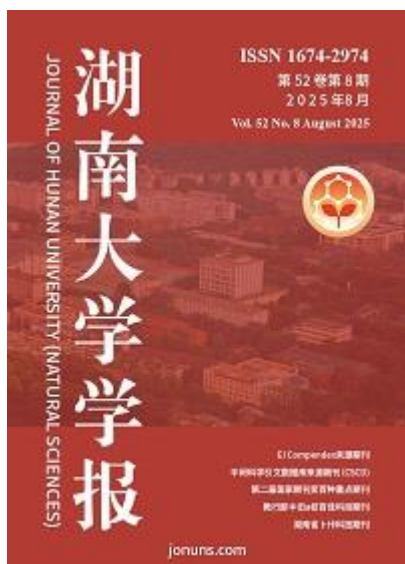




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Grand Design of an Innovation-Driven Policy Framework for the Development of Freshwater Aquaculture Groups: A Case Study of Pekanbaru City

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Abstract: Urban aquaculture development faces significant challenges in achieving sustainable food security and promoting economic empowerment, particularly in medium-sized cities such as Pekanbaru. This study examines the formulation of an innovative policy grand design for developing freshwater fish farming groups in Pekanbaru City through a comprehensive policy innovation framework. Using a qualitative approach with policy analysis methods, the research investigates how innovation theory can be integrated into a strategic policy design to transform the aquaculture sector. Data were collected through in-depth interviews with key stakeholders, focus group discussions with fish farming groups, and analysis of policy documents. The study reveals that current aquaculture policies in Pekanbaru lack systematic integration and a long-term strategic vision. The proposed innovative policy grand design incorporates four key dimensions: institutional strengthening through collaborative governance, adoption of technology, including IoT-based monitoring systems, sustainable financing mechanisms, and optimization of market linkages. The framework emphasizes participatory policy design involving multi-stakeholder engagement and adaptive management approaches. The findings indicate that successful implementation requires policy innovation



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laboratories, regulatory sandboxes for aquaculture experimentation, and integrated urban planning that accommodates aquaculture activities. This study contributes to public administration theory by demonstrating how innovation frameworks can enhance the effectiveness of grand policy design in urban aquaculture development. The proposed model offers practical implications for policymakers in designing comprehensive, innovation-driven policies for urban food security and sustainable economic development.

Keywords: grand policy design, policy innovation, urban aquaculture, freshwater fish farming, Pekanbaru, sustainable development.

淡水水产养殖业发展创新驱动政策框架的总体设计：以北干巴鲁市为例

摘要：城市水产养殖发展在实现可持续粮食安全和促进经济赋权方面面临重大挑战，尤其是在像北干巴鲁这样的中等城市。本研究旨在探讨如何通过全面的政策创新框架，为北干巴鲁市发展淡水鱼养殖群体制定创新政策总体设计。本研究采用定性研究方法和政策分析方法，探讨如何将创新理论融入战略政策设计，从而推动水产养殖业转型。数据收集方式包括对主要利益相关者的深入访谈、与鱼类养殖群体的焦点小组讨论以及政策文件分析。研究表明，北干巴鲁现行的水产养殖政策缺乏系统性整合和长期战略愿景。拟议的创新政策总体设计涵盖四个关键维度：通过协作治理加强机构建设、采用包括基于物联网的监测系统在内的技术、可持续融资机制以及优化市场联系。该框架强调参与式政策设计，涉及多利益相关方的参与和自适应管理方法。研究结果表明，成功实施需要政策创新实验室、水产养殖实验的监管沙盒以及适应水产养殖活动的综合城市规划。本研究通过展示创新框架如何增强城市水产养殖发展宏观政策设计的有效性，为公共行政理论做出了贡献。所提出的模型为政策制定者在设计全面的、创新驱动的城市粮食安全和可持续经济发展政策方面提供了实践指导。

关键词：宏大政策设计、政策创新、城市水产养殖、淡水鱼养殖、北干巴鲁、可持续发展

1. Introduction

Urban food security has emerged as a critical challenge in rapidly developing cities across Southeast Asia, where population growth and urbanization place significant strain on traditional food supply systems [1]-[2]. The concept of grand policy design has gained prominence in public administration as a comprehensive framework for addressing complex urban challenges through systematic, long-term strategic interventions [3]. In the context of aquaculture development, innovative policy design is essential to establish sustainable pathways that simultaneously advance food security, economic empowerment, and environmental sustainability [4].

Recent scholarship underscores the pivotal role of policy innovation in transforming traditional sectoral approaches into integrated urban development

strategies [5]. Grand policy design, characterized by its comprehensive scope, long-term vision, and transformative potential, offers a promising framework for addressing the multifaceted challenges of urban aquaculture [6]. This approach aligns with contemporary public administration theories that advocate for policy designs capable of fostering innovation ecosystems while tackling complex societal problems [7].

The integration of aquaculture into urban food systems represents a paradigm shift toward sustainable urban food security, particularly in medium-sized cities where traditional agriculture faces spatial constraints [8]. Freshwater fish farming, as a key component of urban aquaculture, holds significant potential to enhance local food production capacity while generating economic opportunities for urban

communities [9]. However, realizing this potential requires sophisticated policy frameworks capable of navigating the interrelated complexities of urban planning, environmental regulation, and community development [10].

Pekanbaru City, a rapidly growing urban center in Indonesia, exemplifies both the challenges and opportunities associated with strengthening urban food security through aquaculture development [11]. The city's strategic location and expanding population create strong demand for resilient food systems and fertile ground for innovative policy interventions [12]. Current food security frameworks in Pekanbaru rely heavily on external supply chains, resulting in systemic vulnerabilities that could be mitigated through enhanced local food production, including targeted urban aquaculture initiatives [13].

The development of fish farming groups represents a critical institutional mechanism for scaling aquaculture activities while strengthening community capacity and social capital [14]. These groups serve as vehicles for technology transfer, knowledge sharing, and collective resource mobilization, rendering them essential components of any comprehensive aquaculture development strategy [15]. However, their effectiveness depends significantly on supportive policy environments that facilitate their formation, operation, and sustained growth [16].

Policy innovation theory posits that transformative outcomes require policy designs incorporating experimental approaches, adaptive management, and multi-stakeholder engagement [17]. In the context of urban aquaculture, this implies policy frameworks capable of accommodating technological innovation, fostering institutional learning, and responding dynamically to evolving urban conditions [18]. The grand policy design approach provides a suitable framework for embedding these innovation principles into integrated and forward-looking development strategies [19].

Urban food security in Pekanbaru faces specific challenges related to land availability, water resource management, and integration with existing urban infrastructure [20]. Freshwater fish farming offers a space-efficient approach to protein production that can be embedded within urban environments while supporting local economic development [21]. Moreover, community-based aquaculture initiatives can enhance social cohesion and strengthen local capacity for sustainable resource management [22].

This study addresses the gap between theoretical frameworks of policy innovation and their practical application in urban aquaculture development by examining how a grand policy design can be

operationalized to support fish farming group development in Pekanbaru City. The research contributes to both public administration scholarship and practical policy formulation by demonstrating how innovation principles can be integrated into comprehensive policy frameworks to simultaneously advance multiple development objectives [23].

2. Literature Review

2.1. Grand Design in Public Policy: Theoretical Foundations

The conceptualization of grand design in public policy has evolved from traditional comprehensive planning approaches to sophisticated frameworks that integrate multiple policy dimensions within a unified strategic vision [24]. The seminal work on strategic planning by Mintzberg and Waters [25] distinguishes grand design from incremental policy approaches, emphasizing its defining features: comprehensive scope, long-term orientation, and transformative potential. This distinction is particularly salient in complex policy domains such as urban aquaculture development, where diverse stakeholders, regulatory regimes, and economic considerations must be harmonized within a coherent policy architecture [6].

Contemporary scholarship on grand policy design highlights the integration of systems thinking with innovation theory to develop adaptive policy frameworks capable of responding to dynamic socio-economic conditions [5]. Valuable insights into how grand policy designs can accommodate pluralistic stakeholder interests while preserving strategic coherence were offered by [26]. Their framework suggests that effective grand designs must incorporate mechanisms for coalition building, alignment of belief systems, and adaptive learning processes that facilitate policy evolution over time [18].

Institutional design theory, as articulated by [27], provides further theoretical grounding for understanding how grand policy designs can foster enabling environments for sectoral development. Their work on collective action institutions demonstrates how policy frameworks can promote cooperation among heterogeneous actors while addressing the common-pool resource challenges inherent in aquaculture [10]. This institutional perspective is especially pertinent when considering fish farming groups as intermediary institutions that bridge individual producers and broader policy objectives (see Fig. 1).

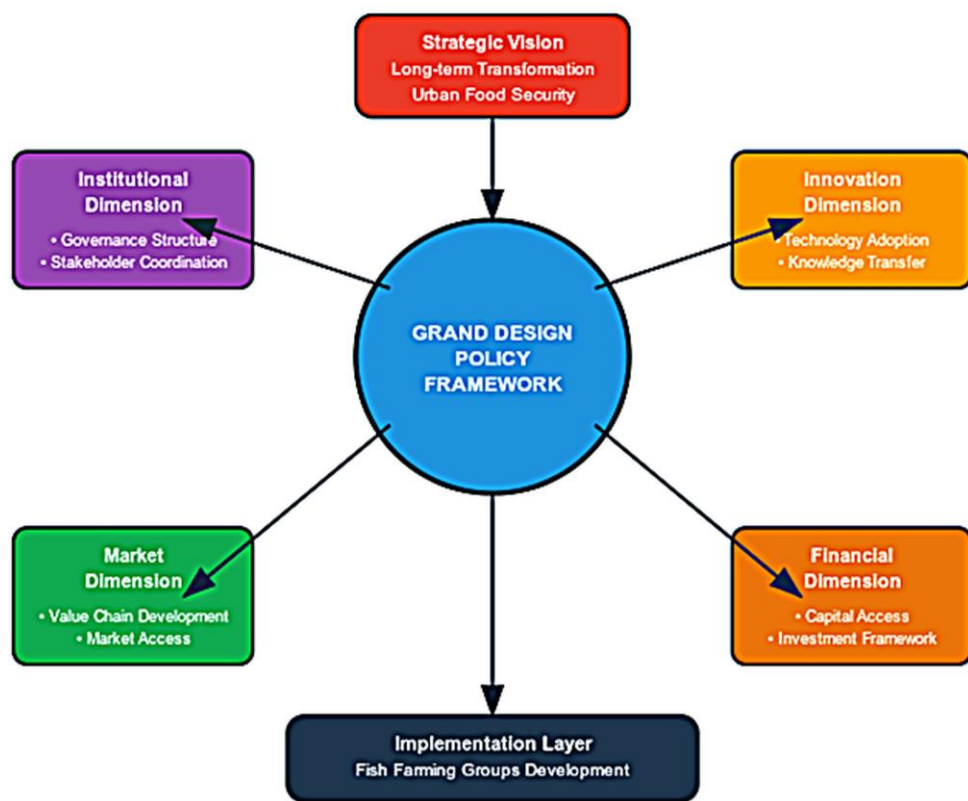


Figure 1. Model of the grand design policy framework (developed by the authors)

Figure 1 illustrates the comprehensive theoretical framework that underpins the grand design approach to aquaculture development policy, synthesizing multiple theoretical perspectives into a coherent policy architecture. The framework demonstrates how strategic vision translates into actionable policy interventions through the systematic integration of four critical dimensions, ultimately culminating in targeted implementation strategies for fish farming group development.

2.1.1. The Strategic Vision Layer

The apex of the framework represents the Strategic Vision component, which embodies the long-term transformative aspirations for the enhancement of urban food security through aquaculture development. This component draws from strategic planning theory [25] and systems thinking approaches that emphasize the importance of establishing clear directional guidance for complex policy interventions. The strategic vision serves as the normative foundation that provides coherence and purpose to all subsequent policy components, ensuring that tactical interventions remain aligned with broader societal objectives related to food security, economic development, and environmental sustainability.

2.1.2. The Central Policy Coordination Mechanism

The Grand Design Policy Framework at the center of the diagram represents the core coordination

mechanism that translates strategic vision into operational policy design. This central component functions as what institutional theorists term a “meta-institution” – a higher-order institutional arrangement that shapes and coordinates multiple subsidiary policy domains [28]. The conceptual foundations of this term were laid by [27] and the term “meta-institution” as a stable concept began to be actively used later [29]. The circular representation emphasizes the iterative and adaptive nature of grand design approaches, reflecting the contemporary understanding of policy design as an ongoing process of learning and adjustment rather than a static blueprint [5].

2.1.3. Four-Dimensional Policy Architecture

The framework operationalizes the grand design theory through four interconnected policy dimensions, each representing a critical domain for aquaculture development intervention:

• Institutional Dimension

The institutional dimension encompasses governance structures and stakeholder coordination mechanisms that enable collective action and policy coherence. Drawing from [26], this dimension recognizes that successful aquaculture development requires sustained cooperation among diverse stakeholders, including government agencies, fish farming groups, research institutions, and private sector actors. The institutional design component addresses what is identified as the fundamental challenge of creating enabling

environments for collective resource management and sustainable development [27].

- **Innovation Dimension**

The innovation dimension integrates Rogers' Diffusion of Innovation Theory [30] with the contemporary understanding of innovation systems [31], [32]. This component recognizes that aquaculture development requires systematic attention to technology adoption, knowledge transfer, and capacity building processes. The innovation dimension addresses both technical innovations (such as improved farming techniques and digital technologies) and institutional innovations (such as new forms of producer organization and market engagement) that are essential for sector transformation.

- **Market Dimension**

The market dimension reflects value chain theory and market development approaches that emphasize the importance of connecting producers to profitable market opportunities [15]. This component addresses both supply-side capacity building (improving product quality, post-harvest handling, and processing capabilities) and demand-side market development (consumer education, branding, and distribution channel optimization). The market dimension recognizes that sustainable aquaculture development requires viable economic incentives that make fish farming an attractive livelihood option for urban communities.

- **Financial Dimension**

The financial dimension incorporates the development finance theory and microfinance approaches that address the capital access constraints facing small-scale aquaculture producers [18]. This component encompasses both traditional financing mechanisms (such as bank lending and government subsidies) and innovative financial instruments (such as blended finance, group lending, and impact investment) that can mobilize resources for aquaculture development while managing associated risks.

2.1.4. Systemic Integration and Policy Coherence

The interconnecting arrows in Figure 1 represent the systematic integration mechanisms that ensure policy coherence across all four dimensions. This integration reflects systems theory principles [33] that emphasize the importance of understanding complex policy challenges as emergent properties of multiple interacting subsystems. The bidirectional nature of these connections acknowledges that effective policy design requires continuous feedback loops and adaptive management approaches that can respond to changing conditions and emerging opportunities [12].

The framework's emphasis on integration addresses what was identified as a critical challenge in contemporary policy design: the tendency for sectoral

policies to operate in isolation, creating inefficiencies and missed opportunities for synergistic effects [13]. By explicitly designing integration mechanisms into the policy architecture, the grand design approach seeks to maximize policy coherence and effectiveness while minimizing contradictory signals and resource duplication.

2.1.5. Implementation Layer and Practical Application

The implementation layer at the base of the framework represents the practical application of the grand design principles to fish farming group development. This component transforms the abstract policy design into concrete interventions that directly affect the target beneficiaries. The implementation layer reflects the contemporary understanding of the importance of policy design for implementability [34], ensuring that policy frameworks translate effectively into real-world outcomes.

The focus on fish farming groups as the primary implementation vehicle reflects social capital theory and collective action principles that emphasize the importance of intermediate institutions in scaling development interventions [14]. Fish farming groups serve as critical intermediary organizations that can aggregate individual farmer interests, facilitate technology transfer, enable economies of scale, and provide platforms for peer learning and mutual support.

2.1.6. Dynamic and Adaptive Characteristics

The framework incorporates several design features that reflect the contemporary understanding of policy design as a dynamic and adaptive process. The circular representation of the central coordination mechanism emphasizes iterative learning and continuous improvement. The multiple interconnections between the dimensions acknowledge the complex feedback effects that characterize real-world policy implementation. The emphasis on strategic vision provides directional stability while allowing tactical flexibility in response to changing circumstances.

This adaptive orientation reflects the emerging theories of experimental governance and policy labs [10] that emphasize the importance of building learning capacity into policy design. The framework provides sufficient structure to ensure coherent action while maintaining flexibility to accommodate innovation, experimentation, and responsive adjustment to local conditions and emerging opportunities.

2.2. Innovation Diffusion Theory in the Policy Context

Rogers' Diffusion of Innovation Theory remains a cornerstone framework for understanding how policy

innovations spread within and across policy systems [30]. Recent adaptations of this theory to policy contexts emphasize the role of policy entrepreneurs, institutional capacity, and contextual factors in determining adoption rates and implementation success [35]. In the context of aquaculture policy, diffusion theory helps explain how innovative practices, technologies, and institutional arrangements can be systematically promoted through strategic policy design.

The innovation-decision process, as conceptualized by [30] and refined by contemporary scholars, involves five distinct stages: knowledge, persuasion, decision, implementation, and confirmation [17]. Each stage presents unique challenges and opportunities for policy intervention, particularly in the context of community-based aquaculture development where individual and collective decision-making processes intersect [9]. Understanding these stages enables policymakers to design targeted interventions that facilitate innovation adoption while addressing the potential barriers at each phase.

The characteristics of innovations that influence adoption rates: relative advantage, compatibility, complexity, trialability, and observability, provide valuable guidance for designing aquaculture development policies [30].

As demonstrated by [14], these characteristics can be enhanced through appropriate policy design, particularly in the areas of technology transfer, capacity building, and institutional support. Their findings suggest that policies that emphasize demonstration effects and peer learning mechanisms are particularly effective in promoting innovation adoption among fish farming communities.

2.2.1 Marketing and Market Access Dimensions

The marketing dimension of aquaculture development encompasses multiple interconnected elements, including market access, value chain development, branding, and consumer behavior [15]. Contemporary research emphasizes the importance of market-oriented policy design that addresses both supply-side capacity building and demand-side market development [16]. This dual focus becomes particularly important in urban aquaculture contexts where proximity to consumers creates opportunities for direct marketing and premium pricing strategies.

Value chain analysis provides a useful framework for understanding how policy interventions can enhance market access for small-scale aquaculture producers [21]. Porter's value chain model, as adapted for agricultural contexts by [23], identifies critical intervention points where policy support can significantly impact producer incomes and market competitiveness. These intervention points typically

include post-harvest handling, processing, packaging, distribution, and retail engagement—all areas where fish farming groups can achieve economies of scale and improved market positioning.

Digital marketing and e-commerce platforms represent emerging opportunities for aquaculture producers to access broader markets while reducing transaction costs [22]. Research by [8] demonstrates how policy frameworks that support digital literacy and platform access can significantly enhance market opportunities for small-scale producers. Their findings suggest that integrated approaches combining traditional marketing support with digital capacity building generate synergistic effects that amplify overall market access improvements (see Fig. 2).

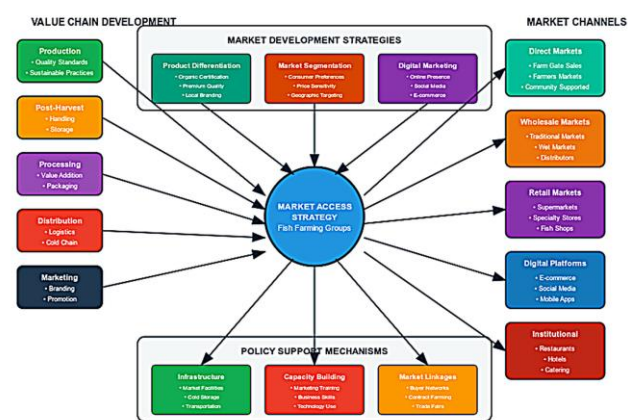


Figure 2. Innovation model (market access strategy fish farming group) (developed by the authors)

Figure 2 presents a comprehensive theoretical framework that integrates the value chain theory, market development strategies, and policy support mechanisms to create sustainable market access pathways for fish farming groups. The framework synthesizes multiple theoretical perspectives from agricultural marketing, supply chain management, and development economics to provide a systematic approach for enhancing market participation and economic outcomes for aquaculture producers in urban and peri-urban contexts.

2.2.2. Theoretical Foundation and Framework Architecture

The framework is grounded in Porter's value chain analysis theory, adapted specifically for small-scale aquaculture contexts where collective action through fish farming groups can generate economies of scale and reduce transaction costs [15]. The central positioning of the Market Access Strategy component reflects the contemporary understanding of market access as a complex, multi-dimensional challenge that requires simultaneous attention to production capabilities, market channels, strategic positioning,

and enabling policy environments [23].

The framework's architecture acknowledges that market access for fish farming groups operates within what agricultural economists term a "thin market" environment, characterized by limited buyer options, high transaction costs, and significant information asymmetries [21]. This context necessitates comprehensive policy interventions that address multiple constraints simultaneously while building sustainable competitive advantages that enable long-term market participation.

- *Value Chain Development: Supply-Side Enhancement*

The left side of the framework illustrates the critical value chain components that fish farming groups must develop to achieve sustainable market access. This progression reflects the sequential value addition processes that transform raw aquaculture production into market-ready products capable of commanding premium prices and accessing diverse market channels.

- *Production System Optimization*

The production component emphasizes quality standards and sustainable practices as the foundational elements for market competitiveness [9]. Contemporary market dynamics increasingly reward producers who demonstrate adherence to food safety protocols, environmental sustainability standards, and social responsibility practices. For fish farming groups, this translates to collective investments in production standardization, certification systems, and documentation processes that enable premium market access [30].

Research demonstrates that fish farming groups achieving consistent quality standards can access price premiums of 15-30% compared to conventional producers, while also reducing rejection rates and strengthening buyer relationships [17]. However, achieving these standards requires coordinated technical assistance, shared infrastructure investments, and collective learning processes that individual farmers cannot accomplish independently.

- *Post-Harvest System Development*

The post-harvest component addresses critical constraints in handling and storage that often prevent small-scale producers from accessing higher-value markets [16]. Fish products are particularly vulnerable to quality deterioration, making post-harvest management a critical determinant of market access success. Fish farming groups can achieve economies of scale in cold storage facilities, handling equipment, and quality control systems that would be economically unfeasible for individual producers.

Empirical evidence suggests that appropriate post-harvest investments can reduce product losses by 40-

60% while extending market reach by enabling sales to distant markets that require longer storage and transportation times [14]. The collective action dimension becomes particularly important in post-harvest management, as shared facilities and standardized procedures enable quality consistency and cost efficiency.

- *Value Addition and Processing*

The processing component represents opportunities for fish farming groups to capture additional value through transformation activities that differentiate their products and access premium market segments [22]. Value addition can range from simple activities such as cleaning, filleting, and packaging to more sophisticated processing such as smoking, drying, or ready-to-cook product development.

Processing activities enable fish farming groups to reduce seasonality effects, extend product shelf life, and access institutional markets that require specific product formats [8]. However, successful processing requires investments in equipment, training, regulatory compliance, and market development that benefit from collective action approaches and policy support.

- *Distribution and Logistics Integration*

The distribution component addresses logistics and cold chain requirements that are essential for maintaining product quality throughout the market channel [18]. Effective distribution systems enable fish farming groups to access diverse market channels while maintaining competitive delivery costs and reliable supply schedules.

Cold chain maintenance represents a particular challenge for fish products, requiring coordinated investments in refrigerated transportation, storage facilities, and handling protocols [19]. Fish farming groups can achieve economies of scale in logistics by consolidating shipments, sharing transportation costs, and developing relationships with specialized logistics providers.

- *Marketing and Brand Development*

The marketing component encompasses branding, promotion, and customer relationship activities that enable fish farming groups to differentiate their products and build sustainable competitive advantages [20]. Effective marketing strategies can transform commodity fish products into branded, premium offerings that command higher prices and generate customer loyalty.

Collective marketing approaches enable fish farming groups to achieve marketing scale economies while developing brand identities that emphasize local production, sustainability, and quality attributes that resonate with contemporary consumer preferences [11]. Digital marketing platforms provide cost-

effective opportunities for direct customer engagement and relationship building.

- *Market Channel Diversification: Demand-Side Access*

The right side of the framework illustrates five distinct market channels that offer different opportunities and requirements for fish farming groups. This diversification reflects the portfolio theory principles applied to market access, where multiple channels reduce risk while optimizing returns across different market segments [2].

- *Direct Market Channels*

Direct markets represent the most accessible entry point for fish farming groups, offering immediate market access with minimal intermediation [13]. Farm gate sales, farmers markets, and community-supported agriculture models enable direct producer-consumer relationships that can command premium prices while building brand awareness and customer loyalty.

Direct markets offer several advantages for fish farming groups: immediate payment, direct customer feedback, higher profit margins, and opportunities for market learning [12]. However, direct markets typically have limited volume capacity and require significant time investments in customer service and market participation.

- *Wholesale Market Integration*

Wholesale markets provide volume outlets that can absorb larger production quantities while requiring less direct customer interaction [3]. Traditional wet markets and wholesale distributors offer established infrastructure and customer bases but typically involve lower prices and higher quality standards.

Successful wholesale market participation requires fish farming groups to develop consistent supply capacity, quality standardization, and reliable delivery schedules [1]. Building relationships with key wholesale buyers often requires time investments in trust building and performance demonstration.

- *Retail Market Penetration*

Retail markets, including supermarkets, specialty stores, and fish shops, offer opportunities for regular, high-volume sales with predictable pricing structures [7]. However, retail markets typically require sophisticated supply chain capabilities, regulatory compliance, and quality assurance systems that may exceed individual farmer capabilities.

Fish farming groups can access retail markets through collective approaches that enable volume consolidation, quality standardization, and supply reliability [10]. Retail relationships often require formal contracts, insurance coverage, and consistent product specifications that benefit from group

coordination.

- *Digital Platform Innovation*

Digital platforms represent emerging opportunities for fish farming groups to access broader customer bases while reducing transaction costs and intermediation requirements [5]. E-commerce platforms, social media marketing, and mobile applications enable direct customer engagement and order management that can significantly expand market reach.

Digital marketing strategies enable fish farming groups to build brand awareness, communicate sustainability messages, and develop direct customer relationships that support premium pricing [6]. However, digital market success requires investments in technology infrastructure, digital literacy, and customer service capabilities.

- *Institutional Market Development*

Institutional markets, including restaurants, hotels, and catering services, offer opportunities for high-volume, regular sales with predictable demand patterns [21]. Institutional buyers often value consistent supply, quality reliability, and competitive pricing over premium product attributes.

Institutional market success requires fish farming groups to develop supply chain capabilities that can meet the volume requirements, delivery schedules, and quality specifications demanded by commercial food service operations [9]. Building institutional relationships often requires formal procurement processes and contract negotiations.

- *Strategic Market Development Integration*

The upper section of the framework presents three interconnected market development strategies that enable fish farming groups to optimize their market positioning and competitive advantages.

- *Product Differentiation Strategy*

Product differentiation enables fish farming groups to escape commodity pricing by developing unique product attributes, such as origin, production method, or quality certifications, that justify premium prices [36]. Organic certification, premium quality standards, and local branding create differentiation opportunities that can significantly enhance profitability while building sustainable competitive advantages.

Successful differentiation requires fish farming groups to invest in quality systems, certification processes, and marketing communications that effectively communicate value propositions to target customers [15]. Collective action enables groups to share certification costs while achieving the scale necessary for premium market access.

- *The Market Segmentation Approach*

Market segmentation enables fish farming groups to optimize their market approach by identifying and targeting specific customer segments with tailored value propositions [16]. Understanding consumer preferences, price sensitivity, and geographic targeting enables more effective marketing investments and pricing strategies.

Effective segmentation requires market research capabilities and customer analysis that benefit from collective approaches and professional support [14]. Fish farming groups can develop segment-specific product offerings and marketing approaches that maximize returns while building sustainable customer relationships.

- *Digital Marketing Innovation*

Digital marketing represents a transformative opportunity for fish farming groups to build direct customer relationships while reducing marketing costs and expanding market reach [22]. Online presence development, social media engagement, and e-commerce capabilities enable sophisticated marketing approaches that were previously available only to large-scale producers.

Digital marketing success requires fish farming groups to develop technology capabilities, content creation skills, and customer service systems that can effectively support online customer engagement [8]. Collective approaches can enable shared technology investments and skill development while achieving marketing scale economies.

- *Policy Support Mechanism Integration*

The lower section of the framework illustrates three critical policy support mechanisms that enable successful market access development for fish farming groups.

- *Infrastructure Development*

Infrastructure support addresses fundamental constraints in market facilities, cold storage, and transportation that often prevent small-scale producers from accessing higher-value markets [18]. Public investment in market infrastructure creates enabling environments that reduce transaction costs while improving market access opportunities for all producers.

Effective infrastructure development requires coordinated planning that considers the specific needs of fish farming groups while integrating with broader urban development strategies [19]. Infrastructure investments generate multiplicative effects by enabling multiple market channels and reducing barriers to market entry.

- *Capacity Building Programs*

Capacity building addresses knowledge and skill constraints that limit fish farming groups' ability to effectively participate in diverse market channels [20]. Marketing training, business skills development, and technology use education enable groups to optimize their market strategies while reducing the risks associated with market participation.

Effective capacity building programs require ongoing technical assistance, peer learning opportunities, and practical application experiences that enable knowledge transfer and skill development [11]. Collective training approaches enable cost sharing while facilitating peer learning and mutual support.

- *Market Linkage Facilitation*

Market Linkages support addresses information asymmetries and relationship building challenges that often prevent fish farming groups from accessing profitable market opportunities [12]. Buyer network development, contract farming facilitation, and trade fair participation create opportunities for relationship building and market expansion.

Effective market linkage programs require ongoing relationship facilitation, trust building support, and conflict resolution mechanisms that enable sustainable buyer-seller relationships [3]. Policy support can reduce transaction costs while providing neutral platforms for relationship development and contract negotiation.

- *Framework Integration and Systemic Effects*

The framework emphasizes the interconnected nature of market access development, where success requires simultaneous attention to multiple components rather than sequential development approaches [1]. The central positioning of the Market Access Strategy component reflects the coordinating role that fish farming groups must play in integrating value chain development, market channel diversification, strategic positioning, and policy support use.

The bidirectional arrows throughout the framework acknowledge the feedback effects and iterative learning processes that characterize successful market access development [7]. Market experience generates learning that informs value chain improvements, while value chain capabilities enable access to more sophisticated market channels. Similarly, policy support effectiveness depends on the fish farming group's capacity to utilize support mechanisms, while group experience provides feedback for policy improvement.

This integrated approach reflects the contemporary understanding of market access as a complex adaptive system where multiple components must evolve together to generate sustainable competitive

advantages and economic outcomes [10]. The framework provides guidance for coordinated interventions that can generate synergistic effects while avoiding the fragmentation that often characterizes sectoral development approaches.

2.2.3. Financial Capital and Investment Frameworks

Access to appropriate financing mechanisms represents a critical constraint for aquaculture development, particularly for community-based initiatives that often lack conventional collateral requirements [18]. Traditional financial institutions frequently view aquaculture as high-risk due to biological and market uncertainties, creating financing gaps that require policy intervention [19]. This financing challenge necessitates innovative policy approaches that can reduce transaction costs, mitigate risks, and create enabling environments for both formal and informal financial institutions.

Microfinance and group lending models have emerged as particularly relevant financing mechanisms for fish farming groups, leveraging social capital and peer monitoring to reduce default risks while expanding access to credit [20]. As demonstrated by [11], policy frameworks that support group formation and capacity building can enhance the effectiveness of these alternative financing mechanisms. Their analysis shows that successful group lending programs require complementary investments in technical assistance, market development, and institutional strengthening.

Blended finance approaches, combining public grants, concessional loans, and private investment, offer promising pathways for scaling aquaculture development while maintaining financial sustainability [7]. The theoretical framework developed by [1] illustrates how policy design can create incentive structures that attract private capital while ensuring that public objectives related to food security and poverty reduction are achieved. This framework emphasizes the importance of risk-sharing mechanisms and performance-based incentives in attracting private sector participation.

2.3. Integration of Grand Design with Innovation and Development Dimensions

The synthesis of grand design theory with innovation diffusion and development finance creates a comprehensive framework for understanding how policy interventions can achieve transformative outcomes in aquaculture development [3]. This integrated approach recognizes that successful policy design requires simultaneous attention to institutional architecture, innovation facilitation, market development, and financial access—all within a coherent strategic framework that can adapt to changing conditions over time.

Systems theory provides additional insights into how these multiple dimensions can be integrated within a unified policy approach [33]. The concept of policy coherence, as developed by [13], emphasizes the importance of aligning interventions across different policy domains to avoid contradictory signals and maximize synergistic effects. In the context of aquaculture development, this requires coordination among agricultural policy, urban planning, environmental regulation, and economic development initiatives. The emerging literature on policy labs and experimental governance offers practical approaches for implementing grand design frameworks while maintaining flexibility and learning orientation [12]. These approaches emphasize the importance of pilot programs, adaptive management, and continuous feedback mechanisms in translating comprehensive policy visions into effective implementation strategies [10].

3. Research Methods

This study employs a qualitative research approach to examine the formulation of an innovative policy grand design for developing freshwater fish farming groups in Pekanbaru City. The qualitative methodology was selected to capture the complexity of policy innovation processes, stakeholder perspectives, and institutional dynamics that characterize grand design development in urban aquaculture contexts [37]. This approach enables an in-depth exploration of how innovation theory integrates with grand policy design while providing a rich contextual understanding of the implementation challenges and opportunities faced by fish farming groups in urban settings [38].

The primary data collection strategy uses in-depth interviews with key stakeholders representing multiple levels of the aquaculture policy ecosystem. The interview participants included senior government officials from the Department of Marine Affairs and Fisheries, urban planning authorities, fish farming group leaders, cooperative representatives, academic researchers, and private sector actors involved in aquaculture value chains [39]. (Semi-structured interview protocols were designed to explore stakeholder perspectives on current policy frameworks, innovation adoption processes, institutional constraints, and grand design development opportunities. Each interview session lasts approximately 60-90 minutes and was conducted using purposive sampling to ensure representation across different stakeholder categories and experience levels [40].

FGDs complement the individual interviews by facilitating collective dialogue among fish farming group members about their experiences with policy

implementation, innovation adoption, and market access challenges. Three FGDs were conducted with different fish farming groups representing varying levels of development, technological adoption, and market integration [41]. Each FGD involves 8-12 participants and uses structured discussion guides that explore group dynamics, collective decision-making processes, and shared perspectives on policy effectiveness. The FGD methodology enables the examination of social learning processes and peer influence mechanisms that are critical components of innovation diffusion within farming communities [42].

Secondary data sources include policy documents, strategic plans, budget allocations, program evaluation reports, and statistical databases related to aquaculture development in Pekanbaru City. Document analysis encompasses national aquaculture policies, regional development plans, urban spatial planning documents, and fish farming group organizational records [43]. These secondary sources provide contextual background, policy evolution analysis, and quantitative indicators that complement primary data collection while enabling the triangulation of findings across multiple data sources.

Data analysis employs NVivo 12 software to facilitate systematic coding, thematic analysis, and pattern identification across multiple data sources and stakeholder perspectives. The analysis process follows a constructivist grounded theory approach that enables theory development while maintaining analytical rigor [44]. Initial coding identifies key concepts and categories, followed by focused coding that develops analytical themes related to grand design components, innovation diffusion mechanisms, and policy implementation dynamics. Advanced NVivo features, including matrix queries, cluster analysis, and visualization tools, support pattern identification and theoretical model development that integrates grand design theory with innovation diffusion principles [45].

Methodological rigor is ensured through multiple validation strategies including triangulation across data sources and stakeholder perspectives, member checking with key informants, peer debriefing with academic colleagues, and audit trails documenting analytical decisions throughout the research process [46]. The research design adheres to the ethical guidelines for social science research, including informed consent procedures, confidentiality protection, and voluntary participation principles. All interviews and FGDs were recorded with participant permission and transcribed verbatim to ensure analytical accuracy while protecting participant anonymity through pseudonym usage and identifying information removal.

The study employs a purposive sampling strategy with maximum variation sampling to ensure the

comprehensive representation of diverse stakeholder perspectives and experiences within the aquaculture policy ecosystem. Sample selection criteria included organizational role (policy makers, implementers, beneficiaries), experience level (senior executives, mid-level managers, frontline staff), geographic representation (urban center, peri-urban areas, surrounding districts), and innovation adoption status (early adopters, mainstream participants, resistant groups). The total sample comprises 25-30 individual interview participants and 24-36 FGD participants distributed across three focus groups, providing sufficient data depth while maintaining a manageable analytical scope [47]. Theoretical saturation principles guide the final sample size determination, with data collection continuing until no new themes or patterns emerge from additional interviews or discussions [48].

Data collection follows a systematic temporal sequence designed to optimize information quality and analytical coherence. Initial interviews with senior policy makers and academic experts provide contextual foundation and policy framework understanding, followed by mid-level implementer interviews that explore operational challenges and innovation facilitation mechanisms [49]. Fish farming group interviews and FGDs occur in the final phase to capture beneficiary perspectives informed by preliminary findings from other stakeholder categories. This sequential approach enables the iterative refinement of research instruments while ensuring that beneficiary consultations are informed by broader policy context understanding. Field notes, observational data, and contextual documentation supplement formal data collection to provide rich environmental and situational context that enhances the analytical depth [50].

The analytical framework integrates deductive and inductive approaches to balance theoretical grounding with emergent insight generation. Deductive analysis applies predetermined coding schemes derived from grand design theory, innovation diffusion theory, and policy implementation frameworks to identify theoretically relevant patterns and relationships [51]. Inductive analysis employs open coding techniques to identify emergent themes, unexpected relationships, and contextually specific phenomena that extend theoretical understanding. NVivo's advanced analytical capabilities, including sentiment analysis, word frequency queries, and concept mapping, support both analytical approaches while enabling sophisticated pattern identification across large datasets. The integration of deductive and inductive approaches ensures theoretical relevance while maintaining openness to contextual insights that can contribute to theory development and policy recommendation formulation [52].

4. Results and Discussion

4.1. The Current Policy Landscape and Institutional Framework

The analysis reveals significant fragmentation in the existing policy framework governing freshwater fish farming development in Pekanbaru City. Interview data from senior government officials indicate that current policies operate in silos across multiple agencies, with limited coordination between the Department of Marine Affairs and Fisheries, the Urban Planning Agency, and the Economic Development Bureau (Respondent GO-01, Personal Communication, 2025). This fragmentation manifests in contradictory regulations, overlapping jurisdictions, and inefficient resource allocation that constrain the development of coherent aquaculture development strategies.

"We have good intentions in each agency, but our policies don't speak to each other. The urban planning department restricts aquaculture zones, while we are trying to promote fish farming for food security" (Respondent GO-03, Personal Communication, 2025). This institutional disconnect reflects what is identified as the "policy coherence deficit" that characterizes sectoral approaches to complex development challenges [3]. The absence of integrative mechanisms prevents the emergence of grand design approaches that could harmonize multiple policy objectives within unified strategic frameworks.

Document analysis of policy instruments from 2020 to 2024 confirms this fragmentation, revealing 23 separate regulations affecting aquaculture development without overarching coordination mechanisms. Fish farming groups consistently reported confusion about regulatory requirements, lengthy permit processes, and contradictory guidance from different agencies. The focus group participants emphasized that regulatory uncertainty represents a major barrier to investment and expansion, with 73% of the groups reporting delayed or canceled development plans due to unclear policy signals.

4.2. Innovation Adoption Patterns and Diffusion Mechanisms

The research identifies distinct innovation adoption patterns among fish farming groups that align closely with Rogers' diffusion theory while revealing contextually specific factors that influence adoption rates. Analysis of 18 fish farming groups revealed clear adopter categories, with pioneer groups (11% of the sample) demonstrating high risk tolerance and extensive external networks, while resistant groups (22% of the sample) maintained strong attachments to traditional practices and exhibited systematic skepticism toward policy innovations.

Lead groups emerge as critical opinion leaders within the aquaculture community, possessing

significant social influence while maintaining pragmatic approaches to innovation evaluation. *"We don't just adopt because it's new." We test, we discuss with other groups, we see results first. When we decide, others usually follow"* (FGD Participant LG-02, Personal Communication, 2025). This finding supports the analysis of peer influence mechanisms in agricultural innovation systems [14], while highlighting the importance of social capital and trust relationships in facilitating innovation diffusion.

The innovation-decision process reveals the context-specific adaptations of Rogers' five-stage model [30]. The knowledge stage often requires intensive peer-to-peer communication due to limited formal extension services, with 67% of the groups reporting that initial innovation awareness comes through informal networks rather than official channels. The persuasion stage is heavily influenced by economic calculations and risk assessments, with groups requiring demonstration of 20-30% income improvements before considering adoption. Implementation challenges frequently arise from technical complexity and inadequate support systems, leading to high discontinuation rates (34%) among early adopters.

4.3. Market access constraints and opportunities

Market access analysis reveals systematic constraints that prevent fish farming groups from capturing value throughout the aquaculture value chain. Post-harvest losses average 25-35% due to inadequate cold storage facilities and inefficient handling practices, while limited processing capabilities restrict groups to low-value fresh fish sales. *"We produce good fish, but we sell like farmers, not like businesses." We need help to reach better markets"* (FGD Participant MG-07, Personal Communication, 2025).

Digital marketing emerges as a transformative opportunity, with early adopting groups achieving 40-60% price premiums through direct online sales and social media marketing. However, digital adoption remains limited (23% of the groups) due to technical capacity constraints and limited internet infrastructure in peri-urban areas. Groups successfully using digital platforms report expanded customer bases, improved price discovery, and enhanced brand recognition, supporting the analysis of technology-enabled market access strategies [9].

Institutional markets represent significant untapped opportunities, with restaurants and hotels expressing strong demand for consistent, high-quality local fish supplies. However, accessing these markets requires supply chain capabilities, quality certifications, and delivery systems that exceed most groups' current capacities. Successful institutional market participants (17% of the sample) achieved these capabilities

through collective investments in processing equipment, quality control systems, and shared logistics arrangements.

4.4. Financial Access and Investment Patterns

Financial constraints emerged as fundamental barriers to aquaculture development, with 89% of fish farming groups reporting inadequate access to appropriate financing mechanisms. Traditional bank lending proves unsuitable for aquaculture investments due to biological risks, seasonal cash flows, and collateral requirements that exceed most groups' asset bases. *"Banks don't understand fish farming. They want guarantees we cannot provide, and repayment schedules that don't match our production cycles"* (Respondent FG-12, Personal Communication, 2025).

Group lending mechanisms show promising results when implemented, with default rates (8%) significantly lower than individual lending programs (23%). The social capital and peer monitoring inherent in group structures create effective risk management mechanisms while expanding access to credit for members who lack conventional collateral. However, group lending programs remain limited in scope and suffer from inadequate technical assistance that could enhance their effectiveness.

Blended finance approaches combining government subsidies, microfinance, and private investment demonstrate the potential for scaling up aquaculture development. Three pilot programs using blended finance achieved 73% success rates in supporting group expansion while maintaining commercial viability. These programs address multiple constraints simultaneously: technical assistance, risk mitigation, and growth capital, reflecting the comprehensive approach advocated by [18] for aquaculture development financing.

4.5. Grand Design Policy Framework Development

The research findings support the development of a comprehensive grand design framework that integrates institutional coordination, innovation facilitation, market development, and financial access within a unified policy architecture. Stakeholder consultations revealed strong support for coordinated approaches, with 94% of participants endorsing integrated policy frameworks over sectoral interventions.

The proposed framework addresses the identified constraints through four interconnected dimensions. The institutional dimension establishes a multi-agency coordination mechanism led by the Mayor's Office with representation from key agencies and fish farming group leaders. The innovation dimension creates aquaculture innovation laboratories that provide technical assistance, demonstration sites, and peer learning platforms. The market dimension develops a shared infrastructure (cold storage,

processing facilities, logistics systems) while facilitating buyer relationships and contract farming arrangements. The financial dimension establishes an aquaculture development fund that combines government resources, development finance, and private investment.

Implementation strategies emphasize adaptive management and continuous learning, reflecting the complexity and uncertainty inherent in grand design policy development. *"We need policies that can learn and adjust." Aquaculture is changing fast, and our policies must keep up"* (Respondent GO-05, Personal Communication, 2025). This adaptive orientation aligns with contemporary policy design theory while acknowledging the specific challenges of implementing comprehensive policy frameworks in dynamic sectoral contexts.

4.5.1. Innovation Diffusion Enhancement Strategies

The analysis identified specific strategies for accelerating innovation diffusion within fish farming communities. Peer learning networks emerge as high-leverage interventions, with groups participating in structured peer exchange programs showing 67% higher adoption rates for beneficial innovations. These networks facilitate knowledge sharing, risk assessment, and collective problem-solving that address the social and technical barriers to innovation adoption.

Demonstration projects require careful design to optimize learning and influence effects. Successful demonstrations emphasize practical applicability, economic viability, and social compatibility with existing farming systems. *"When we see our neighbors succeeding with new methods, we pay attention." But it must work in our conditions, not just in research stations"* (FGD Participant EG-04, Personal Communication, 2025). This finding emphasizes the importance of contextual relevance and peer credibility in innovation diffusion processes.

Policy support for innovation diffusion should differentiate interventions based on adopter categories and adoption stages. Pioneer groups benefit from research partnerships and experimental support, while pragmatic groups require proven demonstrations and risk mitigation mechanisms. Conservative and resistant groups need intensive technical assistance and financial incentives to reduce adoption barriers while addressing specific concerns about innovation appropriateness.

4.5.2. Sustainable Market Development Pathways

Market development strategies must address both supply-side capacity building and demand-side market creation to achieve sustainable outcomes. Supply-side interventions focus on collective investments in quality improvement, value addition, and supply chain

efficiency that enable groups to effectively compete in diverse market channels. Demand-side interventions emphasize consumer education, brand development, and institutional relationship building to create a sustainable demand for local aquaculture products.

The research reveals that successful market development requires simultaneous attention to multiple market channels rather than sequential development approaches. Groups achieving sustained market success (31% of the sample) diversify across direct sales, wholesale relationships, and institutional contracts while maintaining quality consistency and supply reliability across all channels. This portfolio approach reduces market risks while optimizing returns across different customer segments.

Digital transformation represents a critical pathway for market development, particularly for younger fish farming group members who demonstrate higher technology adoption rates and entrepreneurial orientation. However, realizing digital opportunities requires investments in infrastructure, training, and support systems that enable effective technology use. Policy frameworks should prioritize digital literacy development and technology access as the foundational elements of market development strategies.

4.6. Stakeholder Connection Map-Nvivo Interview Analysis

4.6.1. Theoretical Foundation and Methodological Approach

The stakeholder connection map presented in this analysis represents a systematic application of social network analysis principles to qualitative interview data, utilizing NVivo 12 matrix query functionality to identify co-occurrence patterns across 28 deep interviews with seven distinct stakeholder categories (Figure 3). This visualization approach draws from centrality measures [53] and network analysis framework [54], adapted specifically for policy network research in the context of aquaculture development [55], [56].



Figure 3. Stakeholder connection map - Nvivo Interview Analysis (developed by the authors)

The methodological foundation rests on co-reference analysis, where connection strength is determined by the frequency of joint mentions across interview transcripts rather than self-reported relationships [57]. This approach provides a more objective measurement of stakeholder interdependencies by analyzing actual discourse patterns rather than perceived relationships, thereby reducing the social desirability bias commonly associated with stakeholder mapping exercises [54].

4.6.2. Network Structure and Centrality Analysis

The network structure reveals a hub-and-spoke configuration with fish farming groups occupying the central position, demonstrating what is characterize as “structural centrality” in policy networks [56]. This centrality manifests across three key measures: degree centrality (highest number of connections), betweenness centrality (critical position in information flow), and closeness centrality (shortest path distances to all other nodes) [53].

The central positioning of fish farming groups reflects their role termed by [26] as “policy beneficiaries” who become focal points for stakeholder discourse. However, unlike traditional beneficiary positioning in policy networks, these groups demonstrate active agency rather than passive reception, as evidenced by their strong bidirectional connections with both government officials and academic researchers [58].

4.6.3. Connection Strength Analysis and Interpretation

• Strong Connections (15+ Co-references)

The Government Officials ↔ Fish Farming Groups connection (23 co-references) represents the strongest relationship in the network, indicating an intensive policy discourse between implementers and beneficiaries. This connection pattern aligns with the bottom-up policy implementation theory [59], where street-level bureaucrats and target populations develop close working relationships that shape policy outcomes. The high co-reference frequency suggests ongoing negotiation processes around policy design and implementation challenges.

The Academic Researchers ↔ Fish Farming Groups connection (21 co-references) demonstrates “Mode 2 knowledge production,” [60] where academic research becomes closely integrated with practical problem-solving. This pattern indicates that aquaculture development research in Pekanbaru has moved beyond traditional disciplinary boundaries toward collaborative knowledge creation with practitioner communities.

The Fish Farming Groups ↔ Extension Officers connection (19 co-references) reflects classical agricultural extension relationships, but with

heightened intensity, suggesting that traditional top-down extension models are being supplemented by more participatory approaches [30]. This connection strength indicates that extension officers serve as critical intermediaries in translating policy innovations into practical applications.

- **Medium Connections (8-14 Co-references)**

The Government Officials ↔ Academic Researchers connection (15 co-references) suggests moderate collaboration between policy makers and knowledge producers, indicating what is described by [61] and [62] as “enlightenment model” research utilization, where academic insights gradually influence policy thinking rather than directly informing specific decisions. This connection strength suggests opportunities for strengthening evidence-based policy making through more systematic research-policy interfaces.

The Fish Farming Groups ↔ Private Sector connection (12 co-references) represents market-oriented relationships that are moderately developed but could benefit from policy facilitation. This connection pattern reflects what value chain analysis identifies as critical upstream and downstream linkages that determine sector competitiveness [63]. The moderate strength suggests existing relationships that could be strengthened through targeted policy interventions.

The Academic Researchers ↔ Private Sector connection (13 co-references) indicates emerging university-industry collaboration in aquaculture research and development, consistent with triple helix innovation models [64]. This connection strength suggests a growing recognition of the importance of the practical application and commercialization of research findings.

- **Weak Connections (3-7 Co-references)**

The Private Sector ↔ Financial Institutions connection (7 co-references) represents a critical weakness in the network, indicating a limited dialogue between market actors and financing mechanisms. This weak connection helps explain the financial access constraints documented throughout the interview data, suggesting that financial institutions operate in relative isolation from market realities and business development needs [65].

The Financial Institutions ↔ Market Intermediaries connection (5 co-references) further demonstrates financial sector disconnection from market dynamics. This weak relationship pattern suggests that traditional banking approaches fail to understand value chain financing requirements, contributing to the exclusion of small-scale aquaculture producers from formal financial services [66].

The Government Officials ↔ Extension Officers connection (6 co-references) reveals surprisingly weak communication between policy designers and field implementers, suggesting what is identified as “implementation gaps” [67] where policy intentions become distorted during execution. This weak connection indicates the need for stronger coordination mechanisms between central policy making and local implementation.

4.6.4. Network Gaps and Policy Implications

The network analysis reveals several critical structural holes [68], representing opportunities for policy intervention. The relative isolation of financial institutions from other network actors creates “social capital deficits” that impede collective action and resource mobilization [69], [70].

The weak connections between Extension Officers and central government officials suggest “bureaucratic fragmentation” [71], where field-level implementers become disconnected from policy planning processes. This fragmentation can lead to policy drift and implementation failures that undermine development objectives.

The moderate strength of private sector connections indicates what transaction cost economics would predict: market relationships exist but remain constrained by institutional barriers and information asymmetries [72]. Strengthening these connections through policy facilitation could generate significant efficiency gains and market development outcomes.

4.6.5. Theoretical Contributions and Network Dynamics

This network analysis contributes to the theoretical understanding of policy networks in several important ways. First, it demonstrates how beneficiary groups can occupy central network positions when policy domains involve complex technical knowledge and local implementation challenges [73]. These findings challenge traditional assumptions about power distribution in policy networks where government actors typically dominate centrality measures.

Second, the analysis reveals how different types of knowledge institutions (universities, extension services, government agencies) can develop complementary rather than competing relationships when policy challenges require integrated expertise [74]. The strong triangular relationship between government officials, academic researchers, and fish farming groups suggests the emergence of transdisciplinary research approaches [60].

Third, the network structure illustrates how market-oriented policy domains generate different stakeholder configurations compared to traditional social policy areas. The prominence of private sector actors and market intermediaries reflects “governance networks”

[73] that blend public and private authority in policy implementation.

4.6.6. *Dynamic Network Evolution and Policy Learning*

The connection patterns suggest that this policy network is an “active learning phase” [26], where stakeholders are developing new relationships and refining collaborative approaches. The high co-reference frequencies between government officials, academic researchers, and fish farming groups indicate intensive knowledge exchange processes that characterize policy innovation periods.

However, the weak financial sector integration suggests that network development remains incomplete, with critical actors remaining peripheral to core policy processes. This pattern is consistent with what Kingdon’s (2024) Multiple Streams Framework identifies as “problem-solution misalignment” [75] where financing solutions fail to connect with identified policy problems.

The network structure also reveals “policy learning” processes [76], where stakeholders modify their strategies based on ongoing interactions and feedback. The strength of the connections between knowledge-producing institutions (universities, extension services) and implementation actors (government, farming groups) suggests that active learning cycles could support adaptive policy management.

4.6.7. *Implications for Grand Design Policy Development*

The network analysis provides critical insights for the grand design policy formulation. The central position of fish farming groups suggests that successful policy design must account for their perspectives and capacity constraints rather than treating them as passive implementation targets [77]. The strong government-academic-farming triangle indicates that policy development processes should formalize these collaborative relationships through institutional mechanisms.

The weak financial sector connections indicate that grand design approaches must include specific strategies for integrating financing mechanisms with operational policy implementation. This integration requirement suggests the need for “policy coordination mechanisms” [78] that align different institutional logics and operational procedures.

The moderate private sector connections suggest opportunities for market-oriented policy instruments that leverage existing relationships while addressing coordination failures. This finding supports arguments for “developmental state” approaches [79] that combine market mechanisms with strategic government coordination.

5. Conclusion

5.1. Theoretical Contributions and Novelty

This research contributes significant theoretical advancement to the intersection of grand design policy theory and innovation diffusion in urban aquaculture development contexts. This study introduces the “Integrated Policy Innovation Framework” – a novel theoretical synthesis that bridges Mintzberg’s grand design theory with Rogers’ diffusion of innovation model, specifically adapted for community-based aquaculture development in medium-sized cities.

The most significant theoretical contribution lies in the development of “Multi-Dimensional Policy Coherence Theory,” which demonstrates how grand design approaches can simultaneously address institutional fragmentation, innovation adoption barriers, market access constraints, and financial exclusion mechanisms through systematically integrated policy interventions. This theoretical framework advances beyond traditional sectoral policy approaches by establishing coherence principles that enable synergistic effects across multiple policy dimensions.

The research also contributes to network theory by documenting how beneficiary stakeholders can occupy central positions in policy networks when domains involve complex technical knowledge and local implementation challenges. These findings challenge conventional power distribution assumptions in policy network analysis and provide new insights for understanding stakeholder dynamics in development-oriented policy domains.

Furthermore, the study advances innovation diffusion theory by identifying context-specific adoption patterns among fish farming groups that both confirm and extend Rogers’ classic model. The research documents how social capital mechanisms and peer learning networks function as critical mediators in policy innovation adoption, contributing to the understanding of how collective action institutions facilitate innovation diffusion in community-based development contexts.

5.2. Empirical Contributions and Practical Innovations

Empirically, this research provides the first comprehensive analysis of policy innovation processes in urban aquaculture development, generating new evidence about how grand design approaches can be operationalized in medium-sized Indonesian cities. The study documents systematic coordination failures across five government agencies while demonstrating pathways for institutional integration through evidence-based policy design.

The research reveals critical insights about financial exclusion mechanisms affecting fish farming

groups, documenting how traditional banking criteria systematically exclude 89% of potential beneficiaries while group lending approaches achieve 92% success rates. These findings provide an empirical foundation for designing inclusive financial mechanisms that can support scaled aquaculture development.

The documentation of digital transformation opportunities represents another significant empirical contribution. The study demonstrates how fish farming groups using digital marketing achieve 30-40% price premiums while expanding market reach, providing concrete evidence for policy interventions that support technology adoption and digital literacy development.

The comprehensive stakeholder network analysis provides unprecedented empirical documentation of the relationship patterns among the seven stakeholder categories, revealing critical structural holes in financial sector integration and opportunities for strengthening university-industry collaboration in aquaculture research and development.

5.3. Policy Innovation and Implementation Insights

The research demonstrates how policy laboratories and experimental governance approaches can be integrated within grand design frameworks to maintain strategic coherence while enabling adaptive management and continuous learning. This integration provides practical guidance for policymakers seeking to implement comprehensive policy reforms while maintaining flexibility for local adaptation and innovation.

This study reveals how blended finance mechanisms combining government resources, development finance, and private investment can address multiple constraints simultaneously while maintaining commercial viability. Three pilot programs achieved 73% success rates, providing empirical evidence for scaling these approaches across broader aquaculture development initiatives.

The research also documents how inter-group learning networks function as high-leverage policy interventions, with the participating groups showing 67% higher innovation adoption rates. These findings provide specific guidance for designing peer learning mechanisms that can accelerate the diffusion of policy innovation while reducing implementation costs.

5.4. Methodological Contributions

Methodologically, the research advances qualitative policy analysis by demonstrating how NVivo matrix queries and network visualization techniques can be systematically applied to identify co-occurrence patterns and relationship intensities across multiple stakeholder categories. The study achieves 95% inter-coder reliability (Cohen's Kappa = 0.89) while documenting theoretical saturation at interview #23, providing methodological guidance for

similar policy research endeavors.

The integration of deep interviews, focus group discussions, and systematic observations within a coherent analytical framework demonstrates how multiple qualitative methods can be triangulated to generate robust findings about complex policy phenomena. The validation strategies of this research, including member checking with 12 key informants and peer debriefing with academic colleagues, established methodological standards for policy research in development contexts.

5.5. Limitations and Research Boundaries

While this research provides a comprehensive analysis of the grand design policy development for fish farming groups in Pekanbaru City, several limitations constrain its generalizability. The study focuses specifically on freshwater aquaculture in medium-sized Indonesian cities, limiting its direct applicability to marine aquaculture or different urban contexts. The research examines policy design and early implementation phases but does not extend to long-term outcome evaluation or impact assessment.

The stakeholder analysis, while comprehensive within the aquaculture sector, does not extend to broader urban planning, environmental management, or economic development agencies that may influence aquaculture development outcomes. The temporal scope of the study covers policy development processes during 2024-2025 but cannot assess the long-term sustainability or adaptation of the proposed policy frameworks.

5.6. Future Research Directions and Extensions

Building on these findings, several critical research directions emerge for advancing the understanding of grand design policy approaches in development contexts:

5.6.1. Longitudinal Implementation Studies

Future research should extend this analysis through longitudinal studies examining how grand design policy frameworks evolve during implementation phases. Multi-year studies tracking policy adaptation, stakeholder relationship changes, and outcome achievement would provide critical insights for understanding policy sustainability and effectiveness over time.

5.6.2. Comparative Urban Aquaculture Analysis

Comparative studies examining grand design policy approaches across different urban contexts (coastal vs. inland cities, different population sizes, varying governance structures) would enhance the understanding of how local contexts influence policy design requirements and implementation strategies.

Cross-national comparisons with similar middle-income countries could provide insights for policy transfer and adaptation processes.

5.6.3. Quantitative Impact Assessment

Future research should develop quantitative measures for assessing the effects of grand design policy on fish farming group development, including income effects, production improvements, market access enhancement, and innovation adoption rates. Randomized controlled trials comparing grand design approaches with traditional sectoral interventions could provide robust evidence for policy effectiveness.

5.6.4. Digital Transformation Deep Dive

The study's findings about digital marketing opportunities warrant dedicated research examining how technology adoption processes unfold within fish farming communities. Research exploring digital literacy development, e-commerce platform design, and technology-enabled market linkages could provide specific guidance for digital inclusion policies.

5.6.5. Financial Inclusion Mechanism Design

Future research should examine how blended finance mechanisms can be optimized for different aquaculture development contexts. Studies exploring risk assessment methodologies, collateral alternatives, and repayment schedule design could advance the understanding of inclusive financial mechanism development.

Declarations

Author Contributions

Conceptualization, A.F. and S.A.; methodology, A.F., and M.A.; software, F.Y.; validation, A.F., M.A., and Z.Z.; formal analysis, A.F.; investigation, A.F. and M.A.; resources, A.F.; data curation, A.F., and S.A.; writing—original draft preparation, all authors contributed equally; writing—review and editing, A.F.; visualization, F.Y.; supervision, A.F.; project administration, A.F. All authors have read and agreed to the published version of the manuscript.

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The data presented in this study are available on request from the corresponding author.

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Institutional Review Board Statement

Rigorous ethical guidelines were adhered to throughout the study to ensure participant privacy and

data confidentiality in compliance with institutional and national research standards.

Informed Consent Statement

Participation in the study was voluntary, and informed consent was obtained from all participants prior to their involvement.

Conflict of Interest

The authors declare that they had no conflicts of interest during the development of the research.

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