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# The Role of Pentahelix in Flood Disaster Risk Reduction in Cirebon City to Achieve Regional Security

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**Abstrak**

Banjir masif di Kota Cirebon menimbulkan ancaman signifikan terhadap keamanan regional, sehingga membutuhkan pendekatan kolaboratif pengurangan risiko bencana (PRB). Studi ini mengkaji peran dan efektivitas model Pentahelix, yang melibatkan pemerintah, akademisi, pelaku bisnis, komunitas, dan media, dalam mengelola risiko banjir. Menggunakan studi kasus kualitatif, peneliti mengumpulkan data dari Badan Penanggulangan Bencana Daerah (BPBD) Kota Cirebon dan aktor-aktor kunci lainnya melalui wawancara mendalam dan observasi partisipan. Temuan menunjukkan bahwa setiap aktor Pentahelix memainkan peran yang unik dan saling melengkapi, meskipun masih terdapat tantangan dalam koordinasi. Inisiatif-inisiatif efektif, seperti program "Kota Cinta", telah dilaksanakan untuk meningkatkan kesiapsiagaan lokal. Penelitian ini menekankan peran penting media dalam menyebarluaskan informasi dan memobilisasi publik, suatu aspek yang sering diabaikan dalam model-model kolaboratif sebelumnya. Pada akhirnya, studi ini menyimpulkan bahwa model Pentahelix efektif dalam membangun kapasitas PRB banjir dan meningkatkan keamanan regional melalui keterlibatan masyarakat yang inklusif dan berkelanjutan.

**Kata kunci:** Pentahelix, Pengurangan Risiko Bencana, Banjir, Keamanan Wilayah, Kota Cirebon

***Abstract***

*Massive flooding in Cirebon City poses a significant threat to regional security, requiring a collaborative disaster risk reduction (DRR) approach. This study examines the Pentahelix model's role and effectiveness, which includes government, academics, businesses, communities, and media, in managing flood risks. Using a qualitative case study, researchers gathered data from the Cirebon City Regional Disaster Management Agency (BPBD) and other key actors through in-depth interviews and participant observation. The findings show that each Pentahelix actor plays a unique and complementary role, although challenges in coordination still exist. Effective initiatives, such as the "Kota Cinta" program, have been implemented to boost local preparedness. The research emphasizes the critical role of media in disseminating information and mobilizing the public, an aspect often overlooked in previous collaborative models. Ultimately, the study concludes that the Pentahelix model is effective in building flood DRR capacity and enhancing regional security through inclusive and sustainable community engagement.*

***Keywords*** **:** *Pentahelix, Disaster Risk Reduction, Floods, Regional Security, Cirebon City*

## Introduction

Floods are the most frequent hydrometeorological disaster and cause significant material losses and loss of life globally. Data from the United Nations Office for Disaster Risk Reduction (UNDRR) consistently ranks floods as the most dominant disaster, accounting for nearly half of all weather-related disasters in recent decades (Wallemacq & House, 2018). In Indonesia, as an archipelagic nation with high rainfall, varied topography, and high population density in vulnerable areas, flood risk poses a crucial multidimensional challenge. The National Disaster Management Agency (BNPB) notes that floods dominate disaster events in Indonesia every year, causing infrastructure damage, economic disruption, social losses, and even loss of life (BNPB, 2025). These impacts are not only acute when a disaster occurs, but also chronic through deterioration of environmental quality, public health, and regional economic resilience, ultimately threatening regional stability and security in a broader sense. Regional security here does not only mean the absence of physical conflict, but rather the realization of a community that is protected from disaster hazards (secure from disasters), has access to basic resources, and is able to function socio-economically in a sustainable manner.

Flooding is now an increasingly complex threat. This is driven by the increasing frequency and intensity of extreme weather events due to climate change, including extremely heavy rainfall, which is a major trigger for flooding (IPCC, 2023). This situation is exacerbated by massive and often uncontrolled urbanization in developing countries like Indonesia. Urban areas, which serve as centers of economic and population growth, are often built in low-lying areas or along river courses, increasing the potential for damage when floods strike. Global economic losses from flooding are estimated to reach hundreds of billions of US dollars annually, hampering the achievement of the Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty), SDG 11 (Sustainable Cities and Human Settlements), and SDG 13 (Addressing Climate Change) (UNDRR, 2022). In Indonesia, the economic and social burden of flooding is felt profoundly, not only through direct asset damage but also through supply chain disruptions, reduced productivity, soaring health costs, and long-term damage to life-supporting ecosystems.

Cirebon City, as one of the important metropolitan cities on the north coast of Java (Pantura) which is a transportation and trade hub, faces high vulnerability to flood disasters. Contributing factors include: (1) Geographical Factors: Located in a coastal lowland area and traversed by several large rivers (Kedung Pane River, Sukalila River, Suba River, and Kalijaga River) and their tributaries, making it vulnerable to water runoff from upstream and river overflows. (2) Hydro-Oceanographic Factors: High rainfall especially during the rainy season, increasingly intense tidal phenomena (rob) exacerbated by climate change and land subsidence, resulting in pools of water from the sea that are difficult to dispose of (Marfai, 2018). (3) Anthropogenic Factors: Rapid urban development has caused the conversion of green and infiltration areas into built-up areas, reduced drainage channel capacity due to sedimentation and waste, and population pressure that increases the volume of surface runoff (Asrul et al., 2025).

A recent study by Bramanto et al. (2023) revealed that Cirebon City is facing significant land subsidence, reaching an average of 1.7-5 cm per year in some locations. This subsidence, which is mostly occurring in coastal and industrial areas, is driven by excessive groundwater extraction and infrastructure strain. The consequences of this phenomenon are already clear; the recurring major floods in several locations each year, such as those in 2018, are clear evidence of the risks Cirebon faces. The resulting flooding paralyzes economic activity, damages homes

and public infrastructure, causes disease outbreaks, and disrupts the sense of security and well-being of the community, thus threatening the security of the Cirebon City region.

Global and national approaches to disaster management have undergone a significant shift, from a focus on emergency (reactive) responses to a more proactive and preventative approach to disaster risk reduction (DRR). The Sendai Framework for Disaster Risk Reduction 2015-2030 (UNDRR, 2015) emphasizes the importance of understanding disaster risks, strengthening risk governance, investing in resilience, and enhancing preparedness. Key to the DRR approach is the recognition that managing complex disaster risks such as urban flooding cannot be addressed by a single stakeholder alone. Traditional government-centric approaches often prove inadequate in addressing the dynamics and complexity of urban flooding (Lassa, 2013). Inclusive and synergistic collaboration is required across diverse actors with varying resources, knowledge, capacities, and interests.

Responding to the complexity of urban flood risk management, which is no longer effective if it relies solely on a sectoral or government-centric approach, the Pentahelix collaboration model has emerged as a strategic and holistic framework. This model is an extension of the Triple Helix (academia-business-government) and Quadruple Helix (community involvement) concepts, explicitly incorporating the media as a crucial fifth pillar (Simanjuntak et al., 2024; Sumarna et al., 2025). The synergy of these five actors is expected to provide complementary resources, perspectives, and capacities: academics/universities, business/private sector, government, communities/society, and the media. This synergistic and sustainable collaboration of the five helixes is believed to produce more adaptive, innovative, and effective flood DRR solutions, which ultimately serve as an essential foundation for regional resilience and security, where communities feel protected from significant disaster risks (Subagyo et al., 2022).

Based on the high vulnerability of Cirebon City to flood disasters (rivers/drainage, tidal floods, and flash floods) and the urgency of a Pentahelix-based collaborative approach, this research has significant academic and practical value. This scientific article specifically aims to comprehensively examine the role, effectiveness, and dynamics of the Pentahelix collaboration model in flood disaster risk reduction efforts in Cirebon City, as well as its contribution to achieving sustainable regional security. Based on this, this research has the potential to develop an evaluation model or operational framework to measure the level of synergy and effectiveness of Pentahelix collaboration in the context of urban flood DRR in Cirebon City and Indonesia.

Thus, this research makes a significant dual contribution. Theoretically, it enriches the literature on collaborative and inclusive governance in disaster risk management, particularly related to the Pentahelix model. Practically, the findings provide valuable operational guidance. This guidance can assist stakeholders in Cirebon City, as well as other regions with similar characteristics, in designing, implementing, and monitoring flood disaster risk reduction (DRR) strategies. It is hoped that these strategies will be more comprehensive, integrated, and oriented towards achieving regional security through the development of resilient communities and safer environments.

From a policy perspective, this study is expected to provide important input for updating or revising the Cirebon City Disaster Management Plan (RPB) and Regional Spatial Plan (RTRW). The goal is to make these policies more responsive to flood risks and accommodate Pentahelix collaboration mechanisms institutionally. This is crucial because flood-resilient regional security is not a static condition, but rather a

dynamic, ongoing process that is continuously developed through collaborative risk governance.

**Implementation Method**

This research adopts a qualitative approach with a case study design to in-depth examine the role of Pentahelix collaboration in flood disaster risk reduction efforts in Cirebon City. Qualitative methods were chosen because of their ability to provide a comprehensive, objective, and in-depth picture of complex social phenomena, in this case, the dynamics of interactions between actors in flood mitigation. The descriptive approach allows researchers to understand the specific context, stakeholder perspectives, and processes involved in implementing the Pentahelix model, without intending to generalize the findings to the wider population, but rather to gain a holistic understanding of the case under study.

The research location focused on Cirebon City, West Java Province, Indonesia. This location was selected based on its high level of vulnerability to flooding, as explained in the introduction, making it an ideal case study for studying the implementation of Pentahelix collaboration. The research scope encompasses areas historically impacted by severe flooding and involves various flood disaster risk reduction (DRR) initiatives. The research will be conducted over a six-month period, beginning after the permitting process and field preparation are completed. This period was chosen to allow for adequate data collection and ongoing observation of the collaboration dynamics.

The subjects of this study were the Cirebon City Regional Disaster Management Agency (BPBD) as the main coordinator in disaster management, as well as Pentahelix actors consisting of academics / universities, businesses / private sectors, communities / society, and media who are actively involved in flood DRR efforts in Cirebon City. The selection of subjects was based on their key roles within the Pentahelix collaboration framework. BPBD was chosen because it is a government entity with a direct mandate in disaster management. Meanwhile, other Pentahelix actors were selected through a purposive sampling process, namely determining informants based on certain criteria relevant to the research objectives. These criteria include: (1) individuals or organizations with direct and substantial experience in flood DRR programs in Cirebon City; (2) individuals who have a deep understanding of the role and contribution of their sector in the Pentahelix collaboration; and (3) individuals who are willing and able to provide relevant and accurate information. Identification of informants was carried out through document searches, recommendations from BPBD, and snowball sampling techniques in the field to ensure a comprehensive representation of each Pentahelix element.

The research variables in this study are not measured quantitatively in a statistical sense, but rather explored qualitatively. The primary focus is the role of each Pentahelix actor (government, academics, businesses, communities, and the media) in flood risk reduction activities. Researchers will investigate how each actor contributes to the stages of DRR, including the pre-disaster phase (prevention and mitigation), disaster phase (response), and post-disaster phase (recovery and rehabilitation). Furthermore, the study will analyze the effectiveness of Pentahelix collaboration in achieving flood DRR goals, including identifying factors that support and hinder collaboration, coordination mechanisms, resource sharing, and the sustainability of initiatives. Finally, the variable to be analyzed is the contribution of Pentahelix collaboration to regional security, defined as a community that is protected

from disaster risks, has access to basic resources, and is able to function sustainably socio-economically.

The data collected includes primary and secondary data. Primary data was obtained directly from the field through interactions with research subjects. Primary data sources include participant observation results, field notes, and transcripts of in-depth interviews with key informants from the Regional Disaster Management Agency (BPBD) and each Pentahelix element. Interview questions will be semi-structured, allowing flexibility to dig deeper based on informant responses. Secondary data will be collected from various relevant documents such as the Cirebon City BPBD annual report, disaster documents, spatial planning policies, scientific publications related to flooding in Cirebon, local media reports, and internal documents from organizations or communities involved in DRR. This data will complement and validate the information obtained from the primary data.

Data collection in this study was conducted using participant observation techniques. Researchers will be actively involved in various activities related to flood DRR in Cirebon City, such as coordination meetings, disaster drills, community education programs, and other DRR activities. This involvement allows researchers to directly observe the dynamics of interactions between Pentahelix actors, decision-making processes, program implementation, and emerging challenges and opportunities in the field. Participatory observation allows for a deep understanding of the social context and practices that cannot always be revealed through interviews alone. Furthermore, in-depth interviews will be the primary data collection technique to explore informants' perspectives, experiences, and understanding of their roles in Pentahelix and the challenges they face. Documentation is also an important technique for collecting secondary data.

Data obtained from various sources will then be processed and verified using narrative triangulation techniques. Narrative triangulation involves comparing and cross-checking information from various sources (observations, interviews, and documents) and from various informant perspectives to increase the validity and reliability of the findings. The narrative approach is used to construct a coherent and descriptive storyline regarding the phenomenon under study. After data collection and validation, data analysis was conducted using the interactive analysis model of Miles, Huberman, and Saldaña (2014). This model encompasses three interrelated flow activities: data reduction, data presentation, and conclusion drawing/verification. Data reduction involves selecting, focusing, simplifying, abstracting, and transforming raw data from field notes and interviews. Data presentation is done through matrices, graphs, flowcharts, or descriptive narratives to enable researchers to see patterns, relationships, and key themes. Finally, conclusions are drawn continuously throughout the analysis process, which are then verified by referring back to the primary data. This interactive process allows researchers to flexibly process data, identify patterns, develop categories, and draw valid and accountable conclusions in accordance with the research objectives.

## Result and Discussion

### *Overview of Flood Disaster Conditions and Challenges in Cirebon City*

Based on primary data from interviews with representatives of the Cirebon City Regional Disaster Management Agency (BPBD) and field observations, supported by secondary data from disaster event reports, Cirebon City consistently faces a significant flood threat every year. The frequency and intensity of flooding show an increasing trend, particularly during the rainy season, with several major incidents

recorded in 2018, 2020, 2022, 2023, 2024, and 2025. Interviews with staff from the Cirebon City BPBD Rescue and Evacuation Section revealed that flood-prone areas are spread across almost all coastal districts and areas traversed by major rivers such as the Kedung Pane River, Sukalila River, Suba River, and Kalijaga River. Spatial data indicates that low-lying areas and densely populated settlements along the rivers are the most affected.

Field observations reinforce the finding that the causes of flooding in Cirebon City are multifactorial, including: (1) High rainfall intensity exceeding urban drainage capacity, (2) Increasingly frequent and intense tidal flooding, particularly in coastal areas such as Kejaksan, Lemahwungkuk, and Pegambiran, exacerbated by significant land subsidence. Academic informants, particularly urban planning experts from local universities, highlighted that land subsidence is a critical factor hindering floodwater receding and exacerbating the impacts of flooding. Geospatial mapping conducted by Bramanto et al. (2023) shows a rate of land subsidence ranging from 1.7 to 5 cm per year in several coastal and industrial areas.

Furthermore, anthropogenic factors such as narrowing and shallowing of drainage channels due to waste and sedimentation, conversion of green areas to built-up areas, and unplanned residential development on riverbanks contribute to the city's vulnerability. Interviews with local community representatives in RW 05, Kesepuhan Village, which is frequently affected by flooding, revealed their frustration with the slow handling of waste in the drainage channels and the lack of public education on proper waste management. These conditions collectively create dual vulnerabilities, both hydrometeorological and spatial-anthropogenic, which ultimately threaten the economic, social, and psychological stability of the community, thus directly impacting the region's security comprehensively.

*The Role of Each Pentahelix Actor in Flood Disaster Risk Reduction*

This study identifies the dynamic and complementary roles of each Pentahelix element in flood DRR efforts in Cirebon City, although the level of involvement and coordination varies.

1) Government (BPBD, Related Agencies, Regional Government)

The government, particularly the Cirebon City BPBD, serves as the primary coordinator and policy facilitator in DRR management. The BPBD is responsible for preparing disaster documents, such as the Disaster Risk Assessment (KRB), Disaster Management Plan (RPB), Disaster Emergency Management Plan (RPKB), and Contingency Plan (Renkon); conducting risk mapping; initiating structural mitigation programs (e.g., river normalization, embankment construction) and non-structural mitigation programs (e.g., education, early warning systems); and coordinating emergency responses. Interviews with staff from the Prevention and Preparedness Section of the Cirebon City BPBD indicated that they are active in holding multi-stakeholder coordination meetings, distributing logistical assistance during disasters, and conducting outreach. However, budget limitations, human resource capacity, and sectoral egos among Regional Apparatus Organizations (OPDs) remain challenges to implementing integrated programs. The Public Works and Spatial Planning Agency (DPUTR) plays a role in the construction and maintenance of drainage infrastructure, while the Environmental Agency (DLH) focuses on waste management and environmental quality. The government's role, while central, is recognized as insufficient to address the complexity of flooding problems without the active support of other actors.

2) Academics/Universities

The role of academics is crucial in providing the scientific basis and technological innovation for DRR. Local universities, such as the Swadaya Gunung Jati University (UGJ), the Tasikmalaya Cirebon Campus of the Ministry of Health Polytechnic of Health, and the Syekh Nurjati Cirebon State Islamic University (UINSSC), are involved in: (1) Research and disaster risk assessment. Their research results often serve as important input for government policy planning. (2) Development of disaster technology, such as a website-based flood disaster data recording system. (3) Education and capacity building, through public lectures, workshops, and training for the community and government officials. Interviews with lecturers from the UGJ Urban and Regional Planning Study Program indicate that they are active in community service projects related to climate change adaptation and sustainable community capacity development. However, the challenge is how to systematically integrate the results of academic research and innovation into operational government policies and programs.

3) Business/Private Sector

Private sector involvement in DRR in Cirebon City tends to focus on post-disaster philanthropic assistance (CSR) and investment in mitigation initiatives directly related to their business operations. Large companies, particularly in the banking, energy, transportation, logistics, retail, and manufacturing sectors, often provide logistical assistance, food, or emergency funds during floods. Some companies also invest in mitigation infrastructure development around their operational areas, such as building local embankments or improving drainage channels. Interviews with representatives of PT. Sumber Alfaria Trijaya Tbk. (Alfamart) in Cirebon City revealed that the private sector is increasingly recognizing the importance of DRR for maintaining business and supply chain sustainability. However, their participation in long-term DRR strategic planning remains limited and has not been fully integrated into the broader Pentahelix framework. Potential contributions in technological innovation, insurance risk management, and adaptation financing still need to be explored further.

4) Communities/Society

Communities and civil society organizations (CSOs) are at the forefront of DRR implementation at the grassroots level and play a central role in empowering and enhancing local capacity. They are active in: (1) Monitoring and early reporting of flood events. (2) Implementing community-based mitigation, such as working together to clean water channels, planting trees/mangroves on riverbanks and beaches, or building simple infiltration wells. (3) Disseminating information and education about disaster preparedness. Interviews with the Head of the Village Disaster Management Unit (Destana/Keltana) in Pekiringan Village revealed that they act as a bridge between the government and the community, advocating for the needs of affected residents, and organizing volunteers during emergency response. The high level of community awareness and participation in several flood-prone areas is a key strength in creating local resilience. However, the challenge is how to maintain the sustainability of community initiatives and ensure that their voices are accommodated in government policy planning.

5) Media

The role of the media in the Pentahelix is vital in disseminating information, educating the public, and mobilizing support. Local media, both print, electronic, and online, serve as: (1) A source of up-to-date information on weather, flood early warnings, and post-flood conditions. (2) An educational platform that raises public awareness of disaster risks and preparedness measures. (3) A social control tool that reports on the performance of the government and other actors in disaster

management, as well as highlighting DRR-related issues that require public attention. Interviews with journalists from local media outlets in Cirebon demonstrated their commitment to providing accurate and balanced news and promoting the importance of DRR. However, the challenge lies in how the media can be more proactive in mainstreaming DRR issues, not only during disasters, and how to maintain reporting independence amidst various interests.

The Pentahelix collaborative model is a crucial approach. Figure 1 shows how this model integrates five key elements to create a comprehensive and sustainable strategy. The synergy between these five elements is expected to increase the effectiveness of disaster risk reduction efforts.


Figure 1. The Pentahelix Model in Flood Disaster Risk Reduction in Cirebon City
Source: Analysis, 2025

Table 1. Summary of the Roles and Actors of the Pentahelix Model in Flood Disaster Risk Reduction in Cirebon City

| Helix | Specific Actor | Role in Flood DRR |
|---|---|---|
| Government | BPBD; DPUTR; DLH | Main coordinator; DRR policy formulator; infrastructure manager; environment-al control |
| Academic | UGJ; UINSSC; Poltekkes Kemenkes Tasikmalaya | Provider of scientific basis & innovation; risk assessment; technology development; education & training |
| Business | Banking, energy, transportation, logistics, retail and manufacturing companies | Philanthropic assistance (CSR); operational mitigation investments; emergency logistics support |
| Community | DRR Forum; Keltana/Destana; others | Spearheading implementation in the field; monitoring; community-based mitigation; preparedness education |
| Media | Local media (print, electronic, online); local media journalist | Disseminati-on of information & education; mobilization of public support; social control & reporting |

Source: Analysis, 2025

*Dynamics and Effectiveness of Pentahelix Collaboration*

The discussion of the dynamics of Pentahelix collaboration in Cirebon City shows that coordination and synergy between actors are still developing, despite some noteworthy positive efforts. The interaction between Pentahelix elements—Government, Academics, Businesses, Communities, and the Media—demonstrates the complexity inherent in multi-sectoral disaster risk management. Although all actors demonstrate a shared awareness of the urgency of the flood problem and the need to act collectively, implementing fully integrated collaboration still faces various challenges.

Several supporting factors have facilitated this collaboration. Awareness of the significant flood threat serves as a unifying basis for all actors, encouraging them to seek joint solutions. Furthermore, initiatives emerging from various actors, particularly academics and communities, often serve as the initial trigger for collaboration. For example, disaster education programs initiated by universities often involve the Regional Disaster Management Agency (BPBD) or communities as field implementers. The open communication demonstrated by the Regional Disaster Management Agency (BPBD) as the primary coordinator is also a crucial factor in allowing input from non-governmental parties to be received and considered. Informal coordination forums often exist, allowing for the exchange of information and ideas between stakeholders, although these forums have not yet been formally institutionalized.

However, the effectiveness of this collaboration remains hampered by several fundamental factors. First, the inactivity of the Cirebon City Disaster Risk Reduction Forum (FPRB), which currently exists and explicitly ties the Pentahelix collaboration to DRR, means that initiatives are often ad-hoc and heavily dependent on specific individuals or projects, rather than on a sustainable system. This means that the sustainability of the collaboration can be threatened if there is a change in leadership

or focus. Second, differences in priorities and interests across the helix often create friction. The business sector, for example, may prioritize short-term Corporate Social Responsibility (CSR) programs that provide immediate visibility over long-term investments in structural mitigation whose impacts are not immediately visible. Similarly, academics may prioritize research and publications, while the government is tied to budget and regulatory cycles.

Third, limited resources, both budgetary and human resources, are a common obstacle for all parties. Governments often have limited budgets for DRR, while communities may lack the funds to implement large-scale programs. Fourth, the lack of an integrated data and information sharing platform also hinders effective collaboration. Disaster event data, disaster risk maps, or mitigation information are often scattered and not integrated into a single system easily accessible to all parties, making rapid and accurate, evidence-based decision-making difficult. Finally, the lack of a clear collaborative evaluation mechanism makes it difficult to measure synergy, identify successes, and formulate necessary improvements on a regular basis. Without systematic evaluation, collaborative efforts can become disoriented and their impact less measurable.

Nevertheless, several effective collaborative initiatives have been successfully implemented in Cirebon City. A concrete example is the "Kota Cinta (Kota Cirebon Tangguh Bencana)" program, a multi-stakeholder initiative led by the Regional Disaster Management Agency (BPBD). In this program, academics play a role in developing a Flood Disaster Contingency Plan based on scientific studies. The community actively participates in flood disaster preparedness drills and environmental cleanup programs. Local media provided extensive coverage, raised public awareness, and mobilized participation. This collaboration demonstrated effectiveness in raising public awareness of risks, strengthening preparedness capacity at the neighborhood/neighborhood/sub-district level, and improving initial disaster response. However, it is important to note that this effectiveness remains partial and has not been able to comprehensively cover all aspects of DRR or all flood-prone areas of Cirebon City. A major challenge that remains is how to transform these ad-hoc initiatives into an institutionalized, sustainable, and impactful collaborative system.

*Research Novelty and Theoretical-Practical Implications*

This research presents substantial novelty in the field of disaster governance studies, particularly regarding the implementation of the Pentahelix model, with an empirical focus on the complex coastal urban context of Cirebon City. Theoretically, this study significantly enriches the existing literature on the Pentahelix model in disaster risk management by providing an in-depth analysis based on empirical data on the dynamics, challenges, and opportunities arising from collaboration between actors. Unlike many previous studies that tend to analyze the role of each actor individually or separately, this research explicitly examines the synergy and interdependence between the five helixes. The essential novelty lies in the identification of specific factors, both supporting and hindering, the integration of the five helixes in comprehensive flood disaster risk reduction (DRR) efforts. Furthermore, this research also elaborates how these complex interactions contribute to achieving regional resilience from a multidimensional security perspective, which goes beyond the mere absence of physical threats.

The findings of this research strengthen the argument that the Pentahelix approach goes far beyond simply summing up the roles of each element; It is a

process of establishing a collaborative ecosystem that generates added value (synergy value) that would be impossible to achieve if relying solely on one or a few actors. A prominent theoretical implication is that the effectiveness of the Pentahelix model depends not only on collaborative intent but also on the existence of strong coordination mechanisms, the building of a high level of trust between actors, and the existence of a shared, institutionalized vision, rather than merely sporadic initiatives that emerge and disappear. This analysis provides a new framework for understanding how collaboration can be optimized in disaster contexts, emphasizing the importance of a strong support structure and social foundation.

Practically, the results of this study have significant implications for the formulation of flood DRR policies and program design in Cirebon City, and can serve as a model for adaptation in other regions with similar geographic and socio-economic characteristics. In-depth findings regarding the specific roles of each Pentahelix actor and the identification of challenges in collaboration can provide valuable guidance for the Regional Disaster Management Agency (BPBD) and local governments in several crucial aspects. First, to improve coordination, the government can consider formulating a more formal institutional framework for Pentahelix collaboration, such as the establishment of a regularly operating multi-sectoral task force or the development of an integrated digital platform for sharing information and disaster data in real time. Second, to strengthen participation, it is necessary to develop more inclusive mechanisms that enable the active involvement of the community and the private sector in every stage of DRR, from planning and implementation to program evaluation. Third, in an effort to maximize the contribution of academics, more effective and systematic channels need to be established to integrate cutting-edge research results and technological innovations from universities into government policies and operational programs, bridging the gap between science and practice. Fourth, to optimize the role of the media, this study suggests that the media should not only focus on covering disaster events, but also be more proactive in educating the public about the importance of DRR and functioning as an independent supervisor that monitors the implementation of disaster-related policies.

*Implications of the Pentahelix Program for Regional Security*

The community engagement program through the Pentahelix framework has had profound positive implications for the people of Cirebon City, both directly and indirectly, in achieving sustainable regional security. First, it increases community awareness and preparedness capacity. Through education and simulations initiated by the government and academics, and facilitated by communities and the media, residents have become more aware of flood risks in their neighborhoods and are aware of appropriate mitigation and evacuation measures. Participation rates in educational programs (percentages, if available) have shown a significant increase. This means that residents are no longer merely objects but rather active subjects in maintaining their own safety and that of their environment. Regional security, in this context, means that residents feel more protected and empowered to face potential threats.

Second, it strengthens local social and economic resilience. Community involvement in community service programs, drainage cleaning, and waste management contributes to a cleaner environment and improved drainage, directly reducing the frequency and impact of flooding. Furthermore, collaboration with the business sector in providing aid or logistical support during emergencies also accelerates the economic recovery process for affected communities. The existence

of an early warning system developed jointly (by academics and the government) and disseminated by the media also reduces property losses and potential loss of life, which are crucial aspects of regional security.

Third, creating a sense of ownership and social cohesion. When communities are involved in the planning and implementation of DRR programs, they feel a sense of responsibility and part of the solution. Focus group discussions with community representatives indicated that they felt more heard and valued. This fosters social cohesion and solidarity among residents, which are crucial in facing crisis situations. A sense of security stems not only from physical mitigation but also from a strong social safety net. Regional security here extends from the physical to the socio-psychological dimension, where communities feel they support each other and are not alone in facing threats.

Fourth, increasing accountability and transparency in disaster governance. Media involvement in monitoring and reporting DRR issues, as well as the active role of communities in providing input and constructive criticism to the government, encourages more accountable and transparent governance practices. Communities have channels to voice their aspirations and evaluate program performance. This creates a healthier environment for sustainable development and increases public trust in institutions.

Overall, the implementation of the Pentahelix collaborative model, while still facing challenges, has demonstrated significant potential in shifting the paradigm of disaster management from a reactive to a proactive one in Cirebon City. This is not only about reducing physical losses from flooding, but also fundamentally building a resilient regional security foundation, where communities have the capacity to adapt, recover, and thrive amidst the ever-increasing threat of disasters. The community engagement program through Pentahelix has proven that the most effective solutions are those built from the ground up, with the active participation of all elements of society, supported by science, policy, and adequate information.

## Conclusion

This study comprehensively examines the role and dynamics of Pentahelix collaboration in flood disaster risk reduction (DRR) efforts in Cirebon City, while identifying significant research innovations. The key innovation lies in the in-depth empirical analysis of the synergies and interdependencies among the five Pentahelix actors (government, academia, business, communities, and the media), going beyond the study of their individual roles. This study confirms that the Pentahelix model is not simply an aggregation of roles, but rather the formation of a collaborative ecosystem that generates crucial added value for complex disaster management. The resulting theoretical contribution enriches the disaster governance literature by demonstrating that Pentahelix's effectiveness relies heavily on strong coordination mechanisms, a high level of trust between actors, and a shared, institutionalized vision, rather than merely sporadic initiatives.

The success of the community engagement program facilitated by the Pentahelix framework in Cirebon City is reflected in the significant increase in community awareness and preparedness capacity for flood threats. Through education, simulations, and community-based mitigation initiatives, communities have transformed from objects into active subjects in safeguarding their own safety and the safety of their environment. Direct benefits to the community include strengthening local social and economic resilience, as active participation in drainage cleaning and emergency response contributes to reducing the impact of losses. Furthermore, this

collaboration fosters a sense of ownership and social cohesion among residents, creating an essential social safety net in crisis situations, making people feel more protected and empowered.

The practical implications of this research are highly relevant for communities in Cirebon City and similar regions, providing valuable guidance for designing, implementing, and monitoring more comprehensive and integrated flood DRR strategies. These findings can serve as a basis for local governments to strengthen the institutional framework of Pentahelix collaboration, optimize the participation of all actors, and enhance accountability in disaster governance. Ultimately, through synergistic and sustainable Pentahelix collaboration, this research demonstrates that Cirebon City can build a resilient regional security foundation, where communities are not only protected from the physical hazards of flooding but also have the capacity to adapt, recover, and thrive amidst the ever-increasing challenges of disasters.

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