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Adaptive Pentahelix Governance: Integration of Multi-Stakeholder Collaboration and collaboration in Tourism Ecosystem development

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Abstract

Purpose

This study examines how Adaptive Pentahelix Governance enhances sustainable tourism governance through collaboration among government, academia, business, community, and media. It investigates stakeholder interactions in addressing governance complexity while developing an adaptive governance framework emphasizing collaborative learning, trust-building, and local values to strengthen tourism governance and contribute to Sustainable Development Goals (SDGs).

Design methodology :

A qualitative case study based on a constructivist paradigm was conducted in Kebumen Geopark. Data were collected through in-depth interviews with 25 purposively selected stakeholders, participant observation, focus group discussions, policy documents, statistical reports, and a PRISMA-based literature review. Verbal protocol, sociogram analysis, thematic coding, and NVivo software were employed to identify collaboration patterns, governance dynamics, and adaptive learning processes.

Findings :

The findings demonstrate that the Pentahelix model transforms tourism governance from a government-centred approach into an inclusive, participatory, and adaptive network. Collaboration strengthens environmental conservation, tourism innovation, community empowerment, and local economic development. However, coordination complexity, conflicting stakeholder interests, administrative burdens, and trust-building remain challenges. Adaptive learning, complementary stakeholder roles, and local social values significantly improve governance effectiveness, institutional resilience, and sustainable tourism outcomes.

Originality:

This study introduces the Adaptive Pentahelix Governance framework by integrating collaborative governance, adaptive governance principles, and the Pentahelix model within sustainable tourism management. The framework advances existing literature by highlighting adaptive learning, trust-building, and contextual local values as essential governance dimensions. It provides theoretical contributions for governance research and practical guidance for policymakers and destination managers implementing inclusive, adaptive, and sustainable tourism governance.

1. Introduction

The development of contemporary governance paradigms has undergone a fundamental evolution from traditional hierarchical models towards collaborative governance involving multiple stakeholders in addressing the complexity of development challenges (Goswami et al., 2026). This paradigm shift is increasingly relevant in the context of the Anthropocene era, where human activity has become a dominant factor influencing the Earth's system, demanding governance approaches that are more adaptive, inclusive, and knowledge-based (Steffen et al., 2011; Svedin, 2015). In the Indonesian context, this governance transformation aligns with the democratization and decentralization agenda that has been ongoing for more than two decades post-reform.

The concept of collaborative governance is defined as an arrangement where public and non-public actors engage collectively in a deliberative, formal, and shared-goal-oriented decision-making process (Emerson et al., 2012). Many scholars argue that collaborative governance models prove effective for addressing the complexity of multidimensional development issues that require cross-sectoral approaches (Prentice et al., 2019; Weber et al., 2007; Willi et al., 2018). In the context of local government, the collaborative approach becomes a crucial instrument for realizing policy effectiveness and strengthening regional capacity, especially in the management of complex natural resources.

One collaborative model now widely adopted is the Pentahelix model, which expands the Triple Helix (Leydesdorff, 2012) and Quadruple Helix concepts by incorporating the roles of community and media as essential pillars in the innovation and governance ecosystem (Afonso et al., 2012; Leydesdorff, 2012; Miller et al., 2018). This model is considered relevant for managing multidimensional areas such as geoparks, which focus not only on geological aspects but also on education, conservation, and community-based local economic empowerment.

Geoparks as areas with high-value geological heritage require integrative and inclusive governance approaches. UNESCO (2010) defines a geopark as a territory with outstanding geological heritage, managed in an integrated manner for the purposes of conservation, education, and community-based sustainable development. The geopark concept integrates three main pillars: geoheritage conservation, earth science education, and sustainable local economic development. Therefore, a geopark is not merely a conservation area but also a regional development instrument that integrates science, environmental preservation, and the socio-economic welfare of the local community.

One such geopark is the Kebumen Geopark. This geopark is located in Central Java Province and covers an area of 1,138.7 km² of land and 21.98 km² of waters, encompassing 22 sub-districts and 374 villages (BPS Kebumen, 2023). This area possesses extraordinary geological wealth with 41 geosites, 2 biosites, and 14 cultural sites representing the geological evolution of the southern Java region over tens of millions of years (Dinas Pariwisata dan Kebudayaan Kabupaten Kebumen, 2022). The formation history of the Kebumen Geopark originated from the Karangsambung area, known as the largest natural geology laboratory in Indonesia, which has been a site for geological research since 1964 by the research institution now known as BRIN Karangsambung.

Based on data from the Kebumen Regency Government (2023), the Kebumen Geopark has been designated as an Aspiring UNESCO Global Geopark and is in the process towards international recognition. This status presents both opportunities and challenges in management, particularly related to the demands of UNESCO management standards which require collaborative and participatory approaches. The main challenges faced include complex cross-sectoral coordination, limited institutional capacity, budgetary constraints, and the need for community capacity building.

This research offers several important novelties in the discourse of governance and collaboration government. First, this research integrates the Pentahelix framework with a collaborative governance approach in the context of a geopark in Indonesia, filling a literature gap regarding the implementation of multi-stakeholder collaboration models in the management of geological heritage areas. Second, this research develops the concept of "adaptive collaborative governance" which combines the principles of adaptive governance with the Pentahelix model in responding to the complexity of geopark management. Third, this research presents a comprehensive analysis of trust-building mechanisms and social capital in multi-stakeholder collaboration, which has thus far received limited attention in governance studies in Indonesia.

2. Methodology

2.1 Research Design and Approach

This study uses a constructivist paradigm that views social reality as the result of joint construction through interactions between actors (Creswell et al., 2007). A qualitative approach with an in-depth design accompanied by a literature review was chosen to fill the literature gap related to the implementation of multi-stakeholder collaboration models in the governance of geological heritage areas. Second, this study developed the concept of “adaptive collaborative governance,” which combines the principles of adaptive governance with the Pentahelix model in responding to the complexity of geopark management. Third, this study presents a comprehensive analysis of the mechanisms of trust and social capital formation in multi-stakeholder collaboration, which until now has not received adequate attention in governance studies in Indonesia.

The research was conducted in Kebumen Regency, Central Java Province, focusing on the core geopark areas of Karangsambung, Karangbolong, Logending, and Watu Bale. Location selection was based on considerations that these areas represent geosite diversity and collaborative interaction intensity. The research period spanned six months (January-June 2024), covering preparation, data collection, analysis, and validation stages.

2.2 Data Collection : Verbal (Interview) Protocol and Prisma

Cox et al. (2025) originally developed the verbal protocol method, which this study uses to investigate the information processing of informants (Sentanu et al., 2023). Within the framework of data search

analysis, verbal protocols can be used as a step to select interview results from informants, which will reveal thematic analysis patterns to determine the governance of geological heritage and the formation of trust and social capital in multi-stakeholder collaboration. Participants were asked to explain in detail how tourism geology is managed, starting from their initial exposure to policies, technical information on management, and management constraints. This verbal reconstruction provides deep insight into the subjective and contextual dynamics that shape the management system, as shown in Fig. 1.

The research utilized multiple data collection methods to achieve triangulation and analytical depth. Primary data was obtained through in-depth interviews with 25 key informants selected purposively based on their involvement in geopark management. Informants included government officials, BRIN academics, business actors, community members, and media representatives. Participant observation was conducted at geopark locations to watch collaborative interactions, educational activities, and decision-making processes. Focus group discussions were organized in three sessions with participants, each to discuss specific issues related to coordination and collaboration challenges.

The Prisma protocol was then used as a step in supplementing the literature to fill the gap in literature related to the implementation of multi-stakeholder collaboration models in the management of geological heritage areas. Scopus was chosen as the data source because articles published in Scopus-indexed journals are of high quality. The Prisma Protocol involves government documents such as secondary data obtained through policy document analysis, including Kebumen Regent Regulation No. 25 of 2023, the Kebumen Regional Medium-Term Development Plan (RPJMD), and other planning documents. Activity reports include annual geopark management reports, BRIN research reports, and community activity reports. Media publications are monitored through coverage of Kebumen Geopark in local and national media. Statistical data is obtained from the Kebumen Central Statistics Agency (BPS) and the Tourism Office, as shown in Fig. 2.

2.3 Data Analysis

This study employs sociogram analysis, thematic analysis and a literature review. Sociogram analysis is a technique for mapping social relationships, preferences and structures amongst individuals within a group (Mendes et al., 2013) this type of analysis is used to identify models of collaboration amongst actors in the implementation of collaborative governance. Thematic analysis is then used to identify, analyse and interpret patterns of meaning in the data generated from interviews and the literature through coding (Javadi et al., 2025). In conducting the analysis, the researcher uses NVivo for the coding management of interview results (Razak et al., 2024). This facilitates the interpretation of the analysis results.

3. Research Findings

3.1 Implementation of the Pentahelix Model in Indonesia

Behind the visible achievements, the collaborative process faced challenges, particularly in building trust among the five stakeholders, as shown in Fig. 3. Based on interviews with community representatives, in the early years, there was a high level of skepticism towards the geopark program, which was considered a “government project” that would disrupt livelihoods and traditional lands. The process of building trust over 2–3 years was crucial to changing this perception, facilitated by the neutral role of the National Research Agency (BRIN) as a mediator of knowledge and the cultural approach of the local government.

Indonesia has a wide variety of geoparks, such as the Kebumen Geopark, which has unique geological features that reflect the complex tectonic evolution of South Java. According to BRIN data (2025), this region holds records of the subduction of the Indo-Australian Plate under the Eurasian Plate for more than 100 million years. There are 41 geosites classified into five main clusters: the metamorphic rock cluster in Karangsambung, the sedimentary rock cluster in the Waturanda and Penosogan Formations, the igneous rock cluster in Sempor and Buayan, the geomorphological cluster in Karangbolong Karst and Logending beach, and the paleontological cluster in Watu Bale.

In the implementation of the pentahelix model in Indonesia, there is significant involvement from various stakeholders, such as local government, researchers (BRIN), the business sector, the public and the media. This situation presents challenges in implementation, such as coordination between stakeholders; the greater the number of stakeholders involved, the more it hinders communication between them (Perdana, 2025). Another challenge is that as the number of actors increases, so do their respective interests (Sentanu et al., 2023) as indicated by the results of interviews conducted, the involvement of these actors is often driven by motives specific to their own groups.

Consequently, the pentahelix model involving five actors, as shown in Fig. 3, is ineffective and places an administrative burden on local government. Administrative burdens can hinder the efficiency and effectiveness of development programme implementation; consequently, efforts are needed to streamline procedures and enhance collaboration among pentahelix actors (Kelvin et al., 2022). Streamlining procedures within the pentahelix can be achieved by examining the social realities at play, as illustrated in Table 1 regarding the dynamics of the pentahelix viewed as a tourism development strategy. The social realities in Table 1 are used as a grounded theory study to reconstruct the development of the pentahelix concept within good tourism governance.

3.2 The dynamics of the pentahelix strategy in the tourism ecosystem

Pentahelix dipahami sebagai strategi Pembangunan dalam melakukan integrasi dari berbagai macam peran dan fungsi setiap actor (Ahwan et al., 2026). The Pentahelix strategy aims to create a synergistic collaboration among these stakeholders to address challenges, optimize resources, and promote sustainable tourism development (Ramadhan et al., 2025). This approach not only enhances stakeholder engagement but also fosters a more resilient tourism ecosystem that can adapt to emerging challenges (Ramadhan et al., 2025). This resilience is crucial in the face of various threats, including economic fluctuations and environmental changes, ensuring the long-term viability of tourism initiatives. Moreover,

the Pentahelix model highlights the importance of coordinated efforts among government, academia, businesses, communities, and media to effectively tackle these challenges and enhance tourism resilience (Chandra et al., 2025). Pentahelix development is therefore considered an appropriate strategy for building a tourism ecosystem, as shown in the dynamics of pentahelix implementation presented in Table 1.

Table 1
Key Performance and Dimension Pentahelix Exosystem Based on Empiric

Author	Key Performance	Dimension Pentahelix Ecosystem	Quote Direct
(Sanjaya et al., 2025)	Collaboration government, private sectors, Community, academia and media	Tourism development and community welfare	This study examines the influence of penta-helix elements (government, private sector, community, academia, and media) on tourism development and community welfare at Alas Kedaton, Tabanan, revealing significant relationships and a mediating effect of tourism development performance.
(Cornellia et al., 2025)	academia, government, business, community, and media	environmental conservation, cultural preservation, and socio-economic	This study examines Desa Wisata Sambirejo, Indonesia, as a model for sustainable rural tourism, integrating environmental conservation, cultural preservation, and socio-economic growth through a Pentahelix approach, highlighting best practices and challenges for destination competitiveness.
(Maghfira & Pratiwi, 2024; Ramadhan et al., 2025)	government, academia, business actors, communities, and media	enhance economic, social, environmental, and cultural	This study introduces SINERGISTA, a digital-based sustainable tourism strategy through the Pentahelix Connectors model, to enhance economic, social, environmental, and cultural value in Indonesia's agrotourism, promoting synergy among stakeholders and digitalization for market expansion and destination management.
(Chandra et al., 2025)	local communities, government, private sectors, and stakeholders	Community-based tourism	The paper does not specifically address the Pentahelix aspects and dimensions in tourism management. It focuses on community-based tourism (CBT) in Bali, emphasizing local resident involvement and empowerment in a tourism industry historically influenced by external forces. The study highlights the importance of partnerships among local communities, government, private sectors, and other stakeholders to enhance sustainable tourism practices, but does not delve into the Pentahelix framework.
(Purnomo et al., 2020)	leadership, innovation, collaboration, and good governance	spatial, sectoral, human resources, and information technology	In this paper, the authors examined the community empowerment model to develop sustainable tourism villages in Indonesia and found that the tourism development carried out in the Ponggok Village used four approaches (1) spatial approach as a basis in determining the direction of village development; (2)

Author	Key Performance	Dimension Pentahelix Ecosystem	Quote Direct
			sectoral approach through increasing the role of the Village Owned Enterprises to build the village economy; (3) human resources to enhance village communities in managing village potentials; and (4) use of information technology to improve service quality, transparency and accountability.
(Chamidah et al., 2020)	government, academics, community, business, and media	marketing communication	In this article, the authors present explicit findings from an internal perspective, namely the interaction patterns of marketing communication between pentahelix elements and testing the expectations of tourists towards tourism activities through a simulation model between variables.
(Scheyvens & Van Der Watt, 2021)	psychological, social, economic, and political	Empowerment and Sustainable Development Framework	The paper does not specifically address the Pentahelix aspects and dimensions in tourism management. Instead, it critiques the empowerment framework by Scheyvens, which includes psychological, social, economic, and political dimensions, and suggests adding environmental and cultural dimensions. The proposed Empowerment and Sustainable Development Framework emphasizes enabling factors that support community empowerment within the context of sustainable development, but it does not delve into the Pentahelix model.
(Mohamed Al et al., 2023; Musleh, Subianto, & Prasita, 2023)	stakeholder collaboration, including traditional groups, government, and private sectors	initiatives and the role of traditional authority	The paper does not specifically address the Pentahelix aspects and dimensions in tourism management. However, it emphasizes the importance of stakeholder collaboration, including traditional groups, government, and private sectors, in managing pilgrimage tourism. The study highlights facilitative leadership and enabling environmental factors as crucial resources for successful collaborative governance, suggesting that a broader collaboration network could enhance tourism management at the Asta Tinggi site. The focus remains on community-driven initiatives and the role of traditional authority.

Author	Key Performance	Dimension Pentahelix Ecosystem	Quote Direct
(Sumarto et al., 2020)	government, tourism industry, higher education institutions, media, and society	Government collaboration, tourism industry, higher education instituions provide innovation, media promotes, society engages cultural	Penta-Helix in tourism management includes five key elements: the government, tourism industry, higher education institutions, media, and society. Each aspect plays a crucial role in optimizing tourism village management by fostering synergistic interactions. The government supports development, the tourism industry drives economic growth, higher education institutions provide innovation, media promotes attractions, and society engages in cultural preservation. Together, these dimensions enhance the quality of tourism management, attract more visitors, and contribute to sustainable development in tourism villages.
(Eyisi et al., 2021)	engaging local communities, government, private sector, academia, and civil society	Collaboration and community participation	The paper does not specifically address the Pentahelix aspects and dimensions in tourism management. However, it emphasizes the importance of collaboration and community participation among various stakeholders in tourism development. This includes engaging local communities, government, private sector, academia, and civil society to ensure sustainable tourism practices. Listening to and responding to diverse voices and concerns is crucial for effective tourism management and fostering a collaborative environment that benefits all parties involved.
(Haleem et al., 2022)	relationship stakeholder and sustainable management practices	environmental, social, and economic dimensions	The research findings reveal that the majority of studies focus on the environmental dimensions of sustainability, with less attention given to the social dimensions. Additionally, the interaction between environmental, social, and economic dimensions (the triple-bottom-line) is underexplored, suggesting a need for future research to investigate these dimensions collectively to gain a comprehensive understanding of sustainability.

In the context of sustainable tourism development, the performance of the pentahelix model is not only measured by an increase in the number of tourists or economic revenue, but also encompasses broader aspects such as community well-being, destination competitiveness, quality of governance, and the effectiveness of marketing communications, as shown in Table 1 under the pentahelix dimensions,

which can be described as an ecosystem. Collaboration between these actors enables the integration of resources, knowledge, innovation, and communication networks capable of strengthening tourism development performance in a holistic manner.

Figure 4 illustrates that the pentahelix ecosystem encompasses the areas of environmental preservation, socio-economic development, and tourism community governance. The application of the pentahelix model in environmental preservation is designed to address complex environmental challenges by harnessing the unique strengths and resources of each stakeholder (Wicaksono et al., 2023). The impact of applying the pentahelix model to tourism governance facilitates collaboration between managers with a mission of environmental conservation, as shown in Fig. 4.

Furthermore, the pentahelix model can be applied to socio-economic development to drive innovation, thereby boosting economic growth, particularly for SMEs. Furthermore, as shown in Fig. 4, the pentahelix can be applied to tourism community governance with the aim of improving the community's economy through collaborative governance that prioritises the involvement of SMEs and serves as a strategy for stakeholders.

The pentahelix can be implemented through collaborative governance involving stakeholders from government, academia, business and the community, as shown in the analysis in Fig. 4. These stakeholders have distinct roles in the implementation of the pentahelix, as illustrated in Fig. 4: the Government facilitates collaborative governance by establishing regulations and infrastructure. Academia, meanwhile, assesses tourism potential, provides training to the community on tourism governance, and helps develop tourism management frameworks. Furthermore, the business sector provides facilities and long-term investment to stimulate the creation of a new economy within the community. The final stakeholder is the community, which plays a strategic role in managing tourism, prioritising community-based governance practices.

3.3 Pattern Model Collaboration Pentahelix Local Governance

The implementation of the Pentahelix Collaborative Governance Model in Kebumen Geopark has created a tiered governance structure that is vertically and horizontally integrated, ensuring effective coordination from policy formulation to implementation in the field. At the top level, the Geopark Management Board, which includes the Regent of Kebumen, the Director of the National Research Agency (BRIN), and community representatives chosen through a participatory process, helps set overall policy goals and a long-term vision, while also giving political and scientific support for all geopark activities. Through the information provided by the Geopark management, governance requires that regional and national development plans be considered in strategic decision-making. The pentahelix actors in tourism governance form this pattern, as shown in Fig. 5.

The system that coordinates different sectors, based on the government pentahelix, helps bring people together by turning strategic policies into real actions, creating detailed plans, sharing resources, and supporting the pentahelix actors (community representatives, researchers, business groups, and government), as shown in Fig. 5 on how the pentahelix works together. This partnership grows through a cycle of four phases that are all connected. The participatory planning phase begins with a special meeting for geopark development that involves all Pentahelix actors, where academics contribute research data, business actors provide market potential input, communities convey local aspirations, the government proposes policies, and the media helps compile public narratives, resulting in a comprehensive Annual Work Plan with mutual commitments.

The coordinated implementation phase involves everyone taking on specific roles based on their strengths: BRIN handles research and conservation, businesses focus on the creative economy, communities lead social and educational programs, the government supports infrastructure, and the media takes care of communications, all backed by a shared information system to track progress and ensure transparency. The collaborative monitoring phase is carried out jointly using agreed-upon key performance indicators, with quarterly performance review forums analyzing achievements, challenges, and lessons learned from all parties. The learning and adaptation phase is at the core of adaptive collaboration, where monitoring results become materials for collective reflection to document successes as best practices and analyze failures for strategy improvement, enabling the collaboration model to continuously adapt to external changes and internal dynamics.

3.4 Adaptif Pentahelix Model Collaboration

Based on the research findings, the implementation of the Pentahelix Collaborative Governance model has indeed led to governance transformation in Kebumen Geopark. However, these findings expand upon Osborne's (2010) discourse by showing that the transformation from government-centric to network governance is not a smooth linear process, but rather a continuous negotiation colored by power dynamics and conflicts of interest. While the government has shifted its role to become a facilitator, the authority and resources it possesses create a 'shadow of hierarchy' that continues to influence the collaboration process (Goswami et al., 2026).

The government's role transformation is evident in three main dimensions. The government has shifted from a controlling position to a facilitator creating a conducive environment for collaboration, functioning as a catalyst that triggers initiatives and innovations from various stakeholders, and acting as an integrator that unites various resources and capacities to achieve common goals (Emerson et al., 2012). This transformation enables the realization of greater public value through the utilization of collective intelligence and shared resources from all involved actors.

The integration of the five Pentahelix actors creates a synergistic innovation ecosystem with complementary role configurations (Musleh, Subianto, Tamrin, et al., 2023). Academia serves as knowledge producers through research-based knowledge production that forms the scientific foundation for geopark management. The business sector functions as value creators that transform geopark

potential into economic value through innovative product and service development. Local communities act as social mobilizers that mobilize community participation and maintain socio-cultural sustainability. The government plays the role of system facilitator providing regulatory frameworks, policies, and supporting infrastructure. Media functions as image builders that construct positive narratives and expand the reach of geopark promotion.

The synergy of these five actors produces multiplier effects that accelerate geopark development through knowledge dissemination mechanisms, resource sharing, and innovation diffusion (Etzkowitz & Leydesdorff, 2000; Leydesdorff, 2012). Intensive interactions among actors create dynamic complements where the strength of one actor can compensate for the weaknesses of others, thus generating greater added value compared to individual contributions of each actor.

The Pentahelix model successfully surpasses the limitations of the Triple Helix model by including the crucial roles of community and media as the fifth pillar. In the Indonesian context which has strong social capital based on mutual cooperation and family values, community involvement as formal actors in the collaboration structure becomes a determining success factor (Setyo et al., 2025). Community participation not only guarantees representation of local community interests but also utilizes traditionally formed social capital to strengthen social cohesion in geopark management.

Meanwhile, media participation as strategic actors represents a response to the development of information society in Indonesia. With increasingly widespread internet and social media penetration, media has significant influence in shaping public opinion and agenda setting. Media involvement in the Pentahelix model ensures that geopark development narratives can be effectively delivered to wider audiences, while building brand awareness and public support.

These findings align with research emphasizing the importance of adjusting collaboration models to local socio-cultural conditions. The implementation of the Pentahelix model in Kebumen Geopark shows that collaboration success is not only determined by proper institutional design but also by the ability to adapt the model to local social, cultural, and political characteristics (Brinkerhoff, 1999). This contextual approach enables the Pentahelix model to function effectively in Indonesia's unique governance ecosystem.

The transformation towards network governance through the Pentahelix model has brought significant improvement in Kebumen Geopark governance effectiveness. The more decentralized governance structure enables faster and more adaptive responses to local dynamic changes (Steffen et al., 2011). Resource diversity from various actors increases system resilience in facing various challenges. The inclusive nature in decision-making processes strengthens legitimacy and public support for geopark management policies (Gavris & Savage, 2026).

The Adaptive Pentahelix Governance concept proposed in this research differs from conventional collaborative governance models in three aspects: first, explicit emphasis on adaptive learning mechanisms as the soul of collaboration; second, structural integration of five actors with

complementary characteristics; third, contextualization of local values as collaboration enablers rather than merely supporting factors. This concept surpasses the static Pentahelix model by emphasizing learning and adaptation dimensions as the soul of collaboration itself.

These findings have important theoretical implications for governance theory development, particularly in developing country contexts. The contextualized Pentahelix model offers a more comprehensive analytical framework for understanding governance complexity in Indonesia's socio-cultural setting. From a practical perspective, the successful implementation of this model in Kebumen Geopark can become a blueprint for similar area development in Indonesia, with modifications adjusted to specific characteristics of each region.

Governance transformation through the Pentahelix Collaborative Governance model in Kebumen Geopark thus represents not only structural change but also cultural change in local government practices towards approaches that are more collaborative, inclusive, and adaptive to local conditions.

4. Conclusion

This research concludes that the implementation of the Pentahelix Collaborative Governance model has transformed the governance of Kebumen Geopark towards a more inclusive, participatory, and sustainable system. This transformation is marked by a shift from government-centric to network governance where the government acts as a collaboration catalyst. The formation of a knowledge ecosystem integrating academic research, business innovation, community participation, government policy, and media publication became the key success factor.

This multi-party collaboration not only accelerated geopark development but also contributed to strengthening regional governance and achieving SDGs. This success demonstrates that the Pentahelix model can be an effective framework for managing complex areas such as geoparks. These research findings have relevance not only for geopark development but also for the management of other conservation areas and cultural heritage sites in Indonesia.

This research makes important contributions to governance theory development through the conceptualization of "Adaptive Pentahelix Governance" which integrates adaptive governance principles with the Pentahelix model. The elaboration of trust-building mechanisms in the context of multi-party collaboration in Indonesia provides deep understanding of social dynamics in collaboration. The development of a framework for assessing collaborative governance effectiveness in natural resource management offers analytical instruments that can be used in similar studies. These contributions enrich governance studies discourse, particularly in developing country contexts with unique institutional and social characteristics. The integration between Western governance theory and Indonesian local values in this model opens new perspectives in governance studies in the Global South.

For policymakers, this research offers several important implications. Based on the findings, we recommend: (1) Allocation of minimum 5% of total geopark budget for capacity building programs based

on specific needs of each actor; (2) Establishment of an independent monitoring unit with representatives from all five helixes to ensure accountability; (3) Development of financial incentive schemes for companies consistently implementing geopark-based CSR programs. Strengthening local government capacity as collaboration facilitators becomes an urgent need for replicating this model. Sustainable budgeting for collaborative programs needs to become a priority in regional development planning. Participatory monitoring and evaluation systems are required to ensure accountability and continuous learning. For geopark management practitioners, the research findings provide implementation guidance for the Pentahelix model, including coordination mechanisms, trust building, and conflict resolution. Kebumen Geopark experience can become a best practice adapted according to local contexts of each area.

However, this research has several limitations that need acknowledgment. First, as a single case study, the findings and resulting model are highly contextual and rich in local nuances, yet generalizing findings to other geopark contexts with different social and political characteristics must be done carefully. Second, there is potential for participant bias since most informants were actively involved actors who might tend to present a narrative of success. Perspectives from parties who withdrew or felt disadvantaged by the collaboration may not be fully represented. Third, although the collaboration model shows correlation with various achievements, this qualitative research design cannot prove definitive causal relationships. External factors such as national economic recovery post-pandemic may have also contributed to the observed economic growth. Several follow-up studies can be conducted, for example comparative studies between Kebumen Geopark and other geoparks in Indonesia; Longitudinal studies to observe collaboration evolution in the long term; Impact assessment to measure specific impacts on SDGs; Policy analysis to analyze the effectiveness of various supporting policies.

Declarations

Ethical Approval

The research protocol was reviewed and approved by the Research Ethics Committee of Universitas Pancasakti Tegal in accordance with the Committee's ethical guidelines and applicable regulations. The study was conducted in accordance with the ethical principles outlined in the 1964 Declaration of Helsinki and its subsequent amendments, or equivalent ethical standards. All procedures involving human participants adhered to the approved research protocol and ethical requirements. Prior to data collection, written informed consent was obtained from all participants. Participants were fully informed about the objectives and procedures of the study, the voluntary nature of their participation, and their right to withdraw from the study at any time without penalty or adverse consequences. They were also assured that their identities and responses would be kept confidential and anonymous and that all data collected would be used solely for academic and research purposes.

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Author Contribution

AK : Ideas; formulation or evolution of overarching research goals and aims; Preparation, creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation)AZ : Conducting a research and investigation process, specifically performing the experiments, or data/evidence collection; Development or design of methodology; creation of models.MY : Programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components; Oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team.KAR : Preparation, creation and/or presentation of the published work, specifically visualization/data presentation.

Data Availability

The data that support the findings of this study are available from Universitas Pancasakti Tegal, but restrictions apply to the availability of these data, which were used under licence for the current study and so are not publicly available. The data are, however, available from the authors upon reasonable request and with the permission of Universitas Pancasakti Tegal.

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Figures

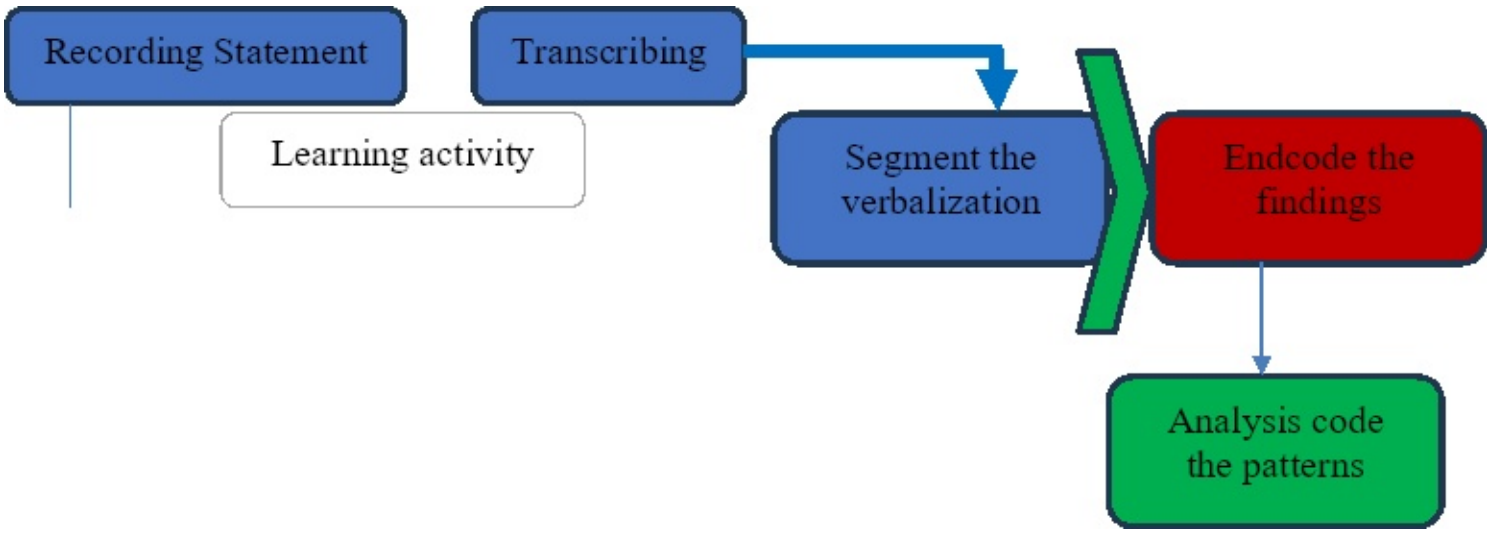


Figure 1

Verbal Protocol Approach

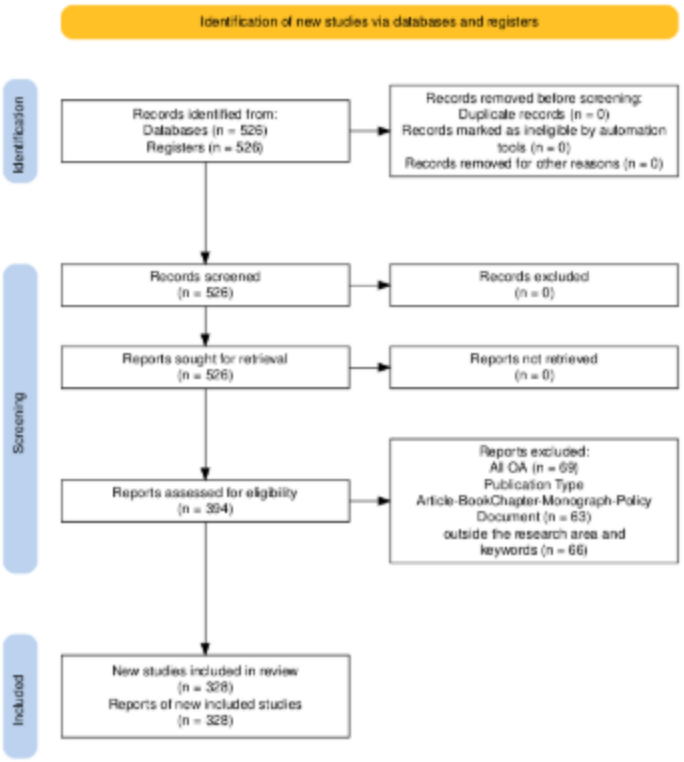
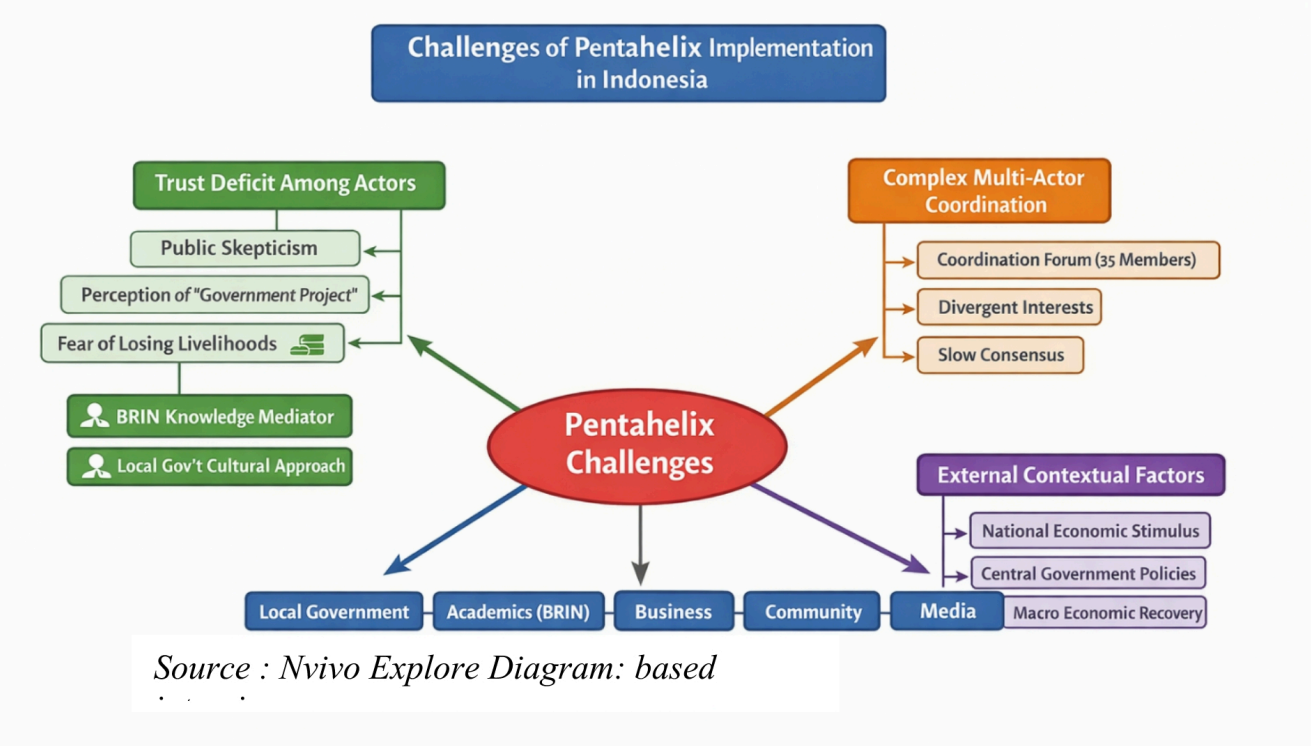


Figure 2

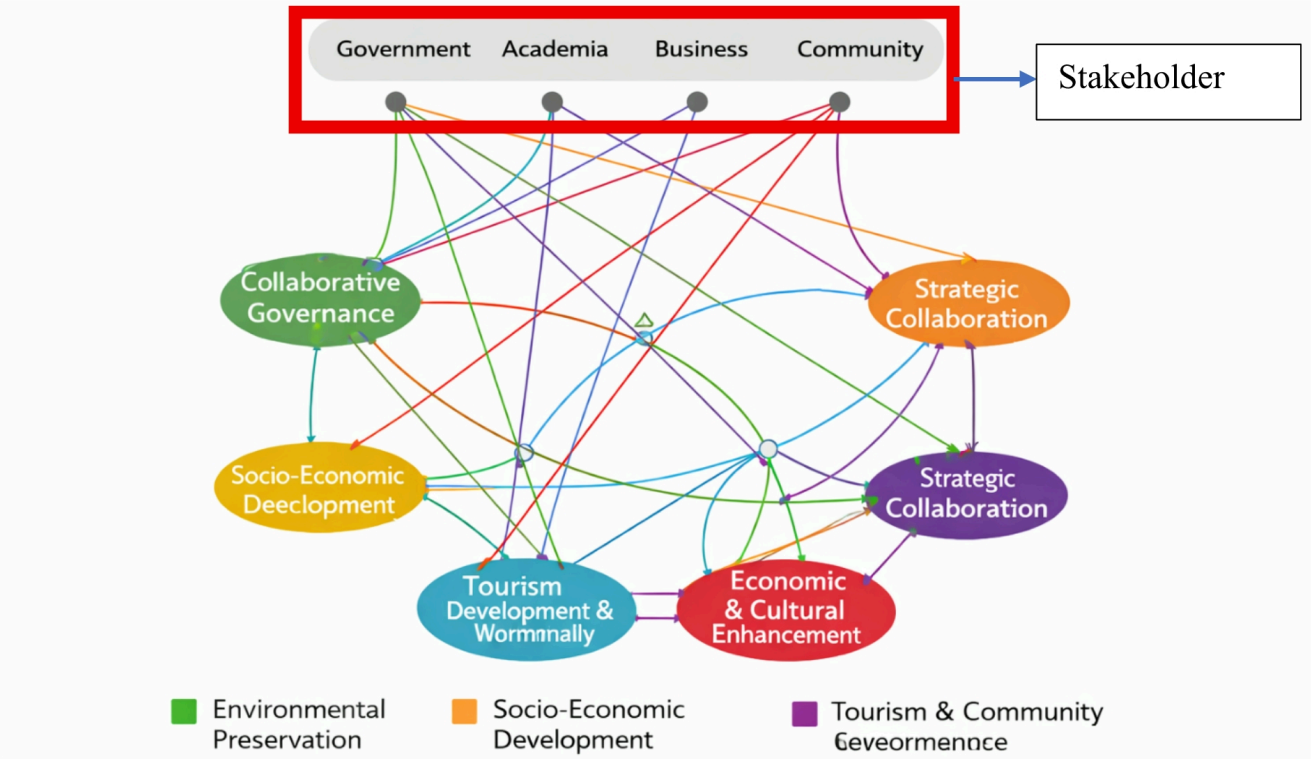
Prisma Protocol: Literature search and secondary documents



Source : Nvivo Explore Diagram: based

Figure 3

Challenges of Pentahelix Administrative

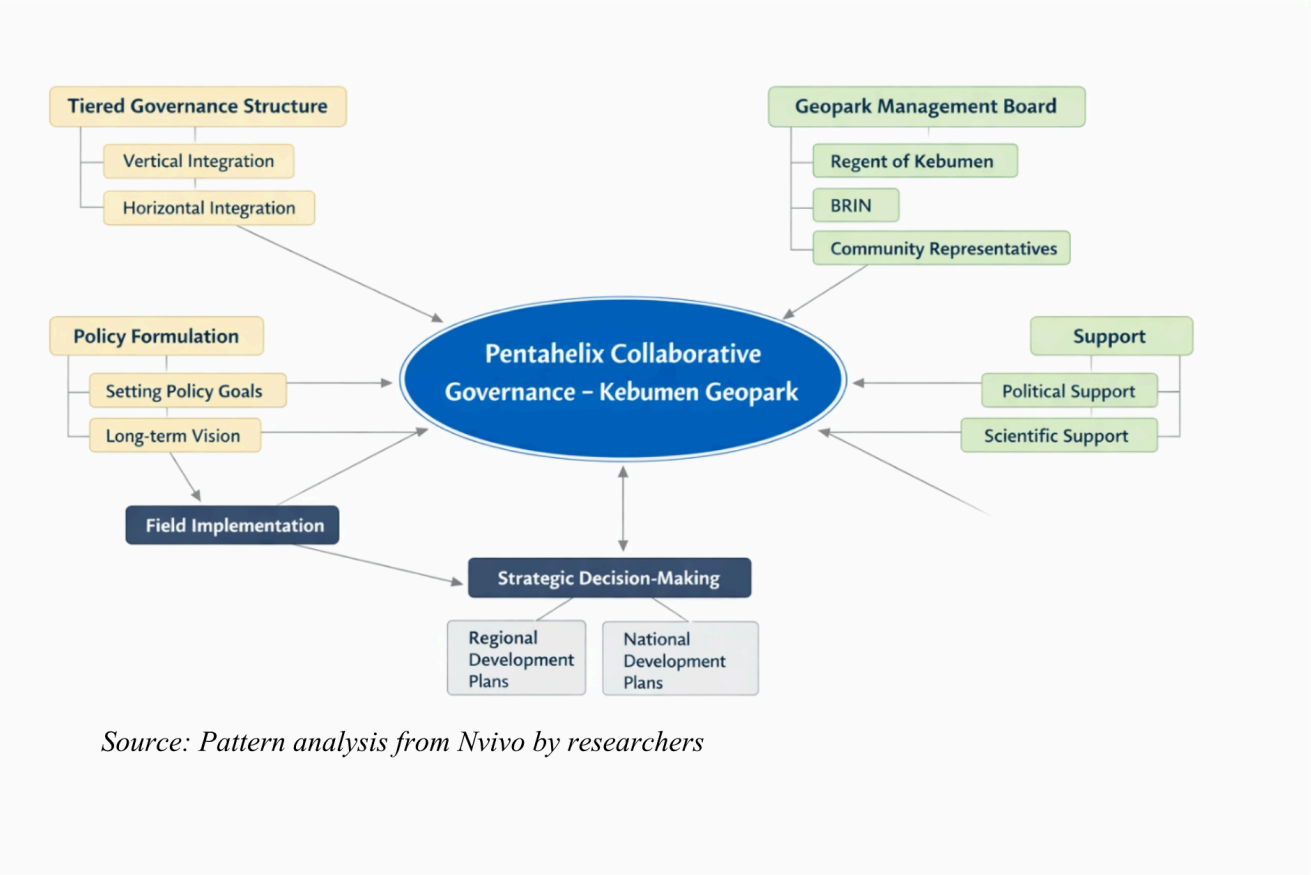


Source: Sociogram analysis from Nvivo by researchers

Source: Sociogram analysis from Nvivo by researchers

Figure 4

Sociogram Nvivo : Key Performance Ecosystem Pentahelix



Source: Pattern analysis from Nvivo by researchers

Figure 5

Pentahelix Model Collaboration