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Analysis of Flood Management Effectiveness Through the Implementation of Drainage Revitalization Policies: A Systematic Literature Review

Sofia Ayu Anggraini Sulu Lazar¹, Irwan Noor², Niken Lastiti V.A³

^{1,2,3}Program Studi Magister Administrasi Publik, Fakultas Ilmu Administrasi Publik, Universitas Brawijaya, Indonesia

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ABSTRACT

Urban flooding has become increasingly frequent due to rapid urbanization, climate change, and the limited capacity of drainage infrastructure, prompting growing scholarly attention to the effectiveness of drainage revitalization policies across countries. However, the literature examining the relationship between policy implementation and flood management effectiveness remains fragmented across different disciplines and methodological approaches, and has not yet been systematically synthesized. This study aims to identify, evaluate, and synthesize scientific literature on the effectiveness of flood management through the implementation of drainage revitalization policies, using a Systematic Literature Review (SLR) approach based on the PRISMA 2020 framework. Literature searches were conducted in Google Scholar, ScienceDirect, MDPI, and Scopus databases using the keywords *policy implementation, drainage revitalization, flood management effectiveness, and flood management policy implementation*, resulting in 41 relevant articles selected from an initial pool of 312 studies after undergoing the stages of identification, screening, eligibility assessment, and inclusion. The synthesis identified four major themes influencing flood management effectiveness through drainage revitalization: governance and institutional coordination; technical and infrastructural capacity; community participation and social adaptation; and approaches based on natural processes and geomorphology. The findings indicate that the success of drainage policies is consistently determined by the quality of implementation, particularly communication, resources, implementers' disposition, and bureaucratic structure, as proposed by Edwards III (1980), rather than solely by the scale of investment in physical infrastructure. This study concludes that flood management effectiveness results from a multidimensional interaction among policy quality, infrastructure performance, and institutional capacity. Therefore, future evaluations of drainage policies should integrate these three dimensions simultaneously to achieve more effective and sustainable urban flood management.

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Corresponding Author:

Sofia Ayu Anggraini Sulu Lazar

Universitas Brawijaya, Indonesia

Email: sofiaayu_asl@student.ub.ac.id

1. INTRODUCTION

Urban flooding is one of the hydrometeorological disasters whose frequency, extent, and intensity have continued to increase across various regions of the world. This phenomenon is influenced by the complex interaction of global climate change, urban population growth, the expansion of built-up areas, and land-use changes that reduce water infiltration capacity. The increasing intensity of extreme rainfall associated with climate change has heightened the risk of inundation and flooding in urban areas with limited drainage capacity [1], [2]. At the same time, rapid urban development is often not accompanied by the provision of drainage infrastructure that is adaptive to changing hydrological conditions. Drainage systems originally designed based on historical hydrological data are increasingly inadequate at coping with rising surface runoff driven by the expansion of impervious surfaces, the conversion of green open spaces, and the growing pressure of urban development [3], [4].

Urban flooding not only causes economic losses but also affects environmental quality, public health, social activities, and the sustainability of regional development. Evidence from numerous studies indicates that cities in developing countries tend to exhibit higher levels of vulnerability due to limited institutional capacity, weak integration of spatial planning, and suboptimal management of drainage infrastructure systems [5], [6]. In the Indonesian context, the increasing occurrence of urban flooding has become a strategic issue that requires serious attention, as most urban areas are characterized by high population density, rapid land-use conversion, and inadequate integration between water resource management and urban spatial planning systems [7].

Various local governments have responded to these challenges through drainage revitalization programs, river normalization, retention pond construction, green infrastructure development, and the implementation of climate-resilient city concepts. Drainage revitalization has emerged as one of the most widely adopted strategies because it is considered capable of increasing water conveyance capacity while restoring the functionality of drainage networks that have experienced performance degradation due to sedimentation, channel narrowing, and physical deterioration of infrastructure. Nevertheless, the success of drainage revitalization programs varies considerably across regions. In some areas, drainage revitalization has successfully reduced inundation levels and enhanced flood control capacity, whereas in other regions similar programs have not produced optimal outcomes despite substantial investments in infrastructure development [8], [9].

Several studies suggest that urban flood management failures are not always attributable to inadequate physical infrastructure but are closely associated with governance issues, institutional capacity, and the effectiveness of policy implementation. Even well-developed drainage infrastructure may fail to deliver optimal benefits when policy implementation processes are ineffective, interagency coordination is poorly synchronized, or community participation in environmental management remains limited [10] [11]. These conditions indicate that urban flooding is inherently a multidimensional

issue that encompasses not only technical aspects but also administrative, institutional, social, and political dimensions.

Studies examining the causes of flooding in Makassar City, for example, indicate that the primary challenges in flood control are not solely related to the limited capacity of drainage channels, but also stem from poorly integrated drainage system planning, the lack of synchronization among flood control programs implemented by regional government agencies, weak institutional coordination, and suboptimal communication between government authorities and communities in flood disaster mitigation efforts [12]. These findings confirm that the policy implementation dimension plays a central role in determining the success of urban flood management. The existence of substantively sound policies does not necessarily lead to effective outcomes if they are not accompanied by well-planned, coordinated implementation mechanisms supported by adequate resources.

From a public administration perspective, policy implementation is regarded as a crucial stage in achieving policy objectives. Implementation refers to the process of translating political decisions into concrete actions through a series of organizational activities, resource allocation, stakeholder coordination, and program supervision. One of the most widely adopted policy implementation frameworks in public policy studies is the Edwards III implementation model. This model identifies four key dimensions: communication, resources, implementers' disposition, and bureaucratic structure as interrelated factors that determine the success of policy implementation [13]. These dimensions are highly relevant in the context of drainage revitalization policies, as program success largely depends on effective institutional coordination, adequate funding, competent human resources, implementers' commitment, and a clear distribution of authority among responsible agencies.

Several recent studies in Indonesia demonstrate that the Edwards III model continues to provide strong analytical insights into both the success and failure of flood control policy implementation. Research conducted in the Kali Lamong River corridor in Gresik Regency found that the success of flood control infrastructure development is strongly influenced by consistent policy communication, human resource capacity, budgetary support, and the clarity of bureaucratic structures regarding the division of tasks and responsibilities among related institutions [14]. Another study on urban drainage management in Indonesian metropolitan areas found that weak cross-sectoral coordination remains a primary factor contributing to the low effectiveness of flood risk reduction programs [15].

At the international level, urban flood management has gradually shifted from conventional structural approaches toward more adaptive, integrated, and collaborative governance-oriented strategies. Such approaches emphasize integrating physical infrastructure, public policies, information technology, early warning systems, community participation, and ecosystem-based management practices [16], [17]. Many countries have begun adopting concepts such as *smart drainage systems*, *nature-based solutions*, and *water-sensitive urban design* as strategies to enhance urban resilience against increasingly complex flood risks [18], [19].

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Recent international research has also highlighted the growing importance of policy implementation in the management of urban drainage systems. A *Systematic Literature Review* (SLR) employing the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA) framework identified four major approaches that determine flood management effectiveness in large cities worldwide: technology-driven drainage management, policy- and regulation-based management, community participation and social adaptation, and approaches grounded in geomorphological characteristics and natural processes [20]. These findings suggest that flood control is no longer viewed solely as an issue of infrastructure development but is increasingly associated with governments' capacity to implement policies effectively, adaptively, and sustainably.

Nevertheless, the existing literature still reveals a significant research gap. Most previous studies have primarily focused on evaluating the technical performance of drainage systems, analyzing infrastructure capacity, or assessing policy effectiveness from a normative perspective. Studies that specifically examine the relationship between the implementation of drainage revitalization policies and the effectiveness of flood management remain relatively limited. Moreover, only a few studies have integrated the policy implementation perspective with the dimension of infrastructure performance as a mechanism linking policy interventions to flood control outcomes. In fact, the performance of drainage infrastructure has the potential to serve as a mediating variable that explains how a policy can generate tangible impacts on flood risk reduction.

This literature gap highlights the need for a more comprehensive scientific synthesis concerning the implementation of drainage revitalization policies within the context of urban flood management. A systematic synthesis approach through a *Systematic Literature Review* (SLR) is therefore essential to identify emerging research themes, determine the factors influencing successful policy implementation, and explore directions for future studies. Accordingly, this study aims to conduct a systematic synthesis of the scientific literature addressing the relationship between the implementation of drainage revitalization policies and the effectiveness of flood management.

More specifically, this study seeks to answer three primary research questions: (1) What themes or approaches have emerged in the literature concerning drainage policy implementation and flood management? (2) What factors have been consistently identified as influencing the effectiveness of drainage revitalization policy implementation? Furthermore, (3) What research gaps can be identified to guide future studies, particularly regarding the mediating role of infrastructure performance in the causal relationship between policy implementation and the effectiveness of urban flood management? The findings of this study are expected to contribute theoretically to the advancement of public policy implementation research while also providing practical recommendations for local governments to design more effective, adaptive, and sustainable urban flood management strategies.

2. METHOD

Research Design

This study employed a Systematic Literature Review (SLR) design following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 framework, as developed by [21]. The PRISMA framework was selected because it provides a systematic and transparent procedure for literature identification, screening, eligibility assessment, and synthesis, thereby minimizing selection bias and enhancing the reproducibility of the review process. This approach has been consistently adopted in recent SLR studies related to urban flood management.

Literature Search Strategy

The literature search was conducted across four major databases, namely Google Scholar, ScienceDirect, MDPI, and Scopus, covering publications from 2015 to 2026 to ensure that the findings reflect recent developments in drainage policies and technologies. Search terms were formulated using Boolean operators (AND/OR) as follows.

Table 1. Literature Search Keyword Combinations

No.	Keyword Combinations
1	("policy implementation") AND ("drainage" OR "drainage system")
2	("drainage revitalization") AND ("flood" OR "flooding")
3	("flood management effectiveness")
4	("Edwards III" OR "policy implementation theory") AND ("flood" OR "infrastructure")
5	("urban drainage system" AND "systematic review" AND "PRISMA")

Inclusion and Exclusion Criteria

Table 2. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Publication Type	Indexed journal articles and reputable conference proceedings	Opinion papers, editorials, unpublished theses
Language	Indonesian and English	Languages other than Indonesian and English
Publication Year	2015–2026	Prior to 2015
Topic	Drainage/flood policy implementation, drainage infrastructure performance, flood management effectiveness	Studies focusing solely on hydraulic or technical aspects without policy or implementation dimensions
Accessibility	Full-text articles available	Abstract-only publications

Selection Procedure (PRISMA Flow Diagram)

The literature selection process was conducted through four sequential stages in accordance with the PRISMA 2020 framework: identification, screening, eligibility assessment, and inclusion. During the identification stage, an initial search across the four databases yielded 312 articles. Following the removal of 58 duplicate records, 254 articles remained for title and abstract screening. At this stage, 167 articles were excluded because they were not relevant to the research topic, leaving 87 articles for full-text eligibility assessment. After applying the inclusion and exclusion criteria, 46 articles were excluded because they did not explicitly address the policy implementation dimension.

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Consequently, 41 articles met the eligibility requirements and were included in the final synthesis.

Table 3. PRISMA Flow Diagram of the Literature Selection Process

PRISMA Stage	Number of Articles	Articles Excluded	Reason for Exclusion
Identification (databases)	312	—	—
Duplicate removal	254	58	Duplicate records across databases
Title and abstract screening	87	167	Not relevant to the research topic
Full-text eligibility assessment	41	46	Did not address the policy implementation dimension
Inclusion (final synthesis)	41	—	—

Data Analysis and Synthesis

Data from the 41 selected articles were analyzed using a thematic synthesis approach developed by [22], consisting of three stages: line-by-line coding of findings from each article, the development of descriptive themes through grouping similar codes, and the generation of analytical themes aimed at addressing the research questions. Data extraction included information regarding authors, publication year, study location, research methods, theoretical frameworks employed, and key findings related to policy implementation and flood management effectiveness.

3. RESULTS AND DISCUSSION

General Characteristics of the Literature

Of the 41 articles analyzed, the majority (24 articles, or 58.5%) employed a descriptive qualitative approach, followed by quantitative approaches, including SEM-PLS (11 articles, or 26.8%) and systematic literature review (6 articles, or 14.6%). Regarding study location, 19 articles (46.3%) focused on the Indonesian context, while the remaining 22 (53.7%) examined international contexts, including Southeast Asia, South Asia, Europe, and the Global South.

Main Themes Identified from the Synthesis

The thematic synthesis identified four major themes that determine the effectiveness of flood management through the implementation of drainage revitalization policies, as summarized in Table 4.

The first and most dominant theme in the literature on governance and institutional coordination consistently refers to the policy implementation framework proposed by Edwards III (1980). A case study of flood control in the Kali Lamong area of Gresik Regency, for example, revealed that the success of embankment construction was supported by consistent communication and socialization efforts conducted by the River Basin Authority, competent human resources, a supportive bureaucratic structure, and a clear, non-overlapping division of responsibilities among implementing agencies [23]. Similar findings have been observed in other public policy contexts in Indonesia beyond drainage management, including waste bank implementation, hazardous waste

management, and village development planning, where the disposition or attitude of policy implementers consistently emerges as a critical prerequisite for ensuring that communication and available resources are effectively translated into implementation actions.

Table 4. Main Themes Identified from the Literature Synthesis (n = 41 articles)

Theme	Brief Description	Supporting Articles
1. Governance and Institutional Coordination	Interagency communication, clarity of authority, bureaucratic structure, and implementers' disposition as key determinants of successful implementation	16 (39.0%)
2. Technical Capacity and Infrastructure Technology	Smart drainage management, hydraulic capacity, and sustainability of physical infrastructure performance	11 (26.8%)
3. Community Participation and Social Adaptation	Community empowerment, education, and collaboration among government, NGOs, and the private sector in flood mitigation and drainage maintenance	9 (22.0%)
4. Natural Process and Geomorphological Approaches	Eco-drainage, infiltration wells, nature-based solutions, and water-sensitive urban design	5 (12.2%)

The second theme, technical capacity and infrastructure technology, is predominantly found in international SLR studies. A systematic review of Sustainable Urban Drainage Systems (SuDS) synthesizing 90 indexed studies found that the success of SuDS in reducing flood risk largely depends on integrating technical system performance, cost-effectiveness, and policy frameworks that support large-scale implementation [24]. This pattern emphasizes that technical infrastructure cannot be separated from the policy framework governing it; rather, both dimensions operate in an integrated manner rather than as independent agendas.

The third theme, community participation and social adaptation, confirms the crucial role of multi-stakeholder involvement. Studies on community empowerment in drainage management indicate that collaboration among government agencies, non-governmental organizations (NGOs), and the private sector has considerable potential to enhance the effectiveness and efficiency of flood mitigation efforts. Governments are responsible for policy formulation and budget allocation; NGOs mobilize communities and conduct awareness campaigns; and the private sector contributes through technological innovation and financial investment [25]. This tripartite collaborative pattern is also evident in studies on community-based adaptation in informal settlements across the Global South, which identify the combination of structural measures (such as drainage systems and elevated sanitation facilities) and non-structural measures (such as community-based early warning systems) as the most effective strategy in resource-constrained settings.

The fourth theme, natural process and geomorphological approaches, refers to eco-drainage strategies and nature-based solutions. Studies on drainage revitalization in coastal areas have found that the implementation of infiltration wells can reduce runoff discharge by up to 23.41%, while simultaneously providing additional environmental benefits,

including groundwater conservation and microclimate stabilization [26]. Such approaches are widely adopted as complementary measures rather than substitutes for conventional drainage infrastructure, particularly in areas with limited space for constructing large-capacity drainage channels.

Frequency of Identified Implementation Factors

An analysis of the frequency of policy implementation factors across the 41 reviewed articles revealed a pattern highly consistent with the Edwards III (1980) framework, as summarized in Table 5.

Table 5. Frequency of Edwards III Implementation Factors in the Selected Literature

Implementation Factor (Edwards III)	Frequency	Percentage of 41 Articles
Disposition/Implementers' Attitude	29 articles	70.7%
Communication and Coordination	27 articles	65.9%
Bureaucratic Structure	22 articles	53.7%
Resources (Budget, Human Resources, Facilities)	31 articles	75.6%

Resources and implementers' disposition emerged as the two factors most frequently identified as determinants of successful drainage policy implementation and flood management, appearing in 75.6% and 70.7% of the reviewed articles, respectively. This pattern is consistent with empirical findings across various public policy contexts in Indonesia, which repeatedly demonstrate that the mere availability of resources is insufficient without the commitment and positive attitudes of implementing personnel in carrying out policies effectively at the operational level.

Discussion

The literature synthesis consistently confirms that the effectiveness of flood management through drainage revitalization is not merely a function of the magnitude of physical infrastructure investment, but rather the result of a multidimensional interaction among policy implementation quality, technical infrastructure capacity, and community social engagement. The dominance of the governance and institutional coordination theme (39.0% of all reviewed articles) indicates that both the global and national literature generally agree that failures in flood management are more often rooted in implementation and coordination issues than in the absence of regulations or deficiencies in technical design. This pattern is consistent with the classical argument proposed by Pressman and Wildavsky (1973), which conceptualizes implementation as a vulnerable link between formulated policies and the outcomes experienced by society.

The convergence between findings from Indonesian and international studies also deserves attention. Edwards III-based studies in the Indonesian context consistently identify implementers' disposition as the most frequently discussed determinant, whereas international PRISMA-based SLR studies tend to emphasize the integration of policy, technology, and social participation as a multidimensional approach. These two streams of literature are essentially complementary: the former explains micro-level mechanisms

operating among policy implementers, while the latter maps macro-level strategies within the broader urban system.

The findings of this synthesis also reveal a significant research gap. Of the 41 articles reviewed, only a limited number empirically examine the causal relationship among policy implementation, infrastructure performance, and flood management effectiveness using quantitative and simultaneous modeling approaches. Most studies still address these three dimensions separately or through descriptive qualitative analyses. This gap presents an opportunity for quantitative approaches based on Structural Equation Modeling Partial Least Squares (SEM-PLS), which can more precisely estimate the magnitude of relationships and mediation mechanisms among variables, as has recently been explored in Edwards III-based public policy studies across various sectors in Indonesia.

The practical implications of this synthesis suggest that local governments designing drainage revitalization programs should consider the four identified themes, governance, technical capacity, social participation, and natural process-based approaches as interrelated and integrated components rather than as separate policy alternatives that can be prioritized independently. Investments in a single dimension without strengthening the others are likely to yield only partial and unsustainable effectiveness, a pattern repeatedly demonstrated in the reviewed literature.

4. CONCLUSION

This Systematic Literature Review was conducted to synthesize existing evidence on the implementation of drainage revitalization policies and their effectiveness in flood management while identifying research gaps for future investigation. The review of 41 scientific articles revealed four dominant themes: governance and institutional coordination; technical capacity and infrastructure technology; community participation and social adaptation; and nature-based and geomorphological approaches. Across the reviewed studies, implementers' disposition and resource availability consistently emerged as the most influential determinants of successful policy implementation, supporting Edwards III's (1980) implementation framework. These findings answer the research objective by demonstrating that effective flood management depends not only on engineering interventions but also on institutional and organizational capacities that ensure policy implementation.

Theoretically, this review contributes to the literature by integrating fragmented findings into a comprehensive conceptual understanding of the relationship between the implementation of drainage revitalization policies and flood management effectiveness. It also highlights an important methodological gap, as existing studies predominantly employ qualitative-descriptive approaches and rarely examine causal relationships among implementation variables. In practice, the findings provide policymakers and local governments with valuable insights for prioritizing improvements in institutional coordination, resource allocation, and implementer commitment when designing and evaluating drainage revitalization programs to enhance flood resilience.

This review is limited by its reliance on published literature that met predetermined inclusion criteria, which may not fully capture unpublished studies, local reports, or evidence from databases not included in the review. Future research is therefore encouraged to employ quantitative approaches such as SEM-PLS or other structural modeling techniques to examine the mediating role of infrastructure performance in the

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relationship between policy implementation and flood management effectiveness. Comparative studies across developing cities in Indonesia and other countries are also recommended to strengthen the generalizability of the proposed conceptual framework and enrich evidence-based policy development.

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