Analysis of the Effectiveness and Sustainability of Urban Planning Policies in Asia – A Case Study of Major Cities in China and Singapore

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Abstract. The process of urbanization since the Industrial Revolution has led to urban sprawl and brought profound negative impacts on the ecological environment. Currently, the environmental and energy crisis has reached a critical stage, directly threatening human survival. The contradiction between economic development and environmental protection has become increasingly prominent, posing significant challenges to governments worldwide. To address this situation, countries have introduced a series of urban sustainable development (USD) policies, but the effectiveness of these policies urgently needs to be analysed and evaluated in depth. As the largest and most populous of the seven continents, Asia's urban sustainable development is directly linked to the survival of all humankind. Considering the strong cultural and political parallels between China and Singapore—respectively representing a developing and a developed nation in Asia—this study conducts a comparative analysis of their urban planning policies to minimize the confounding effects of cultural and social factors. By selecting Guangzhou, Wuhan, and Shanghai as representatives of China, alongside Singapore, this research seeks to highlight the differences in urban planning policies. The policies mainly come from policy documents on the website of Singapore Government Agency Website, People's Congress and Local Regulations Databases. Policy documents from 2014 to 2025 are used to evaluate the effectiveness of policies on sustainable urban development. The ultimate goal is to assist cities in formulating more effective urban liveability and sustainable development policies through analysis of policy effectiveness, providing reference for policymaking.

Keywords: Urban Planning; Sustainability; Quantitative Document Analysis; City Development; Policy.

1 Introduction

Urban sprawl, emerging as a key byproduct of industrialization since the Industrial Revolution, continues to exert significant negative influences on ecological systems, as evidenced by recent studies highlighting its role in biodiversity loss, increased carbon emissions, and disruption of natural habitats [1,2]. Research suggests that these patterns of unchecked urban expansion often lead to inefficient land use, heightened energy consumption, and amplified environmental degradation, though some analyses point to potential mitigating factors like integrated green infrastructure that could offset certain impacts if implemented proactively. The associated environmental and energy crises appear to have escalated to levels that pose substantial risks to human well-being and long-term survival, with reports indicating interconnected threats from climate change, resource shortages, and pollution that demand urgent global action [3]. Balancing economic growth with environmental protection remains a complex challenge for policymakers, particularly in rapidly developing regions like China, where tensions arise from trade-offs between industrial advancement and ecological preservation, though innovative policies show promise in reconciling these goals [4,5]. Urban Sustainable Development (USD) initiatives have been rolled out in various cities to address these issues, yet their long-term efficacy and adaptability warrant careful scrutiny, as evaluations reveal both successes in resilience-building and gaps in equitable implementation [6,7].

Broadly, USD encompasses strategies aimed at fostering cities that emphasize enduring viability through resource efficiency, reduced ecological footprints, and enhanced human-centric progress, integrating interdisciplinary approaches to tackle urbanization's multifaceted demands [8]. This paradigm strives to maintain elevated living standards for present and future generations by equitably weighing social, economic, and environmental dimensions, acknowledging controversies around metrics for success and the need for adaptive frameworks [9]. It positions urban areas as interconnected ecosystems in which human endeavors align symbiotically with nature, though debates persist on achieving this harmony amid varying local contexts and global pressures [10]. Nevertheless, elements like policy resistance—arising from stakeholder conflicts, unforeseen outcomes, and entrenched behaviors—continue to be insufficiently examined in the literature, highlighting the importance of addressing governance hurdles and participatory mechanisms to overcome inertia [11,12].

Asia's vast landmass (29.4% of the global total) and population exceeding 4.1 billion amplify the environmental repercussions of its urban dynamics, underscoring the region's pivotal role in worldwide sustainability efforts. As the largest developing nation and second-largest economy globally, China's sustained rapid expansion provides a valuable case study for examining how urban policies influence economic trajectories while navigating ecological constraints. In Guangzhou, located in the Pearl River Delta, longstanding measures such as low-carbon parks, eco-friendly transit systems, and sponge-city designs integrate with the Greater Bay Area's holistic framework involving Hong Kong and Macau, demonstrating a regional approach to sustainability. Wuhan, positioned as a key Yangtze River hub, leverages expertise in flood mitigation, crisis response, and adaptive planning, with post-pandemic empha-

ses on health resilience adding layers to its strategies. Shanghai, as a leading financial hub and pioneer in China's reforms, has advanced tools like carbon markets, green financing, and design benchmarks, illustrating innovation in high-density urban settings. Collectively, these cities represent China's varied priorities in planning and outcomes. In contrast, Singapore's model as a mature city-state reveals insights into advanced-stage sustainability, emphasizing compact efficiency and policy integration that enriches cross-developmental comparisons.

The objective of this paper is to emphasize the critical need for embedding both efficacy and longevity into urban planning during accelerated urbanization phases. Through textual examination of policies from Guangzhou, Wuhan, Shanghai, and Singapore spanning 2014 to 2025—sourced from official databases and legislative platforms—the study will assess policy sustainability, ultimately gauging their contributions to or impediments against urban sustainability goals in these locales.

2 Literature Review

Current research on sustainable urban development frequently prioritizes practical aspects such as measuring emissions or evaluating urban green spaces, yet it tends to overlook the theoretical foundations of sustainability itself. For instance, theoretical models emphasize the interdependence of environmental, social, and economic dimensions, often framed within concepts like the "triple bottom line" or nested hierarchies where biophysical limits constrain social and economic activities [13]. These foundations draw from seminal works like the Brundtland Report, which defines sustainable development as meeting present needs without compromising future generations [14]. However, practical applications often simplify these theories, leading to imbalances—such as overemphasizing economic growth at the expense of ecological integrity [15].

Urban sustainability indicators (USIs) are pivotal for assessing progress, as highlighted in comprehensive reviews of indicator frameworks [16]. These tools organize metrics across dimensions: environmental (e.g., CO_2 emissions, water consumption), social (e.g., equity in access to services, health outcomes), and economic (e.g., employment rates, productivity). A review of 50 global and European USI frameworks shows that all cover environmental aspects, 90% include social, 82% economic, and about half incorporate institutional governance [17]. Yet, USIs face significant conceptual and technical challenges, including normalization (e.g., standardizing units like $\mu g/m^3$ for air pollutants or liters/capita for water use) and standardization issues that hinder cross-city comparisons [18]. Additional hurdles involve data availability, subjective indicator selection biased by developers' priorities, and difficulties in balancing dimensions—particularly in developing countries where social and economic indicators dominate over environmental ones [19].

Moreover, sustainable urban development is not a uniform solution but a dynamic process requiring customization to each city's unique contexts. Factors such as local demographics, climate vulnerabilities, and historical land use patterns necessitate tailored approaches [20]. For example, in rapidly urbanizing regions, indicators must

account for informal settlements and resource inequities, while in mature cities, focus might shift to resilience against climate shocks [21]. A comprehensive strategy aligning environmental health (e.g., biodiversity preservation), social equity (e.g., inclusive participation), and economic stability (e.g., green job creation) is critical for holistic outcomes [22]. This integration helps mitigate conflicts, such as those between growth and conservation, promoting intergenerational equity as a core theoretical principle [23].

Global examples illustrate innovative strategies for resilience and livability. Freiburg, Germany, exemplifies solar-powered neighborhoods that reduce energy dependence and foster community vitality through renewable integration [24]. Singapore's vertical gardens demonstrate urban greening in dense environments, improving air quality and biodiversity while enhancing aesthetic and recreational value [25]. Other models include Curitiba, Brazil's bus rapid transit system, which prioritizes affordable mobility and social inclusion, reducing congestion and emissions [26]. Copenhagen's cycling infrastructure promotes active transport, aligning with health and environmental goals, while Masdar City in the UAE experiments with zero-carbon urban design [27]. These cases highlight how context-specific innovations can harmonize human and ecological systems, securing opportunities for future generations.

Urban planning policies play a central role in advancing sustainable development, with recent studies showing a shift from theoretical inquiry to practical applications. Scholars increasingly leverage digital technologies (e.g., GIS for spatial analysis), interdisciplinary approaches (e.g., combining urban design with sociology), and global perspectives (e.g., aligning with SDGs) to enhance policy design and effectiveness [28]. For instance, effective policies emphasize guiding urban growth through incentives rather than rigid controls, fostering adaptability [29]. The practicality and comprehensiveness of urban planning make it a vital tool for addressing challenges like sprawl and inequality [30]. However, barriers such as policy instability, insufficient evaluation mechanisms, and limited stakeholder engagement hinder progress, emphasizing the need for robust frameworks that enable reflective learning and collaboration [31].

Globally, policy instruments for sustainable urban development are categorized into four types: command-and-control tools (e.g., regulatory standards for emissions), market-based tools (e.g., carbon taxes, subsidies for green tech), procedural tools (e.g., participatory planning processes), and persuasive tools (e.g., public awareness campaigns) [32]. Historically, command-and-control approaches have dominated in many regions, achieving rapid gains in areas like pollution reduction through mandates [33]. For example, the European Union's directives on air quality exemplify this, enforcing standards across member states. However, such methods can incur high costs and stifle innovation, prompting a shift toward market-based instruments, which are often more cost-effective long-term [34].

Recent efforts balance "sticks" (regulations) with "carrots" (incentives) and voluntary measures. Policies promoting green lifestyles increasingly rely on subsidies and informational campaigns, with mandates as supplements [35]. Research indicates that market-based tools, like energy pricing reforms, can reduce intensity comparably to

administrative targets while encouraging efficiency [36]. The OECD's Policy Instruments for the Environment (PINE) database catalogs thousands of such tools worldwide, including tradable permits and deposit-refund schemes, highlighting their role in environmental protection [32]. In the U.S., the STAR Community Rating System integrates these for local sustainability assessments [37].

The effectiveness of these instruments is maximized through integrated policy mixes, aligning with the "sticks, carrots, and sermons" framework [38]. For instance, the World Bank's Urban Sustainability Framework advocates combining regulations with economic incentives and public engagement to support SDGs, particularly Goal 11 for sustainable cities [39]. In Latin America, the Inter-American Development Bank's Emerging and Sustainable Cities Initiative uses mixed tools to address urban challenges [40]. Challenges persist, including implementation gaps in developing countries due to resource constraints and political will [41]. Scholars advocate for context-sensitive packages that incorporate digital monitoring for evaluation, ensuring adaptability to evolving dynamics [42].

To bridge theoretical and practical gaps, frameworks like the UN-Habitat's City Prosperity Index emphasize participatory indicator selection, reducing subjectivity and enhancing relevance [43]. Opportunities lie in SDG integration, where urban indicators link to broader goals, though 54% of targets lack scientific robustness. Emerging areas, such as urban resilience and smart technologies, offer avenues for innovation, with AI and data analytics aiding real-time assessments [44]. Ultimately, sustainable urban development requires overcoming indicator overload through parsimonious selection and fostering interdisciplinary collaboration to create equitable, resilient cities.

3 Data Resource

The identification process employs a double-layer verification system. We utilized a Python web scraping program to send requests to the local regulation databases and People's Congress websites of Guangzhou, Shanghai, and Wuhan and Singapore Government Agency Website, extracting a total of 725 active local regulations from 2014 to 2025. Through keyword filtering, we primarily identified those related to urban planning. After the web-scraping program extracts the initially identified policies, we conduct a thorough and meticulous manual review of their content. This ensures the accuracy of the extracted policies, ultimately producing a refined list that enhances the reliability of our research.

4 Methodology

4.1 Conceptual framework

Figure 1 presents the workflow of this study. Existing legislation was first filtered by keywords to preliminarily identify policies related to urban planning. Manual screening was then performed to further ensure the quality of the dataset.

Next, the sustainability of the urban planning policies was assessed via quantitative text analysis across three dimensions: social sustainability, environmental sustainability, and economic sustainability.

Policy effectiveness was evaluated using an expert scoring method. Policies were initially classified by type and then examined separately for their balance, intensity, and density.

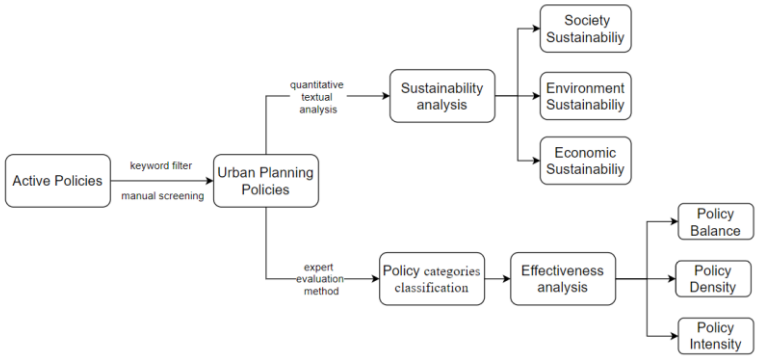

Figure 1. Conceptual framework.

4.2 Quantitative Document Analysis for Policy

The objective of Quantitative Document is to classify policy documents systematically and evaluate the content of the policy documents by extracting and analyzing key words. This approach combines elements of bibliometrics and content analysis. By using keyword frequency and co-occurrence as data points, we can identify underlying themes and classify policies into predefined categories. This method is particularly effective when dealing with a large volume of documents and helps ensure that the classification is both objective and reproducible.

Policy research often categorizes issues into four interconnected domains—city planning, social policy, economic policy, and environmental policy—to better analyze multifaceted challenges [45]. The rationale for selecting our keywords is based on their frequent citation in academic literature and policy reports, which enhances the reliability and credibility of our research. In city planning, keywords such as “城市规划” (urban planning), “土地利用” (land use), “城市设计” (urban design), “公共空间” (public space), “交通规划” (transportation planning), “住房” (housing), “可持续发展” (sustainable development), and “环境改善” (environmental improvement) are consistently referenced in urban studies and planning policies. These terms are widely recognized in research emphasizing how physical layout, infrastructure, and renewal strategies shape societal well-being and economic growth [46]. For instance, “城市更新” (urban renewal) programs are frequently examined for their role in revitalizing deteriorated districts, while “基础设施” (infrastructure) investments are central to

improving public services and mobility [47]. By selecting keywords that are frequently cited in authoritative sources, we ensure that our research framework aligns with well-established academic discourse and policy discussions.

4.3 Policy Sustainability Evaluation

Based on previous studies, we have divided the evaluation of sustainability into three dimensions: social, economic, and environmental. Policies are scored on each of these dimensions using a combination of keyword filtering and manual inspection, where a score of 1 is assigned if the policy meets the criteria for that dimension and a score of 0 otherwise. A policy is considered fully sustainable if and only if it receives a score of 1 in all three dimensions.

Our criteria for selecting keywords are similar to those described in Section 3.2, as they are frequently cited in both classic works and contemporary studies. This enhances the reliability and credibility of our research while facilitating its broader application. Just as in social policy, where terms like “社会” (society), “民生” (livelihood), “医疗” (healthcare), “教育” (education), “社会保障” (social security), “公共服务” (public services), “社会治理” (social governance), and “社会公平” (social equity) are widely used in policy literature [48], our selection follows a similar approach. Recognizing the significance of these frequently cited terms ensures that our research remains well-grounded in established academic discourse. Welfare theorists emphasize that addressing “民生” and expanding “社会救助” (social assistance) are key to reducing inequality and fostering social stability [49]. Additionally, recent studies highlight that “社会组织” (social organizations) and “志愿服务” (volunteer services) complement state-led efforts, strengthening “公共秩序” (public order) and community resilience [50].

Similarly, in economic policy, our selection of keywords—including “经济” (economy), “投资” (investment), “市场” (market), “产业” (industry), “财税” (fiscal and taxation), “金融” (finance), “企业” (enterprise), and “商业” (commerce)—aligns with frequently cited terms in economic research. Scholars emphasize how “市场” reforms, industrial strategy, and “财税” policies contribute to macroeconomic stability and long-term growth [51]. The OECD underscores that “投资” in infrastructure and innovation enhances productivity [52], while “金融” regulation mitigates financial crises. Moreover, local governments often prioritize “企业” development and “商业” expansion to drive employment and social welfare, as demonstrated in research on economic growth and market structures [53]. The repeated use of these terms in economic literature validates their inclusion, ensuring that our research framework aligns with established discourse.

For environmental policy, the selection of “环境” (environment), “生态” (ecology), “污染” (pollution), “绿色” (green), “可持续” (sustainable), “节能” (energy saving), “环保” (environmental protection), and “气候” (climate) follows the same rationale. Climate change and pollution are pressing global concerns, making these terms central to environmental policy discussions. Terms like “节能” and “绿色”

capture the transition toward sustainable technologies, while “环保” and “污染” reflect the regulatory frameworks addressing environmental degradation. Moreover, studies confirm that urban “气候” initiatives—such as low-carbon zoning—effectively mitigate environmental damage and enhance public health [54].

4.4 Classification of Policy Instruments

In this study, we classify policy instruments into four categories based on their different targets and approachs [55]:

(1) Command-and-Control Instruments: These are policies that impose direct, compulsory orders dictating which actions or outcomes must be achieved—or avoided—through specific mandates.

(2) Market-Based Instruments: These tools utilize economic incentives, including adjustments in market prices, to steer target groups toward behaviors that help reduce negative externalities.

(3) Procedural Instruments: This category encompasses various techniques and mechanisms designed to shape the process of policy formulation and its subsequent execution.

(4) Persuasive (or Informative) Instruments: These aim to foster collective action by distributing information and knowledge, thereby influencing the decisions of both individuals and other relevant actors.

In this study, three well-trained researchers took part in classifying policy instruments, and the Fleiss’ κ score was used to evaluate the inter-rater reliability of their classifications.

Fleiss’ κ is employed to assess the degree of agreement among multiple raters on a classification task. Its calculation formula is as follows:

$$\boldsymbol{K = \frac{P - P_e}{1 - P_e}}$$

$$\boldsymbol{P = \frac{\sum_{i=1}^{N}\sum_{j=1}^{k} n_{ij}(n_{ij} - 1)}{Nn(n-1)}}$$

$$\boldsymbol{P_e = \sum_{j=1}^{k}\left(\frac{\sum_{i=1}^{N} n_{ij}}{N \times n}\right)^2}$$

While N represents the total number of subjects under review, n denotes the number of raters evaluating each subject, k is the total number of rating categories, and n_{ij} indicates the number of raters who assigned subject i to category j.

The K-value calculated for 20 test samples is 0.822, demonstrating the consistency between different classifiers in classification.

4.5 Policy effectiveness evaluation

From Wiedemann & Ingold, the capability of a policy instrument to reach its goal is defined as the effectiveness of the

policy instrument [56]. Jayasiri and Ingold define the effectivenes of the policy instruments with three dimensions: (1) balanced implementation of policy instruments, (2) policy instruments density, and (3) policy instruments intensity [57].

4.5.1. Balance Index

According to Glaus [58], optimal policy design is characterized by a balanced mix of instruments drawn from diverse categories. This varied combination enables the attainment of multiple objectives by aligning with different interests and priorities, addressing a wide spectrum of challenges, and actively engaging diverse stakeholders. A balanced policy mix ensures that the policy system simultaneously targets all key areas, reducing the risk of neglect or the compromise of any critical aspect. Moreover, utilizing a range of policy tools can resonate with a broader array of stakeholders, enhancing participation, building trust, and improving compliance—thereby leading to better overall outcomes. Finally, a well-balanced instrument mix lends greater flexibility to the policy framework, allowing it to adapt more effectively to the dynamic nature of urban challenges.

The *balance index* of a policy can be calculated using the formula:

$$\text{Index} = 1 - \frac{\sum_{\text{instrument\_type}_{m=1}}^{M} (\text{instruments}_m \times (\text{instruments}_m - 1))}{(\sum_{\text{instrument\_type}_{m=1}}^{M} \text{instruments}_m) \times (\sum_{\text{instrument\_type}_{m=1}}^{M} \text{instruments}_m - 1)}$$

where the term instruments_m represents the number of policy instruments that are of instrument type m (obtained through simple count). The policy instruments balance index yields a value between 0 and 1, with higher values indicating a more balanced selection of policy instruments.

4.5.2. Policy Density

The policy instrument density is defined as the number of instruments within a specific category expressed as a percentage of the total instruments across all categories. This index offers valuable insights into the relative emphasis and strategic focus within a policy mix and can reveal the strategic emphasis of municipality. For example, if market-based instruments constitute 60% of all instruments, this suggests that the policy is primarily leveraging economic incentives (such as subsidies, taxes, or tradable permits) to influence behavior. The density index is also an indicator that can assist in assessing the policy balance.

4.5.3. Policy Intensity

The policy intensity score is intended to measure the resistance that may be encountered during the implementation of a policy. A high score indicates that the policy is likely to face significant obstacles (lower effectiveness), whereas a low score implies that the policy may be implemented relatively smoothly.

Varone and Aebischer [59] originally introduced a systematic way of assessing how resource use, political feasibility, and targeting affect policy choices. Kammermann and Ingold [60] demonstrated that analyzing multiple factors—like precision and feasibility—can elucidate why certain instruments gain traction while others remain underutilized. These studies highlight the need for a composite metric that captures multiple dimensions of instrument intensity. The scales in our formula of *policy intensity* are designed from these works.

Instrument Intensity Score for policy instrument i is defined as:

$$S_i = w_C C_i + w_R R_i + w_T T_i + w_P P_i.$$

Where:

$$w_C + w_R + w_T + w_P = 1.$$

There are four parameters that indicate the term of intensity:

C_i (ideological/financial constraints): This dimension measures how well the instrument aligns with prevailing political ideologies and its fiscal feasibility. An instrument that aligns well is less likely to face resistance and may be more easily implemented. Conversely, if an instrument has significant ideological or budgetary hurdles (a higher score), it indicates that the policy is designed to be more robust—even if it might be challenging to implement.

R_i (Resource intensiveness): This reflects the number of resources, such as funding, manpower, or technology, that the instrument requires. A high resource requirement (high score) implies that the instrument is intended to make a substantial impact while it may also be hard to implement well.

T_i (Targeting precision): This dimension evaluates how exclusively the instrument is aimed at its intended beneficiaries or sector. Instruments with high targeting precision (low score) are expected to produce more effective outcomes for those specific groups, as they reduce spillover effects and ensure that the benefits are concentrated.

P_i (Political risk): Political risk gauges how likely an instrument is to provoke public backlash or political resistance. A higher score here indicates that the instrument may be controversial or involve significant political costs. While this might mean the policy is bold or ambitious, it can also signal potential hurdles during implementation.

In this dissertation, we set these weights to 0.25 each.

Instrument Intensity Score for policy instrument i is defined as:

$$S_i = 0.25C_i + 0.25R_i + 0.25T_i + 0.25P_i.$$

The following is a detailed scoring criterion of each parameter:

Resource intensiveness (R_i):

- *Score 1*: Minimal additional staff or budget required.
- *Score 3*: Moderate resource demand; partial reallocation of existing budgets.
- *Score 5*: Substantial resource allocation; establishment of new administrative units or dedicated funds.

Targeting precision (T_i):

- *Score 1*: Highly specific to the intended audience or sector.
- *Score 3*: Moderately targeted; some spillover to non-target groups.
- *Score 5*: Very broad, affecting many outside the intended target.

Political risk (P_i):

- *Score 1*: Low visibility or controversy; broad public support.
- *Score 3*: Moderate risk; instrument is somewhat contentious or costly to implement.
- *Score 5*: High risk; potential for public backlash or significant political cost.

Ideological/financial constraints (C_i):

- *Score 1*: Instrument aligns well with dominant ideologies and is affordable.
- *Score 3*: Partial alignment; moderate ideological or budgetary pushback.
- *Score 5*: Significant ideological conflict or financial hurdles.

5 Analysis

5.1 Sustainability Assessment of Policies

5.1.1. Wuhan

The policy goals of the thirty-three studied Acts in Wuhan and their alignment with the three pillars of sustainability are summarized in Table 1. In Wuhan, out of 73 existing local regulations, 33 are related to urban planning. Among these, 27, 14, and 21 policies are sustainable in terms of social, economic, and environmental aspects respectively, reflecting the Wuhan municipal government's emphasis on people's well-being and environmental protection, as well as the current situation. While many municipalities have clear and quantifiable targets for balancing social well-being, economic growth, and environmental protection, several of Wuhan's policies remain broad in scope, lacking specific time-bound commitments.

The Wuhan River Basin Support Ecological Environment Act aims to safeguard water resources and mitigate flood risks (addressing social and environmental sustainability), yet it does not explicitly highlight economic benefits or incentives. Similarly, the Management to Conserve Resources Plan, the Implementation of Old Waste Regulations, and the Implementation for Health and Advisory Act each focus on protecting public health and preserving local ecosystems, but their policy goals do not detail explicit economic growth strategies. In contrast, the Protection of Refinement Act and the People's Air Planning Initiative both reference tourism or industrial development, indicating a partial emphasis on economic viability alongside social objectives, though their environmental scope is less comprehensive.

However, the Conserve of Eco-Friendly Development Act encompasses all three pillars by advocating not only for ecological conservation and public well-being but also for supporting green economic practices. This integrated approach suggests a potential model for future policy design in Wuhan.

Table 1. Policy Goals of the Examined Legal Texts and Their Emphasis on Sustainability in Wuhan

Act	Macro level policy goal	Sustainability pillar		
		Soc	Eco	Env
Wuhan Municipal Fuhuan River Basin Protection Regulations	Enhance watershed governance to support ecological and high-quality development.	1	0	1
Wuhan Municipal Regulations on the Protection of Enterprises and Enterprise Operators' Rights	Safeguard enterprise rights and optimize conditions for sustainable growth.	1	1	0
Wuhan Municipal People's Air Defense Regulations	Integrate air defense into city planning to protect lives and property.	1	1	1
Wuhan Municipal Regulations on	Standardize resource recovery to	1	1	1

the Management of Renewable Resources Recovery	conserve resources and ensure safety.			
Wuhan Municipal Measures for the Implementation of the PRC Circular Economy Promotion Law	Promote resource efficiency and waste reduction for sustainable growth.	1	1	1
Wuhan Municipal Regulations on Building Energy Conservation and the Application of New Wall Materials	Boost energy efficiency and use of eco-friendly materials in construction.	1	1	1
Wuhan Municipal Measures for the Implementation of the PRC Environmental Protection Law	Prevent pollution, protect health, and advance ecological sustainability.	1	0	1
…	…	…	…	…
Percentage		*81.8%*	*42.4%*	*63.6%*

Soc = Social; Eco = Economical; Env = Environmental

In contrast, most of Wuhan's policies that appear to address the social or environmental dimensions do not offer concrete mechanisms to promote economic sustainability. While the broader goals of resource management, health protection, and ecological preservation may indirectly support economic growth, further investigation is needed to clarify how these aims will be operationalized. Strengthening implementation guidelines and monitoring processes could help ensure that these policies achieve measurable outcomes across all three pillars of sustainability.

5.1.2. Guangzhou

The policy goals of the selected Acts in Guangzhou and their alignment with the three pillars of sustainability are presented in Table 2. The study identified and analyzed 220 local regulations in Guangzhou, with 64 pertaining to urban planning. These policy instruments were categorized based on their alignment with sustainability pillars, with 64 related to social sustainability, 64 to economic sustainability, and 60 to environmental sustainability. In some instances, a single policy instrument addressed multiple pillars. Although numerous cities worldwide outline precise targets for social equity, economic resilience, and environmental protection, Guangzhou's policy framework sometimes combines broad aspirational goals with more tangible objectives.

For instance, the Regulations on Reducing Risks and the Guangzhou Services to Boost Green Development Act both emphasize public welfare (social sustainability) and incentivize eco-friendly industries (economic sustainability), while also outlining measures to reduce pollution (environmental sustainability). Likewise, the Technological Innovation Promotion Act highlights job creation, industrial upgrading (economic dimension), and citizen well-being (social dimension), incorporating references to resource efficiency and emissions control (environmental dimension).

Meanwhile, the Shipping Facilities Enhancement Policy and the Xian Village Redevelopment Plan adopt a comprehensive stance by mentioning community improvements, economic revitalization, and green infrastructure initiatives. The Global Fire Coordination Act and the Focus on Urban and Quality-of-Life Development Plan

similarly span all three pillars, advocating both safety measures (social) and sustainable urban planning (environmental) while underscoring economic competitiveness.

Table 2. Policy Goals of the Examined Legal Texts and Their Emphasis on Sustainability in Guangzhou

Act	Macro level policy goal	Sustainability pillar		
		Soc	Eco	Env
Guangzhou Municipal Regulations on Electric Bicycle Management	Regulate all aspects of e-bikes to reduce risks and ensure safe, orderly transport.	1	1	1
Guangzhou Municipal Regulations on Embroidery-Style Urban Governance	Focus on detailed planning and services to boost livability and resident satisfaction.	1	1	1
Guangzhou Economic and Technological Development Zone Ordinance	Use city-level authority to drive innovation, investment, and sustainable industry.	1	1	1
Guangzhou Municipal Regulations on Electric Vehicle Charging Facilities Construction and Management in Residential Complexes	Expand and standardize charging to meet demand and support EV growth.	1	1	1
Guangzhou Municipal Urban Village Redevelopment Ordinance	Improve living conditions with fair redevelopment and better infrastructure.	1	1	1
Guangzhou Municipal Fire Protection Regulations	Upgrade systems and coordination to protect lives and property.	1	1	0
Regulations of Guangzhou on Urban Rail Transit Administration	Improve safety, access, and quality in public transportation.	1	1	1
…	…	…	…	…
Percentage		*100%*	*100%*	*93.7%*

In contrast, although most of Guangzhou's policies incorporate each pillar to some extent, the degree of specificity varies. Some acts articulate explicit targets for reducing pollution or enhancing social welfare, whereas others provide only broad statements of intent. Further investigation into how these policies is executed—particularly regarding funding mechanisms and measurable indicators—could help clarify their actual impact on sustainability outcomes.

5.1.3. Shanghai

The analysis examined 61 local regulations in Shanghai, of which 35 were associated with urban planning (Table 3). Among these, 34 contributed to social sustainability, 34 to economic sustainability, and 25 to environmental sustainability. The policy goals of the Acts studied in Shanghai and their correspondence with the three sustainability pillars are summarized in Table 3. While many international urban centers adopt clearly defined benchmarks for social inclusion, economic innovation, and environmental stewardship, Shanghai's policy suite often merges ambitious visions with overarching regulatory guidelines.

The Administrative Limits to Support Sustainable Growth and the Guidelines for Aesthetics, Preservation, and Development Acts both articulate objectives related to social well-being (e.g., improving public spaces), fostering economic competitiveness (e.g., promoting cultural and creative industries), and protecting environmental resources (e.g., green design requirements). The Regulations on Civility Construction similarly highlight social harmony and ecological protection, with indirect references to economic benefits through tourism and community-based commerce.

However, the Lingang High-Standard Development Policy and the Water Intake Rules and Resource Conservation Act more explicitly address economic and environmental goals, such as encouraging high-tech industries and sustainable water usage, while placing somewhat less emphasis on explicit social outcomes. By contrast, the Administer Safety, Resource Allocation, and Pollution Control Act underscores public health and ecological safeguarding, without detailing the mechanisms for bolstering local economic growth.

Table 3. Policy Goals of the Examined Legal Texts and Their Emphasis on Sustainability in Shanghai

Act	Macro level policy goal	Sustainability pillar		
		Soc	Eco	Env
Shanghai Municipal Measures for the Administration of Shared-Ownership Security Housing	Provide affordable housing with size, price, and resale limits to support low-income families and guide urban growth.	1	1	1
Shanghai Municipal Measures for the Administration of Scenic Lighting	Regulate lighting to enhance aesthetics, preserve culture, and save energy.	1	1	1
Shanghai Municipal Regulations on Civilized Construction Management	Ensure clean, safe, and eco-friendly construction sites while protecting workers.	1	1	1
China (Shanghai) Pilot Free Trade Zone Lingang New Area Administrative Measures	Boost openness and innovation to build a high-standard, globally competitive economic zone	1	1	1
Shanghai Municipal Measures for the Management of Rural Villagers' Housing Construction	Regulate rural construction to optimize land, ensure safety, and align with revitalization goals.	1	1	1
Shanghai Municipal Measures for the Implementation of Water Intake Licensing and Water Resource Fee Collection Management	Conserve water, enforce usage rules, and improve intake licensing and fees.	1	1	1
Shanghai Municipal Measures on the Administration of Building Glass Curtain Walls	Manage glass façade use to ensure safety, reduce glare, and uphold standards.	1	1	1
…	…	…	…	…
Percentage		*97.1%*	*97.1%*	*71.4%*

In contrast, although some Acts in Shanghai clearly incorporate all three pillars, others do so only implicitly. They may recognize environmental or social concerns but lack the precise economic strategies needed for holistic sustainability. Further research into the implementation and regulatory enforcement of these policies is necessary to determine their efficacy and to identify opportunities for strengthening their contribution to social, economic, and environmental objectives.

5.1.4. Singapore

The policy goals of the 133 studied Acts in Singapore and their alignment with national development priorities are summarized in Table 1. Out of 133 local regulations, 122 address social sustainability, 72 focus on economic sustainability, and 48 contribute to environmental sustainability, reflecting the Singapore government's strong emphasis on livability, economic resilience, while neglects the economic problems.

The Environmental Protection and Management (Trade Effluent) Regulations focus on regulating industrial wastewater discharge to safeguard water resources and promote environmental sustainability, thus impacting the social, economic, and environmental dimensions. In contrast, the Planning (Development of Land Authorisation) Notification achieves sustainable development objectives by regulating agricultural and infrastructure development and facilitating minor land development and modifications. Meanwhile, the Housing and Development (Change of Address) Rules are primarily aimed at enhancing administrative efficiency in housing management and ensuring accurate residential records for property owners, placing less emphasis on economic and environmental concerns.

Table 4. Policy Goals of the Examined Legal Texts and Their Emphasis on Sustainability in Singapore

Act	Macro level policy goal	Sustainability pillar		
		Soc	Eco	Env
Housing and Development (Change of Address) Rules	Enhance administrative efficiency in housing management and ensure accurate residential records for property owners	1	0	0
Housing and Development (Penalties for Late Payment) Rules	Ensuring financial discipline by enforcing timely payments and imposing penalties for overdue fees	1	1	0
Income Tax (Exemption of Interest and Other Payments for Economic and Technological Development) Notification 2013	Stimulating economic and technological development by providing tax exemptions	1	1	0
Environmental Protection and Management (Trade Effluent) Regulations	Regulating industrial wastewater discharge to safeguard water resources and promote environmental sustainability	1	1	1
Planning (Housing and Development Board Commercial Premises and Living Quarters Authorisation)	Preserve Urban Planning Intentions， Enhance Public Services and Community Needs	1	1	0

Notification 2011				
Planning (Development of Land Authorisation) Notification	Regulate Agricultural and Infrastructure Develop, Facilitate Minor Land Development and Modifications.	1	1	1
…	…	…	…	…
Percentage		*91.3%*	*54.9%*	*36.1%*

5.2 Effectiveness Assessments of Policies

5.2.1. Wuhan

In Wuhan, among the 33 urban planning policies, 26 are classified as 'control' category, accounting for 78.9%, 18.1% are categorized as 'procedural', and only 1 is classified as 'persuasive', accounting for 3% (Table 4). Calculations show that the balance score of Wuhan's urban planning policies is only about 0.356, which is very low, indicating that the policies are overly inclined towards controlling the status while neglecting other aspects.

Table 5. Policy Categories and Effectiveness Evaluation in Wuhan

Act	Category of Act				Parameter of Intensity			
	Control	Market	Procedural	Persuasive	R_i	T_i	P_i	C_i
Wuhan Municipal Fuhuan River Basin Protection Regulations	1	0	0	0	3	1	1	1
Wuhan Municipal Regulations on the Protection of Enterprises and Enterprise Operators' Rights	1	0	0	0	1	1	3	3
Wuhan Municipal People's Air Defense Regulations	1	0	0	0	3	1	1	1
Wuhan Municipal Regulations on the Management of Renewable Resources Recovery	1	0	0	0	1	1	1	3
Wuhan Municipal Measures for the Implementation of the PRC Circular Economy Promotion Law	0	0	0	1	1	1	1	1
Wuhan Municipal Regulations on Building Energy Conservation and the Application of New	0	0	1	0	1	1	2	3

Wall Materials								
Wuhan Municipal Measures for the Implementation of the PRC Environmental Protection Law	0	0	1	0	1	1	2	1
…	…	…	…	…	…	…	…	…
Percentage	*78.8%*	*0*	*18.1%*	*0.03%*	*67*	*33*	*55*	*52*
Mean					*2.03*	*1*	*1.67*	*1.58*

5.2.2. Guangzhou

Among the 64 urban planning policies, 63 fell under the "control" category, accounting for 98.4%, while the remaining one was classified as "market," making up 1.6%. None of the extracted policies were categorized as "procedural" or "persuasive" (Table 5). The calculated balance score (0.03125) is far more lower than that of Wuhan, underscoring a similar issue in Guangzhou—an excessive emphasis on control-oriented policies.

Table 6. Policy Categories and Effectiveness Evaluation in Guangzhou

Act	Category of Act				Parameter of Intensity			
	Control	Market	Procedural	Persuasive	R_i	T_i	P_i	C_i
Guangzhou Municipal Regulations on Electric Bicycle Management	1	0	0	0	3	1	3	3
Guangzhou Municipal Regulations on Embroidery-Style Urban Governance	1	0	0	0	3	5	1	1
Guangzhou Economic and Technological Development Zone Ordinance	1	0	0	0	5	5	2	3
Guangzhou Municipal Regulations on Electric Vehicle Charging Facilities Construction and Management in Residential Complexes	1	0	0	0	3	1	1	1
Guangzhou Municipal Urban Village Redevelopment Ordinance	1	0	0	0	5	1	5	3
Guangzhou Municipal Fire Protection Regulations	1	0	0	0	3	5	1	1
Regulations of Guangzhou on Urban Rail Transit Administration	1	0	0	0	4	1	2	2
…	…	…	…	…	…	…	…	…
Percentage	*98.4%*	*1.6%*	*0*	*0*	*233*	*164*	*125*	*144*
Mean					*3.58*	*2.52*	*1.92*	*2.21*

5.2.3. Shanghai

As shown in Table 7, Nearly all urban planning policies (97.1%) were classified as "control," with just one categorized as "procedural" (1.6%). No policies fell under the "market" or "persuasive" categories (Table 6). The calculated balance score is higher than Guangzhou while lower than Wuhan, registering at 0.058, indicating a completely imbalanced policy distribution.

Table 7. Policy Categories and Effectiveness Evaluation in Shanghai

Act	Category of Act				Parameter of Intensity			
	Control	Market	Procedural	Persuasive	R_i	T_i	P_i	C_i
Shanghai Municipal Measures for the Administration of Shared-Ownership Security Housing	1	0	0	0	5	2	3	5
Shanghai Municipal Measures for the Administration of Scenic Lighting	1	0	0	0	3	2	1	2
Shanghai Municipal Regulations on Civilized Construction Management	1	0	0	0	4	3	2	2
China (Shanghai) Pilot Free Trade Zone Lingang New Area Administrative Measures	1	0	0	0	4	3	3	4
Shanghai Municipal Measures for the Management of Rural Villagers' Housing Construction	1	0	0	0	3	4	2	3
Shanghai Municipal Measures for the Implementation of Water Intake Licensing and Water Resource Fee Collection Management	1	0	0	0	3	4	2	3
Shanghai Municipal Measures on the Administration of Building Glass Curtain Walls	1	0	0	0	3	4	2	3
…	…	…	…	…	…	…	…	…
Percentage	*97.1%*	*0*	*2.9%*	*0*	*117*	*99*	*84*	*105*
Mean					*3.34*	*2.82*	*2.4*	*3*

5.2.4. Singapore

The analysis of Singapore's policies reveals a noticeable difference compared to Guangzhou and other cities. As Table 8 show, among the 133 policies examined, 92 fall under the control category, accounting for 69.2%, while 21 belong to the market category (15.8%), 11 are procedural policies, and 9 are classified as persuasive. The final calculated policy balance index for Singapore is 0.49, which is significantly higher than Wuhan, Guangzhou and Shanghai.

This indicates that Singapore places greater emphasis on policy balance, particularly in leveraging market stakeholders to promote development and using procedural policies to enhance policy implementation efficiency.

Table 8. Policy Categories and Effectiveness Evaluation in Singapore

Act	Category of Act				Parameter of Intensity			
	Control	Market	Procedural	Persuasive	R_i	T_i	P_i	C_i
Housing and Development (Change of Address) Rules	1	0	0	0	1	3	1	1
Parking Places (Urban Redevelopment Authority) Order	1	0	0	0	3	3	3	3
Environmental Protection and Management (Trade Effluent) Regulations	1	0	0	0	3	3	3	3
Media Development Authority of Singapore Act (Commencement) Notification 2002	0	0	1	0	3	1	1	3
Property Tax (Exemption of Land under Development) (Off-Budget) Order	0	1	0	0	3	3	3	3
Planning (Development of Land Authorisation) Notification	1	0	0	0	3	3	3	3
…	…	…	…	…	…	…	…	…
Percentage	*69.2%*	*15.8%*	*8.3%*	*6.8%*	*379*	*235*	*235*	*375*
Mean					*2.59*	*1.77*	*1.77*	*2.82*

6 Conclusion

The comprehensive, multilevel examination of urban planning regulations in significant Chinese cities reveals enduring difficulties in striking a balance between sustainability on all fronts—social, economic, and environmental. This study ascertains the degree to which local regulations in Wuhan, Guangzhou, and Shanghai from 2014 to 2025 incorporate comprehensive sustainable development goals. The results show that there is little use of market-based, procedural, or persuasive strategies and an excessive reliance on command-and-control tools. Wuhan's score of 0.356 indicates a more balanced policy distribution compared to Guangzhou and Shanghai, but it still shows significant shortcomings, with 78.9% of the policies falling into the control field. Shanghai shows a worse situation, with 97.1% of its urban planning policies being categorized as control instruments, resulting in a balance score of roughly 0.058. Guangzhou exhibited an even more extreme imbalance, with 98.4% of its ur-

ban planning policies falling under the control category and a calculated balance score of 0.031, indicating a complete absence of diversity in policy approaches.

The policy language mentioning ecological protection, economic growth, and public well-being indicates a commitment to social, economic, and environmental sustainability, but the low balance scores imply that these objectives might not be pursued in a flexible or integrated way. Command-and-control overemphasis can reduce policy adaptability, impede innovation, and limit stakeholder engagement. As a result, crucial aspects like stakeholder persuasion and procedural clarity are still poorly understood, which could limit the efficacy of policies in the long run.

Furthermore, even though some policies address several sustainability pillars at once, it's still unclear how much of an actual impact they will have. The prevalence of top-down directives begs the question of how well local governments can encourage participation from the private sector or promote inclusive decision-making processes. The results of policy implementation, the function of public awareness initiatives, and the possibility of more extensive market-based instruments to enhance sustainability performance could all be the subject of future research.

In conclusion, Wuhan, Guangzhou, and Shanghai's reliance on control-oriented policies highlights a common pattern of policy imbalance. Urban sustainability outcomes could be improved by expanding the mix of policy instruments by adding market incentives, persuasive communication, and procedural guidance. In addition to addressing multisectoral priorities, this strategy would encourage adaptability and resilience in a time of complicated environmental pressures and fast urbanization. What's more, Wuhan, Guangzhou, and Shanghai need a policy revamp, and here are some new specific policy recommendations for them. Wuhan could encourage sustainable innovation by implementing industrial transformation and carbon trading pilot programs. Guangzhou requires refined governance innovation, such as rewarding enterprises that achieve closed-loop circular production with land use incentives. Shanghai, facing the most extreme imbalance, should prioritize diversifying its policy instruments by incorporating procedural and market-based measures to enhance regulatory flexibility. For all three cities, fostering resilient communities and transitioning toward digital governance frameworks hold significant potential for the future.

By comparison, Singapore's policies appear to be more balanced. A study on policy intensity indicates that Singapore's policy intensity score is 9.2, reflecting a moderate level of potential policy resistance. In this regard, Singapore is similar to Wuhan and Guangzhou, as policy implementation often leads to tensions between conflicting interests and challenges arise when theory does not fully align with practical execution. During the data review phase, it was found that a significant portion of Singapore's policy content consists of notifications that amend policy details or definitions, resulting in relatively low resource intensiveness and target precision scores. This has, to some extent, affected the analysis of resistance to Singapore's policies. However, it still provides valuable insights into the effectiveness of these policies.

Overall, Chinese local governments can learn from Singapore's policy design to enhance policy implementation efficiency and genuinely improve public well-being.

7 Further Study

Future research could build on this investigation.

Firstly, in the process of urban planning policy text selection, there are certain contents that are difficult to classify and identify. For example, policies focusing on "meteorological disasters" or "disaster prevention and mitigation" may not be extracted, yet they are closely related to urban planning, such as stormwater drainage, underground pipeline design, and sponge city construction. Future research can focus on improving the accuracy and speed of policy classification by enhancing classification algorithms and developing a multidimensional classification system. Integrating Natural Language Processing (NLP) and Deep Learning techniques with advanced text embedding methods such as BERT or GPT can significantly improve classification accuracy, while utilizing word vectors and topic modeling ensures hidden policy impacts, such as disaster prevention measures, are correctly identified. Furthermore, existing classification methods primarily rely on keyword extraction, which can overlook broader policy implications. Establishing a systematic classification hierarchy that incorporates environmental, economic, social, and infrastructure dimensions would provide a more comprehensive perspective. Additionally, applying Policy Network Analysis can help assess how policies influence urban planning through industry connections or cross-sector collaboration, ensuring that indirectly related policies are properly accounted for.

The "0-1" sustainability scoring method adopted in this paper has certain limitations, particularly in its ability to account for implicit influences within policy texts. Sustainability assessments based solely on text analysis may overlook underlying economic, environmental, or social effects that are not explicitly stated in the policy wording. For example, a policy that does not directly address economic aspects may still have significant financial repercussions, influencing supply chains, investment flows, and employment patterns within upstream and downstream industries. These indirect effects can, in turn, impact overall economic sustainability by altering market dynamics or shifting resource allocation. Additionally, policies focused on environmental regulations or urban development may introduce unforeseen financial burdens or incentives that reshape industry landscapes, further reinforcing the interconnected nature of sustainability. To improve the accuracy and comprehensiveness of sustainability assessments, future research should explore more advanced analytical models that integrate contextual data, economic simulations, and cross-sector policy interactions rather than relying solely on explicit text-based categorization.

Further analysis on the existing data is also a feasible research direction. For instance, segmenting policy data based on time periods can provide valuable insights into the evolution of government policy preferences and the shifting emphasis on various policy priorities over different eras. By analyzing trends across specific time frames, researchers can identify patterns of political decision-making, assess the impact of external influences on policy shifts, and evaluate how policy objectives have adapted to emerging societal and economic challenges. This temporal analysis can enhance understanding of policy effectiveness and inform future strategic planning.

Then, one can quantify the quality of sustainable development by examining aspects such as changes in per capita consumption, variations in carbon emissions, and resident satisfaction surveys. Furthermore, it is possible to explore the interaction between different combinations of policy instruments and the policy sustainability scores. By employing multiple regression analysis or structural equation modeling (SEM), one can investigate the causal relationship between policy tool indicators (such as intensity and types) and sustainable outcomes. For example, one could examine whether the combined use of market-based and procedural instruments significantly improves performance in environmental and economic dimensions.

At the same time, various indicators can be incorporated into a comprehensive model by constructing a composite index through weighted summation or product terms. This index would reflect the overall "health" or "adaptability" of a city's policies. Such a composite indicator not only facilitates comparisons across cities but also helps identify how to optimize the synergy among different policy instruments within a single policy mix. Multilevel modeling is also a research method that can be utilized by using policy-level indicators as Level-1 variables and incorporating city characteristics (e.g., urban governance innovation, population density, economic level) as Level-2 variables. Through multilevel modeling, the intrinsic features of the cities can be taken into account, allowing researchers to identify which city-level strategies or resource allocations significantly boost the positive effects of policies.

Furthermore, the study found that the number of policies varies across different sectors, which impacts the assessment of policy sustainability and effectiveness. For example, in the analysis of Singapore's policies, over 90 regulations were related to economic activities such as taxation and housing, while fewer than 30 were related to environmental concerns. Although this reflects the government's developmental priorities, it does not necessarily indicate neglect of other sectors. A weighted approach or random sampling method may be needed to more evenly examine the government's efforts across different dimensions of sustainability.

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