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Collaborative Pentahelix Model in Green Open Space Management in Bandung City

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Abstract.
Background. Green Open Space (RTH) is a critical component of sustainable urban development; however, its provision and management in Bandung City remain substantially below the mandated target.
Aims. This study aims to evaluate the implementation of Green Open Space management policies, identify the institutional and operational factors constraining collaborative governance, and develop an integrative governance model for improving urban green space management.
Methods. A qualitative case study approach was employed, with data collected through in-depth interviews, field observations, and document analysis involving representatives from government agencies, academia, the business sector, communities, and the media. Data were analyzed using an interactive process of data reduction, data presentation, and conclusion drawing and verification. The findings reveal that Bandung City has realized only 12.25% Green Open Space, despite an identified potential of 27.02%, indicating a substantial gap from the mandated 30% target.
Result. The implementation of the conventional Pentahelix model is constrained by fragmented bureaucratic coordination, limited human resource capacity, inadequate planning, weak monitoring and supervision, regulatory inconsistencies, insufficient stakeholder engagement, and limited adoption of digital technologies. To address these limitations, this study proposes an Integrative-Pentahelix Governance Model that extends the conventional collaboration among government, academia, business, community, and media by incorporating a Digital Data Integrator Center supported by Geographic Information Systems (GIS) and an Advocacy and Law Enforcement Network. The proposed model is the study's primary contribution, integrating multi-stakeholder collaboration, real-time spatial data, monitoring, advocacy, and regulatory enforcement within a unified governance architecture.
Conclusion. This framework provides a more inclusive, data-driven, transparent, and accountable approach to accelerating Green Open Space development and strengthening sustainable urban environmental governance in Bandung City.

Keywords: Green Open Space; Collaborative Governance; Pentahelix; Integrative-Pentahelix Governance; Digital Governance; Bandung City.

INTRODUCTION

Green Open Space (RTH) is an essential element and vital ecological infrastructure in modern urban spatial planning that functions not only to maintain environmental balance but also as a catalyst for the socio-economic resilience of urban communities (Wolch, 2024; Bodin, 2017]. Constitutionally, the provision of RTH has been expressly mandated through Law No. 26 of 2007 concerning Spatial Planning, where every urban area in Indonesia is required to provide green open space of at least 30% of its total area, with a specific proportion of 20% allocated for public RTH and 10% for private RTH. Although this legal basis has been established for more than a decade, ecological governance in many large cities, including Bandung, shows a sharp disparity between regulatory targets and implementation achievements in the field (Miao, 2025; Wolch, 2014)..

Bandung City, one of the most densely populated metropolitan areas with rapid development, faces significant structural obstacles in meeting this ecological space ratio. Currently, the area of green open space in Bandung City remains at a critical level, at only around 12.25% (around 2,048.97 hectares) of the total city area [4]. This green space deficit is exacerbated by the high rate of conversion of conservation area land, especially in the North Bandung area, for commercial and residential purposes. In addition to the unmet quantitative aspects, the current management of green open space also faces various governance pathologies, such as the low physical and aesthetic quality of facilities, minimal accessibility for marginalized groups and people with disabilities, and the widespread implementation of *hostile architecture design strategies* that systematically create an exclusive atmosphere and alienate residents from their right to public space (Gehl, 2010; Wolch, 2014). .

This lag in achievement indicates dysfunction in the implemented collaborative governance mechanism (Ansell, 2008; Emeron et al., 2012). Theoretically, managing green open space in a complex urban context requires multi-actor synergy, given that local governments have limited fiscal and managerial capacity (Bryson et al., 2015); Ostron, 1990). The Pentahelix collaboration model is an evolution of the *Triple Helix* and *Quadruple Helix models* that involves orchestration between five main actors: Government, Academics, Business Actors, Community, and Media ([2, 10, 11], and is considered the most comprehensive managerial framework for distributing public policy management responsibilities proportionally. However, in practice in the city of Bandung, this inter-helix interaction is often trapped in the trap of *silo mentality*, where each entity works in a fragmented manner, colored by overlapping authority (sectoral ego), and the absence of a data integration

platform that hinders the agile and adaptive decision-making process (Bodin, 2017; Meifer et al., 2016).

To address the deadlock in implementing existing green open space policies, recalibrating the collaborative governance architecture is urgent (Emerson et al., 2012; Kabisch et al., 2016). The dynamics of the digital transformation era demand that the Pentahelix concept not only be viewed as a conventional social coordination forum, but be transformed into an integrative, data-based governance network (smart policy network) (Meijer et al., 2016; Kankahalli, 2017). Therefore, this study aims to dissect in depth the implementation of green open space management policies in Bandung City, identify the determinant factors that are the main obstacles, and formulate a new model in the form of *Integrative-Pentahelix Governance*. This model not only aims to meet the ecological deficit alone, but is designed to provide inclusive, legally accountable, and integrated urban environmental resilience through the touch of information technology.

METHODS

This research uses a qualitative approach with a case study method. This approach was chosen because it can explore green open space management in depth, detail, and comprehensively in the specific context of Bandung City. Data were collected simultaneously through in-depth interviews, observation, and document analysis (Roso, 2010). [15]. Informants included representatives from the government (e.g., Bappelitbang, DLHK), academics, the business sector, communities (e.g., WALHI West Java), and the media. The data analysis technique used was an interactive model, which includes data reduction, data presentation, and drawing/verifying conclusions.

DISCUSSION

The research results indicate that the implementation of green open space management policies in Bandung City has not been effective. Empirical data show that the total potential for green open space identified in the field reaches 4,520.58 hectares, equivalent to 27.02% of Bandung City's total area. However, the actual green open space area realized and built remains at 12.25%.

In more detail, field findings identified that this policy's ineffectiveness stemmed from a range of structural and operational obstacles. First, weak bureaucratic coordination has triggered a sharp fragmentation of authority among relevant government agencies. Second,

human resource capacity within the bureaucracy remains very limited, both in technical management skills and in the adoption of digital literacy by policy implementers. Third, the quality of green space development planning is considered low and has not been continuously integrated with projections of the region's long-term financial capacity. Fourth, the supervisory function is very weak due to the limited number of supervisory personnel and the lack of a digitally integrated monitoring system. Fifth, policy inconsistencies have been found, as well as the absence of firm legal sanctions for various forms of spatial planning violations, such as the rampant conversion of conservation land. Sixth, the slow internal innovation within the bureaucracy also hampers the adoption of modern technology and the use of adequate geographic information systems.

In addition to these structural barriers, a descriptive narrative evaluation of the implementation of the Pentahelix collaborative model shows that synergy between actors has not been optimal in the city of Bandung (Etzkowitz, 2000; Carayannis et al., 2000). The Government, *which* acts as the main regulator, still faces significant challenges in reducing sectoral egos and optimizing cross-agency coordination (Ansell, 2008; Bryson et al., 2015). Academics, *positioned* as conceptors and evaluators, often find their research results and scientific recommendations neglected and not fully used in formulating regional government technical policies (Etzkowitz, 2000; Arnkil, 2010). The Business sector shows minimal participation, with private-sector support generally limited to incidental Corporate Social Responsibility (CSR) funds at the start of the program, without any long-term maintenance commitment (Etzkowitz, 2000; Carayannis et al., 2009). The Community sector *also* shows low involvement because public spaces are often designed without accommodating the real needs of the community, reducing residents' *sense of belonging* to green spaces (Gehl, 2010; Rosol, 2010). Lastly, the media element *has* not fully fulfilled its optimal function as a catalyst for public awareness education or as a critical supervisor of deviations in the conversion of urban land functions (Kankanhalli, 2017).

The government's implementation of Green Open Space (RTH) management policies is a crucial step in ensuring urban ecological sustainability and fulfilling spatial planning mandates (Wolch, 2014; Kabisch et al., 2016). This policy serves as an instrument for maintaining the city's physical sustainability, providing space for social interaction, and mitigating the impacts of rapid urbanization and land conversion processes (Wolch, 2014).

Despite this regulatory framework, the need for adequate and inclusive green open space in Bandung City remains largely unmet, with the city achieving only 12.25% of the

national target of 30% [4]. In response, current policy implementation faces significant multidimensional challenges. Public spaces often display a rigid bureaucratic atmosphere, and the application of *hostile architecture* further limits the inclusiveness of green spaces for marginalized groups and people with disabilities (Gehl, 2012). The success of this policy depends heavily on collaborative synergy among stakeholders, but field practice shows a fragmented approach still dominated by strong sectoral egos (Ansell, 2008; Emerson et al., 2012).

The findings of this study revealed that implementation of the Pentahelix collaborative model is hampered by weak bureaucratic coordination, limited human resource capacity, low-risk planning, vulnerable oversight, and fluctuating regulatory inconsistencies (Bryson et al., 2015; Bodin, 2017; Rosol, 2010). The results of this study underscore the importance of overhauling the governance structure to ensure that green open space management does not stop at a participatory concept but is also comprehensively monitored and supported by innovation (Emerson et al., 2012; Meiser et al., 2016).

Various factors influence each other in implementing green open space policies, as highlighted by *Collaborative Governance* and Pentahelix theories (Ansell, 2008; Etzkowitz, 2000; Carayannis et al., 2009). According to the Ansell and Gash model, a successful cross-actor collaboration process requires intensive face-to-face dialogue, efforts to build trust, strengthen commitment, and create shared understanding (Ansell, 2008; Emerson et al., 2012; Bryson et al., 2015). However, conditions in Bandung City show that collaboration is running suboptimally because related actors operate within the confines of a silo mentality (a compartmentalized/working-alone mentality), a lack of trust between institutions, and a lack of shared motivation to realize collective actions effectively (Bodin, 2017).

These findings are further strengthened by the views of research informants representing government agencies such as Bappelitbang and DLHK [15]. Based on the results of the interviews, it was revealed that although the provisions regarding the Basic Green Coefficient (KDH) have been formally integrated into the prerequisites for Building Approval (PBG), actual supervision in the field is still very weak due to the limited number of personnel and the absence of firm sanction instruments (Miao, 2025; Ostron, 1990). As a result, various spatial planning violations, such as unauthorized land conversion that occurs in various critical conservation areas (including the North Bandung Area), occur without any burden of legal consequences that serve as a deterrent, thus giving rise to the urgency of establishing an

integrated monitoring mechanism supported by digitalization interventions (Miao, 2025; Meijer et al., 2016); Kankanhalli, 2017).

The findings of this study are also consistent with previous research that highlights the complexity of green space governance systems in dense urban areas (Miao, 2025; Wolch, 2014). Past studies emphasize that limited land, low levels of community compliance, and weak coordination between government agencies are classic obstacles in managing green space in megacities in developing countries (Miao, 2025). This study argues that without a systems-thinking leadership figure and an institutional design capable of enforcing stable spatial control, efforts to achieve ecological and social benefits from green space will remain stagnant (Bryson et al., 2015; Ostron, 1990).

This research highlights the diversity of urban actors' responses to green open space policy regulations and urgently emphasizes addressing currently overlooked weak elements (Gehl, 2010; Wolch, 2014). The quality of physical infrastructure is often below standard, and public spaces repeatedly fail to fulfill their role as calming, secure, and supportive social arenas for participation from all levels of society (Gehl, 2010). The phenomenon of scarcity of innovation within the bureaucracy—particularly evident in the institutional reluctance to adopt digital-based governance architecture models and the slow assimilation of contemporary spatial mapping technologies (such as *Geographic Information Systems* / GIS)—has been shown to hinder the city's capacity to respond to a wide spectrum of threats to urban ecological damage dynamically (Meijder et al., 2016; Kankanhalli, 2017).

Although the classic Pentahelix format (covering elements of Government, Academics, Business, Community, and Media) has successfully provided a fundamental collaborative theoretical foundation (Etzkowitz, 2000; Carayannis et al., 2009; Arnkil, 2010) analytical findings suggest that the five-pillar structure is still too weak to plug leaks in the aspect of spatial law enforcement and data integration gaps that plague the green governance of Bandung City. Based on this argument, the novelty *of* this research lies in proposing a prototype Pentahelix-Integrative Governance model (Etskowitz, 2000; Meijer et al., 2016; Kankanhalli et al., 2017).

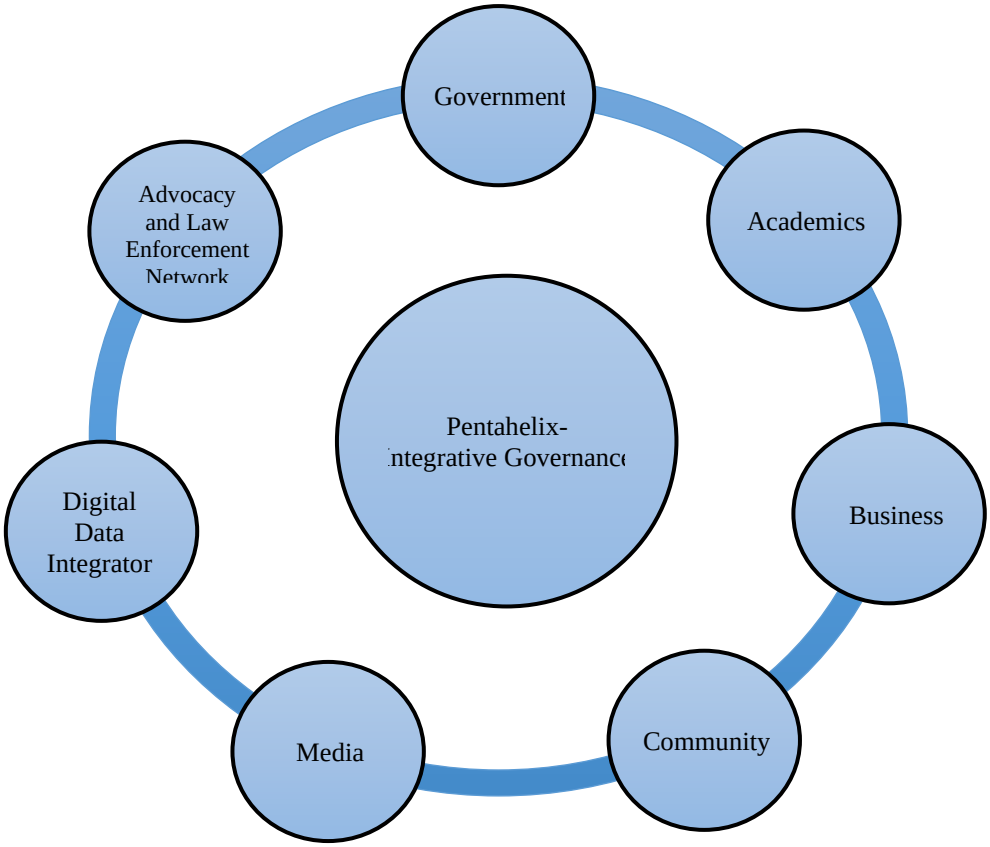

Fig. 2. Pentahelix Integrative Governance

This cutting-edge framework design explicitly recommends the integration of additional instruments by incorporating the function of a digital data integrator actor, combined with a network of environmental sustainability advocates and authoritative spatial law enforcement entities, in order to establish the foundation of a governance architecture that is not only inclusive and participatory, but also operates entirely with *real-time data - driven guidelines* and guarantees accountability under a legal umbrella (Emerson et al., 2012; Meijer et al., 2016; Kankanhalli et al., 2017).

Integrative-Pentahelix Governance Model in the Management of Green Open Space in Bandung City

Based on the results and discussion above, this study produced an Integrative-Pentahelix Governance model for managing green open space in Bandung City.

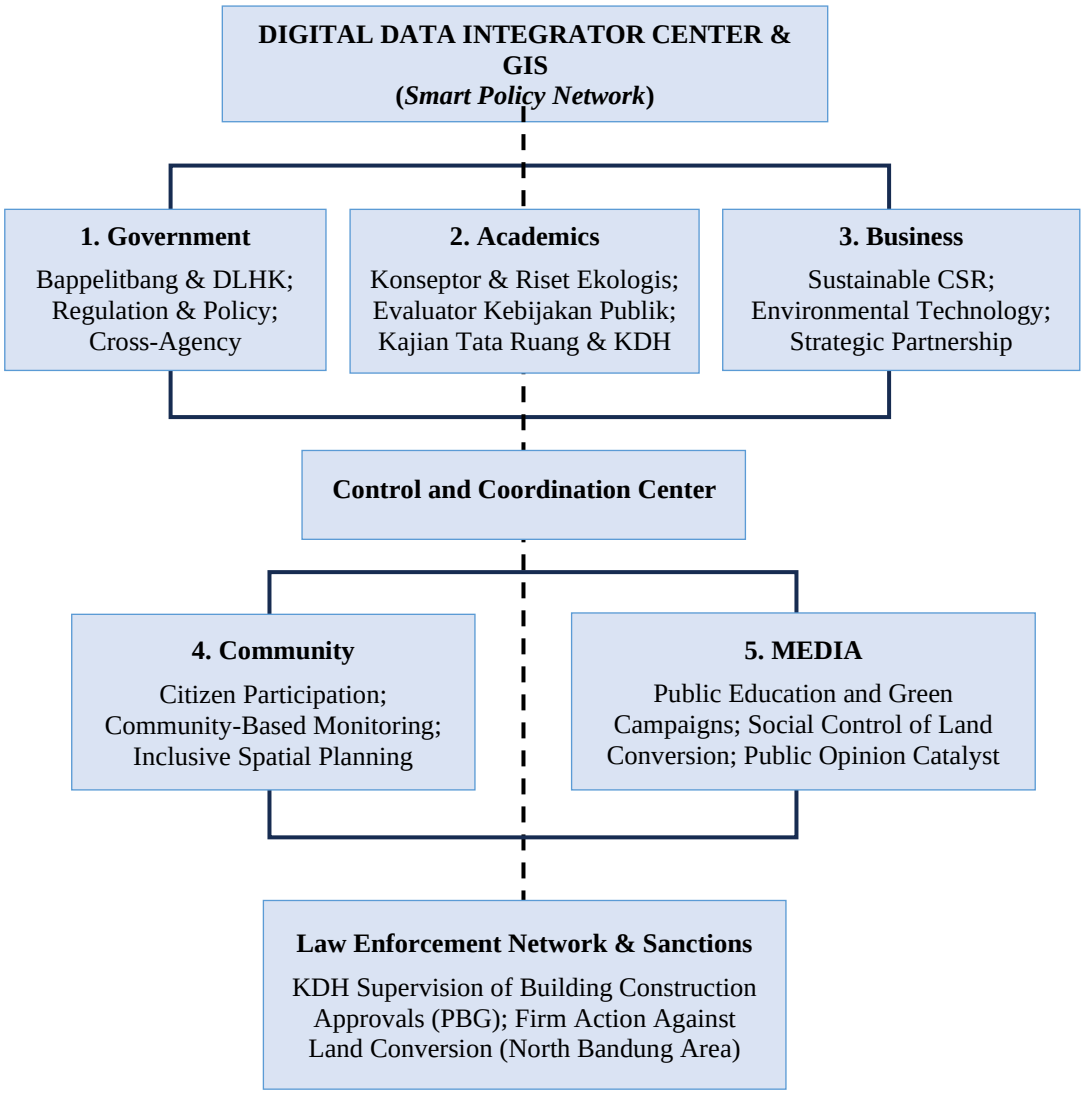

Figure 1. Integrative-Pentahelix Governance Model in the Management of Green Open Space in Bandung City

The Pentahelix Integrative Governance Model places a digital data integrator center and smart *policy network* as the central information hub that connects all stakeholders in *real-time*. This system is supported by Geographic Information System (GIS)-based mapping to transparently monitor the development of green open space (RTH) and accelerate achievement of the 30% target, while also early detecting potential threats of land conversion in urban areas.

The orchestration of this model is then driven through the synergy of five main actor pillars (*Pentahelix*). The Government element, through Bappelitbang and DLHK, acts as the main regulator tasked with reducing sectoral egos and aligning cross-agency policies. The Academic element acts as an independent conceptor and evaluator, providing a foundation for ecological research and spatial planning studies. The Business Sector participates by strengthening alternative funding through targeted *Corporate Social Responsibility (CSR)*

programs and providing environmentally friendly technologies. The Community is actively involved from the planning stage (co-design) to maintenance to foster a sense *of belonging* and ensure public spaces are free from exclusive designs or architecture that marginalizes residents (*hostile architecture*). Meanwhile, the Media element functions as a catalyst for public education, disseminating information on green policies, and acting as a critical watchdog *for* the transparency of public space management.

As a refinement of the conventional collaborative model, this framework explicitly introduces a spatial law enforcement network component to address weaknesses in field oversight and past regulatory inconsistencies. This mechanism is realized by tightening the binding of the Basic Green Coefficient (KDH) into the Building Approval (PBG) licensing instrument, as well as implementing firm and transparent legal sanctions for any party proven to have committed spatial planning violations, especially in critical conservation areas.

CONCLUSIONS

The management of Green Open Space in Bandung City is currently far below the spatial planning achievement standard of 30%, a critical condition largely driven by weak institutional coordination, inconsistent policy implementation, and a lack of technology-based innovation within the bureaucratic apparatus. Traditional collaborative formats are no longer adequate to address the complexity of implementation gaps and obstacles in the field. By transitioning the old approach to the use of the *Integrative-Pentahelix Governance framework model* that specifically integrates the presence of data digitalization actors and strengthens the firmness of the network function of law enforcement officers, the Bandung City Government will have adequate capabilities in formulating and implementing a sustainable green open space management ecosystem that is guided by the principles of transparency and accountability in order to realize the balance of natural ecological rights and the demands of the social life space of its citizens.

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