

ASSESSING THE EFFECTS OF CONTEMPORARY FISHING TECHNOLOGIES ON THE OPERATIONAL EFFICIENCY OF MUNICIPAL FISHERMEN: AN ANALYSIS OF LIMITED TECHNOLOGICAL INTEGRATION

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ABSTRACT

The paper explored the effects of modern fishing technologies on the operational efficiency of municipal fishermen in San Jose, Occidental Mindoro, a region with a well-known marine resource and reliant on fishing as the main source of livelihood. As the pressures of overfishing and environmental change continue to increase, more sophisticated fishing technologies must be embraced to enhance productivity and sustainability in the fishing sector. A total of 30 people were interviewed using a combination of qualitative and quantitative techniques and the sample size of the research was 15 participants representing local fishermen. The proposed subsidy and support program to be used in acquiring technology has been allocated a budget of 28 million pesos. The research found and divided the forms of modern technologies used already such as fish finder, motorized boats, advanced fishing gears, post-harvest preservation methods and digital communication means which all respondents reported their use. The analysis showed that these technologies are playing a key role in enhancing the efficiency of the catch, precision fishing, automated processing and sustainability monitoring, and real-time access to data. Moreover, the suggested subsidy program will provide a 50 percent subsidy on essential technologies, free training workshops, and access to low-interest microloans, which will eventually lead to a higher level of efficiency in operations and sustainability of the environment. This study highlights the pressing necessity of the implementation of modern technologies in the work of municipal fishermen and provides the recommendations that can be implemented to improve the life of local fishers and support sustainable fishermen management. The results highlight the possible socio-economic advantages that may be achieved in such technological solutions, which will be applied to food security and health of the future of the San Jose population in Occidental Mindoro.

Keywords: *Modern fishing technologies, municipal fishermen, operational efficiency sustainability, environmental conservation, technology subsidy and training.*

SDG: SDG 14 – Life Below Water

INTRODUCTION

With more than 7,000 islands comprising its archipelago, the Philippines holds a big part of the world's marine biodiversity and relies very heavily on its fishermen sector for economic sustenance and food security. In particular, the municipal fishermen provide vital livelihood opportunities to innumerable coastal communities across the nation. These fishermen do face increasing challenges from overfishing and the changes to the environment. One of the single most important elements to address is the adoption of modern fishing technologies.

The need for integrating these technologies into the fishing communities becomes even more important given the context of the country. Not only will the integration of these technologies reduce poverty within the communities of fishermen, but it will also improve the efficiency with which these fishermen can catch their fish (Cañete et al., 2021). The Philippine government and others have called for the modernization of the fishing sector to allow the fishermen to cope with the increasingly expensive challenges to fishing while also increasing the efficiency with which they can perform their tasks. Furthermore, the modernization of these fishing communities is required to enable them to have the sustainability of their fishing sector.

Consider the case of the province of Occidental Mindoro. This entire province is surrounded by rich marine fisheries and is heavily dependent upon the municipal fishermen within each of these areas. These municipal fishermen within the province are very important to the province as a whole. The issue for most of these fishermen, however, is that they cannot efficiently perform their tasks due to their lack of access to modern fishing technologies. In particular, the town of San Jose presents many of the same challenges as the other municipal fishermen in the province in that these fishermen struggle with the lack of technological integration within their fishing practices. Even when modern fishing technologies are available, their use has remained uneven, and this has resulted in suboptimal operational performance and lower volumes of catch (Islam & Chuenpagdee, 2022).

This problem is compounded by the fact that there is no systematic assessment of how such technologies have influenced operational efficiency in the said municipal fishermen. The lack of concrete knowledge on the state of technology utilization and its effects may render it quite formidable to devise policies or any support program effectively. Such a gap in research hinders stakeholders from making informed decisions which could significantly bring efficiency and sustainability.

The effects of this problem are also multi-dimensional: loss of operational efficiency results in reduced catch volumes, hence reduced income and livelihood from municipal fishermen. This could even be exacerbated by the reduced post-harvest technologies, increasing spoilage rates, hence further reducing economic returns from fishing activities. There is thus an urgent need to assess various modern technologies with regard to their effect on the efficiency of municipal fishermen and make feasible recommendations to surmount some of these challenges.

This paper, therefore, attempted to fill this research gap by estimating the effects of modern fishing technologies on operational efficiency of municipal fishermen in San Jose, Occidental Mindoro. Specifically, it intended to identify and classify the types of technologies currently in use, assess effects on operational efficiency, and propose a targeted subsidy and support program for technology acquisition. To this end, the study shall benefit by bringing on board those insights that might inform policy and support frameworks towards sustainable development of municipal fishermen within San Jose, Occidental Mindoro.

METHOD

Study Design

An explanatory sequential mixed method research design, statistical analysis used to gather data and explore how modern fishing technologies affects the industry. A series of interviews and focus groups were held with groups of fishermen as a qualitative method to gather information on fishermen's views, experiences and perceptions of the types of technologies that are available to them.

Study Setting

The research was conducted in the municipality of San Jose, Occidental Mindoro, Philippines specifically among the fisherfolks of Barangay Bubog, Caminawit, Labangan Poblacion, Pag-asa, Poblacion 4, Poblacion 5, San Agustin, and San Roque. The research took place during the first semester of the August 2024 to December 2025.

Unit of Analysis and Sampling

There were 2,799 registered municipal fishermen for males and 2,863 for females. This data was from 2023 according to the Municipal Agriculture Office (MAO). The municipal fishermen that were the main focus of this research typically used small boats that ranged to about 15 to 25 feet and incorporated modern technologies into their fishing boats. Additionally, these municipal fishermen caught between one and three metric tons (MT) of fish per trip. There was no predetermined number of the participants to be observed in this research.

The study employed purposive sampling, a specific method in which participants were deliberately chosen based on characteristics relevant to the research objectives. This was evident through a focus on municipal fishermen in designated locations, as well as the application of specific inclusion, exclusion, and withdrawal criteria to ensure participant suitability.

Research Instrument

A semi-structured interview guide was developed and organized into three sections. The first section explored the fishing technologies utilized by municipal fishermen. The second section examined the perceived effects of these technologies on fishing efficiency. The third section elicited participants' insights regarding their needs and preferences for a subsidy program supporting the acquisition of fishing technologies. The interview guide underwent expert validation to ensure content relevance, clarity, and appropriateness, thereby enhancing the credibility and trustworthiness of the data collected.

Data Collection Procedure

Prior to data collection, permission was secured from the Municipal Agriculture Office (MAO) of San Jose, Occidental Mindoro to obtain a list of registered municipal fishermen and identify eligible participants. Institutional approval was likewise obtained from the appropriate academic authority. The validated interview guide was administered through face-to-face interviews conducted at selected fishing communities. Researchers established rapport with participants, explained the study objectives, and addressed questions to facilitate informed participation. Follow-up interviews, including telephone or online interviews, when necessary, were conducted to accommodate participants' availability. Throughout the study, informed consent was obtained, and confidentiality, anonymity, and voluntary participation were strictly upheld.

Data Processing and Analysis

Descriptive statistics, specifically frequency counts and percentages, were used to identify and classify the modern fishing technologies utilized by municipal fishermen in San Jose, Occidental Mindoro. To examine the effects of these technologies on fishing efficiency, qualitative data were analyzed using thematic analysis. Interview responses were transcribed verbatim, coded, and organized into meaningful categories. Similar codes were grouped into subthemes, which were subsequently synthesized into overarching themes that reflected patterns and trends aligned with the study objectives.

Ethical Consideration

The study adhered to established ethical principles throughout the research process. Informed consent was obtained from all participants after providing adequate information regarding the study's purpose, procedures, potential risks and benefits, and their right to withdraw at any time without consequence. Participants' privacy was protected through strict observance of confidentiality and anonymity. Respect for local knowledge, cultural practices, and the significance of fishing to the community was maintained throughout data collection. The principle of beneficence was upheld by ensuring that the study posed minimal risk while generating knowledge that may contribute to improving fishing efficiency and supporting local fisheries development. The researchers also complied with institutional requirements and ethical standards governing research involving human participants.

RESULTS

Types of Modern Fishing Technologies

Table 1 shows that all respondents (100%) use modern fishing technologies. Precisely, 100 percent of the municipality fishermen utilize handheld fish finder device, fishing handlines and motorized boats in fishing. Moreover, all the respondents (100% use ice preservation methods to preserve their catch. In digital communication, 100% of the respondents use smartphone applications. This shows that these modern fishing tools and techniques are fully adopted by the surveyed municipal fishermen.

Table 1. Frequency and percentage of types of modern fishing technologies.

Types of Modern Fishing Technologies	Municipal Fishermen	
	n	100%
Handheld Fish Finder Device	30	100
Fishing Handlines	30	100
Motorized boat	30	100
Ice Preservation	30	100
Smartphone Apps	30	100

Effects of Modern Fishing Technologies

The analysis of the second objective in this study revealed five themes. These are: (1) increased catch efficiency, (2) precision fishing, (3) automated processing, (4) sustainability monitoring, and (5) real-time data access. These themes demonstrate the acknowledgment of the assumptions underpinning this study. The results are as follows:

Theme 1. Increased Catch Efficiency.

The results of the study show that most municipal fishermen in San Jose, Occidental Mindoro find that the use of modern fishing technology contributes to enhanced catch efficiency. Modern fishing technology has enhanced catch efficiency by allowing the participant to use fish finder devices for accurate fish location and programmed navigation, ensuring they take the correct routes and avoid getting lost. With this more accurate fish location, the possibility of mistakenly spending gasoline on wrong routes is greatly minimized or even eliminated. This way, fishermen are able to optimize the fuel consumption and make their fishing trips more successful. The participants argued that:

"The use of this technology has really helped me with fishing because... back then, we didn't have these fish finder devices and motors on our boats. Now, we can just program them, making it easy to know where the fish are, and you're sure that you're taking the right route, so you won't get lost. The sea can be confusing at times, and if you take the wrong route, you'll just waste gasoline, which is a significant expense."

Theme 2. Precision Fishing.

Modern fishing equipment, as noted by the participant, increases precision fishing, which involves using a fish finder to navigate accurately, a motor that helps them travel efficiently, and an ice box to maintain the fresher state of the

fish. Moreover, a cellphone enables one to communicate instantaneously with the buyers, and thereby sell the fish quickly thereby maximizing profits. The participants mentioned that:

"I use a fish finder, and I also have a motor on my boat. I have an ice box too, so after I catch fish, I put them in there to keep them fresh. I also have a cellphone so I can immediately message my wife when I've caught a lot of fish, so she can find a buyer right away and sell them quickly."

Theme 3. Automated Processing.

The municipal fishermen in San Jose, Occidental Mindoro emphasize the use of the latest fishing technology, which allows automated processing and makes the fishing more efficient although it is costly. Observation can be used to learn how to use this technology so that when equipment fails, it is necessary to troubleshoot the issue immediately, which highlights the importance of maintenance in maintaining the efficiency of automated systems in the fishing process. The participants highlighted:

"Buying technology today can be a pain because it's really expensive. When it comes to using it, I've learned by watching other fishermen, but sometimes the equipment can malfunction and not work properly, but a quick fix usually solves the problem."

"Yes, the expenses for tools are high now because they are new. Unlike before, the equipment was cheap, so my expenses are high."

Theme 4. Sustainability Monitoring.

The participants report that the current fishing technology, especially fish finders, has enhanced sustainable monitoring through ease of accessing information, ease of making quick decisions regarding fishing sites and leading to more effective and possibly less damaging fishing activities. The participants indicated that:

"My fishing process becomes easier with the help of a fish finder, as it provides information, and thus allows me to make quicker decisions on where to fish for the fish."

"At least it has changed a bit, before... back then... it was really tight, but now it has loosened up."

Theme 5. Real-Time Data Access.

According to the responses of the majority of the municipal fishermen in San Jose, Occidental Mindoro, modern fishing technology, which is the programmed fish finder, facilitates real time access to data, as it allows fishermen to update and revisit past successful fishing areas, making catches more effective. The participants reasoned that:

"Like before, because back then, they didn't have programmed fish finders. When they went back to the same spots, they hardly caught anything because the location wasn't being 'updated' or 'programmed' anymore. But now, the places they've programmed, they can revisit them again."

Proposed Subsidy and Support Program for Fishing Technology Acquisition

Table 2. Proposed subsidy and support program for fishing technology acquisition.

Key Objective	Responsible Party	Resources (PHP)	Timeline	Expected Outcome
Program launch and awareness campaign	Lgu, bfar, fisherfolk leaders	₱2,000,000	Months 1-3	Increased awareness and fisher participation
Beneficiary selection and training	Bfar, dti, ngos	₱3,000,000	Months 4-6	Trained fishers in sustainable practices
Equipment distribution and financing	Lgu, cooperative banks	₱10,000,000	Months 7-12	Enhanced fishing efficiency
Monitoring and technical support	Fishermen technology support center	₱5,000,000	Year 2-3	Proper utilization and sustainability
Expansion and market linkages	Bfar, private sector, cooperatives	₱8,000,000	Year 3-5	Increased market access and fisher income

Table 2 shows the subsidy program in San Jose, Occidental Mindoro. It is designed to assist municipal fishermen by subsidizing important fishing equipment by 50 percent, conducting free training workshops with the Bureau of fishermen

and Aquatic Resources, and availing low-interest micro loans. It also creates a fishermen Technology Support Center to continue aid and facilitates formation of cooperation to gain access to the market. The program also encourages environmental compliance by providing financial incentives and awareness campaigns to improve livelihoods and create sustainable fishermen in collaboration with local governments, NGOs, and the business sector.

DISCUSSION

Modern fishing technologies are used by municipal fishermen who seek to improve the quantity of the catch and contribute to environmental conservation through providing important data on the number of fish and the condition of the environment (Lucchetti et al., 2023). To minimize environmental impact, they alter gears, such as adding escape zones to nets or excluder devices, or less harmful methods, such as hook-and-line fishing and traps, to minimize bycatch and entanglement (Huang et al., 2024). Others also use motorized boats, which are powered by diesel engines or batteries, allowing them to transport people to the fishing fields faster and recover more (Yu & Lui, 2024).

Effective preservation practices, including ice storage and large iceboxes, are essential in preserving the freshness of fish and avoiding spoilage, which will guarantee quality to the consumer as well as minimize losses (Siddiqui et al., 2024). Also, municipal fishermen use smartphone applications in digital communication and resource tracking which assists in not only decision-making and the management of fisheries but also in Luzon where sustainable practices and the use of resources are encouraged (Calderwood, 2022).

The introduction of modern fishing gears by the municipal fishermen in San Jose, Occidental Mindoro has led to tremendous changes in their efficiency in catching. These hi-tech devices allow the fishermen to have a better control of their paths and make use of them to the fullest to avoid losing their position in the sea as well as save on fuel costs. Fish finders, such as, are very important as they direct fishermen to familiar fishing areas. This specialized fishing method boosts their catchability and enables them to go out on more productive fishing expeditions, and this approach makes their work more sustainable and fulfilling (Muallil et al., 2014; Miola et al., 2024).

In addition to the practical advantages, this is an environmentally sustainable method of fishing which has a positive effect on the conservation of the environment. New innovations in technology have lessened the amount of fuel consumed, lowered overfishing, and positively impacted marine ecosystems; mainly in areas that are already very vulnerable because the ecological balance within them isn't as strong as it should be and where overfishing has a huge impact on the sustainability of the marine ecosystem (Bastardie et al., 2022).

Furthermore, the advantages of using such technologies are not limited to individual fishermen. High productivity can also be a springboard towards economic development of the region that offers people more stable livelihoods and enhances food security among fishing communities. These communities will have a better standard of living as they become more resilient and developed. Finally, the introduction of new technologies in fishing creates a sustainable growth loop, so that fishing can continue to be a viable and sustainable way of earning a living in the future (Tolentino-Zondervan and Zondervan, 2022).

The use of modern fishing technologies has dramatically changed the work of local fishermen, as fishing has become more efficient and responsive to the market situation. Fish finders enable fishermen to locate the most favorable fishing sites accurately, save on time and catch more fish. State-of-the-art motors lead to the ability to reach previously inaccessible areas of fishing, to modify the strategy in real time according to the current circumstances, which increases the volume of the catch and its economic sustainability (Mason et al., 2021).

Modern ice storage, as one of the methods of proper preservation, increases fish freshness, which raises their prices in the market and better management of the supply chain (Siddiqui et al., 2024). Additionally, the mobile phone technology offers a direct connection with buyers and results into quicker sales, price negotiation, and increased cash flow that facilitates sustainable practices (Chhachhar, 2025).

A combination of these technologies, fish finders, efficient motors, ice storage, and mobile communication, generates a synergistic effect, which increases productivity, profitability, and sustainability among municipal fishermen in San Jose, Occidental Mindoro, and eventually improves their livelihoods and conserves marine resources (Rowan, 2022). The high-tech fishing equipment deployed in San Jose, Occidental Mindoro, importantly raises the productivity levels of local fishermen, enabling them to undertake tougher tasks more effectively, including automated fish processing, which makes sorting, cleaning, and packing easier, leaving more time to spend on fishing, and more fish in the catch (Mazuki et al., 2020). The use of this technology has been adopted through peer learning and observation, which enables fishermen to better their skills and troubleshoot small equipment problems, which minimizes their downtime, and continues to sustain operational efficiency (Komugabe-Dixon et al., 2025).

Nevertheless, the use of automated systems leads to challenges, such as the inability to maintain the systems regularly and the presence of long downtimes because of the lack of efficient technical support, which might affect livelihoods in the long run (Gryczka, 2023). Though expensive in the short-term, research indicates that long-term benefits, including higher catch rates, improved resource management, and greater profitability, benefit the community as a whole by enhancing the local economy and encouraging sustainable practices (Bradley et al., 2019). The municipal fishermen of

San Jose is an example of how modern technology can be used to revamp fishing practices, making them resilient and sustainable, and offering them a new opportunity to grow in the future that would not only be beneficial to their livelihoods but also the environmental wellness of their waters (Lucchetti et al., 2023b).

This study demonstrates how modern fishing methods (particularly in the application of fish-finder) have altered the way municipal fishermen track sustainability. Municipal fishermen can utilize the information to make informed and directed decisions reducing their dependence on guess work and traditional fishing techniques because fish-finding technologies provide real-time, precise information on the current fishing conditions and areas in the first place (Tabanao, 2025). Through this new technology, municipal fishermen can map their path, assess a fishing spot and switch their approach in real-time to maximize their harvest and reduce the potential harm they do to marine ecosystems through overfishing and aiding in achieving equilibrium in the marine ecosystems (Victor, 2023).

Fish-finding technologies also create accountability because the data retrieved by fish-finders tells fishermen to avoid overfished and/or protected areas, thus helping to support recovery and conservation efforts (Editoria, 2024). Moreover, the technologies will encourage cooperation and responsibility among fishermen as they will be able to share information that will contribute to managing the sustainably managed fish stocks, thereby making the municipal fisheries more resilient. With the increasing development and availability of these technologies, their potential to enhance the sustainability of the ecological and economic environment underlines the necessity of the further investment and evolution of the responsible fishing technologies (Al-Emran & Griffy-Brown, 2023).

Immediate feedback on areas where fish congregate using programmed fish finders would greatly improve municipal fishermen, fishing practices in San Jose, Occidental Mindoro, if they have access to real-time feedback because most likely they would visit areas they've forgotten or outdated information (Barboza et al., 2024). More often than not, fisherman rely on what fishing holes they used to catch fish at on memory alone or what their fellow fisherman says which could also be inefficient or dated information (Cabico, 2023). Having real-time information can allow fishermen to become more sustainable with fishing, allowing them to observe trends on where not to fish if the population is decreasing and leave fish for the next generation (DeladMin, 2022). Another positive effect is confidence less anxiety while fishing allows fishermen to relax and share their rewarding experiences with their loved ones. Overall technology and immediacy will change the fishing game for the better (Stewart et al., 2024).

The intended subsidy and support program in San Jose, Occidental Mindoro, is geared towards empowering the municipal fishermen in terms of financial support and technical support. The program will diminish the financial barriers through a 50% subsidy of key fishing equipment including fish finders and eco-friendly engines to encourage sustainable measures that will drive operational efficiency and safety. It also incorporates free training programs in cooperation with the Bureau of Fisheries and Aquatic Resources to enhance technology application, sustainable methods and post-harvest management, which promote life-long learning. Moreover, microfinance and low-interest microloans enable fishermen to invest risk-free, and a Fisheries Technology Support Center offers technical support and maintenance advice as well as regulatory guidance to enable equipment to last and operate sustainably. The program also enhances the local fisheries sector by promoting cooperatives, creation of digital marketplaces and provision of cold storage space to minimize spoilage and maximize income. In sum, such a holistic solution would help to increase productivity, sustainability, and economic growth, which will secure a strong future of fishing communities in the area (Ma et al., 2023).

CONCLUSION AND RECOMMENDATION

Based on the study's findings, several key recommendations are proposed. To begin with, it is necessary to introduce a subsidy and support program of fishing technologies in order to raise the efficiency and sustainability of operations of municipal fishermen in San Jose, Occidental Mindoro.

The essential equipment which includes fish finders and environmentally friendly engines should be given at a 50 percent subsidy to minimize financial constraints and interest-free payments should be offered at installment of 24 months. Second, workshops on capacity-building should emphasize the appropriate use of technology and sustainable fishing methods in collaboration with the Bureau of Fisheries and Aquatic Resources (BFAR), which should be complemented by creating a Fishermen Technology Support Center to provide continuous technical support and troubleshooting services.

Third, building cooperatives will empower the fishing industry to buy in large quantities, gain strength in bargaining, and expand their markets, especially via an online marketplace that links fishers with consumers, eliminating the need to go through intermediaries. Also, cold storage facilities will be created, which will resolve the problem of spoilage, save the product quality, and reduce waste. Together, these steps will create a resilient and sustainable fishing community that would help not only sustain the economy but also protect the marine ecosystems to support the future generations.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

DECLARATION OF AI USE

Grammarly was used to check grammar and edit language by the authors. The authors review all the outputs and validate it and assume full responsibility of what is contained.

AUTHOR CREDIT STATEMENT

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