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An Examination of the Influence of Blue Economy Digital Technology on the Economic Advancement of Fishermen in Batam

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Abstract
Purpose: This study aims to investigate the tangible impact of digital technology on improving the livelihoods and income of fishermen in Batam, in alignment with the principles of a sustainable blue economy.
Research Methodology: The research employed a quantitative and qualitative approach through direct field surveys conducted with 52 local fishermen in Batam. The data collected focused on digital tool usage, income changes, and perceived benefits and challenges.
Results: Findings reveal that digital technologies—such as meteorological forecasting applications and online marketing platforms—serve as crucial drivers for economic transformation. Approximately 80% of the observed income increases are attributable to digital literacy and technology use. Notably, over 50% of respondents reported a direct rise in income after adopting digital marketing strategies.
Conclusion: Digitalization significantly boosts fishermen's income and economic resilience. However, this transition is impeded by limited technological adaptation among older generations and inadequate internet infrastructure in coastal regions.
Limitations: The study is limited by its sample size and geographic scope, focusing solely on fishermen in Batam, which may limit the generalizability of the results to other archipelagic regions.
Contribution: This research offers critical insights for policymakers by highlighting the importance of accessible technology training and robust internet infrastructure. These are key to ensuring equitable digital transformation and enhancing the global competitiveness of local fishing communities in Batam.

Keywords: *Blue Economy, Coastal Economy, Digital Technology, Economic Adaptation, Fishermen's Income.*

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1. Introduction

Indonesia is the world's largest archipelagic country, with a coastline stretching over 95,000 km and abundant marine resources. The marine and fisheries sector serves as a key pillar of the national

economy and represents a primary source of livelihood for coastal communities, including fishers (Yamindago, 2015; Yeo et al., 2011). Despite its vast potential, Indonesian fishers, particularly those in regions such as Batam City, continue to face serious challenges in terms of economic conditions, technological capacity, and market access. These constraints hinder welfare improvements and reinforce the cycles of poverty in coastal areas.

The concept of the Blue Economy has emerged as a development approach that integrates sustainable use of marine resources with efforts to improve the socio-economic well-being of coastal communities (Evans, Buchan, Fortnam, Honig, & Heaps, 2023; Gul, Admiral, & Shah, 2021). The Blue Economy aims to create productive and innovative marine ecosystems while preserving environmental sustainability (Karuppiah, Garza-Reyes, & Virmani, 2025). In practice, the implementation of Blue Economy initiatives requires the support of modern technology, including digital technologies that can enhance efficiency and productivity in the fisheries sector and expand the market reach of fishers' catches (Bank, 2021).

The adoption of digital technologies, such as seafood marketing applications, GPS-based navigation systems, weather information systems, and online transaction platforms, has been shown to significantly improve the effectiveness of fishing activities (Lavrakas & Black, 2013; Natsir, Ruchimat, Agustina, & Yulianto, 2019). These technologies reduce fishers' dependence on middlemen, provide direct access to consumer markets, and lower the risk of maritime accidents through the provision of accurate weather information. Chan et al. (2021) found that fishers using digital applications experienced income increases of up to 25% compared to those who did not actively utilize such technologies. In Batam City, an industrial, maritime, and archipelagic region, the development of the Blue Economy holds considerable potential.

The area includes numerous fishing communities located in Pulau Buluh, Nongsa, Belakang Padang and Galang. Although digital infrastructure, such as Internet connectivity, is available in most areas, many fishers still lack the skills and access needed to use digital technologies effectively. This gap is largely due to low digital literacy levels and the absence of sustained training and mentoring programs in the region. Research by Li, Yang, and Tsai (2024) confirms that the use of geographic information systems (GIS) and mobile marine weather applications can improve fishing efficiency and reduce losses caused by extreme weather.

In addition, a study by Indartuti, Rahmiyati, Wulandari, and Ahmad (2025) noted that the digitalization of seafood marketing increased the income of traditional fishers in the coastal areas of East Java by up to 30%, while also expanding their market reach to national and even export markets. Furthermore, Febryanti and Utami (2023) revealed that the use of community-based digital applications such as e-Fishery and FishOn helps fishers determine fishing locations and digitally record their catch, thereby increasing operational efficiency by approximately 20%. Another study by J. Zhang, Jiang, Wang, and Zhao (2025) stated that integrating digital technology into the marine product supply chain can reduce distribution costs and improve fishers' bargaining power with modern markets.

The popularity of eFishery, an aquaculture startup that was once highly promising, has recently declined. Although it previously achieved unicorn status with a valuation exceeding $1 billion and had plans for global expansion, eFishery ultimately collapsed because of the fraudulent actions of its founders. The company's reputation was destroyed after it was revealed that the founders manipulated financial performance by conducting fictitious transactions to enhance the company's image in the eyes of investors (Bahri, Agustina, & Ridha, 2025; Bahri, Dermawan, & Tambunan, 2025). Nonetheless, few studies have specifically examined the impact of digital technology within the Blue Economy framework on improving the economic conditions of fishers in archipelagic regions, such as Batam, Indonesia. This gap is noteworthy because Batam holds strategic potential for developing a digital-based Blue Economy model owing to its proximity to Singapore and Malaysia and local government support for developing capture fisheries and aquaculture.

However, most existing studies predominantly focus on broader coastal regions, such as Java and North Sumatra, while strategically positioned archipelagic areas, such as Batam, remain relatively underexplored (Rozaki et al., 2024; Sambas & Ariani, 2017). Batam's unique geographical location—adjacent to Singapore and Malaysia—and its function as a center of industry and international trade make it particularly well-positioned to accelerate the transition toward a Blue Economy-oriented development model (Heidkamp, Morrissey, Germond-Duret, & Rourke, 2022; Nugroho, Susilowati, Thohir, Prastyadewi, & Suciati, 2021). This research gap highlights the absence of empirical studies evaluating the impact of digital technology on improving the economic conditions of fishers in archipelagic areas with urban and industrial characteristics, such as Batam.

This study addresses this gap by empirically examining the influence of digital technology on improving the economic conditions of fishers in Batam within the Blue Economy framework. This research is innovative because it focuses on a strategic yet understudied location and investigates the direct impact of digitalization on fishers' economic welfare. The findings are expected to contribute to academic discourse and serve as a foundation for developing equitable and sustainable coastal economic development strategies. Therefore, it is crucial to conduct research that does not merely describe the level of digital technology adoption among fishers but also empirically analyzes its impact on economic advancement. This study employs a quantitative methodology to objectively analyze the correlation between the use of digital technology in Blue Economy initiatives and the economic well-being of fishers in Batam.

2. Literature Review and Hypothesis Development

2.1. The Concept of Blue Economy

The Blue Economy is a sustainable development approach that emphasizes the responsible, efficient, and environmentally sound utilization of marine resources for the welfare of coastal communities (Gul et al., 2021; Islam, Ahmed, Habib, & Masud, 2024). According to the Bank (2021), the Blue Economy encompasses a wide range of economic activities directly related to the ocean, such as capture fisheries, marine aquaculture, maritime transportation, and marine tourism. The central objective of the Blue Economy is to create a balance between economic growth and sustainability of marine ecosystems.

In Indonesia, the Blue Economy has become a key strategy for addressing issues related to fisher welfare and overexploitation of marine resources. The Ministry of Kementerian Kelautan dan Perikanan (2022) adopted this concept as the foundational framework for the national marine development policies. The national strategy emphasizes the importance of digitalization, production efficiency, conservation-based marine resource management, and empowering coastal communities. Within this context, fishers serve as the primary actors who must be supported through access to modern technology and relevant information.

2.2. Digital Technology in the Blue Economy

Digital technology in the fisheries sector plays an essential role in strengthening the Blue Economy. Technological innovations help address major challenges faced by fishers, such as limited access to market information, inaccurate weather predictions, and inefficient fishing operations (Ha, 2024; Y. Zhang & Lu, 2020). Relevant forms of digital technology include:

- Marine mapping and navigation applications (e.g., Navionics, MarineTraffic)
- Weather and ocean wave prediction apps (e.g., BMKG, Windy)
- Digital systems for recording catch data
- Digital fisheries marketplaces (e.g., FishGo, Aruna)
- Internet of Things (IoT) systems for aquaculture and seafood processing

Studies by Febryanti and Utami (2023); Sarker, Sarker, Shaha, Sarker, and Borddin (2025) demonstrate that the use of digital market-based applications reduces fishers' dependence on middlemen, increases income by up to 25%, and expands direct access to consumers. Pahlevi, Pratama, Nurfikriyanto, Ihsan, and Santoso (2025) show that digitalization in marine navigation and catch-recording systems improves operational efficiency by approximately 20%.

2.3. Fishermen's Economic Improvement

The economic improvement of fishermen can be measured through several aspects, including monthly income, reduction in operational costs, increased market access, and the growth of productivity in fishing activities (Nairobi, Ambya, Afif, & Pratikno, 2022). Fishermen's income is strongly influenced by various factors such as weather conditions, fish availability, market price fluctuations, and the role of middlemen (Al-Jabri, Collins, OMEZZINE, & BELWAL, 2013; Ratna, Albra, & Arifin, 2018). Digital technology is considered a solution to these problems because it can shorten the distribution chain, provide real-time market price information, and strengthen the bargaining power of fishermen. Astuti et al. (2024) reported that the application of digital marketing in the sale of marine products along the coast of East Java increased fishermen's profit margins by 30%.

2.4. Relationship between Digital Technology and Fishermen's Economy

The utilization of digital technology is a key driver in strengthening the pillars of the Blue Economy, namely, efficiency, inclusivity, and sustainability (Hui, Xie, & Chen, 2024; C. Zhang & Deng, 2024). Digitalization offers solutions to long-standing issues faced by fishermen, such as dependence on middlemen, limited information on market prices, and high marine risk due to weather uncertainty. Through maritime weather applications, GPS-based navigation systems, and online marketing platforms, fishermen can improve decision-making accuracy, reduce operational costs, and expand their direct market access. According to Taulu and Kurniawan (2025) and Mukhlis, Makhya, Yulianto, and Aviv (2025), public–private partnerships in expanding Internet access significantly enhance connectivity for coastal communities.

Several studies support this, Marlina, Almuqaramah, Rusmina, Rahmi, and Zidane (2025) found that supply-chain digitalization reduced logistics costs for small-scale fishermen by up to 15% while also strengthening their connectivity to export markets. With fewer intermediaries involved in distributing marine products, fishermen gain higher profit margins and greater bargaining power with traders and end consumers. Additionally, Kitole, Lihawa, Sesabo, and Shitima (2023) demonstrated that the use of digital communication technology enables fishermen to access real-time price information, thereby reducing information asymmetry that has traditionally disadvantaged them. From an efficiency standpoint, digitalization accelerates decision-making (Musah, James, Asiedu-Ampomah, & Koomson, 2025).

Information regarding fishing locations, weather conditions, and market demand can be accessed quickly and accurately, enabling fishermen to plan their fishing activities with a lower risk. This not only saves fuel costs and time but also increases the quantity and quality of the catch (Sun, Zhang, Jiang, & Zhao, 2024; Tilley et al., 2024). From an inclusivity perspective, digital technologies open opportunities for small-scale fishermen to connect directly with local and global consumers. Thus, digital technology narrows the gap between traditional fishermen and modern markets. However, this positive relationship does not occur automatically in all cases. The success of digital technology adoption is highly influenced by digital literacy, internet infrastructure availability, and access to adequate digital devices (Jusang Bolong, Siti Zobidah Omar, D'Silva, Hayrol Azril, & Musa Abu Hassan, 2013; Salia, Nsowah-Nuamah, & Steel, 2011).

Older fishermen or those with lower educational backgrounds often face obstacles in understanding digital applications, highlighting the need for continuous training programs (Bhattacharjee, Baker, & Waycott, 2020). Moreover, limited Internet connectivity in remote coastal areas reduces the effectiveness of digitalization (Freeman, Park, Middleton, & Allen, 2016; Marshall, Wilson, & Dale, 2023). Institutional factors, such as government support through regulations and facility provision, along with the role of cooperatives or fisher groups, also determine the extent to which digitalization can deliver collective benefits (Kauer et al., 2018; Su, Cheng, Kong, Xue, & Liang, 2023).

2.5. Theoretical Framework

This study is grounded in the Diffusion of Innovations Theory developed by Rogers ((Rogers, 2015). The theory posits that an innovation, particularly digital technology, will be adopted by individuals or social groups through five sequential stages: knowledge, persuasion, decision, implementation, and confirmation. This framework describes the developmental process from initial exposure to an innovation through its full integration into routine practices. Within the fishing communities of Batam, the knowledge stage occurs when fishermen are first introduced to digital technologies, such as weather forecast applications or online marketing platforms, typically through government outreach programs or information shared by fellow fishermen.

The persuasion stage happens when fishermen evaluate the advantages and ease of use of these technologies, including comparisons of catch volume or selling prices before and after using digital applications (Mboya et al., 2023; Sabu, Shaijumon, & Rajesh, 2018). The decision stage occurs when fishermen choose to implement these technologies in their fishing operations or market their catch. The implementation stage is achieved when digital tools are integrated into daily routines, such as using GPS during fishing trips or promoting products through social media. Finally, the confirmation stage is reached when fishermen perceive tangible benefits from digital technologies, such as increased income or improved operational efficiency, reinforcing their commitment to continued use. This theory highlights that the innovation adoption process is influenced by various factors, including individual characteristics (age, education level, and fishing experience), perceived technological benefits (usefulness and ease of use), social support (fishing networks, family ties, and community support), and institutional support (government initiatives, training accessibility, and digital infrastructure policies).

These factors explain the variations in the pace of technology adoption among fishermen. Younger fishermen tend to adopt and master technology more quickly than older generations. For these reasons, the Diffusion of Innovations Theory is highly relevant for explaining digital transformation among fishermen in Batam, Indonesia. This provides a conceptual foundation for understanding the adoption process and facilitates the development of more targeted intervention strategies. Digital literacy training should be aligned with fishermen's adoption stages: for beginners, programs should focus on introducing and simulating the use of key applications; for those already in the implementation stage, training should aim to optimize technology use to increase productivity and expand market reach. The integration of digital technology within the Blue Economy framework ultimately enhances its effectiveness, inclusivity, and sustainability.

2.6. Hypothesis Development

Digital transformation in the fisheries sector is widely regarded as a key catalyst for improving the welfare of coastal communities (Kitole et al., 2023; J. Zhang et al., 2025). The use of digital technologies, including weather applications, GPS-based maritime navigation systems, digital catch-recording tools, and online marketing platforms, enables fishermen to reduce operational costs, enhance safety at sea, and expand market access for their catch (Jusang Bolong et al., 2013; Kiran & Shetti, 2021). According to Wada, Hatanaka, Sano, and Saitoh (2010), digital technologies within the Blue Economy framework can provide competitive advantages for fishermen, especially by strengthening local economic competitiveness. However, not all fishermen can fully leverage these technologies. As highlighted by Mabon and Kawabe (2023), digital integration must be implemented in a way that empowers communities and aligns with their specific needs and contexts, rather than imposing externally driven goals.

Factors such as age, fishing experience, technological skills, and Internet infrastructure availability often serve as limitations that hinder the adoption of digital technologies (Mnatsakanyan & Kharin, 2021; Omar, Hassan, Shaffril, Bolong, & D'Silva, 2011). These constraints create potential disparities in the benefits experienced by fishing communities. In some groups, digital technology can generate direct and significant economic improvements, whereas in others, the benefits may be less apparent (Probst, 2020; Tilley et al., 2024). Previous studies Hamzah, Aswar, and La Nalefo (2015), Saarrankan (2020), Tilley et al. (2024) have also revealed that digital technologies help reduce the environmental impact of fishing activities by optimizing operations and reducing emissions. However, despite the

available infrastructure, local fishing communities may still face challenges such as financial constraints and limited technological knowledge.

Batam presents a unique research context, situated at the intersection of modern industrial development and traditional fishing communities in Indonesia. The city's relatively advanced Internet infrastructure offers strong potential for digital fishery technologies. However, many fishermen continue to face barriers related to digital literacy and access to technological training. This situation positions Batam as an essential region for evaluating whether digital technologies effectively improve fishermen's economic conditionsor whether such technologies fail to produce significant outcomes. Based on this context, we propose the following hypothesis:

Hypothesis 1: The application of digital technology within the Blue Economy framework does not significantly improve the economic conditions of fishermen in Batam.

Hypothesis 2: The application of digital technology within the Blue Economy framework significantly improves the economic conditions of fishermen in Batam.

3. Research Methodology

This study employed a quantitative methodology within an explanatory research framework. The use of a quantitative approach is aligned with the study's primary objective, namely, to scientifically measure and objectively evaluate the relationship between measurable variables that can be statistically analyzed. The explanatory method was chosen because this research aims not only to describe phenomena but also to explain the causal relationship between the independent variable—the implementation of digital technology in the Blue Economy—and the dependent variable—the improvement of fishermen's economic conditions. This approach enables the researcher to assess whether digital technology has a significant effect on fishermen's economic conditions and measure the extent of that effect.

The study was conducted in several coastal areas of Batam City with active fishing communities. The population consisted of all fishermen residing in the coastal regions of Batam City. According to data from the Batam City Marine and Fisheries Office (2024), the number of active fishermen is approximately 1,200. The sampling technique used in this study was accidental sampling, involving the selection of respondents based on individuals encountered by chance who met the criteria of the study (Williamson, 2018). This technique was selected because of time constraints, financial limitations, and the geographically dispersed locations of fishermen across multiple coastal islands. Although accidental sampling has limitations in terms of representativeness, it is effective for reaching respondents who are genuinely active fishermen.

A total of 52 respondents were selected from the current population, which is considered adequate for preliminary explanatory research analysis. The data collection instrument consisted of a structured questionnaire that was directly distributed to the respondents. The questionnaire was designed to assess the level of digital technology utilization in fishing activities and its impact on indicators of fishermen's economic improvement, including income, operational efficiency, and market access. The collected data were analyzed using SPSS software, which was selected for its ability to process quantitative data with precision and efficiency, yielding meaningful and scientifically accountable analytical results.

4. Results and Discussion

4.1. Profile of Fishermen in Batam City

The characteristics of the respondents in Table 1 provide an important sociodemographic overview to understand the context of digital technology adoption among fishermen in Batam City. Based on the age distribution, the majority of fishermen were between 41 and 50 years old (42.30%), followed by those aged 30–40 years (32.69%). Meanwhile, fishermen under 30 years old account for only 7.69%, indicating that most fishers belong to the middle-productive-age group. This group typically has extensive fishing experience but may not be fully familiar with digital technologies. The presence of older fishermen aged 50–60 years (13.2%) further highlights why digital literacy remains a challenge in the fisheries sector's digital transformation.

In terms of marital status, most respondents were married (86.53%), while those who were unmarried or widowed/divorced represented a very small proportion (3.85% and 9.62%, respectively). This is relevant because family structure can influence collective participation in technology adoption, for instance, the involvement of wives or children in using digital marketing applications or digital catch-recording tools. Regarding education level, most fishermen completed senior high school (40.38%), followed by junior high school (25.00%) and elementary school (23.07 %) graduates. Only a small proportion (11.53%) had higher education experience (D3/S1/S2).

This suggests that basic literacy is relatively widespread, but digital literacy may not be high, as mastering digital tools generally requires additional training beyond formal education, especially for older generations who did not grow up in a digital environment. Furthermore, in terms of family size, the majority of fishermen have three family members (34.61%), followed by those with four to six members, with relatively balanced proportions. This indicates that fisher households tend to be small to medium in size, which can be both a strength and challenge. A smaller family unit may be more adaptive and quicker to transform, but it may also pose difficulties if only one member is actively working without assistance from others in the digital adoption process.

Table 1. Characteristics of Fishermen in Batam City

Respondent Characteristics	Frequency (f)	Percentage (%)
Age		
< 30 Years	4	7.69
30 – 40 Years	17	32.69
41 – 50 Years	22	42.30
50 – 60 Years	8	1.32
Marital Status		
Married	45	86.53
Widowed/Divorced	5	9.62
Single	2	3.85
Latest Education		
Elementary School (SD)	12	23.07
Junior High School (SMP)	13	25.00
Senior High School (SMA)	21	40.38
Diploma/Bachelor/Master (D3/S1/S2)	6	11.53
Number of Family Members		
3 Persons	18	34.61
4 Persons	12	23.07
5 Persons	12	23.07
6 Persons	10	19.23

Table 2. Overview of Digital Technology in the Blue Economy of Batam City

Variable	Mean	Std. Dev	Category
Use of Digital Technology (X)	3.70	0.58	Moderately High
Improvement of Fishermen's Economy (Y)	3.90	0.61	High

Source: Research Data (2025)

Based on the descriptive analysis presented in Table 2, the average level of digital technology utilization among fishermen in Batam City shows a mean value of 3.70 with a standard deviation of 0.58, which falls into the "moderately high" category. This indicates that fishermen have begun to adopt various forms of digital technology in their economic activities, such as weather forecast applications, GPS-based marine navigation systems, and digital marketing platforms to sell their catch. Although the adoption level has not yet reached the "very high" category, this trend reflects increasing awareness and openness toward technological change among fishermen, despite existing barriers such as low digital literacy, particularly among older age groups and those with lower levels of formal education.

Meanwhile, the variable measuring the improvement of fishermen's economic conditions recorded a mean value of 3.90 with a standard deviation of 0.61, categorized as "high." This means that most fishermen perceive a positive economic impact from the use of digital technology. This includes increased income, improved operational efficiency at sea, and broader market access through social media and digital fisheries platforms. These findings reinforce the main results of the study, which show that approximately 80% of the income improvement among fishermen is directly related to their digital literacy level and the extent to which they utilize digital technologies.

Table 3. Effect of Blue Economy Digital Technology on the Improvement of Fishermen's Economy

R	R^2	Adjusted R^2	Std Error of Estimate	F (ANOVA)	Sig – value
0,891	0,794	0,790	0,806	67.59	.000

Source: Research Findings (2025)

Based on the regression analysis presented in Table 3, the correlation coefficient (R) is 0.891, indicating a very strong relationship between the use of digital technology within the Blue Economy framework and the improvement of fishermen's economic conditions in Batam. Furthermore, the coefficient of determination (R^2) of 0.794 shows that 79.4% of the variation in fishermen's economic improvement can be explained by the digital technology variable. This means that digital technology plays a significant and substantial role in influencing the economic conditions of fishermen, while the remaining 20.6% is affected by other factors such as weather conditions, market prices, government policies or access to business capital.

The Adjusted R^2 value of 0.790 further strengthens the validity and robustness of the regression model, implying that even after adjusting for the number of predictors, the model remains stable and reliable in explaining the studied phenomenon. The Standard Error of Estimate of 0.806 also falls within an acceptable range, indicating that the deviation between the actual and predicted values generated by the model is not excessively large. The ANOVA test results show an F-value of 67.59 with a significance level (Sig.) The of 0.000 indicates that the regression model is statistically significant at the 99% confidence level ($\alpha = 0.01$). In other words, there is strong statistical evidence that the use of digital technology in the Blue Economy has a significant and measurable impact on improving the economic conditions of fishermen in Batam.

4.2. Discussion

4.2.1. *The Implementation of Digital Technology in the Blue Economy Does Not Significantly Influence the Economic Improvement of Fishermen in Batam*

The assumption that digital technology does not significantly contribute to improving fishermen's economic welfare is no longer relevant in the current maritime sector landscape, particularly in an archipelagic region such as Batam. Empirical findings clearly demonstrate that digitalization has reshaped the fisheries economy in terms of technical efficiency and the structure of work, social interactions, and the way fishermen envision their economic future. Digital technology has evolved from a mere technical tool into a transformative instrument that shifts fishermen from instinct-driven practices and inherited traditional knowledge to information-based, data-driven, and time-efficient operations (Anand, Enayati, Raj, Montresor, & Ramesh, 2024; Nemlioglu-Koca & Erdogan, 2024).

For example, through the utilization of weather applications, GPS-based navigation, and digital market platforms, fishermen can avoid hazardous weather, identify more productive fishing grounds, and access real-time market prices of fish. These capabilities not only increase catch volume but also strengthen long-term economic resilience (Xia, Zeng, & Chen, 2025). Interestingly, this transformation occurs not only at the level of individual fishermen but also within the social dynamics of the fishing communities. The emergence of online communities among fishermen in Batam—where they share weather updates, fishing techniques, and market opportunities—demonstrates that digital transformation carries a strong social dimension (Hamzah et al., 2015; Wade, Alexander, Gerkey, & Biedenweg, 2023).

Therefore, categorizing digitalization as a neutral entity with an insignificant impact oversimplifies the actual complexity of coastal socioeconomic dynamics (Mabon & Kawabe, 2023). In other words, the first hypothesis—stating that digital technology has no significant influence on fishermen's economic welfare—is not only refuted by empirical evidence but is also inconsistent with the ongoing cultural and social transformation occurring within the fishing communities. As fishermen use digital technologies to navigate the sea and market more effectively, they are transitioning from local economic actors to participants in a broader digital economic system (Jusang Bolong et al., 2013; Omar, Shaffril, Bolong, D'Silva, & Abu Hassan, 2012).

4.2.2. *The Implementation of Digital Technology in the Blue Economy Significantly Influences the Economic Improvement of Fishermen in Batam*

This hypothesis is supported not only by quantitative data but also by a social reading of how fishermen in Batam actively adapt to technological developments. The influence of digital technology on fishermen's economic improvement is not merely reflected in monthly income or catch volume but also in more fundamental aspects, such as enhanced economic independence, improved work efficiency, and broader access to information resources that were previously inaccessible (Jusang Bolong et al., 2013; Kitole et al., 2023; Omar et al., 2011; Salia et al., 2011). Through digitalization, fishermen are no longer passive actors in the fisheries supply chain. They are increasingly able to position themselves as active players who independently determine marketing strategies, choose distribution channels, and establish direct partnerships with culinary businesses, restaurants, or urban buyers (Bahri, Agustina, et al., 2025; Cahyani & Bahri, 2022; Dzierzbicka-Głowacka et al., 2024). In other words, digital technology strengthens the bargaining position of fishermen in the Blue Economy ecosystem (Tilley et al., 2024).

However, this positive impact does not occur automatically in all fishing groups. Digitalization is a social process strongly influenced by the capacity of individuals and communities to understand, access, and utilize technological tools effectively (Altanlar, Eren, & Aktan, 2025). Key obstacles found in the field include low digital literacy among older fishermen and limited Internet infrastructure in smaller islands such as Pulau Buluh and Belakang Padang. These conditions produce an adoption gap that prevents the benefits of digitalization from being evenly distributed.

Within the framework of Everett Rogers' Diffusion of Innovations theory, many fishermen in Batam are in the early implementation stage—they have begun to recognize and experiment with technology but have not yet fully integrated it into their daily fishing practices. The lack of progression to the "confirmation" stage can be attributed to insufficient practical training, the absence of local facilitators, and a lack of learning approaches tailored to the local coastal culture. Digitalization in the Blue Economy also has implications for family roles and gender dynamics. The involvement of fishermen's wives and children in managing social media, assisting with product distribution, or running small-scale seafood processing businesses represents another form of social transformation driven by technology (Lu, Xiao, & Wang, 2023; Wijaya, Prabhata, & Putra, 2021).

Economic roles within fishing households are no longer solely centralized in the father as the fisherman but are increasingly shared among family members. This shift marks the emergence of a micro-marine economic ecosystem that is not only more independent but also more resilient (Dong, 2020). Thus, the second hypothesis substantially reflects the realities of the ongoing transformation in coastal communities in India. Digital technology is not merely an operational tool; it is an *enabler* of change that simultaneously influences economic, social, and cultural dimensions. The key challenge moving forward is to ensure that the digitalization process remains inclusive, affordable, and aligned with the actual needs of fishing communities (Fernandes & Reite, 2021; Richmond et al., 2019).

5. Conclusion and Recommendations

5.1 Conclusion

1. The implementation of digital technology within the framework of the Blue Economy has been proven to positively impact the economic improvement of fishermen in coastal areas of Batam.
2. The utilization of digital technology helps fishermen enhance production efficiency, expand market access, and strengthen their competitive advantages.

3. Institutional support and digital literacy are determining factors in optimizing the application of digital technology in the fisheries sector.

5.2 Recommendations

1. The local government needs to expand mentoring programs and digital literacy training for fishermen to ensure that existing technologies are utilized optimally.
2. Fishermen are encouraged to be more proactive in using digital technologies, particularly in marketing their catch and fisheries business management.
3. Future research is recommended to examine other moderating or mediating variables, such as the role of fishermen's cooperatives or financial support, to provide a more comprehensive understanding of Blue Economy implementation.

5.3 Implications

The implications of this study reinforce the importance of government involvement in designing digital literacy training programs tailored to the conditions and needs of fishermen, as well as accelerating Internet infrastructure development in remote coastal areas. These efforts ensure that digital transformation in the fisheries sector remains inclusive and equitable. The findings of this study can serve as a reference for policymakers in formulating coastal development plans centered on the Blue Economy, emphasizing fisher empowerment, increased market access, and strengthening household economic resilience in coastal communities.

Theoretically, this study enriches the academic discourse on digital-based Blue Economy implementation. The findings support the concept of innovation diffusion, indicating that digital literacy, social support, and infrastructure availability are critical factors in the successful adoption of technology by fishermen. This study also opens opportunities for further research to explore additional variables, including institutional support, access to financing, and the role of fishermen communities, to deepen the understanding of the dynamics of digital transformation within the fisheries sector in island regions.

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