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# Spatially Enabled E-Governance for Inclusive Fishermen Empowerment through Web-GIS and Socioeconomic Data Integration

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# Abstract

Accurate beneficiary targeting remains a persistent challenge in small-scale fisheries empowerment programs, frequently leading to inclusion and exclusion errors that reduce the effectiveness of poverty alleviation initiatives in coastal communities. This study evaluates the effectiveness of an e-governance-based information system in improving the identification and selection of eligible beneficiaries for fishermen empowerment programs. A mixed-methods approach was adopted, integrating household socio-economic surveys, spatial mapping, Geographic Information Systems (GIS), and Web-GIS development to establish a comprehensive database of traditional fishing households. The information system incorporates multidimensional indicators, including occupational categories, geographic location, socio-economic characteristics, livelihood needs, and program eligibility. Comparative analyses were conducted between conventional manual targeting procedures and the proposed digital platform. System usability and functionality were refined through iterative development, progressing from a Kodular-based prototype to a WordPress-based content management system with integrated Web-GIS capabilities. The findings demonstrate that the e-governance system substantially improves targeting accuracy, transparency, and administrative efficiency through real-time data validation and spatially enabled decision support. The integrated database facilitates cross-sectoral verification of household characteristics and reveals significant variations in socio-economic conditions and development needs among different categories of fishing households. Compared with conventional approaches, the proposed system reduces targeting errors while strengthening evidence-based resource allocation and policy implementation. The study contributes to the growing literature on digital governance in small-scale fisheries by demonstrating how integrated socio-economic and spatial information systems can support more equitable, transparent, and effective coastal development policies. These findings provide practical guidance for governments seeking to strengthen information system governance and improve the sustainability of fisheries empowerment programs. This research contributes to addressing SDG 1 (No Poverty), SDG 14 (Life Below Water), and SDG 16 (Strong Institutions) through e-governance within marine fisheries systems.


# 1.INTRODUCTION

Small-scale fishing communities remain among the most socio-economically vulnerable populations in many coastal regions of Indonesia. Despite continuous government investment in fishermen empowerment programmes, poverty and livelihood insecurity persist due to weaknesses in programme implementation, particularly the inaccurate identification of eligible beneficiaries. Fragmented socio-economic information, outdated household records, and limited coordination among implementing agencies frequently result in inclusion and exclusion errors that reduce the effectiveness of public assistance and constrain equitable coastal development (Aisyah et al., 2022; Rashid et al., 2023). Improving the governance of information systems has therefore become a strategic priority for strengthening evidence-based policymaking and ensuring that empowerment programmes effectively reach the most vulnerable fishing households.

Digital transformation has fundamentally reshaped public sector governance by enabling governments to collect, manage, and analyse large volumes of socio-economic information more efficiently. Public sector information systems facilitate structured data management, improve information accessibility, and support evidence-based decision-making through integrated digital platforms (Heijlen et al., 2018; Leoni et al., 2023). Web-based database systems further extend these capabilities by providing centralized repositories that allow real-time data validation, remote accessibility, and efficient information sharing among stakeholders (Umoh et al., 2012). Supported by advances in cloud computing, web technologies, and management information systems, digital platforms have evolved from isolated offline databases into scalable online systems capable of supporting transparent governance and more responsive public service delivery (DeSanctis & Jackson, 1994; Khder, 2021; Zhou et al., 2020). Consequently, information system governance has become an essential component of organizational effectiveness, enabling institutions to improve administrative efficiency, accountability, and data-driven decision-making (Van Alstyne et al., 1995; Kaluarachchi & Wickramasinghe, 2023).

Within fisheries governance, digital information systems offer significant opportunities to improve the planning, implementation, and evaluation of fishermen empowerment programmes. Integrated socio-economic databases enable governments to record household characteristics, fishing occupations, geographic distribution, livelihood assets, and programme participation in a systematic and continuously updated manner. When combined with Geographic Information Systems (GIS) and Web-GIS technologies, these platforms support spatial analysis of fishing communities, facilitate the identification of development priorities, and strengthen resource allocation across coastal regions (Sangsefidi et al., 2025). Digital governance also enhances transparency through participatory mechanisms that enable beneficiaries to verify personal information, submit feedback, and report implementation issues, thereby strengthening institutional accountability and public trust (Peacock, 2010). Furthermore, integrating socio-economic information with spatial and environmental datasets provides a stronger foundation for adaptive coastal governance by supporting resilience planning under changing environmental and climatic conditions (Gerland, 1996; Riera-Spiegelhalder et al., 2023).

The importance of accurate beneficiary targeting has been widely recognized in fisheries and coastal development research. Effective empowerment programmes depend not only on financial support but also on transparent governance, reliable beneficiary databases, and accurate identification of vulnerable fishing households (Saavedra-Díaz et al., 2016; Teh et al., 2020). Studies have shown that weaknesses in information management frequently undermine fisheries policies by reducing targeting precision, increasing administrative inefficiencies, and limiting programme effectiveness (Das, 2023; Silva et al., 2022). In Indonesia, although the implementation of e-governance has expanded since Presidential Instruction No. 3 of 2003, many fishermen empowerment programmes continue to rely on fragmented administrative records and manually updated beneficiary lists. These limitations contribute to persistent targeting inaccuracies, duplication of assistance, exclusion of eligible households, and inefficient allocation of public resources (Aisyah et al., 2022). Similar governance challenges have also been reported in other public-sector social assistance programmes where the absence of integrated socio-

economic databases reduces programme effectiveness and institutional accountability (Augusto, 2025; Wolman, 1981).

Although considerable research has examined e-governance, management information systems, GIS applications, and digital public administration, several important gaps remain. Existing studies generally investigate these themes independently, with limited attention to their integration within fisheries governance. In particular, there is a lack of empirical research examining how Web-GIS, socio-economic profiling, participatory data validation, and information system governance can be combined into a unified digital platform to improve beneficiary targeting in fishermen empowerment programmes. Moreover, previous studies rarely compare conventional manual beneficiary selection procedures with integrated digital systems in terms of targeting accuracy, transparency, administrative efficiency, and governance performance. Consequently, the potential contribution of digital information governance to improving programme effectiveness in coastal communities remains insufficiently understood.

This study addresses these research gaps by developing and evaluating an integrated e-governance information system that combines Web-GIS-based spatial mapping, dynamic socio-economic profiling, and real-time beneficiary validation within a web-based database platform. Unlike previous approaches, the proposed system incorporates multidimensional indicators, including occupational categories, geographic zoning, livelihood characteristics, socio-economic conditions, and programme eligibility, thereby enabling more accurate and context-sensitive identification of beneficiary households. The study further contributes by conducting a comparative effectiveness analysis between conventional manual targeting methods and the proposed digital governance system, providing empirical evidence on its ability to reduce inclusion and exclusion errors while improving transparency and administrative efficiency. In addition, the research demonstrates the practical evolution of the platform from a mobile-based prototype developed using Kodular to a scalable WordPress-based content management system integrated with Web-GIS functionality, illustrating the importance of platform adaptability for large-scale public sector implementation.

Beyond its technological contribution, this study advances understanding of information system governance as a critical institutional mechanism for improving policy effectiveness in fisheries development. By enhancing the accuracy of beneficiary identification, the proposed system contributes to more equitable resource allocation, improved public service delivery, and stronger institutional accountability within coastal governance. These outcomes support broader sustainable development objectives, particularly poverty reduction, livelihood resilience, and inclusive governance in marine and island communities. Accordingly, this research offers a practical and replicable governance model that can assist governments and development agencies in strengthening fishermen empowerment programmes and promoting sustainable coastal development through evidence-based digital governance. This research contributes to addressing SDG 1 (No Poverty), SDG 14 (Life Below Water), and SDG 16 (Strong Institutions) through e-governance within marine fisheries systems.

# 2.LITERATURE REVIEW

# 2.1 E-Governance and Digital Inclusion

The transformation of public administration through digital technology has shifted the focus from the mere digitisation of administrative procedures towards a form of governance that is more integrated, responsive, participatory and inclusive (Sucupira Furtado et al., 2023). E-governance has the potential to improve the accessibility of public services, administrative efficiency, transparency, the dissemination of information, and interaction between the government and the public (Sieber et al., 2026). However, the existence of digital government infrastructure does not automatically result in inclusive governance. Previous literature indicates that the effectiveness of e-government is closely linked to the digital divide, as disparities in access to technology, socio-economic resources, digital skills and institutional capacity can determine which sections of society are able to benefit from technology-based public services (Dias & Gomes, 2021).

Recent research also indicates that digital exclusion can arise at various stages of the policy process, including in the design, implementation and use of digitised and automated government systems (Peeters et al., 2025). Consequently, digital transformation must be understood not merely as a technological process, but as a transformation of governance that prioritises issues of equity, accessibility, participation and the distribution of benefits.

The concept of the digital divide has also evolved from merely a distinction between those with and without internet access to a more multidimensional understanding of digital inequality. People may have access to digital technology but lack the skills, resources, confidence or institutional support required to make effective use of digital public services. The digital divide not only influences the choice of communication channels between the public and the government, but also determines the extent to which the public actually uses these digital channels. This perspective is particularly relevant for social groups whose socio-economic status is closely linked to their social and economic circumstances, which may limit their capacity to interact with public institutions via digital channels (Ebbers et al., 2016; Wongmith, 2025).

In the context of fishers and coastal communities, this issue becomes increasingly complex because access to resources and government services is often influenced by geographical remoteness, livelihood characteristics, infrastructure limitations and socio-economic vulnerability(Ebbers et al., 2016; Enthoven, 2025). Government programmes relating to fisheries, social protection, economic assistance, market access, infrastructure and environmental management may be unevenly distributed across regions. E-government systems that view the public solely as individual users risk failing to capture the spatial dimensions of such exclusion. These limitations provide a theoretical and practical basis for the development of spatially enabled e-governance—a model of digital governance that positions geographical location as one of the key mechanisms for integrating community characteristics, public resources and government interventions.

# 2.2 Spatially Enabled E-Governance

The concept of spatially enabled e-governance emphasises the importance of strategically utilising location-based information to optimise public decision-making, policy coordination, service delivery and community engagement. The fundamental argument is that most public issues have a strong spatial dimension. Poverty, infrastructure constraints, environmental risks, access to public services, economic opportunities and social vulnerabilities are not evenly distributed across space. Therefore, Geographic Information Systems (GIS) can provide governments with a mechanism for linking administrative information to geographical locations whilst identifying spatial patterns that may not be apparent in conventional tabular data (Pan et al., 2025).

Spatial Data Infrastructure (SDI) is becoming increasingly important in supporting the exchange and integration of geospatial information between government agencies. However, the effectiveness of SDI depends not only on technological capacity, but also on institutional arrangements, data standards, interoperability, governance structures, and collaboration between agencies that produce and use data(Sjoukema et al., 2021). Furthermore, (Sjoukema et al., 2021) demonstrate that SDI should be understood as a system of governance rather than merely a technical infrastructure. In line with this, research on geospatial governance indicates that institutional fragmentation, limitations in data exchange and weak coordination constitute significant barriers to the utilisation of spatial information within e-government systems (Heyik et al., 2025; Ngereja et al., 2018).

Thus, spatially enabled e-governance can be understood as an extension of the conventional e-government concept. This approach not only reforms the digitalisation of public services but also integrates spatial information into the processes of problem identification, resource allocation, intervention design and communication between the government and the public. This approach enables policies to be designed in a more targeted manner, taking into account regional characteristics, as the government can identify where specific groups are located, what their socio-economic conditions are, and how their access to public resources varies across regions. From this perspective, spatial information no longer serves merely as a visualisation tool, but has evolved into ‘spatial governance intelligence’ that supports future public decision-making.

## 2.3 Web-GIS as Digital Governance Infrastructure

Recent trends in Web-GIS demonstrate the potential for spatially enabled governance by making geospatial information accessible via web-based platforms. Conventional GIS is generally designed for users with specific technical skills, whereas Web-GIS enables a wider range of groups including government officials, researchers, civil society organisations and citizens to interact with spatial information through a relatively user-friendly interface. This shift is highly relevant to digital governance as it means that spatial information is no longer confined to being a source of internal government analysis, but has evolved into a shared public information space (Majidi Nezhad et al., 2025).

In the context of public governance, Web-GIS can serve as a digital interface that links government information with the public’s spatial experience. Interactive maps, for example, can be used to display the status of public service locations, infrastructure, environmental risks, economic opportunities and

government programmes. Furthermore, Web-GIS can facilitate a two-way exchange of information, whereby the public not only receives information provided by the government but can also provide information, input and feedback. This function is in line with developments in participatory governance and collaborative governance, which position the public not merely as recipients of policy but as active contributors to the process of solving public problems (Bressane et al., 2026).

Nevertheless, the governance value of a Web-GIS is largely determined by the quality and integration of the data available within it. A platform with sophisticated map visualisation will not deliver optimal policy benefits if the data is not up to date, inconsistent, fragmented and cannot be shared across agencies. Therefore, Web-GIS should be understood as part of a broader data governance architecture, encompassing interoperability, data quality, institutional coordination, privacy protection and the sharing of responsibilities in data management (Dong et al., 2026; Majidi Nezhad et al., 2025).

## 2.4 GIS, Participatory Mapping and Fisheries Governance

The use of GIS in fisheries and coastal governance initially focused primarily on resource management, marine spatial planning, mapping of fishing activities, habitat conservation and environmental monitoring. This approach subsequently generated spatial information that was vital for the management of marine resources; however, in many cases, it emphasised the biophysical aspects and distribution of resources rather than the socio-economic and institutional dimensions of fishing communities. Participatory GIS has emerged as a key approach to bridging this gap, as it enables local communities to contribute spatial information regarding resources, economic activities, environmental changes, infrastructure, and areas considered vulnerable or subject to conflict. Findings by (James, 2025) have demonstrated that participatory seascape mapping can serve as a relevant community-based approach to marine governance and conservation, as it is capable of integrating local knowledge into decision-making processes.

In the Indonesian context, research by (Rachman & Huang, 2025) has made a significant contribution by using a public participatory GIS approach and structural equation modelling to analyse the dynamics of small-scale coastal fisheries in Jakarta. This study demonstrates that spatially-based information derived from the community can be combined with quantitative approaches to understand the complex relationships that influence the state of coastal fisheries. These findings also indicate that GIS can be developed beyond the function of resource mapping towards a more integrated approach to understanding the social, economic, environmental and governance dynamics of coastal communities. However, the literature on participatory GIS and e-governance still tends to develop along separate paths. Research on participatory GIS focuses more on community mapping, local knowledge and resource planning, whilst research on e-governance focuses more on digital public services, administrative transformation, and interactions between government and the community. There is a lack of research that explicitly explains how Web-GIS can integrate government socio-economic data, spatial information and community-generated knowledge into an e-governance system for the empowerment of fishermen.

## 2.5 Integration of Socio-Economic Data and the Empowerment of Fishermen

One of the limitations of a spatially-based governance approach is that geographical information alone is insufficient to explain the complexity of social vulnerability and empowerment. Fishermen constitute a heterogeneous group, with variations in household income, educational attainment, age, gender, ownership of fishing assets, access to markets, financial services, infrastructure, social protection and institutional networks. Consequently, treating fishermen as a homogeneous group can result in one-size-fits-all policy interventions that fail to address the differing needs across regions and between groups.

The integration of social and economic data with spatial information offers an opportunity to address these limitations. By linking social and economic indicators for households or communities to their geographical locations, the government can identify patterns of social vulnerability and inequality. Information on social and economic conditions, for example, can be integrated with the locations of fishing communities, fish auctions, transport networks, markets, financial institutions, health facilities and government aid programmes. This integration can reveal spatial disparities between community needs and the distribution of public resources. This approach also broadens our understanding of the empowerment of fishermen. Empowerment should not be understood merely as an increase in income or the receipt of government aid. Empowerment also encompasses improved access to information, productive resources, markets, public services, institutional networks and opportunities to participate in public decision-making.

## 2.6 Digital Inclusion and Participatory Empowerment

The process of integrating Web GIS into governance also presents a significant paradox: technology designed to enhance inclusion can actually reinforce exclusion if it is not tailored to the circumstances of the target groups. Digital government platforms can create new barriers when the public faces limitations in digital literacy, connectivity, devices, economic resources or trust in government institutions. Research on digitally vulnerable populations indicates that the accessibility of e-government services must be understood in a multidimensional way and that simply providing services online is not sufficient(Kim & Lee, 2024).

In the context of fishing communities, an inclusive Web GIS must do more than simply provide online maps. The platform must be designed in accordance with the capabilities, needs and social circumstances of its user communities. A user-friendly interface, straightforward access to information, support for digital literacy, and hybrid offline and online mechanisms may be crucial to ensuring meaningful participation. Without such an approach, Web GIS risks being utilised primarily by groups that already possess digital capacity, whilst vulnerable fishing communities remain excluded from governance.

Participation can be understood as more than just government information. Participatory Web-GIS can enable fishermen to identify infrastructure shortcomings, report environmental issues, contribute local

knowledge, validate government data, identify livelihood risks and communicate policy priorities. Thus, Web-GIS can evolve from a one-way information dissemination mechanism into a two-way spatial governance platform. This approach is in line with research on participatory seascape mapping, which emphasises the importance of local knowledge and community involvement in coastal governance.

## 2.7 Research Gaps and Conceptual Contributions

Based on this literature review, there are three main research gaps. Firstly, research on e-governance has expanded to cover digital inclusion and public participation, but remains relatively limited in integrating the spatial dimensions of social and economic inequalities. Secondly, research on GIS and participatory mapping in the fisheries sector has revealed important information regarding spatial aspects and local knowledge, but has not yet sufficiently conceptualised Web-GIS as an e-governance infrastructure integrated with socio-economic data and community empowerment. Thirdly, research on the empowerment of fishermen generally focuses on livelihoods, economic resources, participation and institutional support, whilst the role of spatially integrated digital information in improving the targeting of policies remains under-explored.

Thus, the main gap lies at the intersection of digital governance, spatial intelligence, socio-economic data, and inclusive empowerment. Previous research has mostly examined these components in isolation, rather than as an integrated governance system. To address this gap, this study proposes a conceptual shift from GIS for fisheries management towards spatially enabled e-governance for the inclusive empowerment of fishermen. In examining this, the concept of Web-GIS is conceptualised not merely as a mapping technology, but as a governance infrastructure that connects three mutually reinforcing dimensions: 1) spatial intelligence, namely the ability to identify the geographical distribution of fishermen, resources, services, risks and vulnerabilities; 2) socio-economic intelligence, namely the ability to understand multidimensional differences in living conditions and access to public resources; 3) participatory digital governance, namely the ability to provide a space for fishermen to access information, share local knowledge, identify needs, and participate in decision-making.

Within this framework, the main contribution of this study lies in the integration of the literature on e-governance, spatial governance, Web-GIS, participatory GIS, socio-economic vulnerability and the empowerment of fishermen into a single conceptual framework. This approach does not assume that digitalisation automatically leads to inclusion. Rather, inclusion is positioned as an outcome that depends on spatial visibility, socio-economic differentiation, digital accessibility, meaningful participation and institutional capacity. Thus, spatially enabled e-governance has the potential to transform fragmented socio-economic data into actionable governance intelligence, enabling the government to design policies for the empowerment of fishermen that are more targeted, transparent, participatory and inclusive.

# 3.RESEARCH METHODOLOGY

## 3.1 Site Location

North Sumatra is the fourth largest province in Indonesia, with an estimated population of approximately 14 million people and a total area of around 182,000 km², of which nearly 60% consists of marine territory (Suhaidi et al., 2018). The province possesses substantial marine and fisheries resources, encompassing both capture fisheries and aquaculture potential. Specifically, capture fisheries potential is concentrated in two major zones: the Strait of Malacca, with an estimated yield of 276,030 tons per year, and the Indian Ocean, with a significantly higher potential of 1,076,960 tons per year (dkp.sumutprov.go.id, 2022). These figures highlight the strategic importance of the fisheries sector in supporting regional economic development and coastal livelihoods.

One of the key coastal regions contributing to this potential is Batubara Regency, located along the eastern coast of North Sumatra. The regency is entirely bordered by the Strait of Malacca and features an extensive coastline of approximately 110 km, supporting a coastal population of 28,786 residents (BPS Batubara Regency, 2018). The geographic positioning and resource endowment of Batubara Regency make it a significant hub for small-scale and traditional fishing activities, while also reflecting the socio-economic vulnerabilities commonly associated with coastal communities.

This study was conducted over a one-year period, from January to December 2022, focusing on selected coastal settlements within Medang Deras Village and Pakam Village in Batubara Regency. The research sites included four hamlets (dusun), namely Pematang Eru Hamlet and Kuala Sipare Hamlet in Medang Deras Village, as well as Pematang Pasir Hamlet and Benteng Hamlet in Pakam Village. These locations were purposively selected based on their high dependence on fisheries livelihoods, socio-economic diversity, and relevance to government empowerment programs, thereby providing a representative context for examining the effectiveness of information system governance in targeting fishermen beneficiaries.

To support spatial analysis and enhance the accuracy of socio-economic data representation, this study integrates Geographic Information System (GIS) and Web-GIS technologies in mapping the study area. Spatial data were collected through field surveys using Global Positioning System (GPS) devices to capture the precise coordinates of fishermen households, fishing zones, and supporting infrastructure. These data were then processed and visualized using GIS software to produce layered thematic maps, including settlement distribution, livelihood classification, coastal zoning, and access to fisheries resources. The Web-GIS platform further enables dynamic visualization and interaction with the data, allowing users to identify spatial disparities in socio-economic conditions and program coverage across different hamlets. By linking geospatial data with socio-economic profiles, the system facilitates more accurate targeting of beneficiaries and supports evidence-based decision-making. The integration of GIS also allows for continuous updating and validation of data, ensuring that the information remains current, reliable, and responsive to changes in coastal community conditions. This spatially enabled approach not only strengthens data governance but also provides a scalable model for monitoring and evaluating fishermen empowerment programs in other coastal regions.

# 3.2 Sample Size and Response Profile

This study utilized both primary and secondary data sources to ensure comprehensive and triangulated findings. Primary data were collected between February and March 2022 in Batubara Regency, North Sumatra, through field surveys and direct engagement with fishing communities. Data collection involved structured interviews with key informants, specifically heads of fishing households and active fishermen, using semi-structured questionnaires as the main research instrument. The questionnaire design incorporated both closed-ended questions to capture quantifiable socio-economic indicators and open-ended questions to explore perceptions, experiences, and program-related feedback.

A purposive sampling technique was employed to ensure that respondents met specific inclusion criteria, namely individuals actively engaged in fishing-related livelihoods and residing within the selected coastal hamlets. The determination of the sample size was guided by the Krejcie and Morgan (1970) sampling table, which indicated that a minimum of 279 respondents was required to achieve statistical representativeness for the population in Medang Deras District. Accordingly, a total of 279 respondents were surveyed across four hamlets: Kuala Sipare and Pematang Eru in Medang Deras Village, as well as Pematang Pasir and Benteng in Pakam Village. Among these locations, Pematang Eru Hamlet contributed the highest proportion of respondents, reflecting its relatively larger fishing population and higher dependence on marine-based livelihoods.

Although purposive sampling was the primary approach, elements of probability sampling were incorporated at the household level to minimize selection bias and ensure broader representation within each hamlet. This hybrid approach enhances the reliability of the findings by balancing targeted selection with randomization principles (Kuntjojo, 2009). In line with descriptive research standards, the relatively large sample size strengthens the generalizability and robustness of the analysis (Handayani, 2020). In terms of demographic characteristics, the majority of respondents were male fishermen, reflecting the gendered nature of fishing activities in the study area. Most respondents were within the productive age range of 20 to 40 years, indicating a relatively young and economically active workforce. Despite this, many respondents reported substantial fishing experience, typically ranging from 15 to 20 years, suggesting early entry into the fishing profession and limited occupational mobility. This demographic profile highlights the intergenerational nature of fishing livelihoods and underscores the importance of targeted socio-economic interventions tailored to the specific needs and capacities of coastal communities.

## 3.3 Data Processing Techniques

The processing of collected data in this study combined spreadsheet-based analysis with web-based coding systems to ensure accuracy, accessibility, and usability for subsequent socio-economic and spatial analyses. This multi-platform approach facilitated the integration of raw survey data into a dynamic, user-friendly digital database for the coastal communities of Batubara Regency, as shown in Table 1.

## 3.4 Data Analysis Techniques

Descriptive analysis and information system development were used to analyze the data. Descriptive analysis was used to provide an overview of the sample location and current state of the fishermen. Furthermore, the analysis of information system development is a way to solve problems in data and information management by identifying the information needs that exist in a system to produce an effective operation of information systems or applications is produced (Pradipta, 2010). As shown in Table 2.

Table 2
Stages of Data Analysis Techniques

| No. | Stages |
|---|---|
| 1. | The first stage plans a fishermen database system in accordance with the identification of survey data (socio-economic profile of fishermen, zoning, needs, and evaluation of programs that have been received). Building a database of identified fishermen will simplify the data collection process and integrate the data collection results into information centers. |
| 2. | The second stage of fisherman database design is the design of an information process consisting of the process of entering available data into the KODULAR WEB system, data processing, and data presentation. At this stage, Kodular is used to design the Desa Nelayanku application. Kodular software was used to create the open-source databases. |
| 3. | The third stage is testing the information system that has been prepared. Validation was performed by testing and providing objective evidence. The validation process is carried out by testing the overall system flow, then checking with sample data and tracing to determine that the information system created is correct and operates with the correct information system logic. The overall schema of the database development is presented in Fig. 1. |
| Source: Author's own work, 2026 | |

# 4.RESULTS AND DISCUSSION

**Socio-economic Vulnerability of Traditional Fishing Households**

The socio-economic profile of respondents demonstrates that traditional fishing households remain among the most economically vulnerable groups within the coastal communities studied. Most respondents were married (95%) and lived in modest houses constructed from timber, mixed brick, or wooden boards (32%), reflecting relatively poor housing conditions. Daily earnings were generally low, with 43% reporting an average income of approximately IDR 50,000 per day, which was insufficient to meet basic household needs. Consequently, 78% indicated that they were unable to cover daily living expenses, while 95% reported being indebted and an equal proportion had no financial savings. Livelihood diversification was also extremely limited. Approximately 94% of respondents lacked alternative income-generating skills, and 92% stated that their spouses were full-time homemakers without independent sources of income.

These findings indicate that traditional fishing households remain highly dependent on capture fisheries as their sole source of livelihood, making them particularly vulnerable to seasonal income fluctuations, declining fish stocks, market instability, and environmental change. Such livelihood dependence has

been widely recognised as a major constraint to poverty reduction among small-scale fishing communities because limited economic diversification reduces household resilience and adaptive capacity. The findings therefore reinforce previous studies that identify unstable income, indebtedness, and limited livelihood opportunities as structural characteristics of poverty within traditional fishing communities. From a sustainable coastal development perspective, strengthening livelihood diversification through vocational training, entrepreneurship development, and alternative income opportunities should complement conventional financial assistance to enhance long-term community resilience.

**Institutional Support and Government Service Delivery**

Respondents consistently perceived a substantial disconnect between government empowerment programmes and the actual needs of traditional fishing communities. Limited institutional support, inadequate public service delivery, and weak programme implementation were identified as major factors contributing to continued livelihood insecurity.

Occupational safety emerged as one of the most critical concerns. Nearly all respondents (91%) reported the absence of adequate occupational safety protection despite the hazardous nature of fishing activities. As one respondent explained:

*"We go out to sea every day, but no one ensures we are safe. If anything happens, we are on our own."*

Similarly, government support services remained limited. More than two-thirds of respondents (71%) had never received government assistance, while 89% reported receiving no support in marketing their fish catches. Health protection was also inadequate, with 95% lacking any form of health insurance.

*"Even when we catch enough fish to feed our families, we struggle to sell them at a fair price. There is no help from the government to reach buyers or markets."*

These findings suggest that fisheries empowerment programmes continue to emphasise short-term financial assistance rather than comprehensive livelihood development. Effective fisheries governance requires integrated support mechanisms that include occupational safety, health protection, market access, technical assistance, and institutional coordination. Similar governance deficiencies have been reported in other small-scale fisheries where fragmented institutional arrangements and weak service delivery reduce programme effectiveness despite substantial government investment. Consequently, improving governance structures is equally important as increasing financial allocations for poverty alleviation programmes.

**Capacity Building and Livelihood Diversification**

Government-sponsored capacity-building initiatives demonstrated limited effectiveness in reaching traditional fishermen. Approximately 82% of respondents had never participated in government training

programmes because of inadequate communication, inappropriate scheduling, or exclusion from programme selection.

*"They announce training programs, but we are either not invited or the timing conflicts with our fishing schedules. It feels like these programs were never meant for us."*

Respondents further perceived that government interventions were largely confined to temporary financial assistance rather than sustainable livelihood development. More than half (53%) believed that government attention focused primarily on distributing one-off assistance, while 82% considered the support received to be inconsistent with their actual needs. Instead of temporary cash transfers, respondents prioritised long-term investments in productive assets such as fishing boats (64%), fishing equipment (93%), improved market access, and continuous technical guidance. Moral (88%) and religious support (92%) were also considered important components of community well-being.

*"They gave us money once, but it wasn't enough to repair our boats. Without proper equipment, we can't fish properly, so the aid doesn't really help us survive."*

The limited availability of structured vocational training has constrained livelihood diversification, leaving most respondents dependent on fishing despite declining economic returns. This situation reduces household adaptive capacity and limits resilience to external shocks such as fluctuating fish catches and climate-related risks. Sustainable fishermen empowerment therefore requires a transition from welfare-oriented assistance towards capability-building strategies that strengthen human capital, entrepreneurship, and diversified livelihood opportunities.

**Governance Challenges in Fisheries Empowerment Programmes**

Respondents expressed considerable dissatisfaction with the institutional performance of the Fisheries Department. Approximately 96% believed that coastal activities were rarely monitored, while 90% reported inadequate dissemination of programme information. Furthermore, 85% perceived that government agencies lacked an understanding of the actual needs of traditional fishing households.

*"They talk about helping us, but we never see them check what we actually need. Programs exist on paper, not in reality."*

The COVID-19 pandemic further exposed weaknesses in programme governance. Nearly two-thirds of respondents (64%) received no institutional assistance during the pandemic, while 77% were excluded from government relief programmes and 94% had no access to training or livelihood support.

*"When COVID hit, we were left alone. No one helped, no one asked about our problems, and we barely survived."*

Respondents consistently argued that fisheries policies should prioritise marginalized small-scale fishers rather than commercial vessel owners. They advocated sustained investment in fishing

equipment, affordable financing, market development, and continuous technical assistance tailored to traditional fishing households.

*"Focus on us who fish every day just to feed our families, not on big boats owned by companies. That's where the real help is needed."*

Additional governance concerns included outdated beneficiary databases, weak programme monitoring, inequitable beneficiary selection, and limited institutional engagement. Approximately half of respondents believed that government agencies lacked an adequate understanding of coastal poverty (47%), failed to fulfil their institutional responsibilities effectively (45%), maintained outdated socio-economic records (50%), implemented inequitable beneficiary selection (50%), and rarely conducted systematic monitoring of coastal communities (51%).

*"They say they are here to help, but we never see them in our villages. No guidance, no follow-up, nothing."*

These findings indicate that many challenges confronting traditional fishing communities originate not only from limited financial resources but also from weaknesses in institutional governance, information management, and programme implementation. Inaccurate beneficiary identification, fragmented socio-economic databases, limited inter-agency coordination, and weak monitoring mechanisms reduce the effectiveness of fishermen empowerment programmes and constrain equitable resource allocation.

**Implications for Information System Governance and Sustainable Coastal Development**

The quantitative and qualitative findings provide strong empirical justification for strengthening information system governance within fishermen empowerment programmes. Many of the governance weaknesses identified including inaccurate beneficiary identification, fragmented household databases, weak programme monitoring, and inconsistent service delivery can be addressed through integrated digital governance systems that combine socio-economic databases, Web-GIS technologies, and real-time beneficiary validation. Such systems enable more accurate targeting, improve administrative transparency, reduce inclusion and exclusion errors, and strengthen evidence-based decision-making. Beyond improving programme efficiency, integrated information system governance contributes to broader objectives of sustainable coastal development by enhancing institutional accountability, promoting equitable access to public services, and strengthening the resilience of small-scale fishing communities. The findings therefore demonstrate that digital governance should be viewed not merely as a technological innovation but as a governance mechanism capable of improving fisheries policy implementation, reducing coastal poverty, and supporting the long-term sustainability of marine and island communities, as shown in Table 3.

Table 3
Key Findings on Socio-Economic Status and Government Support for Traditional Fishermen

| 1. | Finding | Statistic | Representative Respondent Quote |
|---|---|---|---|
| | **Absence of occupational safety guarantees** | **91%** | ***"We go out to sea every day, but no one ensures we are safe. If anything happens, we are on our own."*** |
| 2. | No government support services received | 71% | *"Even when we ask for help, nothing comes. It feels like they have forgotten about us."* |
| 3. | Lack of assistance in marketing catch | 89% | *"There is no help to reach buyers or markets. We often sell at very low prices."* |
| 4. | No health insurance | 95% | *"If I fall sick while fishing, I must cover all costs myself. There is no safety net."* |
| 5. | Never attended government training programs | 82% | *"Training programs exist, but we are rarely invited or they clash with fishing schedules."* |
| 6. | Dissatisfaction with aid received | 82% | *"They gave us money once, but it wasn't enough to repair our boats or buy equipment."* |
| 7. | Moral and religious support seen as essential | 88–92% | *"Financial help is important, but encouragement and spiritual support keep us going."* |
| 8. | Coastal activities rarely monitored by Fisheries Department | 96% | *"They say they are here to help, but we never see them in our villages."* |
| 9. | Government lacks commitment to poverty alleviation | 90% | *"Programs exist on paper, not in reality. They don't see our actual problems."* |
| 10. | COVID-19 institutional support absent | 64% | *"When COVID hit, we were left alone. No one helped, no one asked about our problems."* |
| 11. | Excluded from COVID-related beneficiary programs | 77–94% | *"We were not registered anywhere. No relief, no training, nothing."* |
| 12. | Perceived inequitable treatment by government agencies | 50% | *"They focus on big boats and companies, not small-scale fishers like us."* |

Source: Author's own work, 2026

**Website Design "Desa Nelayanku"**

Researchers suggest that the "Desa Nelayanku" database be built as an information system upgrade to accommodate all data collected for government programs for fishermen, considering the socio-economic challenges faced by fishermen. An assortment of connected data is called a database. Data are facts that can be recorded and have undisclosed significance. According to Sumarani and Vanitha (2020), a database provide a database container containing data that must be handled and stored. The process of creating a database system involves collecting and assessing real-world needs, designing

data and system features, and then putting those features into practice (Adrienne Watt, 2019). As shown in Table 4.

Table 4
Database Development Actors

| Number | Actors | Roles |
|---|---|---|
| 1. | Database Designer | The database designer is responsible for identifying the data to be stored in the database and selecting an appropriate structure to represent and store the data. |
| | | It is the database designer's responsibility to communicate with all potential database users to understand their needs and to create a design that meets these requirements. |
| | | Database designers typically interact with each group of potential users, develop a database view that meets the data and processing requirements of that group, and then analyze and integrate with the views of other groups of users. |
| 2. | Data Base Administrator | The management of these resources is the responsibility of the database administrator (DBA). |
| | | The DBA is responsible for allowing access to the database, coordinating and monitoring its usage, and acquiring software and hardware resources, as needed. |
| | | DBAs are responsible for issues such as security breaches and poor system response times. The DBA is assisted by staff who perform these functions. |
| Source: Author’s own work, 2026 | | |

**Building a Kodular and WordPress-Based " Desa Nelayanku " Database**

"Desa Nelayanku" is a Kodular Web-based application built as a data storage container for coastal communities, especially traditional fishermen, which contains socio-economic survey data and fishermen's needs. The provision of this database is addressed to the Ministry of Marine Affairs and Fisheries (deconcentration in the regions is the Fisheries Service and Village Government) as an improvement in the performance of empowerment programs, especially in terms of determining program participants to improve the performance of empowerment programs on target. However, Kodular applications have the disadvantage that they are difficult to upgrade to open-source applications. Based on this weakness, researchers have developed a more efficient backup system called, the WordPress Web. The WordPress web system can be accessed open source without logging in using a username; for that, researchers close fishermen's personal data so as not to be misused by irresponsible parties. The determination of program participants is the process of selecting the appropriate participants for a program plan. The determination of program participants is important to determine the quality of a program (Fournier, 2005). This research also provides education on how to determine program participants through surveys and needs analysis assessments so that they can

create programs according to the needs and wants of fishermen to produce quality and useful programs to improve the socio-economic level of fishermen, as shown in Fig. 2.

*Source: Author's own work*

**Android-based database for "Desa Nelayanku"**

The Android app "Desa Nelayanku" was built using the Kodular Web. The steps to build an Android application called "Desa Nelayanku" are as follows on Table 5.

Table 5
The Steps to Build an Android Application

| Number | Section | Steps |
|---|---|---|
| 1. | Material Preparation | 1.Kodular Website (App Builder) Kodular is a website that creates Android applications with simple tools that replace programming languages with drag-and-drop block programming concepts without having to manually type program code. |
| | | 2.Preparation of questionnaires<br><br>Prepare questions on the questionnaires in accordance with the results of FGDs and observations of fishing communities. |
| | | 3.Filling and collecting data (distributing and filling out questionnaires) Conduct surveys and distribute questionnaires to fishing communities. |
| | | 4.Data input and data analysis results Input questionnaire data and analyze the data. |
| | | 5. Development of the Database "Desa Nelayanku" Build a database of Android applications called "Desa Nelayanku" through the kodular web by entering fishermen's data, such as ID cards, photos of houses, and socio-economic data per fisherman. |
| | | 6. Launch the "Desa Nelayanku" app The Desa Nelayanku app can now be used. |
| 2. | Application Design: "Desa Nelayanku" | 1.Access Kodular Pages<br><br>The development of the Desa Nelayanku Database begins with designing an application through a kodular website: https://www.kodular.io/. Then log in. If you do not have a kodular account, you can create one by filling in identity data, such as username, email, and password. Click "Create Project" to create a new app project. Then type "Project Name" for example, my fisherman, then click next. |
| | | 2.Determine the type of Android app and how it looks<br><br>After creating a new project name, the next step is to set the type of Android that can be used to access the application and its User Interface (User Interface), then click "Finish.” |
| | | 3.Set Android App Name<br><br>The next stage involves setting the name of the application and the initial display of the application to be created. The trick is to fill in the name of the screen title, "Desa Nelayanku" and then press Enter. |
| | | 4.Entering the Fishermen's Socio-economic Database<br><br>The process of entering the fishermen's socio-economic database is the most important thing, because when prospective users access the attendance application and fill in the name on the form, the application will immediately process it by searching for fishermen's data. |

Source: Author’s own work, 2026

| Number | Section | Steps |
|---|---|---|
| | | 5.Create a Program Block<br><br>The next step is to create a program block so that when the user (administrator) accesses the application, there are menu options for several purposes, such as registration forms, fisherman data, geographic information systems (GIS) or location maps, fisherman data diagrams, and fisherman information galleries. |
| | | 6.Change Android App Format<br><br>The last stage is to convert the file format that has been created into an Android Application by clicking "Export" at the top of the project, then clicking Export as "Android Application"After that, download the "Desa Nelayanku" application on the main menu of Kodular. The “Desa Nelayanku" application is ready to use, but this application cannot be accessed through the Google Play Store. |
| Source: Author’s own work, 2026 | | |

Building an application layout on a kodular system is very easy; a template or component palette has been provided as follows: four horizontal layouts that serve to set the boundaries of the application display, seven labels that function as fixed text to name menu buttons and application banners, six card views that function as feature buttons on the menu, and seven images that function to place photos or logos of application features. As an illustration, you can see the following example as shown in Fig. 3.

Source: Author’s own work, 2026

**Users of the application "Desa Nelayanku" (Kodular and Wordpress)**

The Desa Nelayanku application was developed using the Kodular platform and requires authorized users to log in using a username and password. The system is administered exclusively by designated personnel from the Fisheries and Marine Service, who are responsible for maintaining the database through updating, verifying, adding, and deleting fishermen's records as socio-economic conditions change over time. This centralized administrative control ensures data accuracy, consistency, and confidentiality while supporting evidence-based decision-making for fishermen empowerment programmes.

In contrast, the WordPress-based platform (www.datanelayan.wordpress.com) is publicly accessible without requiring user authentication. While the public can view general information and aggregated community data, only authorized administrators have permission to update or modify the database. This approach balances transparency with data security by protecting the personal information of fishing households while allowing policymakers, researchers, and other stakeholders to access relevant information for planning and evaluation purposes.

Beyond its administrative functions, the Desa Nelayanku platform provides significant benefits for island and coastal communities. By maintaining an accurate and continuously updated socio-economic

database, the system enables government agencies to identify vulnerable fishing households more precisely and deliver assistance that corresponds to their actual needs. Improved targeting reduces the risk of eligible families being excluded from empowerment programmes while ensuring that limited public resources are distributed more equitably. Consequently, coastal residents can gain better access to livelihood assistance, fishing equipment, vocational training, healthcare programmes, social protection, and other development initiatives that directly improve their daily living conditions and household economic security.

The platform also strengthens community resilience by enabling timely responses to changing coastal conditions, including seasonal income fluctuations, climate-related hazards, and fisheries-related crises. Up-to-date socio-economic information allows government agencies to monitor changes in community welfare and implement adaptive interventions that support sustainable livelihoods. This is particularly important for traditional fishing communities whose livelihoods remain highly dependent on marine resources and are vulnerable to environmental and economic uncertainties.

Furthermore, the system contributes to preserving the social and cultural fabric of coastal communities. Traditional fishing livelihoods in Batubara Regency are closely associated with local ecological knowledge, family-based fishing practices, community cooperation, and intergenerational transmission of maritime skills. By systematically documenting the socio-economic characteristics and development needs of fishing households, Desa Nelayanku supports policies that are more responsive to local cultural values and traditional fishing practices. In doing so, the platform not only enhances administrative efficiency but also promotes socially inclusive, culturally sensitive, and sustainable coastal development, consistent with the objectives of marine and island community governance.

**Implications for Island and Coastal Communities**

Beyond improving administrative efficiency, the findings demonstrate that effective information system governance has significant implications for the sustainability and well-being of island and coastal communities. The study reveals that small-scale fishing households in Batubara Regency experience persistent socioeconomic vulnerabilities, including unstable incomes, limited access to social protection, inadequate market opportunities, and exclusion from government empowerment programmes. These challenges directly affect their daily lives, as many families struggle to meet basic household needs, finance their children's education, maintain fishing equipment, and cope with seasonal fluctuations in income. By improving the accuracy of beneficiary identification, the proposed e-governance system enables government agencies to allocate assistance more equitably and efficiently, reducing exclusion and inclusion errors that have historically disadvantaged traditional fishing households. Better-targeted interventions can improve access to fishing equipment, healthcare, vocational training, financial assistance, and livelihood diversification, thereby strengthening household economic security and improving the overall quality of life among coastal residents.

The findings further demonstrate that the proposed system contributes to strengthening the socioeconomic resilience of coastal communities. Fishing households are highly dependent on marine

resources and remain vulnerable to climate variability, extreme weather events, declining fish stocks, and market instability. A continuously updated socio-economic database allows government agencies to respond more effectively to these changing conditions by designing adaptive policies and delivering timely assistance during economic crises, natural disasters, or fisheries disruptions. Such responsiveness enhances the capacity of coastal communities to recover from shocks while supporting sustainable livelihood strategies and reducing long-term poverty.

From a cultural perspective, the study also highlights the importance of recognising coastal communities not merely as beneficiaries of development programmes but as custodians of distinctive maritime cultures and traditional ecological knowledge. Fishing activities in Batubara Regency are closely embedded within family traditions, community cooperation, local knowledge of marine ecosystems, and intergenerational transfer of fishing skills. The preservation of these cultural practices depends not only on environmental sustainability but also on the socioeconomic viability of traditional fishing livelihoods. By incorporating community-specific socio-economic information into programme planning, Desa Nelayanku supports development policies that are more responsive to local cultural values, traditional fishing practices, and community priorities. This participatory approach strengthens trust between government agencies and fishing communities while helping preserve the cultural identity and social cohesion of Indonesia's island and coastal societies.

More broadly, this study demonstrates that digital governance should not be viewed solely as a technological innovation but as a mechanism for promoting socially inclusive and culturally sensitive coastal development. By integrating socio-economic profiling with community participation, the Desa Nelayanku platform contributes to more equitable public service delivery, improves the everyday well-being of coastal residents, and supports the long-term sustainability of island and coastal communities. These contributions align closely with the broader objectives of sustainable marine governance, community resilience, and inclusive coastal development.

# CONCLUSION

Unlike previous studies, no research has specifically examined the systematic collection of fishermen's socio-economic information while simultaneously conducting comprehensive needs assessments to support evidence-based empowerment programmes. Earlier studies primarily focused on fisheries management databases incorporating operational variables such as catch type, catch quantity, weather conditions, and fishing locations. For example, the M-Nelayan application provides fishermen with access to complaints reporting, news, weather information, fish prices, and fishing locations (Simanullang, 2021). Similarly, FiRST was designed to improve national fisheries statistics (Garcias, 2006), while the Fishnet Open Images Database supports fisheries research through automated fish identification (Kay, 2021). However, many of these platforms, including FiRST, IMAS-Fish, Sistem Informasi Nelayan Pintar (SINP), and Zaringan Digital Nelayan (ZAGIYAN), are no longer operational or publicly accessible, limiting their long-term usefulness for coastal governance.

Addressing these limitations, this study developed Desa Nelayanku, an integrated Android- and web-based information system using Kodular and WordPress that compiles comprehensive socio-economic profiles of traditional fishermen, including household characteristics, income, education, housing conditions, programme participation, and future development needs. By enabling continuous data updating through quarterly online surveys, the system provides government agencies with a dynamic database that supports more accurate beneficiary identification, programme planning, monitoring, and evaluation. More importantly, the findings demonstrate that effective information system governance extends beyond administrative efficiency and has significant implications for the sustainable development of island and coastal communities. Accurate socio-economic data enable government agencies to allocate resources more equitably, reduce exclusion and inclusion errors, and design interventions that better reflect the everyday realities of traditional fishing households. Such improvements have the potential to strengthen household income security, improve access to training, healthcare, fishing equipment, and social protection, thereby enhancing the quality of life and socioeconomic resilience of coastal residents.

From a broader marine and island development perspective, the system also supports the preservation of coastal communities by recognising their distinctive livelihoods, local knowledge, and long-established fishing practices. By incorporating community needs into programme planning, Desa Nelayanku promotes more participatory and culturally responsive coastal governance, helping ensure that development initiatives remain aligned with local social and cultural contexts. Consequently, this study contributes not only to the advancement of e-governance and information system governance but also to the broader goals of sustainable coastal development, community resilience, and inclusive marine policy. Future research should expand the implementation of Desa Nelayanku across diverse island and coastal regions in Indonesia to examine its long-term effectiveness in supporting adaptive coastal governance, strengthening community resilience, and improving the socio-economic well-being of fishing communities while accommodating regional cultural diversity.

**Limitation and Possible Future Research**

This study has several limitations that need to be highlighted. Firstly, the availability, accuracy and consistency of socio-economic and spatial data may vary between government agencies, which could potentially affect the reliability of the Web-GIS. Secondly, differences in digital access and literacy amongst fishermen may limit the inclusivity and utilisation of the platform (the ‘Desa Nelayanku’ app). Thirdly, the proposed framework cannot fully establish a causal relationship between spatially enabled e-governance and the empowerment of fishermen, as empowerment is also influenced by market conditions, infrastructure, environmental factors and institutional capacity.

Future research is recommended to adopt a longitudinal and comparative approach to examine the long-term impact of GIS on the empowerment of fishers in various coastal contexts. Further research could also integrate real-time environmental and socio-economic data, artificial intelligence and predictive spatial analysis to strengthen policy targeting. Significant attention must also be paid to marginalised

groups, including women, low-income households and digitally vulnerable fishers. Finally, mixed-methods research combining spatial analysis, socio-economic indicators and participatory approaches could provide deeper insights into how, for whom and under what conditions digital spatial governance can contribute to the inclusive empowerment of fishers.

## Declarations

**Ethical approval:**

This research has been approved by the Universitas Sumatra Utara ethics committee, and all procedures have been carried out in accordance with the guidelines and regulations of Universitas Sumatra Utara. A formal ethical approval document has been issued by Universitas Sumatra Utara and is available upon request.

# Clinical trial number

Clinical trial number : not applicable.

# Consent to participate:

Informed consent was obtained from all participants.

**Consent to publish:**

Informed consent to publish was obtained from all participants/ individuals involved in the study.

# Competing Interests:

No competing interest

# Funding:

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# Author Contribution

All authors contributed significantly to the development of the manuscript. D.A. was responsible for conceptualization, data collection, and drafting the original manuscript M.S.S contributed to the literature review, data analysis, and review and editing of the manuscript. A.E carried out an analysis and drafted a revised version of the manuscript and validation processes carried out an analysis and drafted a revised version of the manuscript and validation processes. A.T.S handled resources and writting discussion P.S. writting conclusion and research methods. M.D.E.T contributed by adding the introduction and literature review. R.S.M.S carried out formal analysis and visualization to support the research findings. All authors read and approved the final version of the manuscript prior to submission, ensuring the integrity and quality of the research.

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# Data Availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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## Table 1

Table 1 is available in the Supplementary Files section.

## Figures

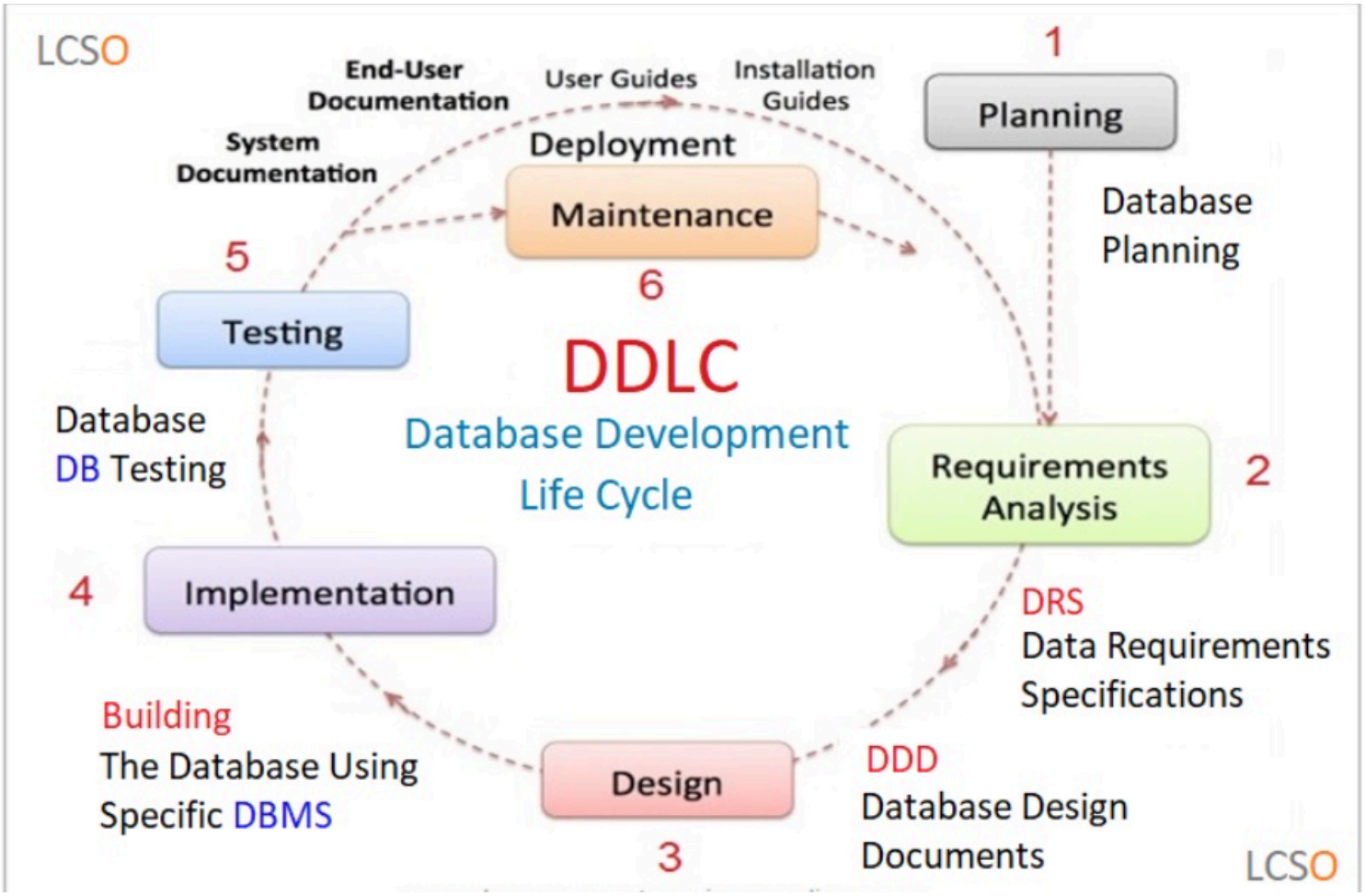



**Figure 1**

Database Development Schema

Source : www.learncomputerscienceonline.com, 2023

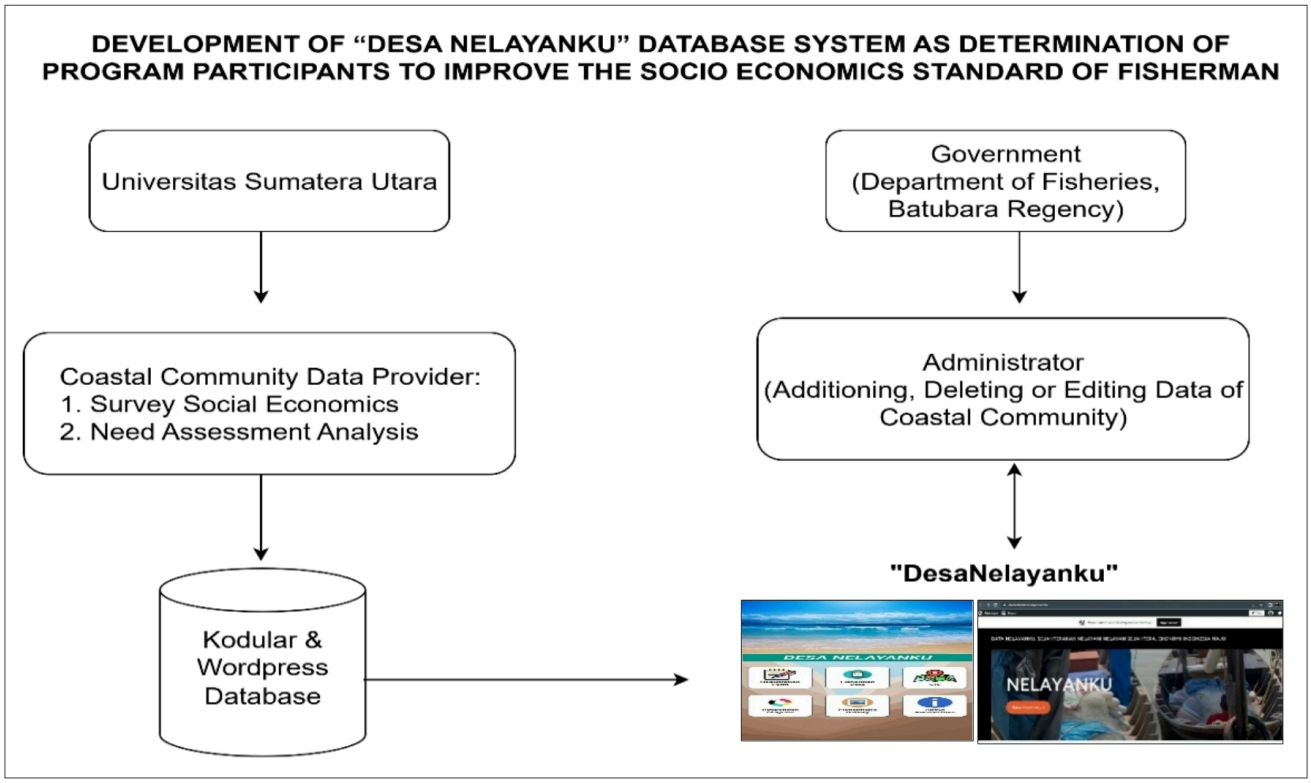



**Figure 2**

Research Flowchart

*Source: Author's own work*

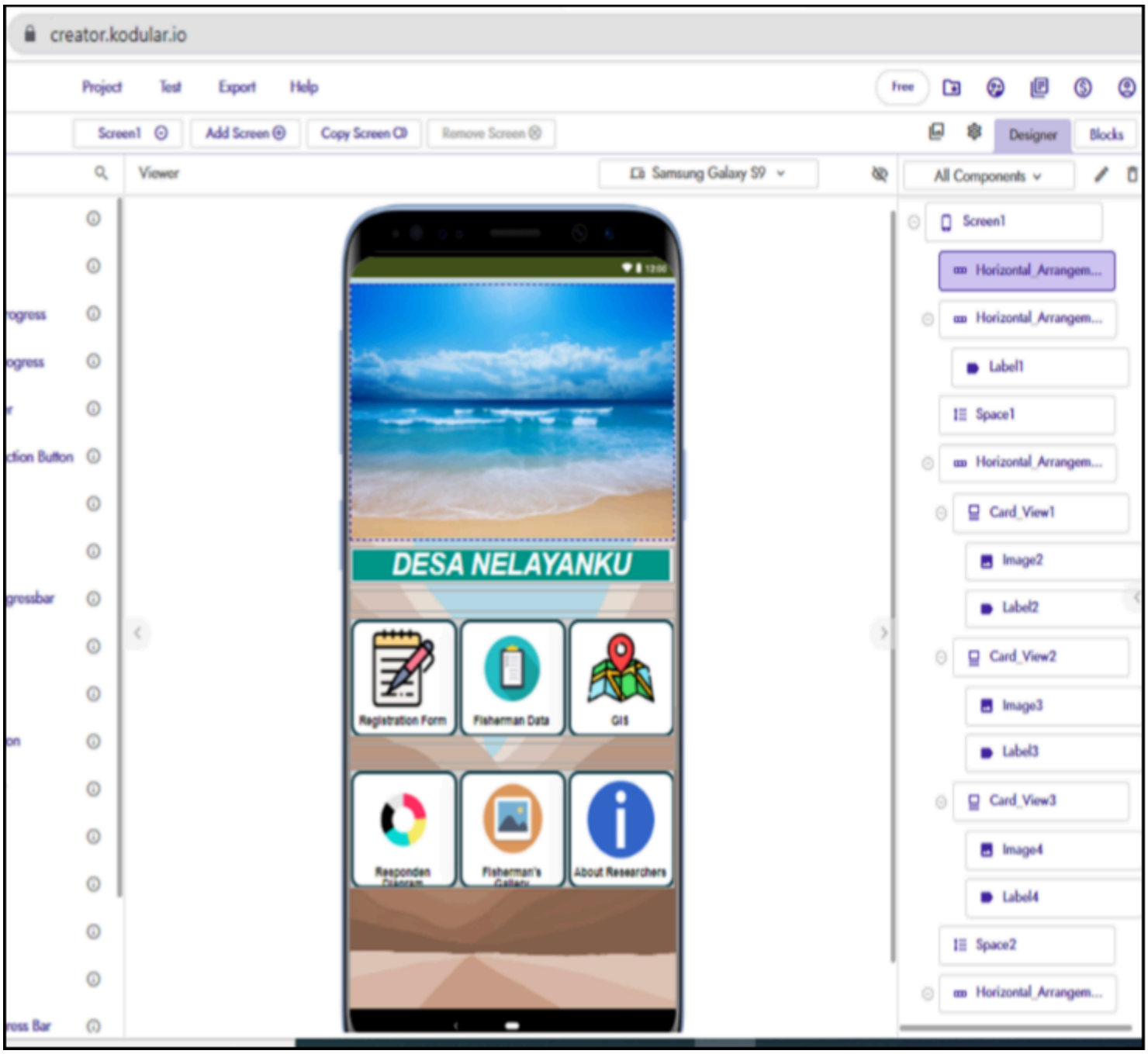



**Figure 3**

Application Development Display "Desa Nelayanku" in Kodular

Source: Author's own work, 2026

## Supplementary Files

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- Table114.docx