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# MAPPING THE DECISION-MAKING FACTORS OF SMALL-SCALE FISHERS: A CASE STUDY OF PENANG

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# Contents

<b>Abstract.....</b>	<b>5</b>
<b>1. Introduction.....</b>	<b>6</b>
1.1 Fisheries and Small-Scale Fisheries.....	6
1.2 Decision-Making.....	6
1.3 Relevance and Objectives of the Research .....	7
1.4 Structure of the Thesis .....	8
<b>2. Literature review .....</b>	<b>9</b>
2.1 Decision-Making and Factors .....	9
2.1.1 Social Factors.....	10
2.1.2 Economic Factors.....	11
2.1.3 Environmental Factors .....	12
2.2 Causal Mapping .....	12
<b>3. Methodology .....</b>	<b>15</b>
3.1 Case Study .....	15
3.2 Data Collection .....	16
3.2.1 Overview.....	16
3.2.2 Phase 1: Expert interview .....	17
3.2.3 Phase 2: Develop Questionnaire .....	18
3.2.4 Phase 3: Sampling.....	19
3.2.5 Phase 4: Interviews with Fishers .....	20
3.3 Data Analysis: Qualitative Thematic Analysis .....	21
<b>4. Results .....</b>	<b>25</b>
4.1 Overview.....	25
4.2 Daily Operational Decisions .....	26
4.2.1 Overview.....	26
4.2.2 Fishing Resource and Tide.....	26
4.2.3 Information, Social Network and Personal Experience.....	28
4.2.4 Safety Concern and its Multiple Causes .....	29
4.2.5 Economic Goal, Labor Availability and Saving Practice .....	30
4.2.6 Insignificant Factors: Environmental Concern and Religious Practice .....	30
4.3 Strategic Fishing and Sales Decisions .....	31
4.3.1 Overview.....	31
4.3.2 Resilience, Income Stability and Access to Credit .....	32

4.3.3	Price, Income, and Long-Term Relationship with Buyer .....	33
4.3.4	Cost of Gear and its Causes .....	34
4.3.5	Market Access and Convenience .....	34
4.3.6	Habit and Personal Preference .....	35
4.3.7	Insignificant Factors: Knowledge & Skills .....	35
4.4	Community Involvement and Collective Action Decisions .....	36
4.4.1	Overview .....	36
4.4.2	Environmental Concern and Income Concern .....	36
4.4.3	Advocating Policy Change and Financial Benefits .....	37
4.4.4	Identity, Responsibility, Communal Reciprocity and Public Expression .....	38
4.4.5	External Pressure and License .....	38
4.4.6	Insignificant Factors: Time and Financial Constraints .....	38
<b>5.</b>	<b>Discussion.....</b>	<b>39</b>
5.1	The Vicious Circle of Resilience .....	39
5.2	Perception of Government and Public Participation .....	41
5.3	Decision-Making and Local Context .....	43
<b>6.</b>	<b>Conclusion .....</b>	<b>46</b>
6.1	Summary of Findings .....	46
6.2	Policy Implications .....	47
6.3	Limitations and Future Research Directions.....	48
	<b>Bibliography .....</b>	<b>50</b>
	<b>Appendices.....</b>	<b>60</b>
	Appendix 1: Decisions and Themes Identified After Expert Interviews .....	60
	Appendix 2: Codes (Factors) Identified in Data Analysis .....	61

## List of Table

Table 1 Social-Demographic Distribution of Sample.....	20
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## List of Figures

Figure 1 Penang and its Location in Malaysia.....	15
Figure 2 Fishing Zones in Penang Showing the Distance of Each Zone from Coastal Line and the Type and Size of Fishing Vessels Permitted Operated in Each Zone (Mohamed, 2018)..	16
Figure 3 Overview of the Four Phases of Data Collection .....	17
Figure 4 Geographical Distribution of Sample in Penang (sample size: 25).....	19
Figure 5 Data Analysis Steps .....	22
Figure 6 Decision-Making Map of Daily Operational Decisions .....	27
Figure 7 Decision-Making Map of Strategic Fishing and Sales Decisions .....	31
Figure 8 Decision-making Map of Community Involvement & Collective Action Decisions	36
Figure 9 The Vicious Circle of Resilience.....	40

## List of Abbreviations

FA	Fishermen's Associations
FAO	Food and Agriculture Organization of the United Nations
SME	Small and Medium-sized Enterprises
SSF	Small-Scale Fisheries

## **Abstract**

Small-scale fisheries are crucial for global food security and economic development but face numerous challenges. Understanding their decision-making processes is vital for developing effective management strategies.

The study employs a qualitative case study approach, including expert consultations and semi-structured interviews with 25 fishers. Factors were identified using qualitative thematic analysis, then filtered by frequency and importance. Causation between decisions and factors were demonstrated by causal mapping.

The results are presented in three decision-making maps, each outlining a specific type of decision-making process: daily operational decisions, strategic fishing and sales decisions, and community involvement and collective action decisions. The factors influencing these decisions show a complex interplay across economic, social, and environmental dimensions. Operational decisions are predominantly shaped by immediate environmental conditions, while strategic decisions depend on long-term financial stability and market dynamics. Decisions involving community involvement are deeply rooted in social identities and interests, reflecting broader socio-political engagements.

Findings reveal that fishers adopt stability-focused strategies to cope with the unpredictability of income and expenses, inadvertently ensnaring themselves in a cycle of precarious resilience. The study also highlights a strong desire among fishers for public participation, spurred by political marginalization. Additionally, the local context such as community network and institutions significantly influence their decisions.

This study can be utilized to inform policy and program designs, ensuring interventions are tailored and locally relevant. Specific policy recommendations include enhancing financial literacy and access to credit, fostering an inclusive development process, and strengthening community-based organizations to support the fishery community. Future research should incorporate quantitative methods and broader stakeholder perspectives to understand the factors influencing small-scale fishers' decisions more comprehensively.

**Keywords:** Small-scale fisheries; Decision-making; Causal mapping

# **1. Introduction**

## **1.1 Fisheries and Small-Scale Fisheries**

Fisheries play a crucial role in ensuring global food security, supporting economic development, and alleviating poverty (Neiland, 2004; Thorpe et al., 2006; Youn et al., 2014). The sector is vital for millions worldwide, providing essential nutrients and employment opportunities. Capture fisheries and aquaculture together produced 177.8 million metric tons of fish in 2020, which provides nearly one-fifth of the average per capita animal protein intake for more than 3.1 billion people (Bennett et al., 2018; FAO, 2022).

Small-scale fisheries (SSF) are the backbone of fishery economy, especially in developing countries. Approximately 492 million people depend at least partially on SSF for their livelihoods, and 60 million people are employed in SSF, which accounts for 90% of capture fisheries employment (FAO, 2023). In recognition of their importance, the United Nations General Assembly declared 2022 as “The International Year of Artisanal Fisheries and Aquaculture” to enhance global awareness and understanding of small-scale artisanal fisheries and aquaculture.

Although there is no universal definition of SSF, according to the Food and Agriculture Organization of the United Nations (FAO) (2023), they generally describe fisheries that “use relatively small production units with relatively low input and low output, and limited levels of technology and small capital investment.” The SSF are commonly managed at the family level, sometimes with a small group of employees, or at the community level. The catches, which can include fish, prawn, crab, or other species, are often sold in local markets but can also reach national and international markets. The terms “small-scale” and “artisanal” fisheries are often used interchangeably. In this study, the specific thresholds used to define SSF are based on local regulations, detailed further in section “3.1 Case Study”.

## **1.2 Decision-Making**

Decision-making is a critical component of management work, as it enhances our understanding of how strategic choices drive economic growth, informs policymakers on effective measures to support small and medium-sized enterprises (SME), and helps identify factors influencing the success and failure of entrepreneurial activities (Zoetermeer, 2003). SSF, as a type of small-scale business, also benefit from decision-making research, as it empowers them to make informed strategic choices essential for their sustainability and growth.

The decision-making processes in SSF are complex. Decisions like when and where to fish, what gear to use, and how to market their catch are influenced by a mixture of environmental,

economic, and social factors (Alam et al., 2002; Allegretti, 2019; D'agata et al., 2020; Hoehn & Thapa, 2009; Kleih et al., 2013). Understanding these factors and the processes, especially by multi-dimensional approaches, is crucial for developing management strategies that enhance the effective advancement of SSF businesses (Marín-Monroy & Ojeda-Ruiz de la Peña, 2016).

### **1.3 Relevance and Objectives of the Research**

Research into SSF decision-making processes is not only relevant but critical for several reasons. It enhances the understanding of how operational and strategic choices drive economic growth and sustainability in the fishery sector, and informs policymakers on effective and efficient interventions to support SSF, who often operate in challenging and fluctuating environments (Mingers & Rosenhead, 2004; Thorpe et al., 2006). Furthermore, it helps identify the factors influencing the success and failure of fishing activities, providing a foundation for interventions that can improve the resilience and livelihoods of fishing communities.

Despite its importance, there is a gap in the literature regarding the nuanced decision-making processes of small-scale fishers, especially considering the unique local conditions that shape these processes. For instance, studies indicate that while there is a broad understanding of the challenges faced by SSF, there is limited empirical data on how these challenges influence decision-making at the local level (Kimani et al., 2020). There is a recognized need for integrating scientific and local knowledge to improve governance, yet this integration often remains unachieved due to various institutional and knowledge barriers (Sutton & Rudd, 2016).

Local-specific case studies are particularly needed because they can illuminate how local conditions shape decision-making processes and outcomes, offering lessons of context-specific development at the international level (Béné et al., 2016). Ratner & Allison (2012) highlights that the diversity of social, ecological and economic characteristics of SSF in developing countries means that context-specific assessments are required.

This study aims to address the gap in the literature on the decision-making processes of small-scale fishers by conducting an exploratory study within the unique context of Penang, Malaysia. By examining the interplay of economic, social, and environmental factors, the research seeks to enhance the understanding of these processes and inform both local and international efforts to support SSF. The following three research questions are explored.

- What decisions are made by small-scale fishers in managing their fishery?
- What factors influence the decision-making of small-scale fishers?

- How do these factors associate with local context economically, socially and environmentally?

The study is conducted in collaboration with the International Center for Living Aquatic Resources Management, commonly known as WorldFish, an international organization dedicated to transforming aquatic food systems to reduce hunger, malnutrition, and poverty. This study stems from WorldFish's need for a baseline understanding of how the decision-making processes of small-scale fishers work and the factors that influence them, with the long-term goal of enhancing development effectiveness through tailored, locally relevant interventions and policies. WorldFish sponsored the study, facilitated data collection and local partnerships in Penang, and provided academic advisory throughout the research process.

## **1.4 Structure of the Thesis**

The thesis is structured as follows: Chapter 1 introduces the background and relevance of the research and specifies the research questions. Chapter 2 reviews the existing literature on decision-making and causal mapping, particularly their application in SSF, and highlights gaps in the research. Chapter 3 outlines the methodology used in the study, detailing the case study context, data collection, and data analysis methods. Chapter 4 presents the results through causal mapping, providing insights into the decision-making processes of the three identified types of decisions. Chapter 5 discusses the critical patterns identified from the results and their potential implications, integrating these findings with existing literature and the local context. Chapter 6 concludes the thesis by summarizing the key findings, elaborating on the limitations, and suggesting implications for policy and future research.

## **2. Literature review**

### **2.1 Decision-Making and Factors**

Decision-making is defined as the process of making a choice from multiple alternatives to achieve a desired outcome (Eisenfuhr, 2011). This concept encompasses three components. Firstly, decision-making requires choosing from among various options, such as a fisher deciding whether to sell their catch to a wholesaler or directly to customers. Secondly, it is a comprehensive process that extends beyond merely picking an option, but also understanding the steps and reasoning leading up to the decision, such as why a fisher chooses to sell their catch to a particular middleman on the jetty. Lastly, the “desired result” in the definition signifies the goal or objective that the decision-maker aims to achieve through this process, such as obtaining higher profits by opting to sell to a particular middleman (Lunenburg, 2010).

Decision-making is crucial for entrepreneurship activities as it drives strategic directions, influences economic participation, and enables adaptation to complex and changing environments (Zoetermeer, 2003). Specifically in SME, decision-making is extensively covered in the literature, addressing various aspects such as risk management, business governance, strategic decisions, and personal characteristics (Dahmani et al., 2020; Elbanna, 2006; Huang, 2009; Weerasekara & Bhanugopan, 2023).

Various frameworks and approaches are utilized to analyze decision-making processes, but no universally accepted framework has been identified. These include integrative models that consider the entrepreneur, the decision environment, and the strategic decision process, all of which dynamically interact to influence outcomes (Zoetermeer, 2003). Additionally, there are analytical frameworks focusing on the individual characteristics of decision-makers, internal organizational context, and environmental factors (Musso & Francioni, 2012). Several studies provide specific frameworks and classifications for decision-making in SME. For instance, a study of Costa Rican dairy farmers proposed a classification method of decisions into Alone, Family, Shared, and Delegated categories (Solano et al., 2001). Similarly, Sakane et al. (2014) developed a conceptual framework for farmers’ decision-making, categorizing internal and external factors and highlighting their influences on land use and interactions with wetland systems. Decision-making processes can be categorized into phases such as identification, development, and selection, each involving specific steps and considerations (Huang, 2009). Rational and incremental decision-making processes are commonly studied, with an emphasis on rational analysis, political behavior, and intuition in decision-making (Elbanna, 2006). Additionally, heuristics and fast-and-frugal decision-making rules are explored, particularly in

the context of financial advisors to SME, focusing on principles like satisficing, recognition, and similarity (Rauwerda & De Graaf, 2021).

The extensive literature on decision-making reveals the influence of various factors, which are categorized under the three fundamental pillars of sustainable development: social, economic, and environmental (Purvis et al., 2019). These dimensions are crucial for analyzing the factors influencing decision-making, as they are intricately linked, often overlapping and acting as both causes and consequences of one another (Hoehn & Thapa, 2009; Sakane et al., 2014; Zhumanova et al., 2016). For example, Hoehn & Thapa (2009) demonstrated how the socio-cultural structure and economic development of communities significantly affect people's environmental perceptions and attitudes. Similarly, Zhumanova et al. (2016) noted that farmers might reduce livestock keeping due to environmental constraints, highlighting the dynamic interplay between these dimensions. For clarity and better readability in the subsequent sections, the discussion of influencing factors will be categorized under each dimension separately.

### **2.1.1 Social Factors**

Social norms and learning have been identified as key influencers of fishing behaviour, suggesting that community standards and educational experiences shape both individual and collective practices (Haase et al., 2023). Similarly, social image and customer preferences are found to be affecting environmental management decisions of farmers (Karali et al., 2014). Additionally, the identity transformation within SSF communities, from traditional fisher roles to more business-oriented identities, influences the communal co-management of resources (Allegretti, 2019). This shift highlights how personal and group identity evolution can impact decision-making in resource management.

The availability and selection of information critically shape how SME perceive problems and make decisions (Gabrielsson & Gabrielsson, 2013). Tversky and Kahneman (1974) highlight that the type of information accessed can fundamentally influence the judgment and decision-making processes of an entrepreneur, affecting the outcomes of their business strategies. The vital role of information is further proved by the search of Zhumanova et al. in 2016, illustrating that experience and skills may significantly increase the probability of land use change decisions. Other studies show that information alone maybe not enough, by concluding that, human capital, such as the experience and skills, combined with their social capital—networks and relationships—significantly enhances decision effectiveness (Evers & O’Gorman, 2011; Jansen et al., 2013). These social connections provide vital information and resources, leading to better strategic outcomes and fostering innovation.

The business environment and decision-making of SME are mutually influential. Sakane et al. (2014) demonstrated that land-use decisions among smallholder agrowetland farmers are shaped by migration patterns and development interventions, illustrating external influences on operational choices. Conversely, Kozubíková et al. (2020) found that social factors such as family influence, media, and social norms significantly shape the business environment, directly impacting SME decision-making. More broadly, the interplay between rational, political, and intuitive approaches in strategic decision-making is underexplored and lacks consensus in existing research (Elbanna, 2006). This interplay highlights the complex dynamics between external social forces and internal business strategies within SME, and the importance of understanding how different factors interact and affect decision-making.

### **2.1.2 Economic Factors**

Economic factors play a crucial role in shaping the decision-making processes of SME, small-scale farmers and fishers, influencing various aspects of their operations from investment and expansion to resource allocation.

Access to credit is a primary concern, as SME often face challenges in securing external financing due to issues related to creditworthiness and the broader economic conditions (Steinerowska-Streb & Steiner, 2014). In the fisheries sector, poor access to credit is cited as a major developmental constraint, impacting everything from day-to-day operations to strategic long-term planning (Kleih et al., 2013). This issue extends into the agricultural sector, where off-farm income and financial incentives significantly impacts land-usage decisions and business sustainability (Karali et al., 2014; Sakane et al., 2014; Zhumanova et al., 2016). Farmers often diversify the businesses on the farms when profitability is low, and are likely to reconsider land use when more lucrative off-farm income opportunities arise, highlighting the interdependence between market access, financial resources, and agricultural decisions.

The economic environment, including taxation and regulatory frameworks, deeply affects SME by altering financial planning and influencing compliance and risk management strategies (Beck & Demircuc-Kunt, 2006). Regulatory changes, in particular, can pose challenges or provide opportunities, making SME sensitive to these dynamics due to their limited resources and scalability constraints. The role of economic fluctuations further emphasizes the vulnerability of SME to external economic pressures (Doacă, 2022). Risk perception also plays a key role, with fishers often making decisions based on short-term risks associated with endogenous factors, social dynamics, and natural conditions affecting profit margins and location choices (Dowling et al., 2015).

Moreover, financial literacy, attitudes towards finance, and a sense of control over financial outcomes are pivotal in determining how SME manage their finances, with these factors crucially influencing their ability to sustain operations and achieve strategic goals in competitive markets (Handayani, 2023). This comprehensive perspective underscores the multifaceted impact of economic factors on the decision-making processes within SME, particularly in sectors directly dependent on natural resources and susceptible to environmental and market variabilities.

### **2.1.3 Environmental Factors**

Environmental factors play a pivotal role in the decision-making processes of SME within the agriculture and fisheries sectors. These factors extend beyond the physical environment to include the broader socioeconomic context in which these enterprises operate. For instance, research by Hoehn & Thapa (2009) illustrates how environmental perceptions and attitudes within fishery communities significantly influence behaviours related to marine resource management, and similar results were found for farmers' environmental management decisions (Karali et al., 2014). Similarly, Hillary (2017) notes that environmental awareness and ethical stances often drive SME to adopt green practices.

The influence of environmental factors is also evident in how SME perceive and respond to climate risks. Cardín-Pedrosa & Alvarez-López (2012) found that in Spain, landscape and climate are critical factors in shaping farmers' decisions regarding agricultural production. Sakane et al. (2014) identified that the land-usage decisions of smallholder agricultural wetland households in rural East Africa are influenced by patterns and durations of flooding. Ye & Li (2022) emphasize that factors such as managers' environmental values and access to tailored climate information are crucial in shaping climate risk perceptions. These perceptions, in turn, guide the environmental strategies and investments of agricultural SME.

Additionally, recent studies using Agent-based models (ABMs) have demonstrated how environmental factors dynamically influence fishing decisions, showcasing the complex interplay between environmental changes and sector-specific strategies (Haase et al., 2023).

## **2.2 Causal Mapping**

Causal mapping is a technique used to visually represent and analyze the causal relationships between different factors or concepts. It involves creating diagrams, where nodes (representing factors or concepts) are connected by arrows indicating causality/influence/implication relationship between nodes (Axelrod, 1976; Eden, 2004). For example, a link from factor A to factor B means that A is believed to causally influence B (Montibeller & Belton, 2006).

Causal mapping has a rich history. It originates from the field theory in the 1940s, which sought to understand actors' behaviours through their internal representations of the world (Tolman, 1948). In the 1970s, Axelrod (1976) brought causal mapping to political science, enhancing the understanding of decision-making processes, and introducing the term "cognitive mapping". Throughout the 1970s and 1980s, researchers like Bougon et al. (1977) extended its application to organizational studies. The 1990s witnessed further formalization and expansion in the use of causal mapping within organizational decision-making, supported by the development of specialized software tools (Eden, 1992). More recently, the "causal revolution" in quantitative data science has sparked renewed interest, with a focus on explicit causation analysis (Pearl, 2000; Pearl & Mackenzie, 2018). Today, with advancements in methodologies and software enhancing its ability to capture complex causal relationships, causal mapping continues to evolve, and is widely used across various disciplines such as management, ecology, and psychology (Barraquand et al., 2021; Fairweather, 2010; Hanisch & Eirdosh, 2021).

Causal mapping has a few related deviations, such as concept mapping, fuzzy cognitive maps, participatory systems mapping, and Bayesian belief networks, all of which align closely with the core definition of a causal map. Variations exist primarily in the extent to which different authors explicitly describe causal links as representing actual causation versus perceptions of causation (Powell et al., 2024). While these methods share the use of visual representations to clarify complex information, the choice of a specific approach often depends on the particular needs of the study or application. Causal mapping specifically focuses on delineating cause-and-effect relationships, and it has been widely employed to represent subjective knowledge about causes and effects (Eden, 1992).

Causal mapping has diverse applications in decision-making, enhancing the ability to visualize and analyze complex interrelationships. Initially, it serves as a powerful tool for problem structuring, enabling decision-makers to identify strategic options and evaluate their impacts (Montibeller & Belton, 2006). Building on this foundation, its role extends into policy analysis and evaluation, where stakeholders can understand and assess perceived causal relationships, thus making more informed decisions (Powell et al., 2024). In organizational contexts, causal mapping captures the mental models of managers and employees, providing insights that inform strategic planning and facilitate better alignment of organizational goals (Brännback & Malaska, 1995). Furthermore, in dynamic multiagent environments, causal mapping supports qualitative distributed decision-making and coordination among agents, which is crucial for collaborative efforts and conflict resolution (Chaib-draa, 2002). Methods for eliciting and comparing causal maps, as presented by Eden (2004), are essential for refining these processes and resolving conflicts within decision-making. Additionally, the use of causal decision trees

improves the applicability and scalability of drawing inferences from complex decision scenarios, reinforcing the structured approach of causal mapping (Li et al., 2017). These interconnected applications demonstrate how causal mapping provides a comprehensive framework that integrates visualization, analysis, and communication of causal relationships, thereby enhancing decision-making processes across various domains.

Research specifically on the application of causal mapping in the context of SME decision-making is limited. However, other studies provide relevant insights. For example, Montibeller & Belton (2006) discuss strategic decision-making using causal maps, and Eden (2004) offers methods for improving decision processes that can be adapted to SME. Kwon's (2011) object-oriented causal mapping framework aids in modeling business processes for better decision-making, and Nadkarni & Shenoy's (2004) approach to constructing Bayesian networks using causal mapping can enhance risk assessment and management in SME. These broader studies offer valuable methodologies applicable to SME.

Several research gaps related to causal mapping and decision-making have been identified. One significant gap is the limited application of causal mapping techniques specifically to the decision-making processes in SME (Montibeller & Belton, 2006; Powell et al., 2024). While causal mapping has been studied extensively in various contexts, focused research on SME is sparse, suggesting a need to address the unique challenges and opportunities within these enterprises. Additionally, there is a gap in exploring the cross-disciplinary applications of causal mapping. Although the technique is used across multiple fields, there is limited research on integrating insights from different disciplines to enhance decision-making processes (Brännback & Malaska, 1995; Kwon, 2011). For example, combining methods from organizational behavior, cognitive psychology, and quantitative analysis could provide a more comprehensive approach to decision-making in SME. Addressing these gaps could lead to the development of tailored causal mapping methodologies that leverage cross-disciplinary insights to better support decision-making in SME.

### 3. Methodology

#### 3.1 Case Study

Penang, one of Malaysia's 14 states, is locally known as "Pulau Pinang" and is situated in the northwest of Peninsular Malaysia (Figure 1). It encompasses both the mainland Seberang Perai and Penang Island, covering an area of 1,049 km<sup>2</sup>. As of 2021, Penang was home to approximately 1.77 million residents (Department of Statistics Malaysia, 2021).

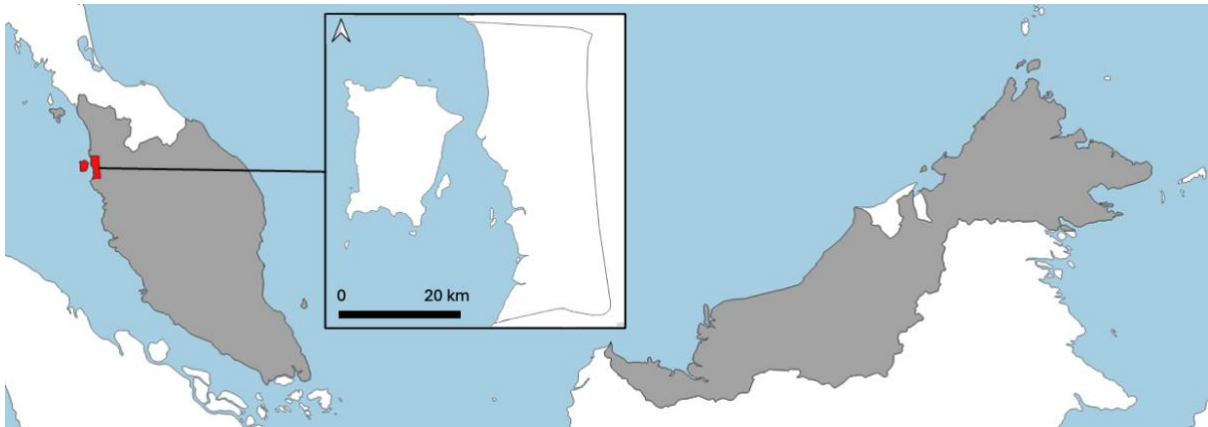


Figure 1 Penang and its Location in Malaysia

Malaysia manages its marine catch fisheries through an area zoning system to avoid excessive trawl fishing and tensions between commercial trawlers and small-scale fishers (Alam et al., 2002), as depicted in Figure 2. This zoning system divides the maritime areas into multiple fishing zones based on distance from the shoreline, and regulates the type, size, and fishing method of vessels permitted within each zone. Despite these regulations, the frequent illegal intrusion of trawlers from farther zones into Zone A continues to be a significant issue, which is also identified as an important factor in the decision-making processes of small-scale fishers in this study. The impact of these intrusions will be further explored in subsequent sections.

For the purpose of this study, a "small-scale fisher" refers specifically to fishers registered in Zone A. In 2022, Penang had a total of 5,272 licensed fishers across all zones, with 4,520 of these operating in Zone A (Department of Fisheries Malaysia, 2023). The ethnic composition of fishers in Zone A is predominantly Malay, expected to be higher than the 58% reported across all zones, followed by 38% Chinese, 2% Indian, and 2% other ethnicities (Department of Fisheries Malaysia, 2023; Wong & Yong, 2020).

Small-scale fishers in Penang commonly use traditional fishing gears, with gill nets being the most prevalent (Department of Fisheries Malaysia, 2023). These fishers target a variety of species including pomfret, threadfin, prawn, crab, and mixed fish.

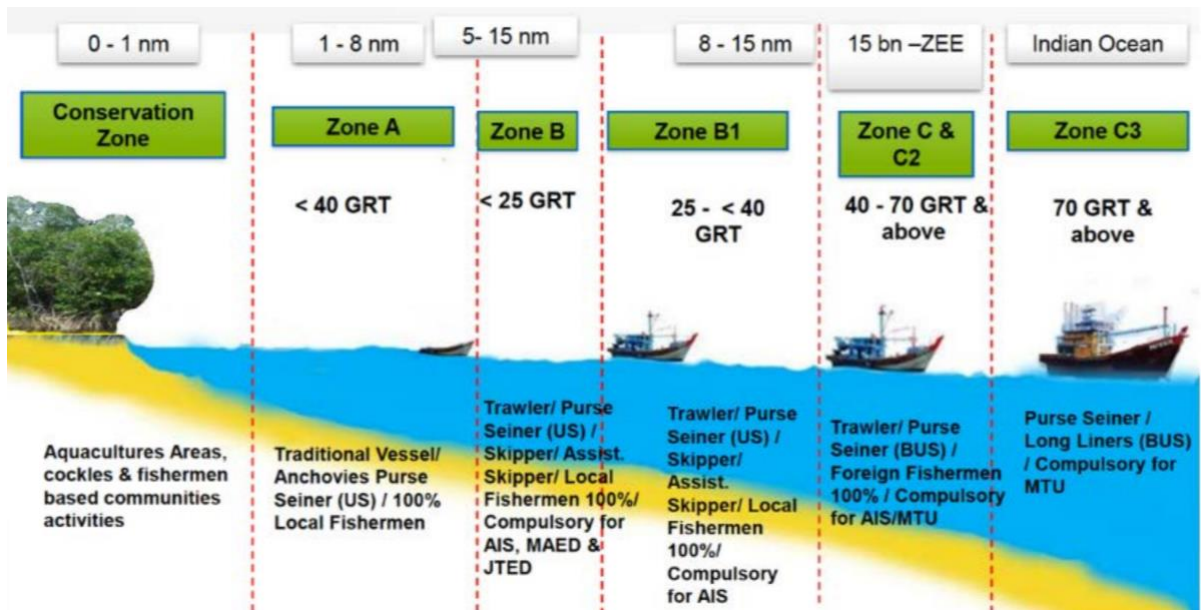


Figure 2 Fishing Zones in Penang Showing the Distance of Each Zone from Coastal Line and the Type and Size of Fishing Vessels Permitted Operated in Each Zone (Mohamed, 2018)

A typical SSF unit in Penang consists of a boat with 1-3 workers. The owner often serves as the captain and may work alone or with the assistance of 1-2 additional crew members. Fishing schedules vary, with each trip lasting between 5 to 10 hours, depending on the day and individual fishers' practices. During non-fishing hours, maintenance activities such as repairing fishing nets are common. Most fishers sell their catch to wholesalers, which include private middlemen or local FA. These wholesalers, in turn, supply market stalls and restaurants. Only a few fishers sell their catch directly to consumers.

Notably, the Penang South Islands (PSI) project has sparked significant tension among local fishers and environmental groups (Audrey Dermawan, 2023a; Speziale, 2024). This large-scale land reclamation initiative aims to create artificial islands off the southern coast of Penang. However, it has faced significant opposition due to concerns over environmental impact and the displacement of local fishing communities (Audrey Dermawan, 2023b). Despite legal actions taken, with NGOs filing lawsuits against the project, fishers have staged multiple protests and have warned of escalating demonstrations if the project continues without addressing their concerns (Audrey Dermawan, 2024). This issue is responded in this study.

## 3.2 Data Collection

### 3.2.1 Overview

The study on small-scale fishers in Penang was conducted in four phases: expert interviews to establish context and themes, development and refinement of a detailed questionnaire, a

strategic sampling process to ensure a representative sample, and finally, semi-structured interviews with the fishers to gather in-depth data. The roadmap is shown in Figure 3, and the detail of the four phases are elaborated in the following parts.

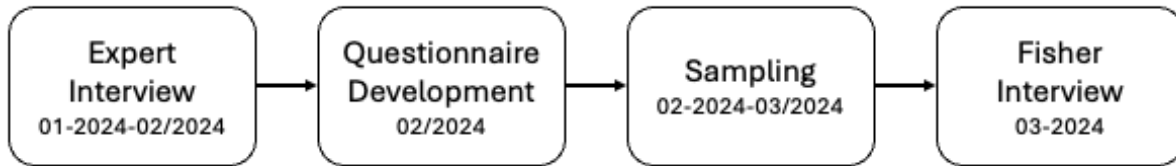


Figure 3 Overview of the Four Phases of Data Collection

### 3.2.2 Phase 1: Expert interview

In this initial phase, exploratory semi-structured qualitative interviews were conducted with local experts to familiarize with the local context and identify pertinent themes, thus laying the groundwork for subsequent interviews with local fishers. Experts were identified through a snowball sampling method, as outlined by Van Audenhove & Donders (2019), and selected based on three key criteria: familiarity with the local SSF context, including the lives and decision-making processes of small-scale fishers; a foundational understanding of research principles and the ability to communicate effectively with the researcher; and a diverse range of perspectives to ensure a broad spectrum of views were gathered.

A total of five expert interviews were conducted - three online and two offline. The experts included members from the management team of the local fishermen's associations (FA), a local NGO supporting small-scale fishers, a researcher from WorldFish with previous experience in the study area, and a community opinion leader, three of whom are also active fishers. Attempts were made to engage the local government fishery department, but no responses were received in time.

The expert interviews were designed to be flexible and explorative, guided by a brief list of predefined open-ended questions covering topics such as the general overview of local fisheries, typical decisions and influencing factors for small-scale fishers, major challenges, and current issues affecting the local fishery, along with advice on survey areas and sampling strategies. Experts were afforded considerable freedom to express their views on what they deemed important, and the researcher had the flexibility to introduce follow-up and new questions to probe deeper into certain topics.

By the end of this phase, insights gathered from the expert interviews, combined with information from a previous literature review, were synthesized to construct a framework of seven key decisions typically made by small-scale fishers and a total of 24 themes that

potentially influence their decision-making process. These decisions include “when to fish,” “where to fish,” “when to terminate a trip,” “how to fish,” “how to sell,” “joining FA,” and “joining protests against coastal development projects.” Out of the seven decisions, the following are confirmed by both expert interviews and literature: when to fish, where to fish, how to fish, how to sell, and joining FA (Lopes & Begossi, 2011; Maunder, 2002; Nalzaró, 2013; Saul & Die, 2016; Watson et al., 2022). The decision of when to terminate a trip is supported by literature only (Maunder, 2002; Saul & Die, 2016), while joining protests against coastal development projects is unique to this case study. Out of the 24 themes, the following are confirmed by both expert interviews and literature: tide, weather, income/financial benefits, price, loan, knowledge & skills, economic goal, personal preference, environmental concern, labor availability, convenience, fishing resource, habit, external information, license, time availability, financial availability, cost of gear, and religious practice (Allegretti, 2019; Cardín-Pedrosa & Alvarez-López, 2012; Gammage & Jarre, 2020; Hoehn & Thapa, 2009; Karali et al., 2014; Kleih et al., 2013; Lopes & Begossi, 2011; Pineda et al., 2023; Sakane et al., 2014; Tversky & Kahneman, 1974). Themes identified from literature only include identity and social referent (Allegretti, 2019; Haase et al., 2023), while perception of the impact of coastal development and perception of the impact of their participation are unique to this case study. The detailed list of identified themes and decisions can be found in Appendix 1.

### **3.2.3 Phase 2: Develop Questionnaire**

The questionnaire was drafted and initially tested with one fisher to ensure its effectiveness and comprehensiveness. This preliminary test was an imitation of the real interview process, involving a complete walkthrough of the questionnaire. During this session, extra explanations were provided for some questions to ensure clarity. Additionally, a feedback conversation was conducted after completing the questionnaire to gather insights on any ambiguities or issues. Based on the feedback received, minor modifications were made to refine the questions, ensuring they were relevant and understandable to the target population.

The finalized questionnaire comprises three sections:

Section 1: Socio-demographic Information. This section collects socio-demographic details of the interviewee along with basic information about their fishing practices. This foundational data provides context for the responses given in subsequent sections.

Section 2: Decision-Making. This section is structured around the seven key decisions identified from the expert interviews and literature review. Each decision is initially explored through an open-ended question asking, “How do you decide?” This allows interviewees to express their decision-making process in their own words. Subsequently, a list of pre-identified

themes is referenced. If the interviewee does not mention a specific theme while answering the open question, the interviewer prompts them to discuss whether that theme influences their decision-making. Besides, follow-up questions are also asked to delve deeper, such as “What influences the weather?” This approach helps in identifying both direct and indirect factors influencing their decisions, facilitating the construction of a causal map.

Section 3: Complementary Information. This section aims to gather additional information that complements the data collected in previous sections. It includes questions about the most significant decisions, the biggest challenges faced by the fishers, and their satisfaction with the entities involved in fisheries management, such as the government and FA. This section helps to understand the broader context of fishery management and capturing the sentiment and attitudes of the interviewees towards various stakeholders.

### 3.2.4 Phase 3: Sampling

The sampling strategy employed in this study was a combination of geographic stratification, snowball sampling, and purposive sampling, to build a representative sample of the population.



Figure 4 Geographical Distribution of Sample in Penang (sample size: 25)

Geographic Stratification. The first step involved dividing the target area, Penang, into different geographical regions based on the expert judgments gained from Phase 1. Figure 4 shows the geographical distribution of sample. This stratification aimed to capture significant variations across areas, considering factors such as ecological differences, fishing practices, and

community structures. This method ensured that the sample reflected the diverse conditions under which fishers operate.

**Snowball Sampling.** Within each geographically stratified area, FA initiated the contact chain through their networks, leading to further referrals within the community. This method was especially useful in accessing fishers who are typically hard to reach and ensuring that the sample covered a broad network of participants. However, this method also posed constraints, such as potential bias in selecting participants who are interconnected within certain community segments.

**Purposive Sampling.** Towards the end of the data collection phase, an initial analysis of the sample composition was conducted to identify any missing or under-represented sub-groups, such as specific age groups, ethnicities, or genders. Additional participants were then selectively recruited based on specific criteria to address these gaps, ensuring a more comprehensive representation of the population.

The final sample consisted of 25 fishers, with detailed socio-demographic information collected to provide context to the findings. The distribution of the sample regarding gender, age and ethnic is shown in Table 1.

Gender	Male	24
	Female	1
Age	30-39	4
	40-49	6
	50-59	6
	60-69	8
	70+	1
Ethnic	Muslim	16
	Chinese	6
	Indian	3
Total		25

Table 1 Social-Demographic Distribution of Sample

### 3.2.5 Phase 4: Interviews with Fishers

This phase of the research involves conducting semi-structured qualitative interviews with fishers, adhering to the previously developed questionnaire. Each interview lasts approximately one hour, allowing for a thorough exploration of the subjects outlined in the questionnaire while accommodating the natural flow of conversation that semi-structured interviews facilitate (Adams, 2015). Given the linguistic diversity in Penang, Malay is predominantly spoken, along with Hokkien and Mandarin. The researcher is fluent in English and Mandarin. For interviews

conducted in Malay and Hokkien, a locally recruited translator facilitates communication between the interviewee and the researcher.

To acknowledge and appreciate the time and effort of the respondents, a token of appreciation was provided. Upon feedback from WorldFish researchers with experience in the study site, it was recommended to offer a shopping voucher worth 50 Malaysian ringgits (equivalent to approximately 10 Euros at the time of data collection). This amount was chosen carefully to ensure that it was not too small to make participants feel their time was wasted, nor too large to encourage social desirability bias.

### **3.3 Data Analysis: Qualitative Thematic Analysis**

This study employs qualitative thematic analysis using an inductive approach to interpret textual data from interviews with small-scale fishers in Penang, Malaysia. Drawing on the principles of Grounded Theory (Glaser & Strauss, 2017), this methodology emphasizes the inductive development of theories rather than merely testing hypotheses. The process begins with the observation of specific cases, which leads to the construction of general concepts and eventually, the formulation of theories (Hodkinson, 2008). Decision-making maps, central to this analysis, were developed through an eight-step process that identified and categorized influencing factors. Figure 5 provides an overview of these data-analysis steps, illustrating each stage with concrete examples. The detailed explanations of these steps are presented below.

**Step 1: Open coding.** In this step, interview texts are meticulously disassembled into manageable segments such as sentences or phrases. Each segment is then carefully analyzed, and “sub-codes” are assigned based on its contextual relevance to specific decision-making processes relevant to a particular decision. The concept of “sub-code” employed in this study mirrors the “first-order” concepts described by Sarantakos (2005). This phase concludes once all interview texts, encompassing discussions around all seven decision types, are thoroughly examined and coded.

**Step 2: Axial coding.** Axial coding serves to synthesize the segmented data into a more coherent and integrated framework. During this stage, sub-codes that reflect common concepts or overarching themes are aggregated to form broader “codes”. This process is dynamic; as new relevant sub-codes emerge, the previously identified codes may be renamed, expanded, or divided, often necessitating multiple rounds of iteration (Karali et al., 2014). This coding step is methodically repeated for each of the seven decision categories identified in the study. By the end of this step, a comprehensive list of codes, specific to each decision type, is established, facilitating deeper analysis in subsequent phases.

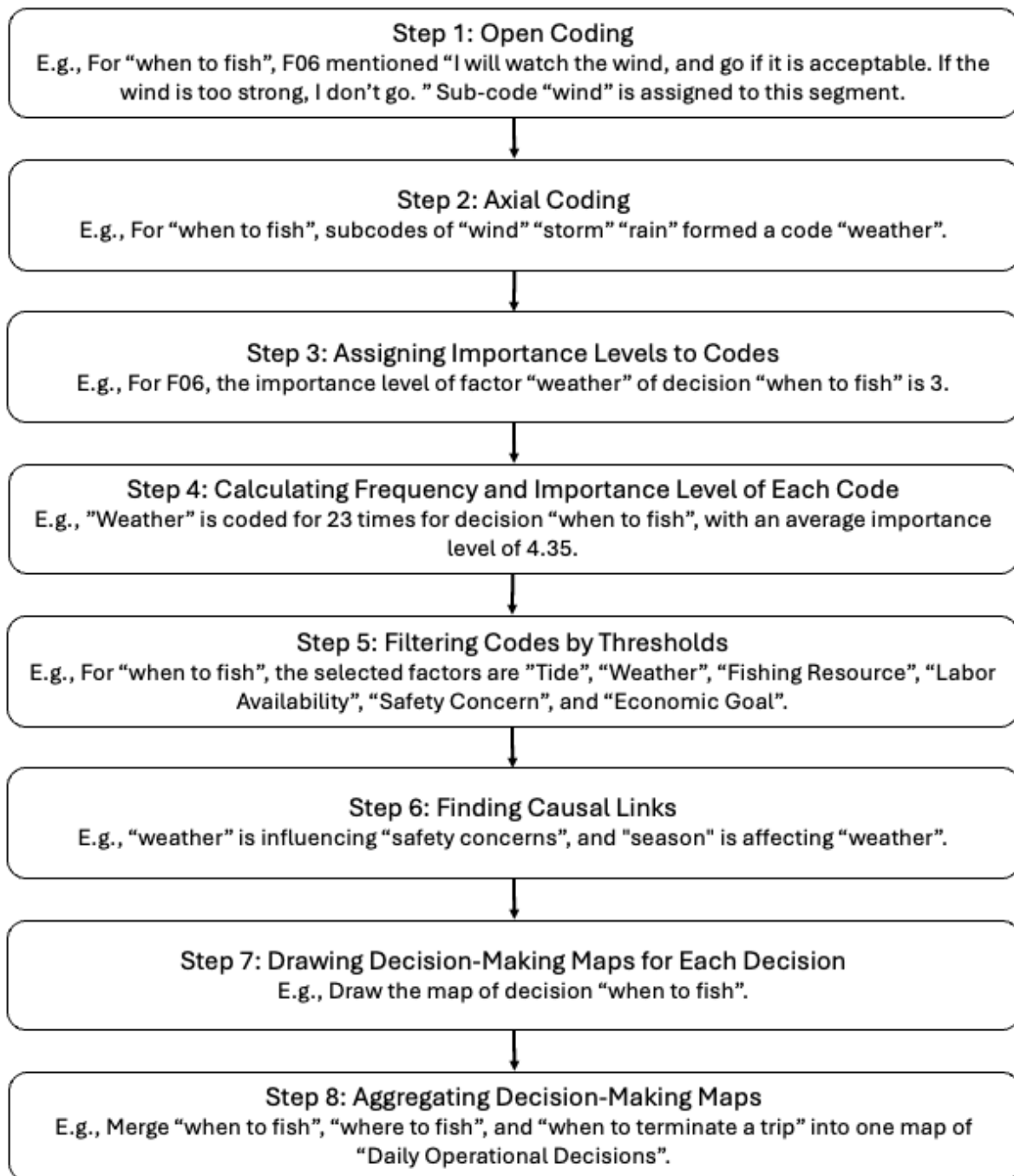


Figure 5 Data Analysis Steps

**Step 3: Assigning importance levels to codes.** Each interviewee’s response to is assessed against the identified codes for each decision, and an importance level is assigned accordingly. The importance scale ranges from 1 to 5, where 1 denotes “not important at all,” 2 signifies “of little importance,” 3 represents “of average importance,” 4 indicates “important,” and 5 stands for “very important.” If an interviewee does not mention a code, it is considered non-applicable, and thus no data is recorded for that particular code. The outcome of this process is a detailed

data sheet, where each row captures a unique dataset consisting of “interviewee, decision, code, and importance level,” totalling 935 rows.

**Step 4: Calculating frequency and importance level of each code.** The frequency of codes for each decision is calculated, and the importance level is averaged. The average importance level is determined by dividing the sum of importance levels by the frequency of mentions. For instance, the code “price” is mentioned 24 times in the context of “how to sell,” with an average importance level of 3.29. Frequency, rather than sample size, is utilized as the denominator for two reasons. First, the absence of a mention of a factor does not necessarily imply that the factor is unimportant. For instance, a fisher might simply forget to mention it. Therefore, it is inaccurate to assume that unmentioned codes are of low importance. Second, while employing frequency as the denominator can result in a higher importance level for codes that are significant to only a minority of respondents, this potential issue is systematically addressed in Step 4 by applying a frequency threshold. This approach ensures that the analysis remains balanced and reflects genuine patterns of emphasis among the participants. At the end of this step, a total of 73 codes are delineated. A comprehensive list of these codes, along with their frequencies and calculated importance levels, is included in Appendix 2.

**Step 5: Filtering codes by thresholds.** This step filters codes by established thresholds to ensure relevance and impact. Codes are retained if they meet a frequency greater than 3 and an average importance level of at least 2, ensuring they are both commonly mentioned and deemed significant by respondents. Conversely, codes with a frequency of three or less are considered to lack widespread significance, such as “lack of material,” which, was mentioned only once but with a high importance level. Similarly, codes with high frequency but low importance levels, like “knowledge & skill” for the decision of “how to fish” which has a frequency of 21 but an importance level of only 1.71, are deemed unimportant. This discrepancy often arises because these codes are pre-included in the questionnaire from prior literature review and expert interviews, not necessarily reflecting their actual importance to local fishers. By the end of this process, 41 codes are identified as “coded factors,” with a complete list available in Appendix 2 for further reference.

**Step 6: Finding causal links.** In this step, causal linkages are identified by analyzing the coded segments for each selected code. Causal coding involves highlighting specific quotes within statements to discern causal claims, which entail identifying an “influence factor” and a “consequence factor” (Powell et al., 2024). This analysis reviews all coded segments, establishing causal connections based on the context provided by the interviewees. Additionally, “explaining factors” are identified for linkages that extend beyond the selected codes. For instance, “weather” and “safety concern”, as “coded factors” identified in Step 5,

are linked, with weather influencing safety concerns; at the same time, “season” is identified as an explaining factor affecting weather.

**Step 7: Drawing decision-making maps.** Utilizing the “coded factors” from Step 5 and the causal linkages and explaining factors from Step 6, decision-making maps for each decision are constructed. These maps visually represent the causal relationships between different factors, with each categorized as social, environmental, or economic. The maps also highlight the average importance levels of the coded factors. In this step, seven decision-making maps are produced, each corresponding to one of the seven decisions analyzed in the study.

**Step 8: Aggregating decision-making maps.** Causal maps incorporating information from a variety of different sources can be combined (Powell et al., 2024). In this step, maps that share similar factors are grouped and synthesized into a comprehensive overview, ensuring that no information from the individual maps is lost. For example, decisions such as “when to fish,” “where to fish,” and “when to terminate a trip” share several common factors and emphasize “fishing resource” as a key factor, leading to their aggregation into a category named “Daily Operational Decisions.” At the same time, the variable “aggregated importance” is calculated for the shared factors from different decisions that are aggregated into the same map, by calculating the average of “average importance level”. For example, “weather” has an average importance level of 4.35 for “when to fish”, 3.46 for “where to fish”, and 3.46 for “when to terminate a trip”; its aggregated importance level for “daily operational decisions” is 3.75. The aggregated importance of all the factors is shown in Appendix 2. In the following discussion, “importance level” refers to “aggregated importance level”. This step results in the creation of three aggregated maps that succinctly summarize the seven decisions examined in this research.

The data analysis process is facilitated using Microsoft Excel and MAXQDA. MAXQDA is utilized in Steps 1, 2, and 6 to facilitate the development of the coding hierarchy and to assist in querying specific coded segments, as outlined by Guetterman & James (2023). This software enhances the systematic organization and retrieval of qualitative data. Microsoft Excel, on the other hand, is employed in Steps 3, 4, and 5 to manage the quantitative aspects of the analysis, particularly in calculating and tracking the importance levels of various codes.

## 4. Results

### 4.1 Overview

The decision-making processes of small-scale fishers in Penang, are categorized into three distinct types based on the analysis, for each a decision-making map is drawn:

- **Daily Operational Decisions:** These decisions are crucial for day-to-day fishing operations and are aggregated from the analysis of decisions regarding “when to fish”, “where to fish”, and “when to terminate a trip”. These operational decisions are directly influenced by immediate environmental, economic and social conditions.
- **Strategic Fishing and Sales Decisions:** This category encompasses decisions that affect the long-term sustainability and profitability of fishing activities. They are derived from analyzing how fishers choose fishing methods (“how to fish”) and their strategies for selling their catch (“how to sell”). These decisions often involve considerations of income, market accessibility, resilience and personal preference.
- **Community Involvement and Collective Action Decisions:** These decisions are related to the social aspects of fishing communities. They include decisions regarding “joining FA” and “joining protesting activities against coastal development”. Such decisions reflect the collective ethos and the socio-political engagement of the community, influenced by broader social and policy environments.

A list of factors is identified which is influencing decisions of small-scale fishers in Penang, whether directly or indirectly. They are categorized into:

- **Economic Factors:** A total of 15 factors, which are labor availability, economic goal, resilience, gear, saving practice, inflation, income, market accessibility, convenience, market demand, proximity, stability of income, access to loan, financial benefits and alternative livelihood.
- **Environmental Factors:** A total of 8 factors, which are fishing resource, weather, season, tide, safety concern, environmental concern, stability of catch, and fishing time.
- **Social Factors:** A total of 19 factors, which are information, social network, personal experience, record & research, habit & familiarity, coastal development, pollution, trawler intrusion, festivity, health, public expression, identity, long-term relationship, personal preference, responsibility, advocate policy change, communal reciprocity, external pressure and license.

All types of decisions are influenced by a complex interplay of economic, social, and environmental factors, showing a multi-dimensional nature of decision-making of small-scale fishers. These factors vary in importance and interact differently depending on the specific context of each fisher.

Each decision-making map includes a yellow node on the right side indicating the type of decision being explained. Other nodes represent various influencing factors: blue for environmental, orange for economic, and green for social factors. The maps also differentiate between “coded factors” and “explaining factors,” as detailed in Steps 5 and 6 of the Methodology, respectively. Dotted nodes denote explaining factors, while solid nodes indicate coded factors. Each solid node includes a number that signifies the aggregated importance level of the coded factor, as determined in Step 4 of the Methodology.

In the subsequent sections, the decision-making process of the three identified types of decision will be illustrated separately. Each section will begin with an overview of the respective decision-making map, followed by a logical grouping of the factors displayed within the map. These groupings will be further elucidated through detailed findings and illustrative examples.

## **4.2 Daily Operational Decisions**

### **4.2.1 Overview**

Figure 6 provides a detailed overview of the various factors influencing the Daily Operational Decisions made by small-scale fishers. Specifically, it includes the decisions of when to fish, where to fish, and when to terminate a trip. Environmental, economic, and social factors all play an important role in shaping the decisions, a balanced mixture. Key influences include fishing resources, previous catch, tide, personal experience, and fixed routine, with these factors generally holding greater importance compared to others.

### **4.2.2 Fishing Resource and Tide**

Fishing resources (importance level: 4.45) are a critical factor for the daily operational decisions of fishers. This significance is reflected not only in their high importance level but also in their central role connecting multiple factors. Fishers go fishing when and where there will be more catch (importance level of previous catch: 4.38). For example, the behavior of target species like pomfret, which are more active during evening and night, compelling fishers to adapt their schedules accordingly. Previous catch, influenced by fishing resources, directly impact fishers’ decisions, particularly regarding “where to fish” and “when to terminate” during a trip. A smaller catch might prompt fishers to consider changing their fishing location or returning early, while a substantial catch often leads them to extend their fishing time.

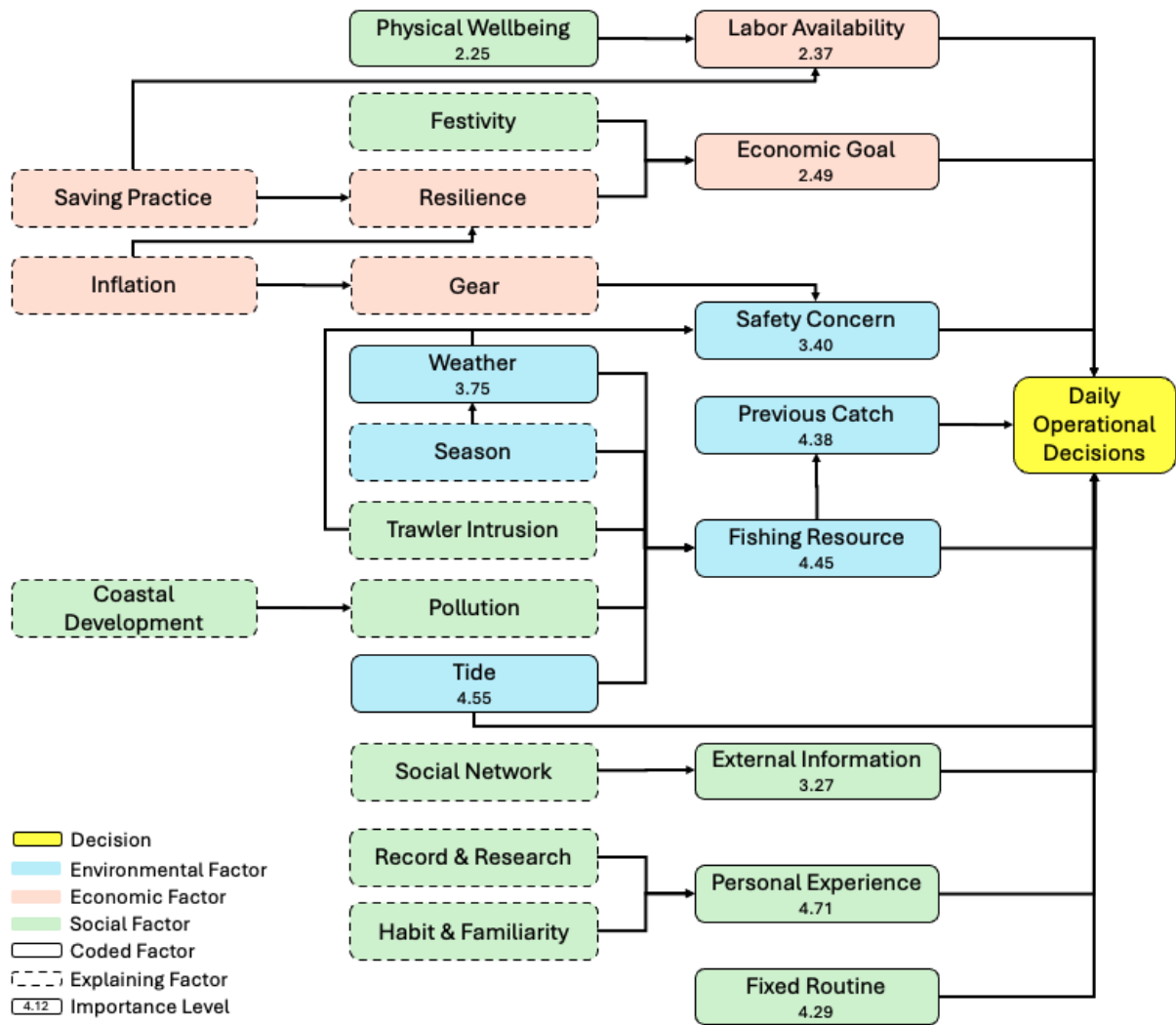


Figure 6 Decision-Making Map of Daily Operational Decisions

Fishing resources are profoundly influenced by both environmental and social factors. On the environmental front, tide (importance level: 4.55), season, and weather (importance level: 3.75), are the factors influencing fishing resources. Tides are crucial as they dictate the movement of nets and the availability of fish. For example, some fishers note that a lack of tidal movement prevents nets from capturing prawns, and high tides generally increase fish availability. Seasonal changes further influence fishing by affecting fish migration and reproductive patterns, compelling fishers to adapt their strategies throughout the year. For example, a fisher explained, “At different seasons, they (fish) will migrate... This will be like a cycle where the fish will go to this location now, then move on to the next location during the next season, then to another one, then eventually return to the original location” (F12, Pos. 57). Moreover, weather conditions directly affect the availability of certain species, such as prawns, which are less abundant in excessively hot weather, while storms can unexpectedly increase their numbers.

On the social front, the intrusion of trawlers and pollution significantly degrade the marine ecosystem. The destructive fishing practices of trawlers, harvesting not only adult but also juvenile fish, alongside their illegal encroachments, have led to the decline and migration of fish populations. These practices damage critical underwater habitats, including corals and seabed, contributing to the extinction of various marine species in certain areas (F03, Pos. 36). Furthermore, coastal development contributes to pollution that alters seabed and kills marine life, as a fisher describes the detrimental impact of construction debris falling into the sea during bridge building activities: *“During the construction of the Penang second bridge...the waste fell into the sea... This caused the seabed to be changed and damaged. The marines couldn't survive because the waste had fallen onto them and buried them”* (F12, Pos. 57).

Tide (importance level: 4.55) plays a multifaceted role in influencing fishers' decisions, impacting both fishing resources and operational logistics. While tide affects the availability of fish, dictating the best times to deploy nets for optimal catch, it also directly regulates the ability of fishers to navigate ports. In many villages, the constant flow of water throughout the day allows fishers flexibility in scheduling their trips. However, for those in specific locations, tide can severely restrict port access, dictating the times fishers can safely enter or exit. One fisher describes this constraint: *“I have to depend on the tide and avoid leaving the port during low tide so that my boat can exit. If there is no water, my boat cannot exit. I have to make sure to leave before there is no water”* (F22, Pos. 25). This dual influence of tides necessitates careful planning and timing by fishers to synchronize their activities with tidal patterns, thereby optimizing both their catch potential and their operational efficiency.

#### **4.2.3 Information, Social Network and Personal Experience**

Information derived from both external sources (importance level: 3.27) and personal experience (importance level: 4.71) is pivotal in the daily decision-making, particularly given the high unpredictability and fluctuation of catch volumes. This information includes real-time updates on weather conditions and the locations of fishing resources.

Fishers heavily rely on real-time information exchange within their personal social networks, which can take various forms: a call with close friend before departing, walkie-talkie communication during the trip, casual conversations at the jetty, regular participation in WhatsApp groups of FA, or even organized trials of fishing locations with friends. This network enables fishers to stay updated on the latest information regarding fishing resources and weather conditions, shaping their fishing plans accordingly. For instance, one fisher described this exchange by saying, *“Sometimes, we scatter all around and when we got more*

*fish from there, we would just inform each other, or else when we came back, we would compare who got more in which location”* (F20, Pos. 57).

Personal experience also significantly influences decision-making, which can be really diverse among fishers. Personal experience could stem from a fisher’s own records, research, and habitual practices, and these individual practices reflect diverse personality traits. For instance, some fishers prefer to rely on their observations to predict weather patterns, while others like to test and utilize various online forecasting tools. In terms of fishing locations, preferences can range from sticking to familiar spots to keeping detailed annual records or conducting extensive research to find the best strategies.

Although fishers generally believe they are using the most suitable methods for themselves, outcomes can vary significantly, and the difference can be bridged by social networks. For example, some fishers frequently catch more fish than their peers due to their unique approaches, making them go-to consultants within their circle. As noted by a veteran fisher, *“I have more experience. Some of the peer fishers will contact me for the information. I will give it to them”* (F09, Pos. 36).

However, perspectives on information sharing differ, reflecting the tension between cooperation and competition in accessing common-pool resources. Generous information sharing tends to occur among close friends rather than in public settings to avoid increased competition. Additionally, skepticism about the reliability of shared information exists, with some fishers experiencing deceit that leads to wasted cost, as one expressed, *“I often get misled... it wastes my fuel costs... They trick you to test a spot. If you catch something, then they will also come”* (F18, Pos. 56). This tension underscores the complex interplay of information, trust, and social networks in the decision-making processes of fishing communities.

#### **4.2.4 Safety Concern and its Multiple Causes**

Safety concern (importance level: 3.40) shapes fishers’ decisions through factors including weather (importance level: 3.75), gear, and the trawler intrusion. Firstly, adverse weather conditions can halt fishing trips altogether or force fishers to change locations or prematurely end their excursions. Secondly, trawlers pose a considerable threat, especially at night when visibility is low. This danger is articulated by a fisher who noted, *“If the trawlers didn’t turn on the lights, they might pull in everything including the boat and human into their nets and they will die in the trawl...I have to listen to the big noises made by the trawlers to locate their direction”* (F25, Pos. 27). Thirdly, while upgrading fishing gear could theoretically allow fishers to venture further and withstand harsher conditions, economic constraints limit this

option for many, with inflation worsening the difficulty. The escalating costs deter upgrades, as highlighted by one fisher's concerns about affordability and safety: "*Most of the things are also getting expensive. Boats and engine are tens of thousands. I don't think I am going to upgrade them*" (F17, Pos. 89). These factors collectively underscore the complex interplay between economic limitations and safety in shaping the operational decisions of small-scale fishers.

#### **4.2.5 Economic Goal, Labor Availability and Saving Practice**

Economic goal (importance level: 2.49) influences fishers' decisions regarding when to fish and when to terminate a trip, particularly in relation to festivity, resilience, saving practices, and inflation. Fishers often extend their fishing hours during festive periods or holidays when household expenses increase. For instance, one fisher noted, "*I will try harder when it is near Chinese New Year. It's usually festivals and holidays, when my family have more expenses*" (F15, Pos. 35). Inflation exacerbates the financial pressure on fishers, impacting their economic resilience. However, the degree of influence varies depending on the fisher's resilience level. Those with established saving habits are better cushioned against economic fluctuations; they are less affected by festive spending pressures due to their financial prudence. For example, one fisher mentioned his strategy of setting aside half of his daily earnings for emergencies and future needs, thus ensuring they are well-prepared for financial uncertainties (F20, Pos. 42).

Labor availability (importance level: 2.37) affects fishers' daily trip decisions, influenced by factors of physical well-being (importance level: 2.25) and saving practice. When a fisher or their fishing partner is in poor health, possibly due to chronic conditions or adverse weather, they may need to cancel or cut short their fishing trip. Though such instances are not frequent, and minor health issues may not necessarily prevent them from working, the impact is still notable. Additionally, personal saving practices of the crew can also affect labor availability. As one fisher expressed frustration about crew reliability, "*There are a lot of bad assistants. If they earn enough for that time, they might not want to go to the sea... This problem was frequent, but now I am lucky to have a good assistant*" (F25, Pos. 49).

#### **4.2.6 Insignificant Factors: Environmental Concern and Religious Practice**

Environmental concern (importance level: 1.12) and religious practice (importance level: 1.65) are not emphasized in the decision-making map due to their perceived low relevance by the interviewees. The fishers uniformly reported that they do not consider environmental impacts when making decisions about their fishing practices, nor do they limit their catch volumes. They believe their fishing methods are not harmful to the ecosystem and emphasize the necessity to maximize their catch due to its unpredictable nature. As one fisher explained, "*I*

will catch as much as possible because tomorrow maybe nothing... We have to seize the moment” (F07, Pos. 78). On the topic of religion, while most interviewees identified as Muslim and engage in regular prayers at sea, only minor adjustments are made to their schedules, particularly for Friday prayers which they observe at mosques. This integration of religious practice into their daily routines illustrates its normalized role in their lives without significantly influencing operational decisions.

### 4.3 Strategic Fishing and Sales Decisions

#### 4.3.1 Overview

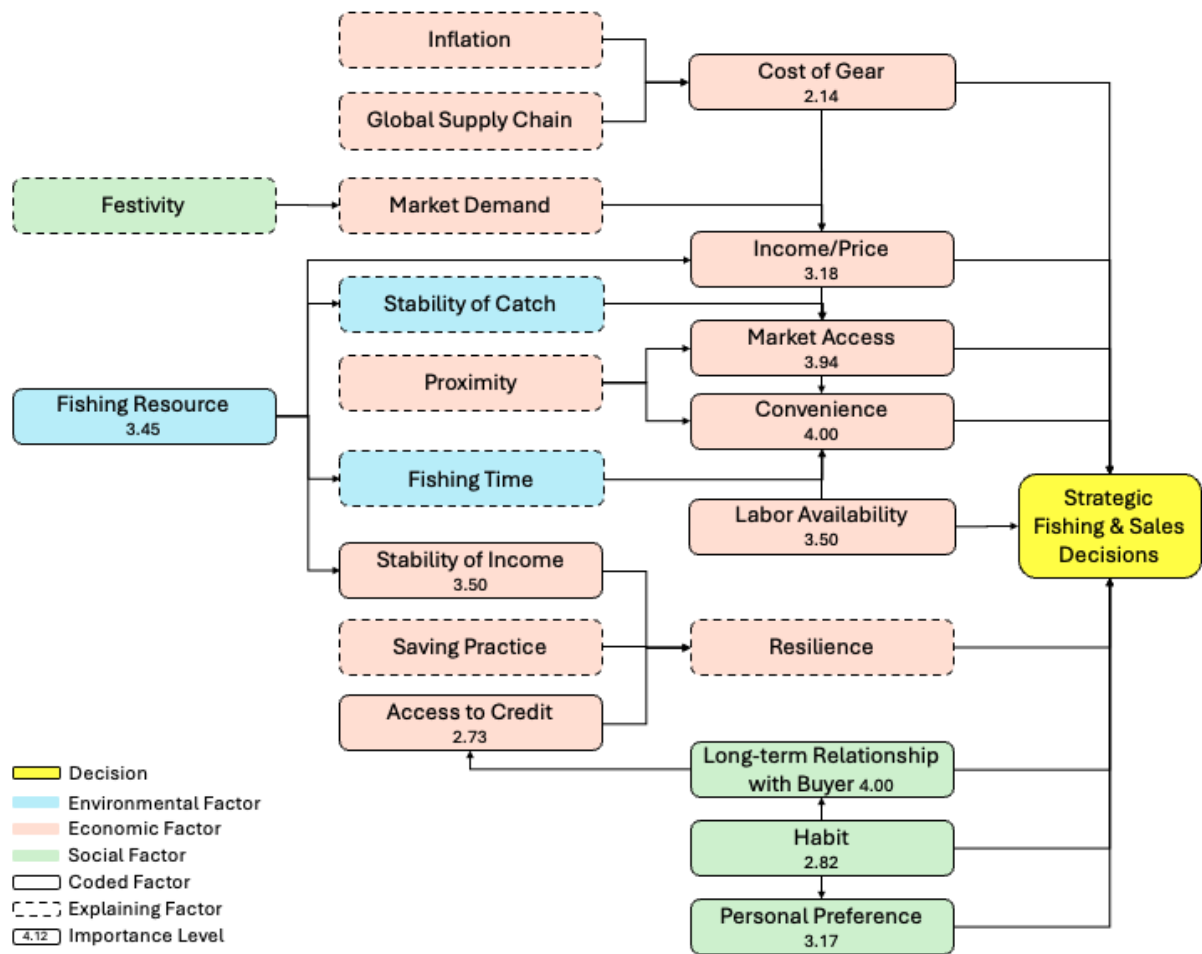


Figure 7 Decision-Making Map of Strategic Fishing and Sales Decisions

Figure 7 offers a comprehensive overview of the various factors influencing the Strategic Fishing & Sales Decisions of small-scale fishers, focusing on decisions of how to fish and how to sell their catches. Economic and social factors play a significant role, exerting a direct impact on decision-making. Additionally, while the influence of environmental factors, particularly fishing resources, are more indirect, it remains fundamental to these strategic decisions. Key

influences include convenience and long-term relationship with buyer, with these factors generally holding greater importance compared to others.

#### **4.3.2 Resilience, Income Stability and Access to Credit**

Resilience emerges as the key link between fishing and selling strategies among small-scale fishers, connecting factors of stability of income (importance level: 3.50), saving practice, and access to credit (importance level: 2.73), and long-term relationship with buyer (importance level: 4.00). Fishers must navigate various risks such as the unpredictable nature of catches, adverse weather conditions, and potential accidents.

Resilience is crucial for these fishers, some of whom prioritize stability of income over higher but less consistent earnings. For example, although pomfret catching usually gives higher income in the long-term, some fishers choose to catch prawn because it guarantees a more stable and consistent income. As a fisher described, *“I use prawn net because...prawns can be caught every day, but the fish is only caught about 15 days in a month, it depends on the season”* (F15, Pos. 81). Saving practice also plays a significant role in enhancing resilience, though not all fishers save or have sufficient savings for difficult periods.

In cases of financial urgency without available savings, obtaining a loan from buyers is a common and convenient solution for many in Penang. These loans are generally provided interest-free, with repayment structured gradually through the fishers' future catches, allowing fishers to manage cash flow without the immediate financial burden of interest. Wholesalers (private middlemen and FA) are the primary sources of such financial support. Loans from private middlemen are typically informal and founded on trust, emphasizing the importance of maintaining long-term relationships. Fishers can also seek loans from FA where available, but the process may take longer, with active members generally receiving priority. This availability of financial support plays a crucial role in the decision-making processes of fishers, particularly when selecting wholesaling buyers. Even for those who have never taken a loan, simply knowing that financial support is available provides a sense of security. Moreover, fishers often prefer selling to wholesalers rather than directly to customers, primarily due to the financial support and stability offered by wholesalers, which is typically absent in direct-to-consumer sales. For example, one fisher notes the importance of these loans in times of emergency: *“When there is an emergency, I will borrow from them... like when the engine broke down, I am most afraid when this happened because the repair will be in thousands of Ringgits”* (F25, Pos. 97). Thus, the strategic decisions regarding how to fish and sell are deeply intertwined with the fishers' ability to manage risk and ensure financial stability through resilience-building practices.

However, some fishers who avoid taking loans often hold negative views and believe them of having unfavorable impact. Some claim that while the loans are interest-free, middlemen might charge a hidden interest by offering lower prices. Fishers without loans can compare prices and change buyers, while loan will delete this freedom. As one fisher said, “*Middlemen give free loans... so you're tied to him... if he buys for the price of 35 ringgit per kilo, you can't do anything*” (F24, Pos. 102). This highlights the complexity of the financial support provided by wholesalers, which will be further discussed in section 5.1.

#### **4.3.3 Price, Income, and Long-Term Relationship with Buyer**

Long-term relationships (importance level: 4.00) between fishers and wholesale buyers are highly valued and involve more than just financial transactions such as loans. Fishers often remain loyal to a single buyer for extended periods, sometimes lasting over 20 years, fostering a deep sense of trust and integrating each other into their local social networks. This stability is crucial; fishers are generally hesitant to switch buyers due to trust issues and concerns about long-term business viability. For instance, one fisher expressed, “*If you ask me to sell to another one, I don't know if he is a good person*” (F18, Pos. 101), while another highlighted the risks of changing buyers: “*If I sell to other people, they might give many profits, but maybe one day they don't want to buy anymore. Then if we decide to come back to the FA, but the FA might not want us anymore*” (F14, Pos. 106). Additionally, some local FA offer extra benefits, like annual bonus and benefits for children education, further cementing this relationship. These dynamics illustrate the importance of long-term relationships for small-scale fishers, emphasizing how it goes beyond mere transactions to include significant social and community elements.

However, higher income (importance level: 3.18) and better business relationship do not always stand on the same side, and diverse strategies are applied by fishers to navigate the complexities of price, income, and business relationship. On one end of the spectrum, certain fishers are highly income-driven, continually seeking out the highest paying markets. For example, one fisher stated, “*Threadfin fish price in my village is lower. So even though the distance to the next village is more, I sell to them*” (F25, Pos. 111). Conversely, other fishers value the security and reliability of consistent buyers over fluctuating market prices. These fishers are willing to accept lower prices for the benefit of long-term security, as illustrated by another fisher: “*I just accept even though the price is quite low, but it doesn't matter to me. Because when there is no income, they will help me*” (F16, Pos. 89). Meanwhile, a middle ground is sought by some fishers who attempt to balance income optimization with maintaining strong buyer relationships. These fishers engage in negotiations to try to secure better prices while remaining loyal to their buyers.

#### 4.3.4 Cost of Gear and its Causes

The cost of gear (importance level: 2.14) plays a minor role in fishers' decision-making. Some fishers are unable to upgrade their equipment due to high costs, preventing them from utilizing beneficial tools like GPS. For instance, prawn nets are more expensive than other types of nets, affecting fishers' profits and influencing their choice of fishing methods. However, this factor shows relatively low importance as net prices have a limited impact on overall profit.

Indirect factors such as inflation and the global supply chain also affect gear costs. The rising prices of engines, nets, and living expenses reduce fishers' affordability. Notably, the global supply chain significantly impacts prices, as most fishing nets are imported from Thailand, leading to price fluctuations. A fisher highlighted this issue, stating, *"...the price of the nets is being monopolized by the merchants... There are no factories in Malaysia producing the nets. They are mostly made in Thailand. We couldn't buy directly from the factory since the factory already signed agreements to sell only to their agents in Malaysia"* (F22, Pos. 78). Therefore, both the structure of the global supply chain and inflation influence gear costs.

#### 4.3.5 Market Access and Convenience

Fishers' decisions on how to sell their catch are intricately linked to market access (importance level: 3.94) and convenience (importance level: 4.00), influenced by a variety of factors such as the stability of catches, fishing time, labor availability, proximity to markets, and fluctuating market demand.

Firstly, due to the unpredictable nature of fishing, the types and quantities of fish caught can vary daily, making it challenging to consistently meet the specific demands of direct customers. Wholesalers alleviate this issue by purchasing all types of catch from fishers, providing a stable outlet for their goods. For instance, one fisher noted, *"FA make it convenient. If I sell to other people, they might not buy everything from us. So, I will have to continue selling by myself"* (F14, Pos 50).

Secondly, fishing times can be highly irregular, often ending at late hours when most markets are closed. Wholesalers accommodate these schedules, enabling fishers to sell their catch immediately upon return regardless of the time.

Thirdly, after a long day at sea and maintaining their gear, fishers are typically exhausted and prefer rest over traveling to markets to negotiate with customers. Some fishers, supported by family members, manage to sell directly to customers despite these challenges.

Fourthly, proximity to markets significantly influences selling strategies. In areas close to cities, fishers often sell directly to nearby restaurants, unless their catch volume exceeds what these

establishments can handle. Stability in catch type, such as consistently catching crabs, also aids in establishing regular buying relationships.

Lastly, seasonal fluctuations in market demand, such as during the Chinese New Year when demand and prices for seafood soar, occasionally prompt fishers to sell directly to consumers. However, these instances are relatively minor compared to their overall catch volume, and most fishers rely on wholesalers for the bulk of their sales, valuing the convenience and reliability they offer.

#### **4.3.6 Habit and Personal Preference**

Habit (importance level: 2.82) and personal preference (importance level: 3.17) play essential roles in defining the fishing and selling strategies, reflecting a deep interconnection between personal history, lifestyle choices, and professional practices. Many fishers inherit their fishing methods from previous generations, fostering strong habits that shape their approach to fishing. This traditional influence often extends to their business relationships, with many fishers choosing to consistently sell to the same buyers with whom they have developed trust over time. Personal preferences also significantly impact how fishers decide on their fishing strategies. These preferences might be shaped by long-standing habits, specific time preferences, or favored fishing methods. For instance, some fishers prefer fishing for pomfret because it allows them to work at cooler times of the night. Personal comfort and interests influence the choice of fish and method, as one fisher expressed: “*You must have interest in what you like to use*” (F01, Pos. 88).

#### **4.3.7 Insignificant Factors: Knowledge & Skills**

Knowledge and skills (importance level: 1.68) are not included in the decision-making map as the majority of interviewees perceived them to have low relevance. Most fishers regard the acquisition of various fishing methods and marketing skills as straightforward, viewing these skills as non-constraining factors in their decision-making process. Nevertheless, a minority of fishers acknowledge that their specific research and advanced marketing skills contribute to their greater success compared to others.

## 4.4 Community Involvement and Collective Action Decisions

### 4.4.1 Overview

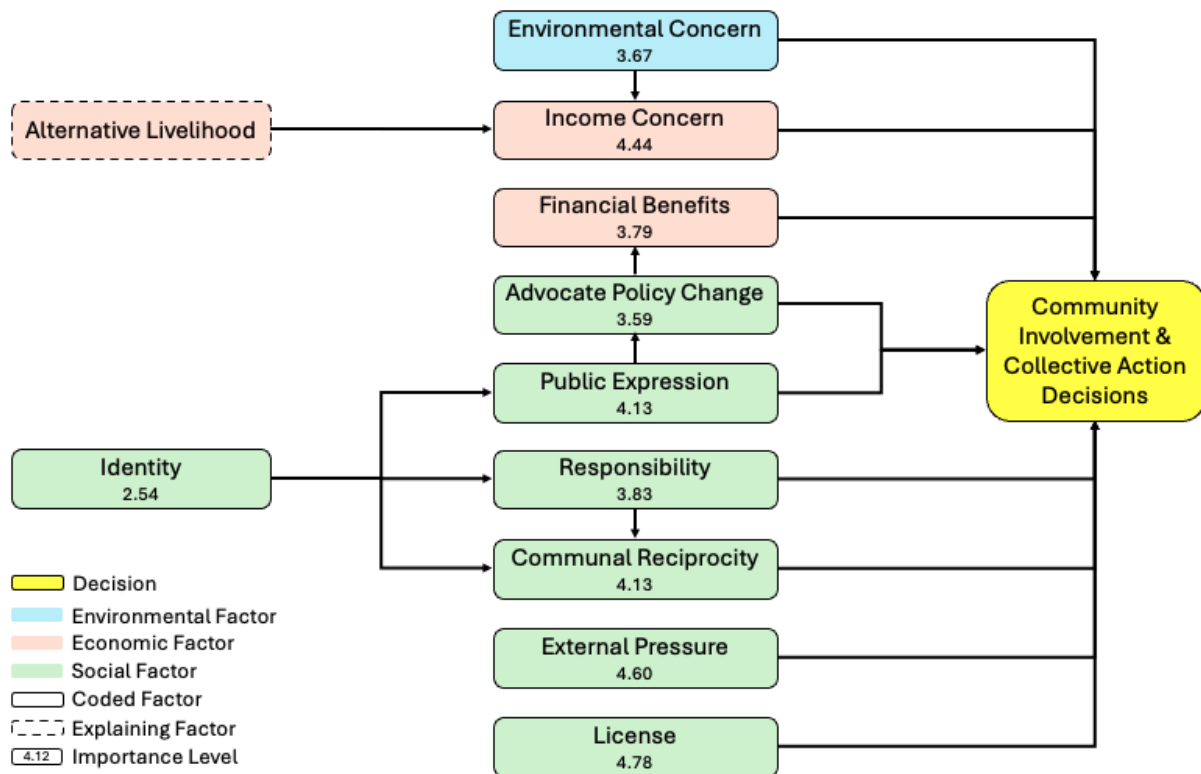


Figure 8 Decision-making Map of Community Involvement & Collective Action Decisions

Figure 8 offers a comprehensive overview of the factors influencing the Community Involvement & Collective Action Decisions of small-scale fishers, focusing on decisions of joining FA and joining protesting activities against coastal development. The map demonstrates that social factors are predominant in guiding these actions, reflecting the importance of community dynamics and personal identities in shaping these decisions. Meanwhile, environmental and economic factors are intricately intertwined and also play critical roles in shaping the decisions. Key influences include income concern, public expression, communal reciprocity, license, and external pressure, with these factors generally holding greater importance compared to others.

### 4.4.2 Environmental Concern and Income Concern

Fishers' environmental (importance level: 3.67) and income concerns (importance level: 4.44) are deeply interconnected, significantly motivating their active engagement in community activities. There is a prevailing belief among fishers that land reclamation adversely affects the ecosystem by altering the seabed and polluting the water, insights gained from prior experiences with coastal development projects. Additional information sources include their

own research and educational sessions organized by FA. For instance, one fisher reflected, “*I joined because I love our village. Since the project started, I can see a difference. When I was young as a teenager, I saw a lot of fishes. Now...fishes have reduced*” (F22, Pos. 113). The impact on fishers’ income is not solely due to ecological changes; it also includes gear damage and heightened competition. In some cases, their nets are destroyed by improperly disposed waste from reclamation projects. Fishers near such projects often face direct impacts, compelling some to travel further for fishing, which inadvertently increases competition in other areas.

Conversely, when environmental and income concerns are weak, fishers tend to show less interest in community involvement and collective actions. A minority opinion suggests that coastal development might eventually lead to environmental improvements, citing a specific example: “*We should look forward, after the projects, the sea might get better...In Gurney, when it was developing, the fishers objected. However, now there are more prawns, and many people enjoy the facilities*” (F12, Pos. 151). Additionally, when alternative livelihoods are available, such as part-time jobs or personal businesses—though not widespread—fishers exhibit less income concern, resulting in decreased participation in communal activities.

#### **4.4.3 Advocating Policy Change and Financial Benefits**

Advocating policy change (importance level: 3.59) is a significant factor influencing fishers’ decisions to participate in collective actions. On one hand, some fishers are motivated by the belief that their involvement can lead to impactful outcomes, as their voices are heard, and policymakers are prompted to reconsider their decisions. This belief is reinforced by past experiences where collective action by fishers led to the postponement or scaling down of reclamation projects, demonstrating the effectiveness of their efforts. On the other hand, a sense of disillusionment can deter participation when fishers perceive that their efforts are futile. This sentiment is captured by a fisher who shared, “*I joined before; however, I stopped going because I am frustrated...I feel that the government makes the decisions for all the activities...the result is the same*” (F01, Pos. 143). This feeling of frustration and perceived ineffectiveness can lead to decreased engagement in collective actions.

Financial incentives (importance level: 3.79) also play a role in motivating fishers to join communal activities. In the context of protests against reclamation, some fishers participate with the hope of receiving compensation from the government. Additionally, joining FA is appealing because of the monthly allowances and petrol compensation. This dual motivation—both ideological and financial—shapes the landscape of fishers’ participation in collective and communal activities.

#### **4.4.4 Identity, Responsibility, Communal Reciprocity and Public Expression**

Public expression (importance level: 4.13), responsibility (importance level: 3.83), and communal reciprocity (importance level: 4.13) significantly influence fishers' decisions, all deeply rooted in their identity (importance level: 2.54). Some fishers participate in protests to represent the collective voice of all small-scale fishers, which they feel is often overlooked in public discourse. For instance, one fisher expressed, *"I don't go to join the activity for my own purpose, but I join to represent all the fishers in Penang. I can feel that the upper ranks look down on the fishers...they neglected the fishers. We helped the fishing sector a lot, but this is what they do to us"* (F17, Pos. 128). Some fishers think it is a natural responsibility to join the activities as fishers, while the result doesn't really matter, as said here, *"Even though there is a win or loss, I still do what I must do, because I am a fisherman"* (F20, Pos. 137). This ingrained sense of responsibility also prompts the communal reciprocity within SSF community, even though some activities are not directly impacting them. During protests against reclamation, for example, the strong sense of solidarity is evident: *"Because the fishers are united, we should help each other"* (F16, Pos. 121). Similarly, when joining FA, fishers see these organizations as crucial support networks they can rely on in times of need.

#### **4.4.5 External Pressure and License**

The decisions to engage in community involvement and collective actions are not always made freely by fishers; they can sometimes be the result of external pressure (importance level: 4.60). For instance, joining FA is often a necessity rather than a choice, as membership is required to obtain fishing licenses (importance level: 4.78) and qualify for subsidies. Similarly, participation in protests against coastal development projects is sometimes coerced by local FA. Fishers who depend on their FA for licenses and financial benefits may feel compelled to participate in these activities to preserve their long-term relationships within the association. The fear of standing out or opposing the majority is a significant concern, leading to reluctant compliance. One fisher described this pressure, stating, *"They want to protest, okay, I follow... I cannot be a one-man show or else I will be kicked out of the association"* (F24, Pos. 145).

#### **4.4.6 Insignificant Factors: Time and Financial Constraints**

Time (importance level: 1.52) and financial constraints (importance level: 1.40) are considered relatively minor factors in the decision-making process regarding participation in reclamation protests. Fishers often place greater importance on other discussed factors and are typically willing to sacrifice both time and money to support these causes. Furthermore, the FA, which organizes these protests, takes active measures to schedule these events at convenient times and ensure ease of participation for all members to facilitate broader involvement.

## 5. Discussion

### 5.1 The Vicious Circle of Resilience

Unpredictability is a common theme for both the earnings and expenses of fishers, settling them in a vicious circle of resilience, especially when saving practices and credit access are scarce.

The earnings and expenses of fishers are fluctuating and unpredictable. On the income side, fishers' income is highly unstable due to the inherent unpredictability of fishing. Fishing resources are influenced by multiple factors, making fishing a matter of luck. Even though experience, knowledge, and information can increase the chance of catching more fish, each trip is still a gamble, with the possibility of returning empty-handed. As highlighted by a fisher, *"tomorrow maybe nothing (to catch) ... We have to seize the moment"* (F07, Pos. 78). This unpredictability is amplified by risks such as storms, engine failures, or intruding trawlers. On the expense side, daily expenses occur regardless of whether there is a catch, and periodic expenses such as festivities and accidents add to the burden. For example, engine failures are common and costly.

To mitigate this unpredictability, fishers adopt two stability-focused strategies: choosing fishing methods that offer more stable income and turning to their buyers for financial support. For instance, pomfret fishing is dependent on the tide schedule, allowing for fishing only around 15-20 days a month during locally called "high tide" periods. Conversely, prawn fishing is less tide-dependent, allowing fishers to fish almost daily. Some fishers opt for prawn fishing for its stable income, as an interviewee mentioned, *"I prefer my current net because I will always catch something for the day"* (F01, Pos. 85). Fishers also maintain long-term relationships with their buyers to secure interest-free loans during financial difficulties. In the SSF in Penang, buyers, whether private middlemen or FA, commonly provide loans to regular suppliers. For example, if a fisher's engine breaks down, they can request an interest-free loan from their regular middleman, to be repaid through future catches.

Unfortunately, both strategies do not guarantee the highest income in the long term. Choosing stable fishing methods may not be the most profitable, preventing fishers from accumulating savings. As highlighted by a fisher, *"actually you can earn more if you catch fish, but prawn at least you get something every day"* (F15, Pos. 81). Relying on buyers for financial support limits fishers' ability to explore more lucrative sales channels, forcing them to stick with existing buyers regardless of profitability. Fishers' opinions on taking loans from wholesalers are polarized. Those who receive loans or hope to obtain them often express satisfaction and

gratitude. Eight out of 13 fishers who sell to private middlemen rated their buyers as “satisfied” or “very satisfied,” citing credit availability as a key factor. Conversely, fishers who avoid taking credit or sell directly to customers often hold negative views. Some claim that while the loans are interest-free, middlemen might offer lower prices for future catches, effectively charging a hidden interest. Fishers without loans can compare prices and switch buyers more freely. As one fisher said, “*Middlemen give free loans... so you’re tied to him. Make sure don’t take loan from them... if he buys for the price of 35 ringgit per kilo, you can’t do anything*” (F24, Pos. 102). Similar conclusions are found in Africa, where SME heavily rely on informal sources of credit, which often have unfavorable terms and conditions (Kleih et al., 2013).

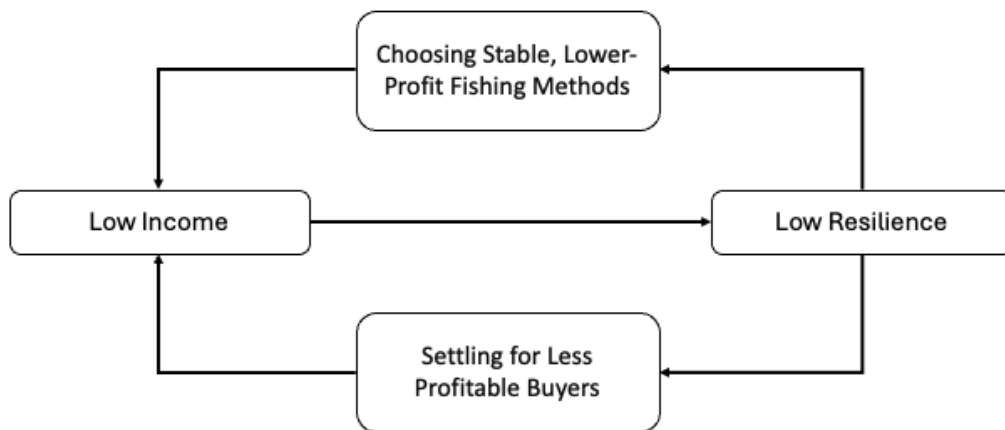


Figure 9 The Vicious Circle of Resilience

Therefore, both fishing and selling strategies trap fishers in a vicious circle of resilience (Figure 9). They face daily expenses with highly unstable income, compounded by various risks. These factors push fishers to adopt stability-focused strategies that perpetuate long-term financial vulnerability.

This vicious circle is sustained by the lack of saving practices and limited credit access, creating a fragile financial environment. Savings are uncommon among local fishers, as reported by interviewees. Some spend all their earnings quickly or stop fishing temporarily once they have enough money. The lack of saving habits and financial management skills is also noted by local fishers, “*We have to manage our finance... I felt that many fishers don’t have the awareness to do saving*” (F17, Pos. 36). Studies in various places have shown that the lack of saving prevents smallholders from investing in productivity and harms their ability to manage risks (Batista & Vicente, 2020; Myeni et al., 2019; Shiferaw et al., 2009). In times when everything operates smoothly, fishers manage to make ends meet, but unavoidable risks can quickly escalate into crises due to the absence of savings and difficulty accessing credit. Poor access to credit is one of the major constraints to the development of SME (Abera et al., 2020; Kleih et al., 2013). In Penang, FA provides credit, but it is limited in scope and accessibility. Not every fishing village

has an FA branch, creating geographic barriers. FA loans must be used for fishery-related purposes, and the administrative process can be lengthy. Additionally, the amount of financial aid available from the FA is limited. Savings are essential for the long-term sustainability of small-scale farms (Mizik, 2021).

To shift to a positive cycle, the opportunity may lie in enhancing financial resilience through improved financial literacy and enhancing accessible financial support. Financial literacy training can improve the financial attitudes and behaviours of smallholder farmers, enabling better risk management (Gaurav et al., 2011; Ntakyo et al., 2021; Sayinzoga et al., 2016). Kleih et al. (2013) found that traditional financial instruments often fail to meet the financial needs of SME in the fisheries sector, highlighting the necessity for innovative financial models to bridge the gap between traditional banking and grant-based donor finance. With these improvements, fishers will be better prepared to adjust their fishing and sales strategies, and therefore increase income and build greater resilience.

## **5.2 Perception of Government and Public Participation**

Government is deeply involved in various aspects of fishers' lives, mutual interactions. Gov permitting licenses; offering monthly allowance and petrol subsidy; policy and regulations; fishers report illegal trawlers intruding Zone A and relying on the government to kick them out; government progressing coastal development projects and fishers make their voice and reaction, hoping for changes and compensation etc.

However, satisfaction with the government is low, with an average rating of 2.52 on a 1-5 scale, which is the lowest among other entities like private middlemen (3.31), FA (3.84), NGOs (4.27), peer fishers (4.32), and customers (4.50). Only 7 out of 25 participants gave a positive rating to the government, while 18 participants rated it neutral or negative, with 9 rating it as "very dissatisfied."

Several reasons contribute to this low satisfaction. Firstly, fishers feel neglected in local development priorities. One fisher stated, "*In Penang, the government is focusing to earn money only and abandon the fishers. For example, in this area, we can see better facilities prepared for the tourism instead of for the fishers*" (F04, Pos. 159). Secondly, inflation increases both fishing-related expenses and living expenses. While petrol subsidies receive positive feedback, other expenses are heavily impacted by inflation. A lack of government effort in controlling inflation is perceived, as fishers complain, "*The price of everything is increasing. They (government) are not doing anything about it*" (F01, Pos. 159). Additionally, fishers criticize the government's low efficiency in stopping trawler intrusions, suspecting corruption when police do not arrive in time.

In this study, the most frequently cited reason for the fishers' feeling of neglect is a major focus, as it has become a significant motivator for their participation in protests regarding coastal development. To understand this motivation, it is essential to differentiate between "advocating policy change" and "public expression." Both are crucial factors influencing fishers' decisions to join protests against coastal development.

Fishers who advocate for policy change participate in protests because they hope their involvement will lead to tangible changes and make a difference. When they believe their efforts might result in policy adjustments or improvements, they are motivated to engage actively. Conversely, if fishers become disillusioned and realize their participation is unlikely to bring about any change, they may withdraw from the protests. As one fisher explained, "*I joined however I stopped because I am frustrated about the result... the government are the ones that make all decisions*" (F01, Pos. 130). This statement underscores the frustration and helplessness that can lead to disengagement.

On the other hand, fishers who participate for "public expression" do so regardless of the expected outcomes. Even if they are pessimistic about the results, they view protests as an opportunity for public participation and a platform to voice their concerns as fishers. For instance, a fisher noted, "*I'm quite sure that... the government will continue (the coastal development projects), but from my point of view, I join because I want the voice to be heard*" (F16, Pos. 136). This sentiment highlights a fundamental need for recognition and the desire to be heard, even in the face of likely government inaction.

This desire for public participation is deeply rooted in the feeling of being neglected. Fishers who feel excluded from public decision-making processes now seek to assert their existence and express their opinions. They want to draw attention to their plight and ensure their voices are acknowledged. One fisher articulated this sentiment, saying, "*I join to represent all the fishers in Penang. I can feel that the upper ranks will look down on the fishers... I feel that they neglected the fishers... They didn't consider our income*" (F17, Pos. 128). Another fisher echoed this feeling of marginalization, stating, "*This project is approved by the government, but we are just doing it as this is our job as a fisherman*" (F20, Pos. 137). In short, whether driven by the hope for policy change or the need for public expression, fishers' participation in protests is a response to their perceived marginalization and a desire to assert their identity and rights in the face of governmental and societal oversight.

The fishers' low satisfaction with the government and their subsequent participation in protests underscore the critical need for more inclusive and responsive governance. Building effective governance structure in SSF communities requires inclusive stakeholder involvement,

community engagement, partnerships as well as state support (Eriksson et al., 2015; Freed et al., 2016). Addressing the root causes of fishers' dissatisfaction requires a concerted effort from policymakers to engage more directly with the fishing community. By fostering transparent communication channels, implementing policies that reflect the actual needs of fishers, the government can rebuild trust and support among fishers (Freed et al., 2016). Ultimately, recognizing and validating the fishers' voices and contributions will not only improve their satisfaction but also enhance their overall participation in sustainable development initiatives.

### **5.3 Decision-Making and Local Context**

The decision-making process of small-scale fishers in Penang is deeply intertwined with the local context, encompassing social, economic, and environmental factors.

Local social context posed significant impact on the decision-making of small-scale fishers, particularly by FA, community networks, government policies, and cultural practices. Firstly, FA play a crucial role in providing institutional support, are crucial in facilitating licenses, subsidies, and fair market access for fishers, acting as intermediaries between the government and fishers, which influences various aspects of the decision-making of fishers. Secondly, fishers rely on social networks for vital information on fishing techniques, locations, and weather conditions. These networks, built on trust and long-term relationships, are essential for operational decisions and underscore the value of social capital in fisheries. Thirdly, government policies on marine management and environmental regulations significantly affect fishers' operational and strategic decisions. Issues such as coastal reclamation and pollution directly influence where and how fishers operate, compelling them to engage in public advocacy and adjust their livelihood strategies. Additionally, cultural and religious practices significantly impact fishing activities. For instance, Muslim fishers adjust their schedules for Friday prayers, and events like Chinese New Year influence market demands, affecting economic decisions across the fishing community.

The economic context shapes the decision-making processes of small-scale fishers in Penang through local practices, national economic conditions, and global economic factors. A "vicious circle of resilience," characterized by local saving practices, credit access, and market channel choices, is embedded within the broader cultural and economic fabric of the community, influencing both day-to-day fishing operations and broader sales strategies. On a national scale, macroeconomic factors like inflation significantly affect the cost of essential fishing gear and overall living expenses. This economic pressure limits fishers' capacity to invest in improved equipment and build savings, hindering their financial stability and operational efficiency. Furthermore, the global supply chain dynamics affect local economic conditions, particularly

in the pricing of fishing gear, most of which, like nets, are imported from Thailand. The dependency on these imports subjects local prices to the fluctuations of the global market and currency exchange rates, adding an additional layer of economic unpredictability. This global economic linkage further complicates fishers' daily decisions and long-term planning, thus reinforcing the challenges within the vicious circle of resilience.

Environmental factors affecting small-scale fishers in Penang are shaped by both local and global influences. Locally, environmental variables like fishing resources, tides, specific locations, and weather conditions are deeply interlinked with local ecosystem, varying from village to village and making each fishing scenario unique. Moreover, the sustainability of fish stocks is impacted by local social and economic activities, including coastal reclamation, pollution, and trawler operations. Globally, climate change and the continuous decrease of fishing resources have exacerbated the challenges faced by small-scale fishers in Penang. Fishery resources have continued to decline due to overfishing, pollution, poor management, and other factors (FAO, 2022). Although not all fishers are aware of climate change, they frequently complain about the increased unpredictability of the weather. These large-scale drivers heighten the vulnerability of fishers, highlighting the urgent need to promote resilience and adaptive capacity (Aguilera et al., 2015; Defeo et al., 2013). It is essential to consider climate stressors in fisheries and aquaculture management by connecting adaptation plans with management or development actions, incorporating local and context-specific indicators (FAO, 2022).

The three aspects, social, economic, and environmental, are profoundly interconnected, with various local actors playing crucial roles. Changes in one domain, such as economic inflation or environmental degradation, can ripple through social and political spheres, affecting every aspect of a fisher's life from daily income to engagement in community activism. For instance, market access and convenience are highly dependent on buyer availability, especially during Chinese New Year when fishers face a dual scenario: in some villages, private wholesalers who are celebrating Chinese New Year are unavailable, leading some fishers to not fish, versus in some other villages with available sales channel, increased market demand drives higher fish prices, motivating others to fish more. Economically, factors like inflation and coastal development not only threaten fishing livelihoods but also fuel dissatisfaction with the government, further driving fishers towards political participation. This intricate interplay involves key actors such as the government, FA, private wholesalers, trawlers, and customers, each impacting the dynamics within the fishing community.

Understanding the local context is crucial for effectively addressing the challenges in SSF. As highlighted by Giron - Nava et al. (2021), strategies to support the well-being of fishers and the sustainability of fisheries must integrate a wide set of perspectives, disciplines and institutions. By paying attention to the linkages and the roles various local actors play, stakeholders can develop more integrated strategies ensuring that interventions are socially appropriate, economically viable and environmentally sustainable.

## **6. Conclusion**

### **6.1 Summary of Findings**

This study aimed to understand the decision-making processes of small-scale fishers in Penang, Malaysia, with a focus on understanding the factors that influence their choices in daily operations, strategic fishing and sales decisions, and community involvement. By conducting an in-depth case study, this study provides insights into the multifaceted nature of decision-making within SSF and highlights the interplay of economic, social, and environmental factors. Specifically, the three research questions are answered as below.

Seven decisions of small-scale fishers in Penang are identified, including “when to fish,” “where to fish,” “when to terminate a trip,” “how to fish,” “how to sell,” “joining FA,” and “joining protests against coastal development projects.” Based on the similarity of their influencing factors, these decisions are categorized into three main types: daily operational decisions, strategic fishing and sales decisions, and community involvement and collective action decisions.

Daily operational decisions, such as when and where to fish, are heavily influenced by environmental conditions like fishing resources, tides, weather, and seasonal changes. Fishers also rely on their social networks and personal experiences to gather real-time information about fishing conditions, helping them adapt to the dynamic marine environment. Strategic fishing and sales decisions are primarily shaped by the economic factors including income, financial stability and market access. Fishers often choose methods that provide consistent income and maintain strong ties with buyers to secure interest-free loans and reliable markets for their catch, protecting them from the unpredictable nature of fishing, although some fishers prioritize higher income at the cost of extra effort and risks. Community involvement and collective action decisions are strongly influenced by social identity, public expression, and external pressures. Fishers participate in protests against coastal development driven by a sense of responsibility, communal reciprocity, and the need to voice their concerns as a marginalized community. External pressures from FA, the necessity of obtaining fishing licenses, and financial incentives such as subsidies also impact their decisions to engage in community activities.

The interplay of economic, social, and environmental factors within the local context significantly shapes the decisions. Economically, factors such as income stability, access to credit, and market convenience play crucial roles. Socially, the influence of community networks, institutions, policies and cultural practices are predominant. Environmentally, the

availability of fishing resources, weather conditions, and the impact of coastal development are key considerations. These factors are reflected on both local-level and macro-level: local-level factors such as social networks and FA; macro-level drivers such as inflation, international trade, and climate change. These factors are deeply intertwined with the context of the case, highlighting the complexity and multi-dimensional nature of the decision-making processes, and emphasizing the need of integrated support strategies. Understanding these nuanced interactions is essential for developing tailored interventions that support the sustainability and resilience of SSF in Penang.

Moreover, the discussion section highlights two critical themes that emerged from the research: the vicious circle of resilience and the perception of government and public participation. Fishers' fluctuating and unpredictable financial situations force them to adopt stability-focused strategies, which trap fishers in financial vulnerability, underscoring the need for improved financial literacy and accessible financial support to break this cycle and enhance economic stability. Fishers generally feel neglected by the government, and this dissatisfaction drives their participation in community protests, seeking recognition and validation of their concerns. Effective governance requires direct engagement with the fishing community, transparent communication, and policies that reflect fishers' actual needs.

## **6.2 Policy Implications**

The findings from this study have significant implications for policy development aimed at supporting small-scale fishers in Penang and similar contexts. The decision-making processes are influenced by a complex interplay of various factors, which must be considered in policy formulation. To address these complexities, several key policy recommendations emerge.

Enhancing financial literacy and access to credit is crucial. Small-scale fishers often rely on informal credit sources that can entrap them in cycles of debt and dependency. Implementing tailored financial literacy programs and expanding access to credit can help mitigate fishers' reliance on buyers, thus fostering greater financial stability and independence.

Fostering an inclusive policy-making process is essential. Engaging fishers in the decision-making processes that affect their livelihoods can lead to more effective and accepted policies. This includes involving fishers in the planning and implementation of coastal development projects by adequate communication to mitigate negative impacts on fishing resources and community well-being.

Strengthening community-based organizations like FA and ensuring they have adequate resources can significantly enhance their effectiveness. By providing integrated support to

fishers, such as capacity building, collective bargaining, resource sharing, and advocacy. FA can lead to a more resilient and empowered fishing community.

At a broader level, this study provides a blueprint for how future development interventions can conduct baseline studies to understand how decision-making processes currently work and what the influencing factors are at the community level. For WorldFish and other research institutions and development agencies, this knowledge can be utilized to inform program designs and policy recommendations, ensuring interventions are tailored and locally relevant to SSF communities. By understanding the specific needs and contexts of these communities, interventions can be more targeted and impactful.

### **6.3 Limitations and Future Research Directions**

There are several limitations that should be acknowledged. Firstly, although the findings highlight the various actors involved, such as buyers, trawlers, customers, and government, their voices are absent, particularly those of government officials. The inability to secure interviews with government representatives restricted the study's ability to gain a comprehensive understanding of the policy perspective, including the rationale and process behind policy decisions. Including perspectives from various stakeholders would provide a more holistic view of the external influences on fishers' livelihoods and operations. Secondly, the study relies heavily on qualitative data obtained through interviews with the fishers themselves. While this approach provides detailed insights into the personal perceptions, it also introduces potential biases such as recall bias and social desirability bias, which can affect the reliability and validity of the findings. The qualitative nature of the data also means that it is largely interpretive and subjective, limiting the objectivity of the conclusions drawn. Moreover, given the linguistic diversity in Penang, the use of translators may introduce inaccuracies or misunderstandings. Translators, despite their best efforts, might misinterpret nuances or fail to convey the full context of the fishers' responses. This issue is particularly pertinent given that subtle differences in language can affect the interpretation of qualitative data. Ensuring accurate and culturally sensitive translations and interpretation is challenging, and potential lapses can impact the fidelity of the findings.

Future research on the decision-making processes of small-scale fishers in Penang should incorporate several key directions to build a more comprehensive understanding. First, quantitative studies are essential to quantify the impact of specific factors on fishers' decisions. Conducting surveys with larger sample sizes and employing statistical analyses can help validate qualitative insights, build robust decision-making models, and provide more generalizable results. Second, incorporating the perspectives of a broader range of stakeholders,

such as buyers, customers, and government officials, can offer a more holistic view of the external influences on fishers' decision-making processes. Additionally, more focused studies on the nuanced impact of factors such as public participation, social networks, income stability, and access to credit are necessary. These targeted research can uncover the subtle dynamics at play and inform more effective policy and support interventions tailored to the specific needs and challenges faced by small-scale fishers.

## Bibliography

- Abera, W., Assen, M., & Budds, J. (2020). Determinants of agricultural land management practices among smallholder farmers in the Wanka watershed, northwestern highlands of Ethiopia. *Land Use Policy*, *99*, 104841. <https://doi.org/10.1016/j.landusepol.2020.104841>
- Adams, W. C. (2015). Conducting Semi-Structured Interviews. In *Handbook of Practical Program Evaluation* (pp. 492–505). Wiley. <https://doi.org/10.1002/9781119171386.ch19>
- Aguilera, S. E., Cole, J., Finkbeiner, E. M., Le Cornu, E., Ban, N. C., Carr, M. H., Cinner, J. E., Crowder, L. B., Gelcich, S., Hicks, C. C., Kittinger, J. N., Martone, R., Malone, D., Pomeroy, C., Starr, R. M., Seram, S., Zuercher, R., & Broad, K. (2015). Managing Small-Scale Commercial Fisheries for Adaptive Capacity: Insights from Dynamic Social-Ecological Drivers of Change in Monterey Bay. *PLOS ONE*, *10*(3), e0118992. <https://doi.org/10.1371/journal.pone.0118992>
- Alam, M. F., Omar, I. H., & Squires, D. (2002). Sustainable fisheries development in the tropics: trawlers and licence limitation in Malaysia. *Applied Economics*, *34*(3), 325–337. <https://doi.org/10.1080/00036840110036305>
- Allegretti, A. (2019). “We are here to make money”: New terrains of identity and community in small-scale fisheries in Lake Victoria, Tanzania. *Journal of Rural Studies*, *70*, 49–57. <https://doi.org/10.1016/j.jrurstud.2019.05.006>
- Audrey Dermawan. (2023a, May 14). Fishermen’s group warns of more protests if PSI proceeds. *New Straits Times*. <https://www.nst.com.my/news/nation/2023/05/909224/fishermens-group-warns-more-protests-if-psi-proceeds>
- Audrey Dermawan. (2023b, November 20). Fishermen claim PSI project will threaten economic, social survival. *New Straits Times*. <https://www.nst.com.my/news/nation/2023/11/980352/fishermen-claim-psi-project-will-threaten-economic-social-survival>
- Audrey Dermawan. (2024, February 14). Fishermen, NGOs file action against PSI project. *New Straits Times*. <https://www.nst.com.my/news/crime-courts/2024/02/1013304/fishermen-ngos-file-action-against-psi-project>
- Axelrod, R. (1976). The analysis of cognitive maps. *Structure of Decision*, 55–73.

- Barraquand, F., Picoche, C., Detto, M., & Hartig, F. (2021). Inferring species interactions using Granger causality and convergent cross mapping. *Theoretical Ecology*, *14*(1), 87–105. <https://doi.org/10.1007/s12080-020-00482-7>
- Batista, C., & Vicente, P. C. (2020). Improving access to savings through mobile money: Experimental evidence from African smallholder farmers. *World Development*, *129*, 104905. <https://doi.org/10.1016/j.worlddev.2020.104905>
- Beck, T., & Demirguc-Kunt, A. (2006). Small and medium-size enterprises: Access to finance as a growth constraint. *Journal of Banking & Finance*, *30*(11), 2931–2943. <https://doi.org/10.1016/j.jbankfin.2006.05.009>
- Béné, C., Arthur, R., Norbury, H., Allison, E. H., Beveridge, M., Bush, S., Campling, L., Leschen, W., Little, D., Squires, D., Thilsted, S. H., Troell, M., & Williams, M. (2016). Contribution of Fisheries and Aquaculture to Food Security and Poverty Reduction: Assessing the Current Evidence. *World Development*, *79*, 177–196. <https://doi.org/10.1016/j.worlddev.2015.11.007>
- Bennett, A., Patil, P., Kleisner, K., Rader, D., Viridin, J., Basurto, X., Bank, W., Basurto, X. 2018, & Zoubek, S. (2018). *Contribution of Fisheries to Food and Nutrition Security: Current Knowledge, Policy, and Research Environmental Defense Fund Citation Acknowledgments*. [https://nicholasinstitute.duke.edu/sites/default/files/publications/contribution\\_of\\_fisheries\\_to\\_food\\_and\\_nutrition\\_security\\_0.pdf](https://nicholasinstitute.duke.edu/sites/default/files/publications/contribution_of_fisheries_to_food_and_nutrition_security_0.pdf)
- Bougon, M., Weick, K., & Binkhorst, D. (1977). Cognition in organizations: An analysis of the Utrecht Jazz Orchestra. *Administrative Science Quarterly*, 606–639.
- Brännback, M., & Malaska, P. (1995). Cognitive Mapping Approach Analyzing Societal Decision-Making. *World Futures*, *44*(4), 231–245. <https://doi.org/10.1080/02604027.1995.9972547>
- Cardín-Pedrosa, M., & Alvarez-López, C. J. (2012). Model for decision-making in agricultural production planning. *Computers and Electronics in Agriculture*, *82*, 87–95. <https://doi.org/10.1016/j.compag.2011.12.004>
- Chaib-draa, B. (2002). Causal maps: theory, implementation, and practical applications in multiagent environments. *IEEE Transactions on Knowledge and Data Engineering*, *14*(6), 1201–1217.

- D'agata, S., Darling, E. S., Gurney, G. G., McClanahan, T. R., Muthiga, N. A., Rabearisoa, A., & Maina, J. M. (2020). Multiscale determinants of social adaptive capacity in small-scale fishing communities. *Environmental Science & Policy*, *108*, 56–66. <https://doi.org/10.1016/j.envsci.2020.03.006>
- Dahmani, S., Boucher, X., Gourc, D., Peillon, S., & Marmier, F. (2020). Integrated approach for risk management in servitization decision-making process. *Business Process Management Journal*, *26*(7), 1949–1977. <https://doi.org/10.1108/BPMJ-07-2019-0279>
- Defeo, O., Castrejón, M., Ortega, L., Kuhn, A. M., Gutiérrez, N. L., & Castilla, J. C. (2013). Impacts of Climate Variability on Latin American Small-scale Fisheries. *Ecology and Society*, *18*(4), art30. <https://doi.org/10.5751/ES-05971-180430>
- Department of Fisheries Malaysia. (2023). *Malaysian Annual Fisheries Statistics 2022*. <https://www.dof.gov.my/sumber/perangkaan-perikanan-i/>
- Department of Statistics Malaysia. (2021, August 20). *Malaysia at a Glance*. Official Portal of Department of Statistics of Malaysia. [https://v1.dosm.gov.my/v1/index.php?r=column/cone&menu\\_id=SEFobmo1N212cXc5TFILVTVxWUFXZz09](https://v1.dosm.gov.my/v1/index.php?r=column/cone&menu_id=SEFobmo1N212cXc5TFILVTVxWUFXZz09)
- Doacă, E.-M. (2022). The Influence of the Macroeconomic Environment on the Financing Decision in SMEs. *Proceedings of CBU in Economics and Business*, *3*, 25–31. <https://doi.org/10.12955/peb.v3.289>
- Dowling, N. A., Wilcox, C., & Mangel, M. (2015). Risk sensitivity and the behaviour of fishing vessels. *Fish and Fisheries*, *16*(3), 399–425. <https://doi.org/10.1111/faf.12064>
- Eden, C. (1992). On the nature of cognitive maps. *Journal of Management Studies*, *29*(3), 261–265.
- Eden, C. (2004). Analyzing cognitive maps to help structure issues or problems. *European Journal of Operational Research*, *159*(3), 673–686.
- Eisenfuhr, F. (2011). *Decision making*. New York, NY: Springer.
- Elbanna, S. (2006). Strategic decision-making: Process perspectives. *International Journal of Management Reviews*, *8*(1), 1–20.
- Eriksson, H., Conand, C., Lovatelli, A., Muthiga, N. A., & Purcell, S. W. (2015). Governance structures and sustainability in Indian Ocean sea cucumber fisheries. *Marine Policy*, *56*, 16–22. <https://doi.org/10.1016/j.marpol.2015.02.005>

- Evers, N., & O’Gorman, C. (2011). Improvised internationalization in new ventures: The role of prior knowledge and networks. *Entrepreneurship & Regional Development*, 23(7–8), 549–574.
- Fairweather, J. (2010). Farmer models of socio-ecologic systems: Application of causal mapping across multiple locations. *Ecological Modelling*, 221(3), 555–562. <https://doi.org/10.1016/j.ecolmodel.2009.10.026>
- FAO. (2022). *The State of World Fisheries and Aquaculture 2022*. FAO. <https://doi.org/10.4060/cc0461en>
- FAO. (2023). *International Year of Artisanal Fisheries and Aquaculture 2022*. <https://doi.org/10.4060/cc5034en>
- Freed, S., Dujon, V., Granek, E. F., & Mouhhidine, J. (2016). Enhancing small-scale fisheries management through community engagement and multi-community partnerships: Comoros case study. *Marine Policy*, 63, 81–91. <https://doi.org/10.1016/j.marpol.2015.10.004>
- Gabrielsson, P., & Gabrielsson, M. (2013). A dynamic model of growth phases and survival in international business-to-business new ventures: The moderating effect of decision-making logic. *Industrial Marketing Management*, 42(8), 1357–1373.
- Gammage, L. C., & Jarre, A. (2020). Using Structured Decision-Making Tools With Marginalised Fishers to Promote System-Based Fisheries Management Approaches in South Africa. *Frontiers in Marine Science*, 7. <https://doi.org/10.3389/fmars.2020.00477>
- Gaurav, S., Cole, S., & Tobacman, J. (2011). Marketing Complex Financial Products in Emerging Markets: Evidence from Rainfall Insurance in India. *Journal of Marketing Research*, 48(SPL), S150–S162. <https://doi.org/10.1509/jmkr.48.SPL.S150>
- Giron-Nava, A., Lam, V. W. Y., Aburto-Oropeza, O., Cheung, W. W. L., Halpern, B. S., Sumaila, U. R., & Cisneros-Montemayor, A. M. (2021). Sustainable fisheries are essential but not enough to ensure well-being for the world’s fishers. *Fish and Fisheries*, 22(4), 812–821. <https://doi.org/10.1111/faf.12552>
- Glaser, B., & Strauss, A. (2017). *Discovery of grounded theory: Strategies for qualitative research*. Routledge.

- Guetterman, T. C., & James, T. G. (2023). A software feature for mixed methods analysis: The MAXQDA Interactive Quote Matrix. *Methods in Psychology*, 8. <https://doi.org/10.1016/j.metip.2023.100116>
- Haase, K., Reinhardt, O., Lewin, W.-C., Weltersbach, M. S., Strehlow, H. V., & Uhrmacher, A. M. (2023). Agent-Based Simulation Models in Fisheries Science. *Reviews in Fisheries Science & Aquaculture*, 31(3), 372–395. <https://doi.org/10.1080/23308249.2023.2201635>
- Handayani, A. (2023). The Role Of Financial Factor On The Financial Behaviour Of Small And Medium Enterprises (SMEs). *Journal of Business and Management Review*, 4(4), 295–305. <https://doi.org/10.47153/jbmr44.6752023>
- Hanisch, S., & Eirdosh, D. (2021). Causal Mapping as a Teaching Tool for Reflecting on Causation in Human Evolution. *Science & Education*, 30(4), 993–1022. <https://doi.org/10.1007/s11191-020-00157-z>
- Hillary, R. (2017). *Small and Medium-Sized Enterprises and the Environment: Business Imperatives* (R. Hillary, Ed.). Routledge. <https://doi.org/10.4324/9781351282840>
- Hodkinson, P. (2008). Grounded theory and inductive research. In *Researching social life* (Issue 5, pp. 80–100). Sage Publications Ltd.
- Hoehn, S., & Thapa, B. (2009). Attitudes and perceptions of indigenous fishermen towards marine resource management in Kuna Yala, Panama. *International Journal of Sustainable Development & World Ecology*, 16(6), 427–437. <https://doi.org/10.1080/13504500903315938>
- Huang, X. (2009). Strategic decision making in Chinese SMEs. *Chinese Management Studies*, 3(2), 87–101. <https://doi.org/10.1108/17506140910963602>
- Jansen, R. J. G., Curşeu, P. L., Vermeulen, P. A. M., Geurts, J. L. A., & Gibcus, P. (2013). Information processing and strategic decision-making in small and medium-sized enterprises: The role of human and social capital in attaining decision effectiveness. *International Small Business Journal: Researching Entrepreneurship*, 31(2), 192–216. <https://doi.org/10.1177/0266242611406762>
- Karali, E., Brunner, B., Doherty, R., Hersperger, A., & Rounsevell, M. (2014). Identifying the Factors That Influence Farmer Participation in Environmental Management Practices in Switzerland. *Human Ecology*, 42(6), 951–963. <https://doi.org/10.1007/s10745-014-9701-5>

- Kimani, P., Wamukota, A., Manyala, J. O., & Mlewa, C. M. (2020). Analysis of constraints and opportunities in marine small-scale fisheries value chain: A multi-criteria decision approach. *Ocean & Coastal Management*, *189*, 105151.
- Kleih, U., Linton, J., Marr, A., Mactaggart, M., Naziri, D., & Orchard, J. E. (2013). Financial services for small and medium-scale aquaculture and fisheries producers. *Marine Policy*, *37*, 106–114. <https://doi.org/10.1016/j.marpol.2012.04.006>
- Kozubíková, L., Dvorský, J., & Ključnikov, A. (2020). Social factors' impact on the quality of business environment in the SME segment. *Scientific Papers of the University of Pardubice, Series D: Faculty of Economics and Administration*.
- Kwon, S. J. (2011). Conceptual modeling of causal map: Object oriented causal map. *Expert Systems with Applications*, *38*(1), 360–370. <https://doi.org/10.1016/j.eswa.2010.06.073>
- Li, J., Ma, S., Le, T., Liu, L., & Liu, J. (2017). Causal Decision Trees. *IEEE Transactions on Knowledge and Data Engineering*, *29*(2), 257–271. <https://doi.org/10.1109/TKDE.2016.2619350>
- Lopes, P. F. M., & Begossi, A. (2011). Decision-making processes by small-scale fishermen on the southeast coast of Brazil. *Fisheries Management and Ecology*, *18*(5), 400–410. <https://doi.org/10.1111/j.1365-2400.2011.00795.x>
- Lunenburg, F. C. (2010). The decision making process. *National Forum of Educational Administration & Supervision Journal*, *27*(4).
- Marín-Monroy, E. A., & Ojeda-Ruiz de la Peña, M. Á. (2016). The role of socioeconomic disaggregated indicators for fisheries management decisions: The case of Magdalena-Almejas Bay, BCS. Mexico. *Fisheries Research*, *177*, 116–123. <https://doi.org/10.1016/j.fishres.2016.01.009>
- Maunder, M. N. (2002). The relationship between fishing methods, fisheries management and the estimation of maximum sustainable yield. *Fish and Fisheries*, *3*(4), 251–260. <https://doi.org/10.1046/j.1467-2979.2002.00089.x>
- Mingers, J., & Rosenhead, J. (2004). Problem structuring methods in action. *European Journal of Operational Research*, *152*(3), 530–554.
- Mizik, T. (2021). Climate-Smart Agriculture on Small-Scale Farms: A Systematic Literature Review. *Agronomy*, *11*(6), 1096. <https://doi.org/10.3390/agronomy11061096>

- Mohamed, A. F. B. O. (2018, November 6). *Fisheries Country Profile: Malaysia*. Southeast Asia Fisheries Development Centre. <http://www.seafdec.org/fisheries-country-profile-malaysia-2018/>
- Montibeller, G., & Belton, V. (2006). Causal maps and the evaluation of decision options—a review. *Journal of the Operational Research Society*, 57(7), 779–791. <https://doi.org/10.1057/palgrave.jors.2602214>
- Musso, F., & Francioni, B. (2012). The Influence of Decision-Maker Characteristics on the International Strategic Decision-Making Process: An SME Perspective. *Procedia - Social and Behavioral Sciences*, 58, 279–288. <https://doi.org/10.1016/j.sbspro.2012.09.1002>
- Myeni, L., Moeletsi, M., Thavhana, M., Randela, M., & Mokoena, L. (2019). Barriers Affecting Sustainable Agricultural Productivity of Smallholder Farmers in the Eastern Free State of South Africa. *Sustainability*, 11(11), 3003. <https://doi.org/10.3390/su11113003>
- Nadkarni, S., & Shenoy, P. P. (2004). A causal mapping approach to constructing Bayesian networks. *Decision Support Systems*, 38(2), 259–281. [https://doi.org/10.1016/S0167-9236\(03\)00095-2](https://doi.org/10.1016/S0167-9236(03)00095-2)
- Nalzar, O. G. (2013). Organizational Membership of Fisherfolks in Fishing Villages in Palawan, Philippines. *Asian Journal of Business and Governance*, 3(1). <https://doi.org/10.7828/ajobg.v3i1.348>
- Neiland, A. E. (2004). Fisheries Development, Poverty Alleviation and Small-Scale Fisheries: A Review of Policy and Performance in Developing Countries Since 1950. In *Poverty and Small-scale Fisheries in West Africa* (pp. 189–208). Springer Netherlands. [https://doi.org/10.1007/978-94-017-2736-5\\_11](https://doi.org/10.1007/978-94-017-2736-5_11)
- Ntaky, R. P., Johnny, M., Robert, B., Diana, N., & Robert, K. (2021). Influence of informal financial literacy training on financial knowledge and behavior of rural farmers: Evidence from Uganda. *Journal of Development and Agricultural Economics*, 13(3), 192–204. <https://doi.org/10.5897/JDAE2021.1290>
- Pearl, J. (2000). Causal inference without counterfactuals: Comment. *Journal of the American Statistical Association*, 95(450), 428–431.
- Pearl, J., & Mackenzie, D. (2018). AI Can't reason why. *Wall Street J.*

- Pineda, F., Molina, E., Torregroza-Espinosa, A. C., Cardona-Almeida, C., & Suarez, A. (2023). Sustaining local ecological knowledge of artisanal fishers: a perspective from northern Colombia. *Latin American Journal of Aquatic Research*, 51(4), 491–502. <https://doi.org/10.3856/vol51-issue4-fulltext-2941>
- Powell, S., Copestake, J., & Remnant, F. (2024). Causal mapping for evaluators. *Evaluation*, 30(1), 100–119. <https://doi.org/10.1177/13563890231196601>
- Purvis, B., Mao, Y., & Robinson, D. (2019). Three pillars of sustainability: in search of conceptual origins. *Sustainability Science*, 14(3), 681–695. <https://doi.org/10.1007/s11625-018-0627-5>
- Ratner, B. D., & Allison, E. H. (2012). Wealth, Rights, and Resilience: An Agenda for Governance Reform in Small-scale Fisheries. *Development Policy Review*, 30(4), 371–398. <https://doi.org/10.1111/j.1467-7679.2012.00581.x>
- Rauwerda, K., & De Graaf, F. J. (2021). Heuristics in financial decision-making: the selection of SME financing by advisers in an increasingly diverse market. *Management Decision*, 59(7), 1728–1749. <https://doi.org/10.1108/MD-09-2019-1269>
- Sakane, N., van Wijk, M. T., Langensiepen, M., & Becker, M. (2014). A quantitative model for understanding and exploring land use decisions by smallholder agrowetland households in rural areas of East Africa. *Agriculture, Ecosystems & Environment*, 197, 159–173. <https://doi.org/10.1016/j.agee.2014.07.011>
- Sarantakos, S. (2005). *Social research Palgrave Macmillan*. China.
- Saul, S., & Die, D. (2016). Modeling the Decision-Making Behavior of Fishers in the Reef Fish Fishery on the West Coast of Florida. *Human Dimensions of Wildlife*, 21(6), 567–586. <https://doi.org/10.1080/10871209.2016.1198853>
- Sayinzoga, A., Bulte, E. H., & Lensink, R. (2016). Financial Literacy and Financial Behaviour: Experimental Evidence from Rural Rwanda. *The Economic Journal*, 126(594), 1571–1599. <https://doi.org/10.1111/eoj.12217>
- Shiferaw, B. A., Okello, J., & Reddy, R. V. (2009). Adoption and adaptation of natural resource management innovations in smallholder agriculture: reflections on key lessons and best practices. *Environment, Development and Sustainability*, 11(3), 601–619. <https://doi.org/10.1007/s10668-007-9132-1>

- Solano, C., León, H., Pérez, E., & Herrero, M. (2001). Who makes farming decisions? A study of Costa Rican dairy farmers. *Agricultural Systems*, 67(3), 181–199. [https://doi.org/10.1016/S0308-521X\(00\)00053-6](https://doi.org/10.1016/S0308-521X(00)00053-6)
- Speziale, D. (2024). “Penang Rejects Reclamation”: Pre-capitalist worldviews and post-development ideals within a Malaysian environmental movement. *Journal of Political Ecology*, 31(1). <https://doi.org/10.2458/jpe.5476>
- Steinerowska-Streb, I., & Steiner, A. (2014). An Analysis of External Finance Availability on SMEs’ Decision Making: A Case Study of the Emerging Market of Poland. *Thunderbird International Business Review*, 56(4), 373–386. <https://doi.org/10.1002/tie.21627>
- Sutton, A. M., & Rudd, M. A. (2016). Factors influencing community fishers’ leadership engagement in international small-scale fisheries. *Frontiers in Marine Science*, 3, 116.
- Thorpe, A., Reid, C., van Anrooy, R., Brugere, C., & Becker, D. (2006). Asian development and poverty reduction strategies: Integrating fisheries into the development discourse. *Food Policy*, 31(5), 385–400. <https://doi.org/10.1016/j.foodpol.2005.09.007>
- Tolman, E. C. (1948). Cognitive maps in rats and men. *Psychological Review*, 55(4), 189.
- Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science*, 185(4157), 1124–1131. <https://doi.org/10.1126/science.185.4157.1124>
- Van Audenhove, L., & Donders, K. (2019). Talking to people III: Expert interviews and elite interviews. *The Palgrave Handbook of Methods for Media Policy Research*, 179–197.
- Watson, J. W., Muench, A., Hyder, K., & Sibly, R. (2022). Factors affecting fisher decisions: The case of the inshore fishery for European sea bass (*Dicentrarchus labrax*). *PLOS ONE*, 17(3), e0266170. <https://doi.org/10.1371/journal.pone.0266170>
- Weerasekara, S., & Bhanugopan, R. (2023). The impact of entrepreneurs’ decision-making style on SMEs’ financial performance. *Journal of Entrepreneurship in Emerging Economies*, 15(5), 861–884. <https://doi.org/10.1108/JEEE-03-2021-0099>
- Wong, H. S., & Yong, C. C. (2020). Fisheries regulation: A review of the literature on input controls, the ecosystem, and enforcement in the Straits of Malacca of Malaysia. In *Fisheries Research* (Vol. 230). Elsevier B.V. <https://doi.org/10.1016/j.fishres.2020.105682>
- Ye, W., & Li, M. (2022). Are We Vulnerable? Climate Risk Perception and Vulnerability of Small and Medium Size Agricultural Enterprises in China. *ASR Chiang Mai University*

*Journal of Social Sciences and Humanities*, 9(2).  
<https://doi.org/10.12982/CMUJASR.2022.006>

Youn, S.-J., Taylor, W. W., Lynch, A. J., Cowx, I. G., Douglas Beard, T., Bartley, D., & Wu, F. (2014). Inland capture fishery contributions to global food security and threats to their future. *Global Food Security*, 3(3–4), 142–148. <https://doi.org/10.1016/j.gfs.2014.09.005>

Zhumanova, M., Wrage-Mönnig, N., & Darr, D. (2016). Farmers' Decision-making and Land Use Changes in Kyrgyz Agropastoral Systems. *Mountain Research and Development*, 36(4), 506–517. <https://doi.org/10.1659/MRD-JOURNAL-D-16-00030.1>

Zoetermeer, P. G. (2003). *The decision-making entrepreneur Literature review Elissaveta Ivanova*. [www.eim.nl/smes-and-entrepreneurship](http://www.eim.nl/smes-and-entrepreneurship)

## Appendices

### Appendix 1: Decisions and Themes Identified After Expert Interviews

Decision	Theme
When to fish	<ul style="list-style-type: none"> <li>• Tide</li> <li>• Weather</li> <li>• Fishing resource</li> <li>• Economic goal</li> <li>• Religious practice</li> <li>• Labor Availability</li> </ul>
Where to fish	<ul style="list-style-type: none"> <li>• Weather</li> <li>• Fishing Resource</li> <li>• External information</li> </ul>
When to terminate a trip	<ul style="list-style-type: none"> <li>• Weather</li> <li>• Economic goal</li> <li>• Environmental concern</li> </ul>
How to fish	<ul style="list-style-type: none"> <li>• Cost of gear</li> <li>• Personal preference</li> <li>• Income</li> <li>• Fishing Resource</li> <li>• Knowledge &amp; skill</li> </ul>
How to sell	<ul style="list-style-type: none"> <li>• Convenience</li> <li>• Price</li> <li>• Knowledge &amp; skill</li> <li>• Loan</li> <li>• Habit</li> </ul>
Joining Fishermen's Associations	<ul style="list-style-type: none"> <li>• License</li> <li>• Financial benefits</li> <li>• Identity</li> <li>• Social referent</li> </ul>
Joining protests against coastal development projects	<ul style="list-style-type: none"> <li>• Perception of the impact of coastal development</li> <li>• Perception of the impact of their participation</li> <li>• Identity</li> <li>• Social referent</li> <li>• Time availability</li> <li>• Financial availability</li> </ul>

## Appendix 2: Codes (Factors) Identified in Data Analysis

Codes (factors) noted with \* are the factors selected after Step 5 in the data analysis section.

Decision	Codes (Factors)	Frequency	Average Importance	Aggregated Importance
Join FA	License*	23	4.78	4.78
Join FA	Financial Benefits*	24	3.92	3.79
Join FA	Community Aid*	8	4.13	4.13
Join FA	Social Referent	20	1.45	1.51
Join FA	Identity	21	1.71	2.54
Join FA	Collective Action	1	5.00	5.00
Join FA	Information	2	4.00	4.00
Join FA	Infrastructure	2	5.00	5.00
Join protest	Environmental Concern*	15	3.67	3.67
Join protest	Income Concern*	16	4.44	4.44
Join protest	Advocate Policy Change*	17	3.59	3.59
Join protest	Public Expression*	8	4.13	4.13
Join protest	Identity*	20	3.40	2.54
Join protest	Responsibility*	6	3.83	3.83
Join protest	External Pressure*	5	4.60	4.60
Join protest	Compensation*	5	3.20	3.79
Join protest	Social Referent	19	1.58	1.51
Join protest	Financial Availability	25	1.40	1.40
Join protest	Time Availability	23	1.52	1.52
Join protest	Others	2	4.00	4.00
How to sell	Convenience*	24	4.00	4.00
How to sell	Price*	24	3.29	3.18
How to sell	Market Access*	16	3.94	3.94
How to sell	Long-term Relationship*	12	4.00	4.00
How to sell	Access to Credit*	22	2.73	2.73
How to sell	Habit*	22	2.32	2.82
How to sell	Knowledge & Skill	17	1.65	1.68
How to sell	Limited Choice	2	3.00	3.00
How to sell	Lack of Material	1	3.00	3.00
How to fish	Cost of Gear*	22	2.14	2.14
How to fish	Habit*	6	4.67	2.82
How to fish	Personal Preference*	23	3.17	3.17
How to fish	Income*	25	3.08	3.18
How to fish	Stability of Income*	6	3.50	3.50
How to fish	Fishing Resource*	22	3.45	3.45
How to fish	Labor Availability*	4	3.50	3.50
How to fish	Safety Concern	3	3.67	3.67
How to fish	Previous Catch	3	4.67	4.67
How to fish	Knowledge & Skill	21	1.71	1.68

<b>Decision</b>	<b>Codes (Factors)</b>	<b>Frequency</b>	<b>Average Importance</b>	<b>Aggregated Importance</b>
How to fish	Targeted Fish	2	3.50	3.50
How to fish	Technology Exposure	1	4.00	4.00
How to fish	Jellyfish	1	4.00	4.00
When to terminate a trip	Physical Wellbeing*	14	2.43	2.25
When to terminate a trip	Weather*	24	3.46	3.75
When to terminate a trip	Economic Goal*	22	2.95	2.49
When to terminate a trip	Fishing Resource*	10	4.50	4.45
When to terminate a trip	Previous Catch*	13	4.38	4.38
When to terminate a trip	Fixed Routine*	6	4.33	4.29
When to terminate a trip	Tide*	4	4.25	4.55
When to terminate a trip	Environmental Concern	25	1.12	1.12
When to terminate a trip	Capacity	3	4.00	4.00
When to terminate a trip	Labor Availability	3	3.33	2.37
When to terminate a trip	Market Access	1	4.00	3.67
When to terminate a trip	Market Demand	1	3.00	3.00
Where to fish	Weather*	24	3.46	3.75
Where to fish	External Information*	23	3.70	3.27
Where to fish	Fishing Resource*	25	4.40	4.45
Where to fish	Experience*	14	4.79	4.71
Where to fish	Gear Constraint	1	3.00	3.00
Where to fish	Safety Concern	2	3.00	3.40
When to fish	Tide*	25	4.60	4.55
When to fish	Weather*	23	4.35	3.75
When to fish	Fishing Resource*	25	4.48	4.45
When to fish	Labor Availability*	24	2.25	2.37
When to fish	Safety Concern*	8	3.50	3.40
When to fish	Economic Goal*	25	2.08	2.49
When to fish	Religion	23	1.65	1.65
When to fish	External Information	7	1.86	3.27
When to fish	Market Access	2	3.50	3.67
When to fish	Physical Wellbeing	6	1.83	2.25
When to fish	Experience	3	4.33	4.71
When to fish	Fixed Routine	1	4.00	4.29
When to fish	Jellyfish	1	4.00	4.00