policy, participation, and planning terms connect inclusivity and sustainability clusters without dominating the discourse.
- The prominence of Global South identifiers (Africa, South Africa, Latin America, China) confirms the geographical relevance of these themes. It justifies excluding "Global South" as a hard-coded search term.

4.1.4 An Integrated Bibliometric Synthesis of Urban Research in the Global South.

To synthesise the findings from the three consecutive bibliometric phases and consolidate all publications identified from the sustainability–resilience, pandemic-focused, and inclusivity-inequality stages, **Error! Reference source not found.** (down) presents the resulting network. It captures the structural convergence of research themes shaping urban scholarship in the Global South.

The integrated network is centred on the dominant node COVID-19, reflecting the pandemic's role as a catalytic event that restructured existing sustainability and urban development discourses rather than replacing them. Surrounding this core, several densely connected clusters emerge, each corresponding to one or more of the following six thematic domains identified earlier:

1. **Urban Resilience to Health Crises (Strong Alignment)** This theme corresponds to a central, high-frequency cluster of terms including COVID-19, pandemic, lockdown, quarantine, and SARS-CoV-2. Related methodological and analytical keywords, such as GIS, remote sensing, and time series, further underscore the prominence of spatial and computational approaches. The cluster's centrality and dense network connections show that urban resilience to health crises is a dominant focus in the literature.
2. **Social and Spatial Inclusivity (Strong Alignment)** Keywords such as inequality, poverty, gender, education, and inclusive education form a dense sub-cluster, often co-occurring with COVID-19 and Global South identifiers (Africa, Brazil, South Africa). The cluster's high-frequency, density, and proximity to pandemic-related terms indicate that social and spatial inclusivity are major concerns, particularly in contexts characterised by pre-existing urban inequalities.
3. **Housing, Informality, and Urban Inequality (Strong Alignment)** A dense sub-cluster of terms, such as housing, informality, slums, urbanisation, and accessibility, overlaps with the inequality cluster. High semantic coherence and strong co-occurrence with vulnerability and pandemic-

related terms indicate that housing and informal settlements are central concerns in the literature, particularly in urban contexts in the Global South.

4. **Environmental Sustainability and Climate Co-benefits (Strong Alignment)** This theme is represented by a well-defined cluster comprising sustainability, sustainable urban development, green infrastructure, urban heat island, and environmental indicators such as PM2.5 and air quality. The cluster is dense, central, and linked to pandemic and resilience nodes, confirming the prominence of Environmental Sustainability and Climate Co-benefits in contemporary urban research.
5. **Governance and Institutional Coordination (Moderate Alignment)** Nodes, including governance, policy, local government, participation, and citizenship, form a bridge cluster that connects resilience, inclusivity, and sustainability clusters. While conceptually central, the lower frequency and peripheral positioning of these nodes indicate that governance is important but less dominant than health and inequality themes, resulting in moderate alignment.
6. **Mobility and Access to Services (Moderate Alignment)** Keywords such as mobility, transport, travel behaviour, and accessibility appear as smaller, peripheral nodes that bridge health, inclusivity, and urban form clusters. While relevant to pandemic impacts on urban systems, the lower frequency and less dense connections justify a moderate alignment classification.

The analysis offers a strong empirical basis. This will support the later examination of urban policies and planning. It will also help academic articles about Cairo and Alexandria, thus ensuring a smooth connection between the bibliometric evidence and the case paper analysis.

4.2 Review of Documents of the Cities of Cairo and Alexandria, Egypt

4.2.1 Centrality and the Strength of Relationships Between Core Concepts

Phase II uses a Pressure–State–Response (PSR) framework (Figure 3). The PSR framing highlights that pandemic resilience in Global South cities is not a short-term emergency response but a cumulative result of sustained governance action, inclusive planning, and environmentally sustainable urban development. This reframing shows that pandemic resilience in Global South cities emerges not as an isolated emergency intervention, but as the cumulative product of environmental stewardship, institutional coordination, and socially inclusive urban development. By positioning housing, mobility, and inclusivity as mediating state variables between governance–environmental pressures and resilience responses, the diagram synthesises the multi-scalar interactions that shape adaptive capacity. It therefore offers a structured visualisation of how global sustainability discourse translates into urban policy configurations and long-term transition pathways.

The state of urban conditions represents the lived configuration of vulnerability and capacity within the city. Housing, informality, and inequality reflect the material and socio-economic realities that shape exposure to crises, including overcrowding, insecure tenure, and unequal access to infrastructure. Mobility and access to services reflect the spatial functionality of the urban system, showing how effectively residents can reach healthcare, employment, transport, and essential services. Social and Spatial Inclusivity synthesises these dimensions, indicating the extent to which opportunities, protections, and risks are equitably distributed across neighbourhoods and demographic groups. The associative linkages among these state variables illustrate their systemic interdependence: housing precarity constrains mobility, mobility gaps reinforce inequality, and inclusivity mediates how vulnerabilities accumulate. Together, these elements describe the condition of the urban system before and during a crisis, revealing whether cities are structurally prepared or inherently fragile.

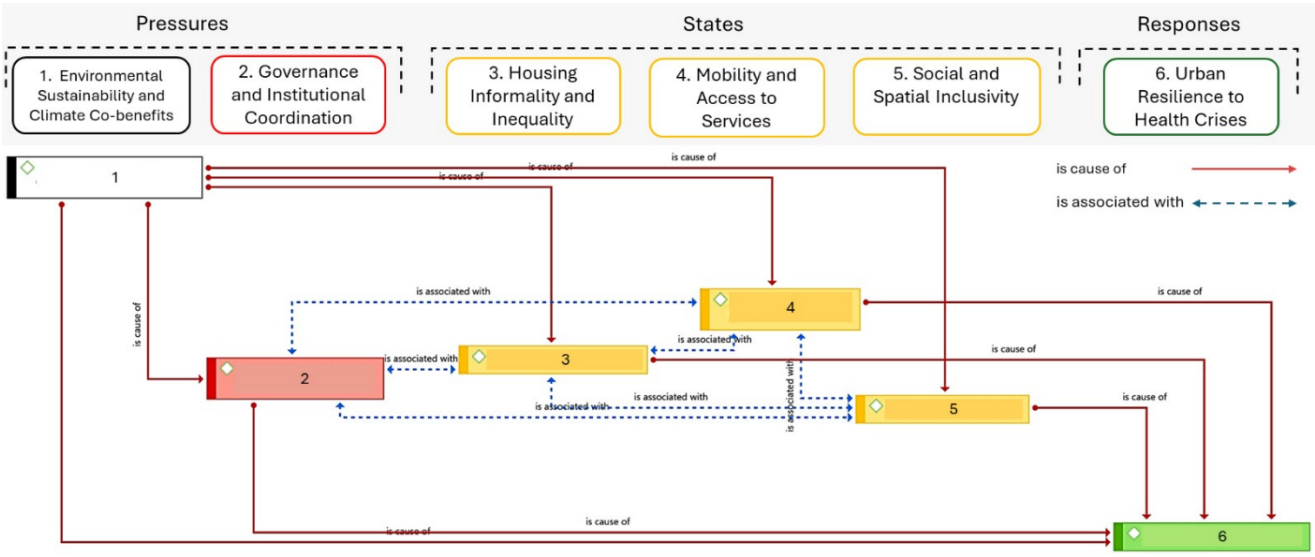

Figure 3. Analytical structure, highlighting the interconnected pressures, state variables, and response elements within the PSR framework.

Pressures generate and shape urban vulnerability and adaptive capacity under pandemic conditions. Environmental Sustainability and Climate Co-Benefits(ii) define the ecological baseline within which urban life unfolds. Pollution exposure, climate stress, and environmental degradation intensify health risks and exacerbate socio-spatial inequalities. Governance and institutional coordination operate as institutional pressures that condition how environmental and social challenges are managed. Governance determines regulatory coherence, resource allocation, inter-agency coordination, and policy responsiveness. The directional arrows in the figure show that these pressures directly affect housing conditions, service accessibility, and inclusive outcomes. Environmental degradation amplifies vulnerability in informal settlements, while fragmented governance constrains equitable service provision. In this sense, pressures do not merely precede urban states; they actively configure and reinforce them.

Urban resilience to health crises is a response that shows a city's capacity to absorb, adapt, and transform in the face of pandemic shocks. It is not merely a function of emergency response mechanisms but the result of interactions between governance structures, environmental sustainability, and inclusive spatial arrangements. The directional arrows illustrate that resilience is both caused by and contingent upon improvements in institutional coordination, environmental management, and social inclusion. Where governance is adaptive and inclusive, mobility systems are equitable, and housing conditions are adequate, resilience becomes embedded rather than reactive. Conversely, weaknesses in any mediating component undermine the system's adaptive capacity.

The figure ultimately converges on a systemic understanding of pandemic urban resilience as a dynamic product of PSR. Governance and environmental sustainability generate structural pressures; mobility, housing, and inclusivity represent the evolving state of the urban system; and resilience to health crises reflects the effectiveness of institutional and policy responses. This layered configuration highlights that resilience in Global South cities cannot be reduced to health infrastructure alone. It is deeply conditioned by environmental quality, distributive justice, and coordinated governance. By visually linking causal drivers, mediating urban conditions, and resilience outcomes, the framework provides a strategic and analytical roadmap for scholars and policymakers seeking to operationalise sustainable and inclusive urban development under pandemic uncertainty. This framework provides a structured analytical lens for the qualitative policy and planning analysis of the cities of Cairo and Alexandria in Phase II.

4.2.2 Code Co-Occurrence Analysis: Mapping Conceptual Density and Relational Strength

The Sankey diagram in Figure 4 shows Phase III. This phase, along with the co-occurrence table, helps us understand the progression of themes in urban resilience in Cairo and Alexandria, Egypt, during the pandemic. It shows a structured, directional progression consistent with the PSR architecture that guides the research. The visual flow begins with systemic pressures: Environmental Sustainability and Climate Co-Benefits and Governance and Institutional Coordination, which channel influence toward mediating urban states, including Housing, Informality, and Inequality; Mobility and Access to Services; and Social and Spatial Inclusivity. These converge into the overarching response domain: Urban Resilience to Health Crises.

The diagram shows that urban resilience in Cairo and Alexandria is not framed as an isolated policy aim but as the cumulative outcome of interacting environmental, institutional, and socio-spatial dynamics. Co-occurrence intensities substantiate this layered progression, highlighting environmental and governance dimensions as structurally dominant, while inclusivity-oriented themes function as integrative bridges. The resulting knowledge architecture reflects a semi-integrated resilience discourse, strongly anchored in environmental governance but unevenly embedded in distributive urban reform.

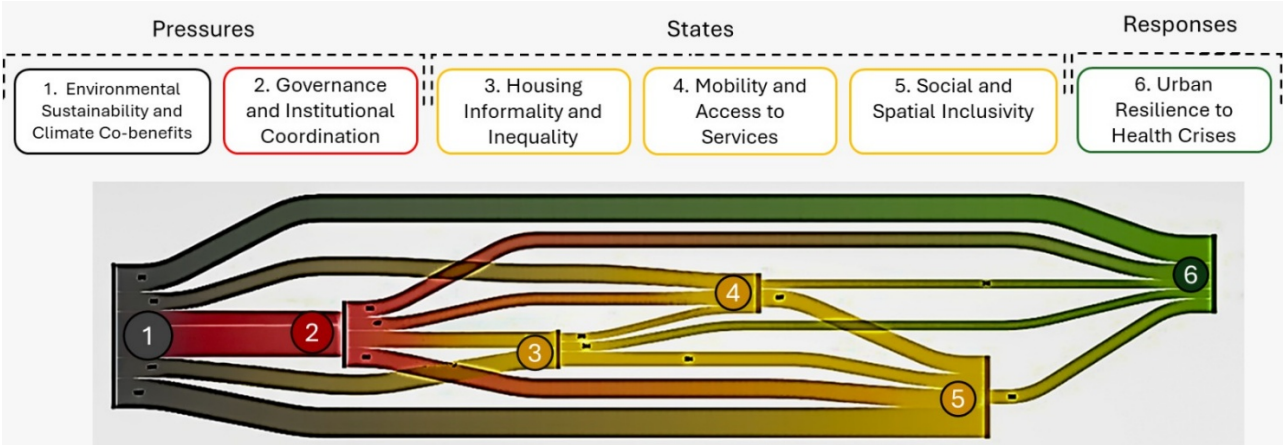

Figure 4. Sankey diagram mapping the directional influence of pressure variables on state dynamics and their collective contribution to urban health resilience.

The most grounded codes, Environmental Sustainability and Climate Co-Benefits (Gr = 4401), Governance and Institutional Coordination (Gr = 2721), and Social and Spatial Inclusivity (Gr = 1914), demonstrate extensive relational connectivity across the matrix (Table 1). These themes operate as conceptual hubs within the PSR flow. Environmental Sustainability strongly co-occurs with Governance (1575) and Urban Resilience to Health Crises (970), confirming its centrality in shaping resilience narratives. Governance shows robust linkages with Social and Spatial Inclusivity (1057) and Housing, Informality, and Inequality (600), underscoring its mediating role between structural pressures and socio-spatial conditions. This distribution indicates that environmental and governance discourses form the structural backbone of the corpus, while inclusivity and socio-spatial factors function as mediating dimensions, linking foundational drivers to applied resilience outcomes.

Strong relational patterns emerge in the co-occurrence coefficients, highlighting the interdependence between themes. Environmental Sustainability shows the strongest linkage with Governance (coefficient = 0.28), confirming that sustainability narratives are framed through institutional coordination mechanisms. Social and Spatial Inclusivity is associated with Mobility (coefficient = 0.23), while Urban Resilience exhibits moderate associations with Environmental Sustainability (0.19), Governance (0.15), and Inclusivity (0.19). These patterns indicate that Governance acts as a structural mediator, integrating environmental pressures with social and spatial states, whereas inclusivity

functions as a bridging variable connecting foundational drivers to outcome-oriented resilience planning.

Table 1. Pairwise co-occurrence counts and normalised association coefficients among thematics.

	Environmental Sustainability and Climate Co-benefits Gr=4401	**Governance and Institutional Coordination Gr=2721**	**Housing, Informality, and Inequality Gr=1565**	**Mobility and Access to Services Gr=1304**	**Social and Spatial Inclusivity Gr=1914**	**Urban Resilience to Health Crises Gr=1679**
Environmental Sustainability and Climate Co-benefits Gr=4401	0					
Coefficient	0.00					
Governance and Institutional Coordination Gr=2721	1575	0				
Coefficient	0.28	0.00				
Housing, Informality, and Inequality Gr=1565	729	600	0			
Coefficient	0.14	0.16	0.00			
Mobility and Access to Services Gr=1304	666	457	276	0		
Coefficient	0.13	0.13	0.11	0.00		
Social and Spatial Inclusivity Gr=1914	1057	682	504	607	0	
Coefficient	0.20	0.17	0.17	0.23	0.00	
Urban Resilience to Health Crises Gr=1679	970	563	344	318	970	0
Coefficient	0.19	0.15	0.12	0.12	0.19	0.00

Housing and Mobility, while central to socio-spatial concerns, show weaker associations with Urban Resilience (0.12–0.12), suggesting that structural inequality and accessibility constraints are not fully operationalised in resilience frameworks. Urban Resilience itself is primarily linked to environmental and Governance mechanisms, reflecting a discourse that emphasises ecological integrity and institutional coordination over direct infrastructural or social interventions. The PSR interpretation of cross-tabulation data underscores a semi-integrated structure: pressures (environmental and Governance) dominate, states (housing, mobility, inclusivity) are moderately embedded, and responses (resilience outcomes) are strongly environmentally and institutionally oriented, highlighting persistent gaps in addressing socio-spatial vulnerabilities in the cities of Cairo and Alexandria.

4.3 Quantitative Analysis

Statistical significance is consistent across all models. The p-value is less than or equal to 0.001. Effect sizes, including Phi and Cramer's V, are modest, indicating meaningful relationships. However, interpret them cautiously. Consider the practical impact on planning.

4.3.1 Pressure Variables Linkages

The analysis reveals significant associations between Environmental Sustainability and Climate Co-benefits, and between Governance and Institutional Coordination. The Pearson Chi-Square test yielded a result of $\chi^2 = 699.242$. Lambda, Goodman, and Kruskal tau values further indicate that knowledge of

one variable modestly improves the prediction of the other, with slightly stronger predictive value when Environmental Sustainability and Climate Co-benefits are dependent (Table 2).

While the relationship between environmental sustainability and governance is statistically robust, the magnitude of the association remains moderate. The results indicate that governance meaningfully conditions environmental sustainability discourse; however, environmental themes do not singularly determine governance structures. This finding aligns with the broader analytical framework by positioning governance as a mediating and structuring component within the sustainability–resilience nexus rather than as a reciprocal or equivalent counterpart.

Table 2. Pressure variables linkages: Chi-Square values, significance, and association strengths.

	Value	df	Asymp. Sig. (2-sided)	Approx. Sig
Chi-Square	699.242a	1	0.000	
Continuity Correction b	698.046	1	0.000	
N of Valid Cases	12087.000			
Phi	0.241			0.000
Cramer's V	0.241			0.000

a. 0 cells (0.0%) have expected count less than 5

b. Computed only for a 2x2 table

Pressures and state variables linkages

A clear depiction of the causal links and mutual influences between governance structures, environmental sustainability efforts, and essential urban achievements is presented, alongside the prevailing pressures- All Chi-Square analyses yielded statistically significant results ($p \leq 0.001$), implying that the disparities observed in Housing Informality and Inequality, Mobility and Access to Services, and Social and Spatial Inclusivity are indeed associated with the variations in Environmental Sustainability and Climate Co-benefits, and in Governance and Institutional Coordination. The strength of these associations, reflected in Phi and Cramer's V values, ranges from modest (0.082 for sustainability and housing inequality) to moderate (0.170 for sustainability and social and spatial inclusivity), suggesting that while all pressures influence urban states, some outcomes, particularly social and spatial inclusivity, are more strongly linked to sustainability and governance efforts (Table 3).

Table 3. Pressure-State variables linkages: Chi-Square values, significance, and association strengths.

Pressure Variable	State Variable	Values	Chi-Square Sig (p)	Phi / Cramer's V
Environmental Sustainability and Climate Co-benefits	Housing Informality and Inequality	80.316a	0.000	0.082
Environmental Sustainability and Climate Co-benefits	Mobility and Access to Services	135.726a	0.000	0.106
Environmental Sustainability and Climate Co-benefits	Social and Spatial Inclusivity	347.650a	0.000	0.170
Governance and Institutional Coordination	Housing Informality and Inequality	258.154a	0.000	0.146
Governance and Institutional Coordination	Mobility and Access to Services	131.645a	0.001	0.104
Governance and Institutional Coordination	Social and Spatial Inclusivity	224.419a	0.001	0.136

0 cells (0.0%) have expected count less than 5.

Results show that institutional coordination and environmental initiatives exert pressure on urban conditions, with coordinated governance exerting slightly stronger effects, highlighting the critical role of policy and institutional frameworks in promoting equitable, accessible, and inclusive urban development.

4.3.2 State Variables Linkages

The results show strong, statistically significant relationships between Social and Spatial Inclusivity and both Mobility and Access to Services, as well as Housing Informality and Inequality ($p < 0.001$ in all tests). The association between social-spatial inclusivity and mobility/access is strong ($\chi^2 = 1034.599$; Phi = 0.293), indicating a moderate-to-strong relationship: areas with greater inclusivity also show substantially better access to mobility and essential services, highlighting the close structural connection between transport accessibility and inclusive urban development. In comparison, the relationship between social-spatial inclusivity and housing informality/inequality is still significant ($\chi^2 = 361.443$). These findings emphasise that social and spatial inclusivity are deeply intertwined with service accessibility and housing conditions, reinforcing the idea that inclusive urban systems depend heavily on equitable mobility infrastructure and improved housing structures (Table 4).

Table 4. State variables linkages: Chi-Square values, significance, and association strengths.

Variable	Associated with	Chi-Square (χ^2)	Sig. (p)	Phi / Cramer's V
Housing Informality and Inequality	Social and Spatial Inclusivity	361.443	0.000	0.173
Mobility and Access to Services	Social and Spatial Inclusivity	1034.599	0.000	0.293

2 cells (0.0%) have expected count less than 5.

4.3.3 Response Variables Linked to the State and Pressures

Environmental Sustainability and Climate Co-benefits, Governance, and Institutional Coordination are key pressures that shape the structural and institutional context of the urban system. The significant associations ($p < 0.001$) indicate that these pressures strongly influence urban conditions. Environmental sustainability shows a relatively strong linkage with urban resilience (Phi = 0.178). Governance coordination (Phi = 0.106) also plays a meaningful role, suggesting that policy frameworks, institutional capacity, and climate-oriented strategies exert a measurable influence on how cities function and prepare for disruptions (Table 5).

Table 5. Pressure and State variables linkages with Responses Chi-Square values, significance, and association strengths.

	Variable	Associated with Response	Chi-Square (χ^2)	Sig. (p)	Phi / Cramer's V
Pressures	Environmental Sustainability and Climate Co-benefits	Urban Resilience to Health Crises	384.281	0.000	0.178
	Governance and Institutional Coordination	Urban Resilience to Health Crises	135.745	0.000	0.106
State	Housing Informality and Inequality	Urban Resilience to Health Crises	98.364	0.000	0.090
	Mobility and Access to Services	Urban Resilience to Health Crises	134.613	0.000	0.106
	Social and Spatial Inclusivity	Urban Resilience to Health Crises	299.246	0.000	0.157

0 cells (0.0%) have an expected count less than 5.

This structure uses Housing Informality and Inequality and Mobility and Access to Services to represent the state of the urban system, reflecting existing social and infrastructural conditions. These states are strongly associated with Urban Resilience to Health Crises, which comprises the response dimension. The results show that better mobility and service access (Phi = 0.106) and improved housing conditions (Phi = 0.090) are linked to stronger resilience outcomes. Thus, resilience emerges as a systemic response shaped by underlying pressures (sustainability and governance) and mediated through urban states (housing and mobility conditions), highlighting the interconnected pathway through which structural and institutional factors translate into crisis-response capacity.

4.4 VIKOR Analysis of Urban Resilience Drivers

The VIKOR method was applied to evaluate the relative contributions of five thematic domains to pandemic-related urban resilience in Cairo and Alexandria. The sixth theme, Urban Resilience to Health Crises, is not included in the VIKOR ranking because it serves as the system's overall outcome rather

than an independent input factor. Unlike the other five themes, which act as drivers influencing resilience, this theme reflects the cumulative effect of their interactions. Since the VIKOR method is designed to prioritise and compare contributing criteria, incorporating an outcome variable would distort the analysis by evaluating a result alongside its own determinants. Therefore, it is excluded to preserve the methodological integrity of the assessment and to ensure that the rankings accurately represent the relative influence of the underlying resilience drivers. Its performance depends on the combined effects of the evaluated drivers. The analysis uses normalised relational values derived from the co-occurrence matrix and statistical association measures presented in earlier sections. Table 6 presents the resulting S, R, and Q values, along with the corresponding ranking of the resilience factors.

Table 6. Computed VIKOR indices (S, R, and Q) and final rankings for the five urban resilience drivers, illustrating their relative priority within the decision-making framework.

Criterion	S	R	Q	Rank
Environmental Sustainability and Climate Co-benefits	0.567	0.324	1.000	1
Governance and Institutional Coordination	0.531	0.200	0.483	2
Social and Spatial Inclusivity	0.476	0.210	0.308	3
Mobility and Access to Services	0.484	0.174	0.224	4
Housing, Informality, and Inequality	0.434	0.162	0.000	5

Urban areas' ability to withstand health crises is a result, not a starting point. We are not analysing urban resilience to health crises. It is considered a system output. Its performance depends on the combined effect of the drivers studied.

The VIKOR method proves that Environmental Sustainability and Climate Co-benefits are the strongest drivers of urban resilience, followed closely by Governance and Institutional Coordination, confirming earlier statistical associations between environmental initiatives, institutional capacity, and resilience outcomes. Social and Spatial Inclusivity ranks third, indicating an important but indirect influence that operates mainly through mobility and access to services. Mobility and Access to Services itself ranks fourth, reflecting its mediating role linking environmental conditions, governance and daily urban functioning. Housing, informality, and inequality demonstrate a weaker direct influence on resilience, even though they are statistically relevant. The results from applying the VIKOR method suggest that environmental and governance pressures primarily shape resilience in the cities of Cairo and Alexandria, while socio-spatial conditions serve as key mediators. When integrated with the PSR framework, the findings highlight that pandemic resilience emerges from the combined interactions of ecological systems, institutional coordination, and socio-spatial infrastructure rather than from isolated policy actions.

5 Discussion

5.1 Interpretation of Results

Sustainable and resilient urban development in the Global South during a pandemic is characterised by thematic convergence in global knowledge production and partial integration into local policy practice. These findings can be further understood in relation to SDGs 3, 10, 11, 13, and 16, which collectively frame the interdependencies between health resilience, equity, environmental sustainability, governance effectiveness, and knowledge integration. The bibliometric analysis shows that environmental sustainability, health resilience, social inclusivity, governance, housing informality, and mobility have become increasingly interconnected in post-COVID urban research. However, the empirical application of the PSR framework to Cairo and Alexandria reveals a semi-integrated structure in which environmental sustainability and governance dominate policy discourse. Meanwhile, socio-spatial inequalities, particularly housing and mobility disparities, remain only moderately embedded within resilience strategies. These findings support the claim that pandemic-driven resilience agendas in Global South cities are environmentally and institutionally anchored but socially uneven in implementation.

Inclusivity is most strongly associated with mobility and access to services, rather than with housing informality alone, suggesting that everyday spatial connectivity functions as a critical mediator of resilience. While resilience responses are statistically associated with environmental sustainability and governance pressures, the comparatively weaker association with housing and mobility suggests that structural inequality remains insufficiently integrated into formal resilience planning. The results advance the argument that resilience, as operationalised in policy frameworks, often reinforces incremental adaptation rather than transformative socio-spatial reform.

The dominance of environmental sustainability and governance in resilience discourse stems from the evolution of global policy frameworks over the past decade. International agendas, such as climate adaptation strategies and DRR frameworks, have emphasised ecological management, institutional coordination, and risk governance as measurable, administratively tractable entry points (United Nations Office for Disaster Risk Reduction, 2022). Egypt's joint MOHP–WHO–USAID initiatives significantly strengthened vaccine logistics, cold chains, adverse event monitoring, infection prevention and control (IPC), and automated national databases. However, these systems were primarily designed for national programming rather than neighbourhood-level targeting in megacities. City planners in Cairo and Alexandria often lacked disaggregated dashboards capable of directing mobile vaccination units, IPC audits, or post-acute care to specific districts, commuter corridors, or port zones (Abdelftah, Emam, Kabil, Elsayed, & Saleh, 2024; Dinana et al., 2024; Salem, Hegazy, Abd El Fatah, Shahib, & Hejazi, 2023). This gap reflects scalar misalignment in achieving SDG11: resilience infrastructure is improved vertically at the national-level while remaining horizontally under-integrated at the metropolitan scale.

Global recovery models emphasise embedding rehabilitation across the continuum of care (Dinana et al., 2024). Egyptian quarantine hospitals showed strong respiratory physiotherapy protocols and rehabilitation outcomes, but these services remained concentrated in tertiary facilities rather than diffused through primary healthcare networks and municipal referral pathways. Health-system assessments also reveal workforce strain and uneven distribution, thereby limiting the scalability of rehabilitation and IPC capacity in peripheral districts. This illustrates that institutional strengthening at the apex of the health-system does not automatically translate into equitable citywide coverage, thereby constraining progress toward SDG3.

Risk communication further illustrates divergence between global prescriptions and local practice. International frameworks call for iterative, evidence-based communication cycles to counter misinformation and strengthen public trust (United Nations Office for Disaster Risk Reduction, 2022). However, local youth-focused studies in Egypt reveal that many young residents relied on television and social media while expressing low confidence in official messaging (Oxford Business Group, 2021). Similarly, research on epidemic and endemic diseases proves that misinformation undermines compliance. These findings suggest that risk communication was not fully institutionalised as a co-produced process, highlighting shortcomings in achieving SDG 16, a two-way process within metropolitan governance structures.

Equity targeting within dense and informal urban fabrics represents another planning gap. Despite national vaccination programmes improving aggregate equity and the deployment of Egyptian Red Crescent convoys to underserved areas, metropolitan-scale planning instruments systematically prioritise informal settlements, peri-urban port communities, and high-traffic commuter nodes, which remain underspecified. Post-pandemic urban equity assessments similarly note uneven service availability across districts (Abdelftah et al., 2024). This finding aligns with earlier critiques that resilience planning often privileges institutional coherence over distributive targeting.

Institutional constraints further clarify these dynamics. Centralised administrative systems can facilitate policy coherence at higher levels while limiting cross-sectoral integration at the local scale. Previous research has shown that resilience planning frequently adopts technocratic approaches focused on infrastructure and emergency preparedness, often overlooking distributive justice and informality (Vale, 2014). The present findings are consistent with this critique: resilience is institutionally

articulated yet only partially transformative in addressing entrenched inequalities, which reinforces persistent challenges in advancing SDG 10.

The strong association between inclusivity and mobility offers a point of partial departure from earlier studies that foreground housing density and informal settlements as the primary determinants of vulnerability during COVID-19 (Hamidi et al., 2020). While housing conditions remain significant, the results suggest that accessibility to transport networks and essential services may exert a more immediate influence on inclusive resilience. This finding extends the existing literature by highlighting the infrastructural dimension of equity and supports emerging scholarship that emphasises mobility justice as central to sustainable, inclusive urban transitions in line with SDG 11.

The integrated PSR–VIKOR model presented in Figure 5 synthesizes these insights into a coherent urban resilience framework. Environmental sustainability and governance make up the foundational pressures shaping urban system conditions. Inclusivity, mobility, accessibility, and housing conditions define the state of the urban system and determine how risks and resources are distributed among residents. VIKOR prioritisation indicates that environmental and governance dimensions exert the strongest influence, while socio-spatial variables mediate the link between structural drivers and everyday urban functionality. Mobility infrastructure and inclusive service access emerge as essential operational bridges that enable equitable distribution of health resources and crisis-response capacity.

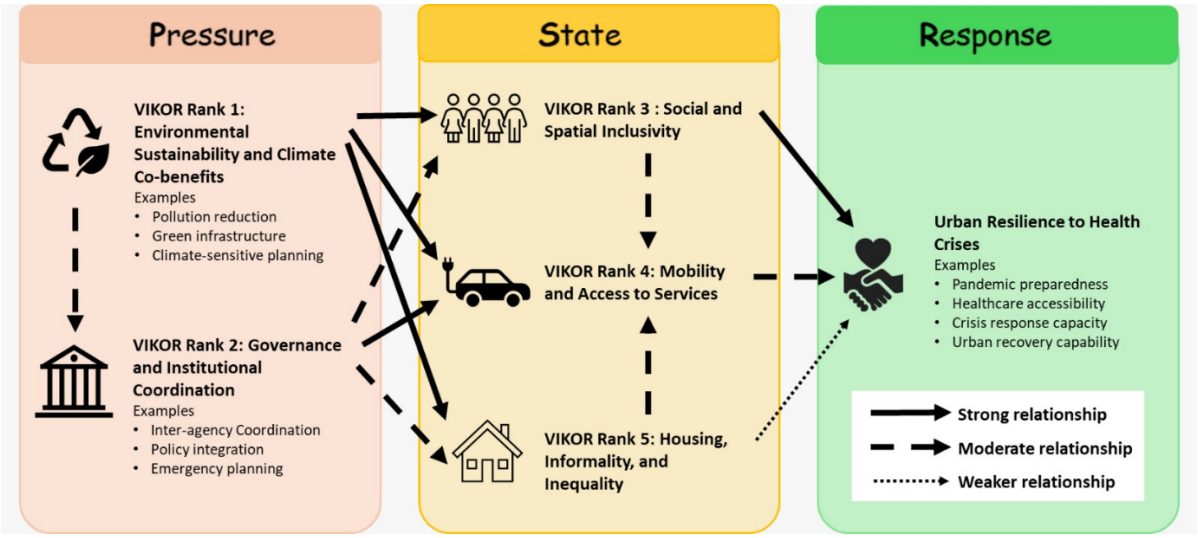

Figure 5. Integrated urban resilience model for Global South cities combining the PSR framework with VIKOR prioritisation.

The model therefore reinforces the paper's central argument, i.e., pandemic resilience in Global South megacities is not solely a function of emergency preparedness but the cumulative outcome of environmental sustainability, coordinated governance, and socially inclusive urban systems. While systemic risk theory is validated by the statistically significant relationships across PSR domains, the uneven distribution of influence among variables challenges the assumption that resilience frameworks inherently incorporate equity. Instead, the findings suggest that equity can be sidelined unless explicitly institutionalised.

Bridging sustainability, inclusiveness, and resilience requires more than thematic convergence or national-level reforms. It demands the development of metropolitan-scale integration mechanisms capable of translating systemic understanding into localised, data-driven, and equity-oriented practice. Pandemic resilience risks acting as mere adaptive stabilisation, rather than promoting structural transformation, if such mechanisms are absent. The results presented here provide a coherent empirical foundation for designing more integrated and equitable resilience strategies in the cities of the Global South.

Table 7 provides an integrated overview of the analytical insights discussed above. It synthesises the observed relationships and their effects across the PSR–VIKOR domains, providing a coherent empirical foundation for the planning recommendations proposed for cities in the Global South.

Table 7. Consolidated findings from RQ1–RQ3 reflecting how global knowledge trends, policy implementation constraints, and metropolitan planning needs intersect within the PSR–VIKOR integrated resilience model.

Research Question	Key Findings & Insights
RQ1: Knowledge Production	The literature shows convergence on sustainability, resilience, governance, inequality, mobility, and health resilience.
	Identified conceptual gaps and fragmentation between environmental, institutional, and socio-spatial dimensions of resilience
RQ2: Policy Translation	Planning gaps and institutional constraints include (a) Insufficient data granularity for metropolitan planning, (b) Uneven rehabilitation integration into primary healthcare pathways, and (c) Ineffective risk communication, especially among youth.
	Centralised authority, fragmented data governance, and limited trust-building with communities weakens cross-sector stabilisation
RQ3: Planning Implications	PSR–VIKOR results show governance, coordination and environmental sustainability as the strongest resilience drivers
	Data gaps, rehabilitation integration, and youth-focused communication require localised interventions. Stabilising local economies requires standardised cross-sector protocols and stronger institutional coordination. Strategic recommendations include (a) establishing metropolitan health analytics units, (b) embedding rehabilitation in primary care, (c) codifying continuity standards into local laws, (d) fostering evidence-driven risk communication, and (e) implementing equitable service operations.
	Immediate agenda: launch analytics cells, pilot rehabilitation hubs, issue municipal Standard Operating Procedures (SOPs), and deploy 90-day equity initiatives

The paper empirically validates a systemic interpretation of urban resilience grounded in Pressure–State–Response (PSR) relationships, thereby contributing to resilience theory. It highlights that this systemic approach does not guarantee equitable outcomes due to uneven domain influence. The integration of PSR with the VIKOR method offers a methodological advancement by connecting system understanding with decision-making prioritisation, allowing for both analytical insights and policy-focused ranking of resilience drivers.

5.2 Limitations

Metropolitan resilience strategies in Cairo and Alexandria appear to be grounded in solid environmental and institutional principles, but they have been only partially translated into actionable interventions at the neighbourhood scale. The analysis suggests that strengthening resilience requires more than high-level policy commitments; it depends on building metropolitan data infrastructures capable of capturing dynamic urban conditions, improving the spatial planning of local service accessibility, and developing mobility strategies that integrate transport, land use, and social needs. Equally important is the establishment of institutional coordination mechanisms that can effectively convert national directives into coherent, city-level programmes.

The inquiry's main limitation lies in its dependence on coded qualitative material and secondary datasets, which constrains the depth of causal interpretation. The moderate strength of observed associations further indicates that the findings should be treated as indicative rather than definitive. To enhance empirical robustness, future research would benefit from incorporating primary data collection or spatially explicit datasets. Extending the PSR–VIKOR framework through longitudinal or spatial analyses would allow researchers to capture temporal dynamics, identify causal pathways with greater precision, and provide stronger validation for resilience assessments.

5.3 Implications

Improving equitable access to services and infrastructure is critical for reducing vulnerability in informal and underserved urban areas- this is one of the implications of the inquiry. Second, metropolitan governance reforms should focus on data interoperability, decentralised planning capacity, and integration of health and urban systems. Urban planners should prioritise mobility access and service distribution as operational levers to enhance inclusive resilience.

6 Conclusions

The research examined how sustainable, resilient, and inclusive urban development has been conceptualized in Global South scholarship during COVID-19, and how these global frameworks have been translated into policy and planning practice in Cairo and Alexandria. The research employed bibliometric mapping in conjunction with a PSR–VIKOR analytical framework to investigate the concordance between international resilience discourse and metropolitan implementation within the context of pandemic-related DRR. The paper enhances a comprehensive understanding of resilience trajectories in relation to SDGs 3, 10, 11, 13, and 16.

The paper demonstrates that while global scholarship increasingly conceptualises urban resilience as an integrated system, its implementation in Cairo and Alexandria remains only partially realised. This statement underscores the interconnectedness of ecological, institutional, and socio-spatial frameworks, while simultaneously questioning the premise that systemic analysis inherently promotes fairness.

The paper introduces an integrated PSR–VIKOR framework that links causal analysis with decision prioritisation. The VIKOR multi-criteria analysis clarified the relative importance of resilience drivers, confirming that environmental sustainability and governance coordination establish the primary structural foundations of pandemic resilience, while socio-spatial variables such as mobility and inclusivity function as mediating mechanisms within the urban system. This layered structure highlights the interdependence of SDG domains and underscores the need for coordinated cross-sectoral implementation strategies.

The paper shows that environmental sustainability and governance are dominant structural drivers, while mobility and inclusivity function as critical mediators shaping resilience outcomes. The findings are significant for both sustainability theory and urban DRR practice. Theoretically, the results validate systemic risk perspectives by demonstrating measurable interconnections among the environmental, institutional, and socio-spatial dimensions of resilience. However, they also challenge assumptions that systemic framing automatically produces transformative equity outcomes. From an SDG perspective, this suggests that alignment at the conceptual level does not automatically translate into integrated implementation. Empirically, the research identifies mobility and service accessibility as particularly influential mediators of inclusive resilience, extending previous research that has primarily emphasised housing density and informality. The results highlight the importance of metropolitan-scale analytics, integrated rehabilitation pathways, targeted equity operations, and youth-centred risk communication in advancing SDG-aligned resilience in Global South megacities.

Sustainable and resilient urban development in pandemic contexts requires more than institutional strengthening and environmental adaptation; it demands the deliberate integration of socio-spatial equity into metropolitan governance systems. Cairo and Alexandria illustrate both the progress and the limitations of current resilience approaches: national preparedness and institutional coordination have advanced significantly, yet distributive and neighbourhood-scale mechanisms remain underdeveloped. Addressing this imbalance is essential for achieving integrated outcomes across SDGs. Bridging this gap will require governance reforms that enhance data interoperability, fiscal flexibility, and localised planning capacity. Ultimately, resilient cities in the Global South ought to move beyond incremental adaptation toward structurally inclusive and operationally integrated urban transformation.

This research makes a significant contribution to the field of urban resilience. The findings indicate that achieving SDG-aligned resilience requires both conceptual integration and the institutional and spatial translation of these concepts at the metropolitan level.

Notes

(i) Alignment strength is based on cluster centrality, node frequency, density, and semantic coherence with the pre-defined research framework. Strongly aligned themes represent dominant research streams, whereas moderately aligned themes serve as bridging or complementary dimensions.
(ii) Environmental sustainability is conceptualized here as a structural pressure because environmental degradation amplifies systemic health risks and conditions urban vulnerability.

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Ethical Approval Declaration
The study was conducted in accordance with established standards for research integrity and ethics. The authors declare that this research did not involve human participants or animals and, therefore, ethical approval was not required.

Informed Consent Statement
Not Applicable

AI Declaration
The authors utilised AI tools to support the development of this work. They used Copilot and Scopus AI in preparing the literature review, as well as Grammarly and Quilbot for language editing. The authors made all intellectual contributions, interpretations, and final decisions. The use of AI did not replace critical thinking, domain expertise, or ethical responsibility in the research process.

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Conflicts of Interest
The authors declare no conflict of interest.

References

Abdelftah, H. M., Emam, Z., Kabil, M. S., Elsayed, T. M., & Saleh, S. S. (2024). Rehabilitation program and challenges in managing hospitalized COVID-19 patients: A case series from Egypt. *Bulletin of Faculty of Physical Therapy*, *29*(1). https://doi.org/10.1186/s43161-024-00192-9

Ariza-Montobbio, P., Carrión, A., & Delgado-Ramos, G. C. (2022). Urban resilience in Latin America: Questions, themes and debates. In *Urban Book Series* (pp. 93–122)

Bambra, C., Riordan, R., Ford, J., & Matthews, F. (2020). The COVID-19 pandemic and health inequalities. *Journal of Epidemiology and Community Health*, *74*(11), 964–968. https://doi.org/10.1136/jech-2020-214401

Chen, X., Guo, Z., Zhou, H., Qian, X., & Zhang, X. (2022). Urban flood resilience assessment based on VIKOR-GRA: A case study in Chongqing, China. *KSCE Journal of Civil Engineering*, *26*(9), 4178–4194. https://doi.org/10.1007/s12205-022-2257-9

Cobbinah, P. B. (2021). Urban resilience as an option for achieving urban sustainability in Africa. In *Local and Urban Governance* (Vol. Part F11, pp. 257–268)

Croese, S., Green, C., & Morgan, G. (2020). Localizing the sustainable development goals through the lens of urban resilience: Lessons and learnings from 100 resilient cities and Cape Town. *Sustainability*, *12*(2). https://doi.org/10.3390/su12020550

Das, D. K. (2025). Resilient and sustainable urban infrastructure in the global south: Strategies to address climate change-linked vulnerabilities. *Urban Planning*, *10*. https://doi.org/10.17645/up.10037

Dinana, H., Saleh, B. M., Aly, E. M., Barakat, F. M., Ismail, H. A., Hafiz, M., & Soliman, R. (2024). Sustainability and resilience in the Egyptian health system

Fitzgibbons, J., & Mitchell, C. (2019). Just urban futures? Exploring equity in "100 Resilient Cities". *World Development*, *122*, 648–659. https://doi.org/10.1016/j.worlddev.2019.06.021

Friese, S. (2019). *Qualitative data analysis with ATLAS.ti* (3rd ed.). SAGE

Hamidi, S., Sabouri, S., & Ewing, R. (2020). Does density aggravate the COVID-19 pandemic? Early findings and lessons for planners. *Journal of the American Planning Association*, *86*(4), 495–509. https://doi.org/10.1080/01944363.2020.1777891

IFHV, B. E. H. (2025). *WorldRiskReport 2025 focus: Floods*

Kochskämper, E., Glass, L. M., Haupt, W., Malekpour, S., & Grainger-Brown, J. (2025). Resilience and the sustainable development goals: A scrutiny of urban strategies in the 100 Resilient Cities initiative. *Journal of Environmental Planning and Management*, *68*(7), 1691–1717. https://doi.org/10.1080/09640568.2023.2297648

Levine, A. C., Park, A., Adhikari, A., Alejandria, M. C. P., Bradlow, B. H., Lopez-Portillo, M. F., … Heller, P. (2023). The role of civil society organizations (CSOs) in the COVID-19 response across the global south: A multinational, qualitative study. *PLOS Global Public Health*, *3*(9). https://doi.org/10.1371/journal.pgph.0002341

Mamba, S. F., & Ncube, A. (2025). Climate change adaptation in the post-COVID world. In *Handbook on Planning and Climate Change Adaptation* (pp. 307–320). Edward Elgar Publishing Ltd

Meerow, S., Newell, J. P., & Stults, M. (2016). Defining urban resilience: A review. *Landscape and Urban Planning*, *147*, 38–49. https://doi.org/10.1016/j.landurbplan.2015.11.011

Mngumi, L. E. (2021). Exploring the contribution of social capital in building resilience for climate change effects in peri-urban areas, Dar es Salaam, Tanzania. *GeoJournal*, *86*(6), 2671–2689. https://doi.org/10.1007/s10708-020-10214-3

Moayedfar, S., Mohebbi, H., Mozaffaree Pour, N., & Sharifi, A. (2025). Developing a localized resilience assessment framework for historical districts: A case study of Yazd, Iran. *PLoS One*, *20*(2), e0317088. https://doi.org/10.1371/journal.pone.0317088

Muhammad, S., Long, X., & Salman, M. (2020). COVID-19 pandemic and environmental pollution: A blessing in disguise? *Science of the Total Environment*, *728*, 138820. https://doi.org/10.1016/j.scitotenv.2020.138820

Munishi, E. J., Kirumirah, H. M., & Lwoga, E. T. (2021). COVID-19 and urban-based informal vendors in global south: A review of associated livelihood threats and policy implications. *African Journal of Applied Research*, *7*(2), 88–107. https://doi.org/10.26437/AJAR.10.2021.07

Nazmul Haque, M., & Sharifi, A. (2024). Justice in access to urban ecosystem services: A critical review of the literature. *Ecosystem Services*, *67*, 101617. https://doi.org/10.1016/j.ecoser.2024.101617

Oxford Business Group. (2021). *Egypt Covid-19 recovery roadmap*. Retrieved from https://mcit.gov.eg/Upcont/Documents/Reports%20and%20Documents_1852021000_Egypt_Covid_19_Recovery_Roadmap.pdf

Parnell, S., & Robinson, J. (2012). (Re)theorizing cities from the global south: Looking beyond neoliberalism. *Urban Geography*, *33*(4), 593–617. https://doi.org/10.2747/0272-3638.33.4.593

Pauleit, S., Vasquéz, A., Maruthaveeran, S., Liu, L., & Cilliers, S. S. (2021). Urban green infrastructure in the global south. In C. M. Shackleton, S. S. Cilliers, E. Davoren, & M. J. du Toit (Eds.), *Urban Ecology in the Global South* (pp. 107–143). Springer International Publishing

Salem, M. R., Hegazy, N., Abd El Fatah, S. A. M., Shahib, A. E. M., & Hejazi, A. M. (2023). COVID-19 prevention and rehabilitation related knowledge and practices among Egyptian post-COVID-19 patients. *PLOS ONE*, *18*(10), e0292247. https://doi.org/10.1371/journal.pone.0292247

SDG Knowledge Hub. (2025). GAR 2025 leverages resilience to break the cycle of shocks, losses, and debt. Retrieved from https://sdg.iisd.org/news/gar-2025-leverages-resilience-to-break-the-cycle-of-shocks-losses-and-debt/

Senthamizh, R., & Anbarasan, P. (2025). Urban agriculture in a changing world: A thematic review of global trends, innovations, governance, and pathways to sustainability. *Frontiers in Sustainable Food Systems*, *9*. https://doi.org/10.3389/fsufs.2025.1624426

Sharifi, A., & Khavarian-Garmsir, A. R. (2020). The COVID-19 pandemic: Impacts on cities and major lessons for urban planning, design, and management. *Science of the Total Environment*, *749*, 142391. https://doi.org/10.1016/j.scitotenv.2020.142391

Shekhar, H., Rautela, M., Maqsood, M., Paris, R., Flores de León, R. M., Romero-Aguirre, M. F., ... Rahman, M. S. (2022). Are leading urban centers predisposed to global risks – A analysis of the global south from COVID-19 perspective. *Habitat International*, *121*. https://doi.org/10.1016/j.habitatint.2022.102517

UN-Habitat. (2020). *World Cities Report 2020*. UN-Habitat

United Nations Office for Disaster Risk Reduction. (2022). *Global Assessment Report on Disaster Risk Reduction 2022: Our world at risk: Transforming governance for a resilient future*. UNDRR

United Nations Office for Disaster Risk Reduction. (2025). *Global Assessment Report on Disaster Risk Reduction 2025: Resilience pays: Financing and investing for our future*. Retrieved from https://www.undrr.org/gar/gar2025#download

Vale, L. J. (2014). The politics of resilient cities: Whose resilience and whose city? *Building Research & Information*, *42*(2), 191–201. https://doi.org/10.1080/09613218.2014.850602

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