

Examining collaborative governance models in strategic smart initiatives for addressing climate change in urban contexts*

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Abstract

Climate change has become a critical challenge for urban planning, driving cities to enhance resilience and sustainability through strategic initiatives. Collaborative governance models have the potential to foster transparency, optimize resource management, and increase stakeholders' participation in climate policy. This study examines collaborative governance models implemented in 25 European smart cities (SCs) to address climate-related issues using ETs. By analyzing 1,439 strategic initiatives, three governance models are identified in accordance with the stakeholders' level of engagement: open participation, selected participation and bureaucratic model of governance. The study finds that open participation and selected participation are the most prominent governance models used in climate adaptation initiatives across European SCs. While each presents strengths and limitations, it is recommended that cities develop hybrid governance frameworks -combining inclusive public engagement with structured expert collaboration- to effectively address climate challenges. These frameworks balance inclusiveness, efficiency, and transparency, contributing to improved urban planning and effective climate policy implementation in European smart cities.

Keywords

Emerging Technology, Climate Change, Stakeholder Engagement

1. Introduction

In the 21st century, cities are confronted with a multitude of challenges, including climate change (CC), urban expansion, and mounting pressure on natural resources [1], requiring adaptation and mitigation strategies in urban planning to ensure urban resilience and sustainability [1]. CC is widely regarded as a significant, global, and complex problem, associated with social pluralism, institutional complexity, and scientific uncertainty [2]. Stoker [3] proposed that dialogue-based work among stakeholders, and networked arrangements can promote public value. Collaborative models facilitate a better understanding of the issues, a greater chance of finding viable solutions, and more effective implementation [2].

Public administrations are thus increasingly aware that they cannot optimize strategic intent on their own for facing CC in an effective way, thereby requiring cooperative approaches [4] and not only actions at different public administration levels [5]. There is an acknowledgement of the necessity for the involvement of additional stakeholders in broader democratic processes to achieve progress in their efforts to combat CC [6]. This encompasses the sorting, prioritizing and adjustment

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of responses to CC according to geographic location, socioeconomic conditions and governing capacity [5]. This assertion is already embedded in principle no. 10 of the Rio Declaration on Environment and Development [7].

However, while collaboration can offer numerous benefits, it can be challenging to establish and maintain in a public-sector context due to governance complexity and accountability [2]. The design and management of collaborative processes face barriers such as institutional resistance, limited citizen engagement, and the need for adaptive governance aimed at climate uncertainty. These issues hinder genuine public value co-creation. Consequently, while the call for stakeholders' participation in CC adaptation is general, recent research indicates that this collaboration is not real [8]. In the context of natural-based solutions (NBS), while acknowledging the significance of collaborative approaches [9][10], local authorities are entrusted with a pivotal role in integrating NBS into location-based planning strategies [11].

The problem here is not leadership in CC projects, but institutional inertia and entrenched practices driven by organizational power and political interests [12]. In collaborative governance, leadership is key, requiring a shift from structures to managerial practices [2]. Public managers should act as partners in public value creation, engaging stakeholders and citizens [6][12]. Frameworks like Arnstein's ladder [13] reveal levels of stakeholder influence, from informing to empowerment. More recent models propose five levels -informing, consulting, involving, collaborating, empowering- as a guide to evaluate real power dynamics [14]. These models underscore the importance of moving beyond symbolic participation toward genuine citizen involvement in decision-making.

Moreover, the intricacies inherent in the CC problem underscore the significance of contextual considerations, thereby necessitating the adoption of a local perspective. This entails the identification of specific local needs, the assessment of the capacities of the local population to respond, and the undertaking of a local analysis of the socio-environmental vulnerability of the local population, with the objective of devising effective local solutions that cater to all stakeholders [15]. In brief, the implementation of actions to address CC must be aware of the social and environmental differences between different localities [16].

To achieve these aims, the rapid advancement of information and communication technologies (ICTs) has offered new opportunities in the urban context for the development of forward-looking plans for reducing vulnerability and disaster threats [17] and in the so-called 'smart cities' (SCs) due to their intensive use of ICTs in urban areas, advanced governance models and the pursuit of sustainability goals [18]. Special attention should be paid to emerging technologies (ETs) in SCs, which have the potential to assist these cities in achieving resilience [19]. Indeed, digital transformation and ETs provide new opportunities for improving urban planning and climate management [19]. Furthermore, they have been incorporated into SCs initiatives for integrating innovative solutions into government decision-making, facilitating real-time data analysis, allowing cities to respond proactively to CC and optimizing resource allocation in key sectors such as energy, mobility, and infrastructure [20].

However, recent research has indicated that many local governments have overlooked how technologies interact with users and the urban environment -crucial for smart city (SC) success [21]-. The main problem lies in governance inefficiencies that hinder equitable urban transformation [21]. Fragmented institutions, poor coordination, and weak regulations undermine effective climate adaptation [22][23][24]. Consequently, while the implementation of ETs in SCs initiatives could potentially enhance the response to CC, their success depends on strong governance structures. In this regard, recent literature on participatory governance, co-creation, and deliberative democracy [25][26] has emphasized that fostering inclusive decision-making goes beyond digital tools -it requires institutional spaces and mechanisms where citizens, civil society, and experts can deliberate and co-produce public solutions. Thus, the framing of smart governance must move from technical approaches to participatory models grounded in inclusion and shared responsibility. The justifies renewed focus on SCs and their strategic adaptation initiatives, despite extensive prior research [27]. Nonetheless, there is a paucity of literature on this issue. The present research seeks to address this research gap by analyzing strategic smart initiatives for climate adaptation in European SCs, focusing on governance models (RQ1), key stakeholders involved (RQ2), and engagement techniques used (RQ3).

2. Methodology and sample selection

The study employs a methodological approach that integrates documentary analysis with case studies to examine governance models in European SCs and assess the role of ETs in collaborative processes aimed at mitigating CC.

The sample selection was based on internationally recognized SC and urban sustainability rankings, including Euro Smart Cities 2024/2025, Cities in Motion 2022, EasyPark, IMD, and Innovation Cities. Cities that appeared recurrently in these indices were prioritized, as their presence indicates strong performance in key dimensions such as competitiveness, innovation, sustainability, and urban governance. Consequently, 25 European cities were selected. These cities not only rank highly in SC indicators but also demonstrate significant progress in strategic projects related to digital transformation, sustainability, and urban innovation.

Data collection was conducted in two phases. First, official strategic documents related to resilience and CC were retrieved from municipal government websites between October and November 2024. These documents were then systematically analyzed to extract information on the developed initiatives, the stakeholders involved, and their levels of participation. Through this process, a total of 1,439 smart initiatives were identified.

The analytical framework follows Yigitcanlar's [28] methodological model, which structures the relationship between smart city development (ETs used), governance mechanisms, and sustainability goals through the integration of socio-technical dimensions. This model typically encompasses three interrelated dimensions: (1) the technological and innovation infrastructures of smart cities, (2) governance and institutional arrangements, and (3) societal outcomes, particularly environmental sustainability, equity and resilience. In this study, the model was adapted to analyze how European smart cities articulate CC adaptation through strategic initiatives. Key variables include governance models -categorized as open participation, selective participation or bureaucratic structures-; stakeholder ecosystems -encompassing local governments, private sector actors, academic institutions, and civil society organizations [29]; and participation techniques -such as public consultations, discussion forums, surveys, and digital platforms designed to enhance citizen inclusion [30].

By analyzing these variables, this study provides a comprehensive perspective on how European SCs integrate collaborative governance models into their strategies to address CC challenges, thus offering empirical insights to support the design of future public policies related to governance models and CC strategies, including an analysis of the stakeholders involved and the techniques primarily used to engage them.

3. Results

RQ1. Which governance models are SCs implementing in their strategic smart initiatives for addressing CC?

Nearly 40% of initiatives analyzed do not specify a governance model for addressing CC, highlighting transparency issues (see figure 1). Among those that do, open participation is the most prevalent (30.65%), fostering broad engagement among government institutions, businesses, NGOs, and the public. This model enhances policy legitimacy and innovation by incorporating diverse perspectives, increasing public trust and acceptance of climate policies. However, multistakeholder decision-making can introduce complexity, requiring well-structured frameworks and equitable representation to ensure effectiveness [24].

The selected participation model, present in 21.40% of cases, involves government collaboration with predefined stakeholders, such as private companies, NGOs, academia, and representatives of vulnerable groups. While this model leverages specialized knowledge for more informed policies, it limits inclusiveness by restricting participation to selected actors, raising concerns about decision-making being influenced by specific interest groups rather than broader community needs [23].

The bureaucratic model (8.27%) centralizes decision-making within government institutions, ensuring efficiency by minimizing delays but limiting stakeholder involvement. While this approach streamlines policy implementation, it risks overlooking external expertise and public input, potentially reducing the adaptability and social acceptance of climate measures [23]. The lack of

stakeholder engagement in such models may also increase resistance to adaptation efforts. Notably, governance models that enable broader participation may not only foster institutional trust and transparency but also contribute to social cohesion by reinforcing collective responsibility and inclusive community involvement in climate adaptation.

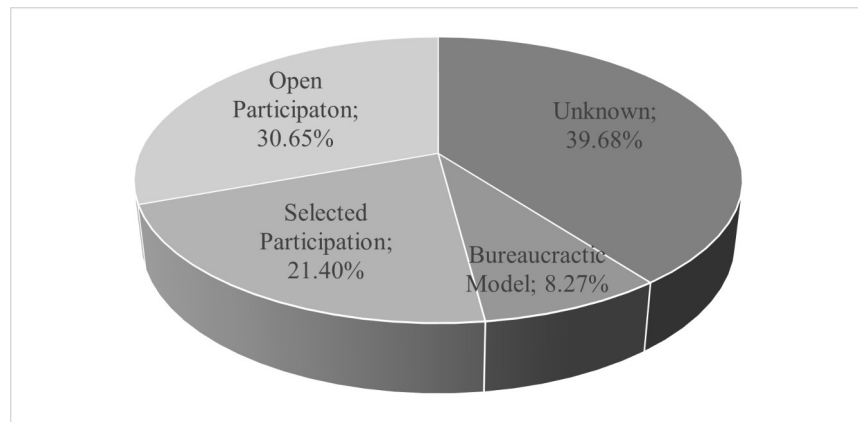


Figure 1. Governance models adopted by European Smart Cities

RQ2. Who are the stakeholders mainly involved in the collaborative governance models?

The effectiveness of collaborative governance in SC climate initiative depends on diverse, engaged stakeholders. Citizens' participation (20.95%) -see figure 2- plays a crucial role in enhancing policy legitimacy and public trust. This aligns with previous studies emphasizing the importance of inclusive governance models in increasing policy acceptance [7]. Public administration (14.10%), private companies (13.53%), and NGOs (12.51%) also play key roles, citizen involvement ensuring localized adaptation strategies, while private sector participation fosters innovation and resource optimization [23][31]. However, academia (7.32%), neighborhood associations (2.25%), and educational institutions (1.35%) remain underrepresented, limiting knowledge and community input. Additionally, 28% of European smart initiatives fail to specify the stakeholders involved, raising concerns about openness and inclusivity -see figure 2-.

Governance models shape stakeholder involvement. The selected participation (21.40%) is characterized by structure collaboration, where government engage predefined actors-private companies, NGOs, academia, and representatives of vulnerable groups. Research suggests that the implementation of this model with structured collaborations facilitates policy adoption and technical accuracy, although there is a risk of exclusion of less influential groups [8][23][24].

The open participation model fosters broader civic engagement and multi-stakeholder involvement -see figure 3-, reinforcing legitimacy and acceptance of climate policies [22]. This model places citizens at the center (43.57%), supporting previous findings that public involvement fosters commitment and sustainability [31]. However, private sector (12.96%) and public administration (12.86%) involvement is comparatively lower, indicating that businesses prefer structured collaborations over open participatory settings, while governments may be shifting toward decentralized models. Associations and transnational networks (21.83%) play an active role, while academia remains more engaged in structured partnerships than in open engagement models.

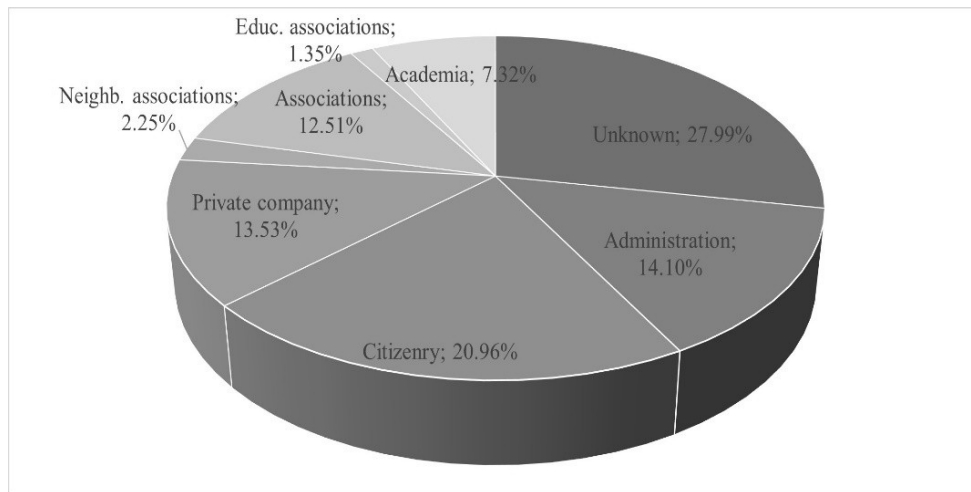


Figure 2. Stakeholders involved in European smart initiatives

The selected participation model involves targeted collaboration, where governments lead decision-making (28.01%), engaging specific stakeholders in structured partnerships rather than fully decentralized governance. Private sector participation (26.08%) follows a similar pattern, preferring structure collaborations over broad governance forums. While past research highlighted the scarcity of private sector involvement in smart strategy implementation, despite its proven link to successful technology adoption [8][23][24], a shifting trend is emerging. Policymakers recognize the need to engage private companies in smart initiatives to optimize resources, reduce costs and ensure the proper functioning of ETs.

Associations and NGOs (11.89%), both environmental and social, emphasize their role in addressing climate challenges and promoting social equity. Academia (11%) plays a key role in structured partnerships, contributing scientific knowledge and data-driven solutions to climate adoption, though its role remains more advisory than policy-oriented. This governance model prioritizes efficiency and technical expertise, with decision-making centered on public administration, private companies and expert groups. While structured collaboration improves implementation, it may lack legitimacy and inclusiveness. In contrast, broader stakeholder involvement, especially that of civil society organizations and citizens, can bridge gaps and strengthen social ties through shared urban action.

Finally, the bureaucratic model has been shown to centralize decision-making within government institutions, thus neglecting stakeholder engagement in decision-making processes (as illustrated in Figure 3). This has resulted in rigid governance structures that hinder the promotion of participatory climate policies [24].

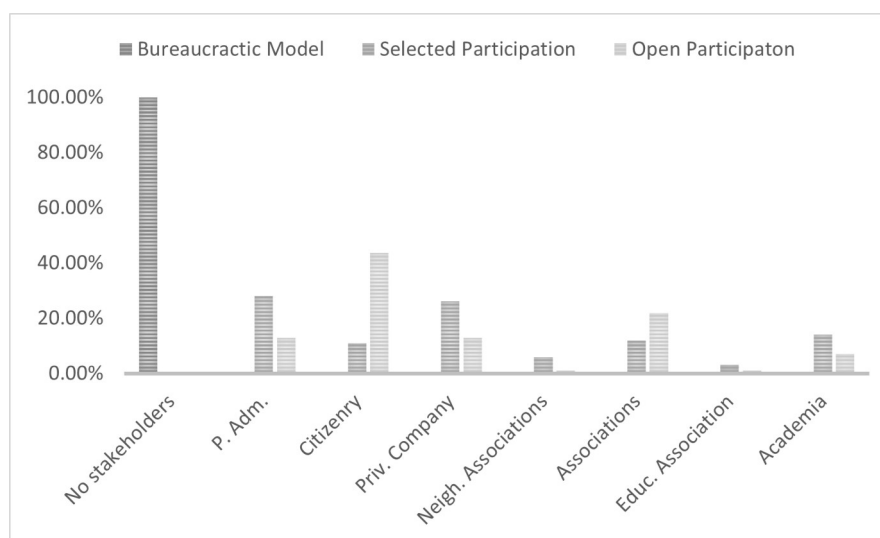


Figure 3. Stakeholders engaged according to governance models

RQ3. Which techniques are primarily employed for the purpose of engaging stakeholders in each of the governance models implemented within the SC initiatives?

Stakeholders' participation in European smart initiatives varies significantly depending on the governance model and engagement techniques. While some models promote structured collaboration with selected actors, others adopt broader, more inclusive approaches. Understanding these variations is essential to assess whether participation is fully open or remains limited to specific activities.

Among the most used techniques (see figure 4), consultation (24.19%) and co-design/creation (22.96%) indicate that participatory governance primarily relies on deliberative mechanisms. Forums, educational programs, and workshops (9.64%, 9.45% and 9.27%) facilitate knowledge exchange among stakeholders, aligning with previous research highlighting their role in strengthening engagement [22]. However, certain participatory tools remain underutilized, such as participatory budgeting (0.43%), which enables citizens to influence financial decisions but is rarely implemented, suggesting that resource allocation remains government controlled. Similarly, coaching (2.15%) and volunteering (1.78%) are marginal, reflecting limited emphasis on direct civic engagement.

In accordance with the different governance models analyzed, the bureaucratic model restricts participation to consultation (50%) and digital platforms (50%) (see figure 5), prioritizing top-down decision-making over interactive governance. This model lacks space for deliberation and participatory processes, reinforcing findings that rigid governance structures hinder stakeholder inclusion [22].

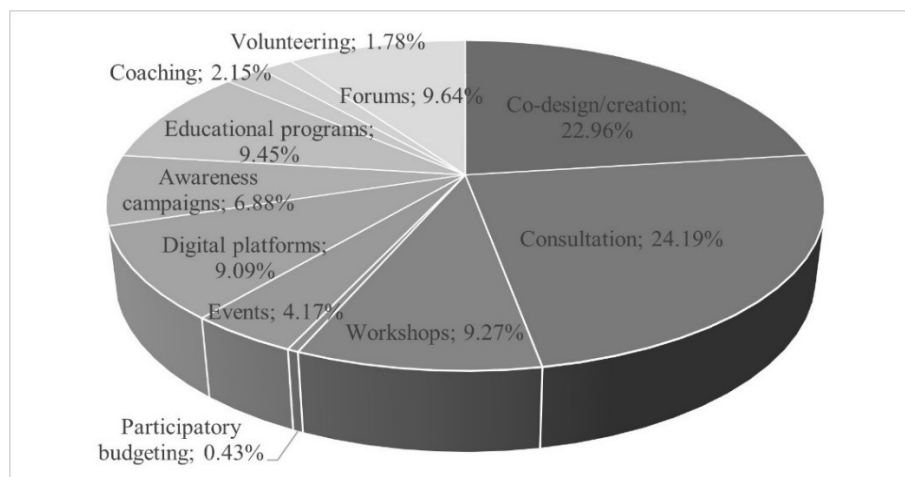


Figure 4. Participation techniques applied in European smart initiatives

The selected participation model is structured but controlled, with co-design/creation (36.08%) and targeted consultation (23.61%) engaging predefined actors, such as private companies, NGOs, and experts. While this model ensures technically informed policies, it limits broader inclusiveness and risks concentrating decision-making within select groups, aligning with research that warns of the exclusionary effects of technocratic governance [23]. Forums (11.32%) serve as spaces for expert-driven policy deliberation rather than open public debate.

The open participation model fosters broader civic engagement, primarily through public consultation (24.27%), allowing citizens to voice their opinions on smart initiatives. Other widely used methods, including educational programs (11.27%), workshops (11.09%), and awareness campaigns (8.45%), align with studies emphasizing the importance of capacity-building in participatory governance [31]. Forums (8.91%) provide public discussion spaces, differing from the expert-driven deliberation in selected participation. However, despite its inclusive nature, open participation does not always translate into equal influence in decision-making, as volunteering (2.09%) and participatory budgeting (0.45%) remain marginal, reinforcing previous findings on the limitations of participatory techniques in shaping policy decisions [8].

Overall, while open participation enhances inclusiveness, it does not always ensure stakeholder's

significant decision-making power. Conversely, selected participation provides structured collaboration but restricts broader engagement, reinforcing concerns about exclusivity in governance frameworks. The findings highlight the need for participatory models that balance inclusiveness and decision-making influence, ensuring more effective and transparent stakeholder engagement in European smart initiatives [22][23][31].

Furthermore, when participation mechanisms are designed not only to inform but also to empower, they may reinforce social cohesion by enabling more equitable involvement of different communities' groups in shaping urban responses to CC.

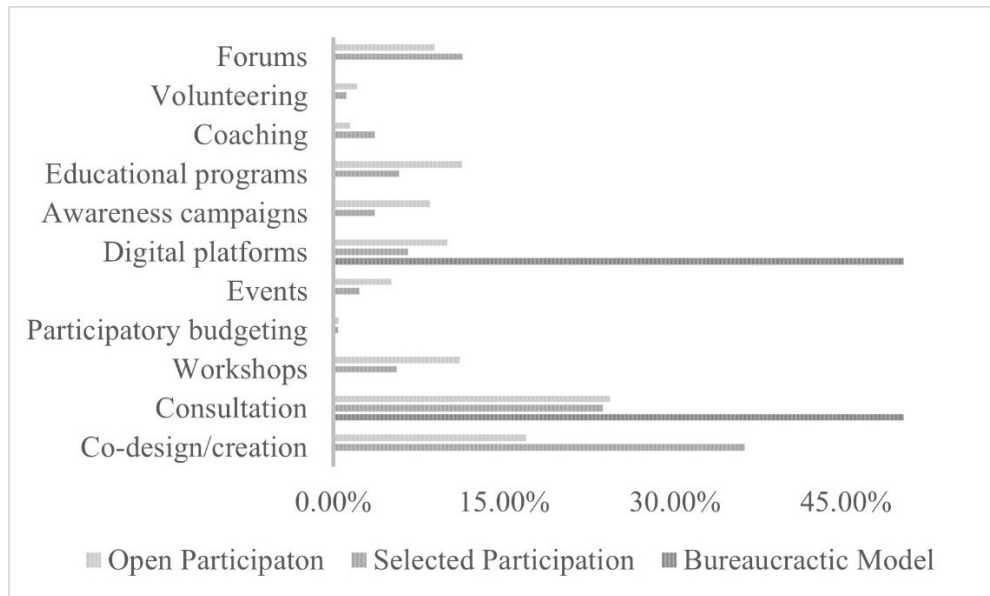


Figure 5. Participation techniques according to governance models

4. Discussion and Conclusions

This study examines the governance models implemented in strategic smart initiatives for CC adaptation in sample European SCs, analyzing the role of key stakeholders and the integration of ETs to facilitate engagement. The findings confirm that while open participation models are pre-dominant in strategic initiatives, significant barriers remain in ensuring effective stakeholder integration and transparency in decision-making processes.

The results, aligned with previous studies, highlight the relevance of collaborative governance in addressing complex public challenges such as CC [2]. However, the research identifies persistent inequalities in the involvement of key stakeholders, with public administration and private sector actors playing a dominant role over civil society organizations and academia, as Beckers et al. [31] have previously noted. Furthermore, the study corroborates the limited presence of truly decentralized governance models, reinforcing the challenges documented in the literature regarding the practical implementation of inclusive and effective climate adaptation strategies [5].

The effective implementation of ETs in local governance depends not only on technical innovation but also on institutional strength and inclusion. While capacity-building programs are essential to equip public administrations with skills in participatory governance, strategic planning, and digital integration, they must also tackle structural barriers [32]. These include interoperability issues between existing systems, organizational resistance linked to hierarchical cultures or limited digital competences, and insufficient resources to support innovation [32]. Additionally, the unequal distribution of digital infrastructure and skills may exacerbate social disparities, undermining equitable access to ET-based CC initiatives. These realities underscore that deploying enabling technologies requires not just technical skills, but also governance aligned with public value, transparency, and inclusion.

From a practical perspective, the findings offer key recommendations for public managers, policymakers, and urban planners. Hybrid governance models should be promoted, combining open

participation with structured collaboration among selected stakeholders to balance inclusiveness with efficiency. Transparency and accountability mechanisms need to be reinforced, as nearly 40% of the initiatives analyzed lack a specified governance model, signaling limited openness in decision-making processes.

While enabling ETs can enhance data collection, monitoring and responsiveness, overly technocentric models risk reducing citizens to data providers and excluding them from decision-making. Without inclusive institutional space, these models risk reinforcing centralized power and diminishing democratic legitimacy, especially in climate governance. In addition, participatory processes themselves may lose their transformative potential if poorly structured. When engagement mechanisms are limited to consultation or symbolic inclusion, it can exclude marginalized voices and reinforce inequalities. Without deliberate efforts to ensure diversity, accessibility and influence in decision-making, participatory governance may perpetuate social gaps. This highlights the need for frameworks that not only gather input but also share power and build trust.

The findings highlight the need to rethink climate governance strategies so that the development of CC initiatives not only enhances environmental resilience but also promotes social well-being and inclusion. A more participatory approach can strengthen institutional trust, mitigate resistance to CC policies, and encourage stronger engagement from private sectors and community actors. From a societal perspective, the findings emphasize the urgency of reinforcing the role of citizens as key agents of urban sustainability. The climate crisis requires responses that extend beyond public administration and corporate actors to actively incorporate social civil perspective, knowledge and priorities. The patterns observed suggest that governance models emphasizing openness and collaboration may offer added value not only in terms of policy legitimacy, but also in building more equitable, cohesive communities.

The study also has broader political and social implications. The findings highlight the need to rethink climate governance strategies to ensure that strategic planning in SCs is not only efficient but also inclusive. More participatory approaches can strengthen institutional trust, mitigate resistance to climate policies, and encourage stronger engagement from private sector and community actors. From a societal perspective, the results emphasize the urgency of reinforcing the role of citizens as central actors in sustainable urban transformation. The climate crisis requires responses that extend beyond public administration and corporate actors to actively incorporate civil society perspectives, knowledge, and priorities.

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Declaration on Generative AI

The author(s) have not employed any Generative AI tools.

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