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The Influence of Traditional Navigation Knowledge and the Utilization of Ethnomathematics on the Success of Traditional Fishermen's Operations

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ABSTRACT

Purpose of the study: This study aims to analyze the influence of traditional navigation knowledge and the use of ethnomathematics on the success of traditional fishermen's operations in Indonesia. Using a quantitative approach and the Partial Least Squares Structural Equation Modeling (SEM- PLS) method, this study identifies the relationship between latent variables. The survey was conducted on traditional fishermen who have been operating for more than five years, utilizing local navigation knowledge, and applying mathematical principles in going to sea.

Methodology: The research instrument was a closed questionnaire with a 5-point Likert scale to measure three main variables: Traditional Navigation Knowledge, Utilization of Ethnomathematics, and Success of Traditional Fishermen's Operations. Data were analyzed through validity, reliability, and structural model tests.

Main Findings: The results show that traditional navigation knowledge has a significant effect on the success of fishermen's operations with a path coefficient of 0.45 ($p = 0.002$). The use of ethnomathematics also has a significant effect with a path coefficient of 0.36 ($p = 0.005$). Overall, the two independent variables explain 60% of the variation in the success of fishermen's operations. This finding emphasizes the importance of integrating local wisdom and scientific approaches to improve the effectiveness and efficiency of traditional fishermen's activities.

Novelty/Originality of this study: This research has a novelty by integrating two approaches, namely the influence of traditional navigation knowledge and ethnomathematics, and exploring mathematical concepts in local culture. The results provide an important contribution in developing a model that combines local wisdom and scientific principles to support the sustainability of traditional fishermen's operations in Indonesia.

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1. INTRODUCTION

Indonesia, as the largest archipelagic country in the world, has a rich and diverse maritime culture. The lives of coastal communities, especially traditional fishermen, are greatly influenced by their ability to read sea, wind, and weather conditions. One important element that supports the success of fishermen in their daily activities

is traditional navigation knowledge. This knowledge has been passed down from generation to generation as part of local wisdom that shows the ability of coastal communities to adapt to their natural environment. In this context, traditional navigation is not only a cultural element, but also a factor that supports the economic sustainability of coastal communities [1]-[3].

On the other hand, ethnomathematics as a culture-based mathematical approach has begun to gain attention as a way to understand and utilize local practices that are rich in mathematical values. Ethnomathematics offers the perspective that many traditional practices, including fishermen's navigation, contain mathematical elements that can be explained scientifically. For example, the calculation of distance, direction, and time in navigation using stars or ocean waves, all involve mathematical principles. Unfortunately, the contribution of ethnomathematics to the success of traditional fishermen's operations has not been widely revealed through academic research [4]-[6].

The success of traditional fishermen's operations is not only determined by luck, but also by the ability to integrate traditional knowledge with a scientific approach. The use of ethnomathematics provides an opportunity to explain and improve the navigation strategies used by fishermen. In this way, traditional fishermen can improve the effectiveness and efficiency of their operations, including in facing modern challenges such as climate change and exploitation of marine resources. This study focuses on two main factors, namely traditional navigation knowledge and the use of ethnomathematics, to understand how both affect the success of traditional fishermen's operations [7], [8] .

This approach is becoming increasingly relevant in the modern era when traditional cultures face major challenges from modern technology and lifestyle changes. Integrating local knowledge with mathematical approaches can be an innovative way to maintain the sustainability of maritime culture while improving the standard of living of coastal communities. Therefore, this study aims to provide scientific contributions in understanding the relationship between traditional navigation knowledge, the use of ethnomathematics, and the success of traditional fishermen's operations [9]-[11].

Through quantitative analysis using the Partial Least Squares Structural Equation Modeling (SEM- PLS) method, this study is expected to provide new insights into how local wisdom can be combined with a scientific approach to achieve social and economic sustainability of coastal communities. In addition, this study is expected to be a reference for policy makers to support the preservation of maritime culture and the development of traditional fishing communities in Indonesia [12]-[14].

Based on research conducted by Ernawati & Izzati [15] shows a gap analysis of this study, where this study focuses on the influence of Traditional Navigation Knowledge and Utilization of Ethnomathematics on the Success of Traditional Fishermen's Operations. This study emphasizes the influence of two latent variables on operational success in the context of fishermen's sea activities. Meanwhile, previous studies explored ethnomathematics elements in the Pandan Saji Hood of the Lingga Malay community, focusing on identifying mathematical concepts such as spatial shapes, flat shapes, folding symmetry, and angles in cultural artifacts for use in mathematics learning. In terms of method approach, this study uses a quantitative approach with the PLS-SEM method which allows for the analysis of direct and indirect relationships between latent variables. On the other hand, previous studies used a qualitative approach with the ethnographic method, aiming to understand and analyze cultural elements descriptively through interviews, observations, and document analysis.

The population and object of study in this study are traditional fishermen with a focus on navigation practices and the application of ethnomathematics in sea activities. In contrast, previous studies focused on the Lingga Malay community with the object of study being the Pandan Saji Hood as a cultural heritage containing mathematical elements. The contribution of this study lies in increasing operational efficiency and economic sustainability of coastal communities through the integration of local wisdom with a mathematical approach. Meanwhile, previous studies contribute to the preservation of local culture while providing innovation in mathematics learning through the exploration of real cultural objects. In terms of main objectives, this study aims to understand the influence of cultural factors on economic success in the operational context of traditional fishermen. In contrast, previous studies aim to explore mathematical concepts in local culture and apply them in more contextual and concrete mathematics learning [16], [17].

This study will integrate Traditional Navigation Knowledge and Ethnomathematics to develop a new understanding of the role of mathematical concepts in local culture, such as symmetry, spatial shapes, and plane shapes found in coastal community cultural artifacts, in supporting the operational success of traditional fishermen [18]. This aims to show how mathematical principles can improve the efficiency of fishermen's navigation practices which have so far been empirical. With a multidisciplinary approach that combines quantitative SEM-PLS methods and qualitative approaches, this study will provide a more holistic picture of the interaction between culture, traditional knowledge, and mathematical theory, and their relationship to the economic success of fishermen. In addition, this study will apply the concept of ethnomathematics in the context of coastal economics to improve the welfare and sustainability of traditional fishermen's operations, expanding the application of mathematical concepts that were previously limited to educational contexts. This study will also develop a model

that combines local wisdom with mathematical principles to create a more efficient and sustainable local wisdom-based economic development strategy, thereby contributing to strengthening the economy of coastal communities.

This research has significant implications in various aspects, both in education, economy, and preservation of local culture. In terms of education, this research can enrich the mathematics learning curriculum by including elements of local culture as contextual and concrete learning sources. In the economic context, the results of this study can contribute to increasing the operational efficiency of traditional fishermen by applying mathematical concepts in navigation practices and sea activities. In addition, this research can also be a basis for developing policies that support the economic sustainability of coastal communities through the use of local wisdom and mathematical principles [19]-[21].

The urgency of this research lies in the need to integrate traditional and scientific knowledge in addressing the challenges faced by coastal communities, especially traditional fishermen. The sustainability of traditional fishermen's operations is highly dependent on the efficiency of navigation and the utilization of existing natural resources. Meanwhile, the preservation of local culture containing ethnomathematics elements also needs to be considered as part of efforts to maintain cultural identity while contributing to education and the economy. Thus, this research is very relevant to bridge traditional knowledge and mathematical approaches in the context of a sustainable economy [22]-[24].

The main objective of this study is to examine and understand the influence of Traditional Navigation Knowledge and the Utilization of Ethnomathematics on the operational success of traditional fishermen. This study aims to explore how mathematical concepts contained in local culture can improve efficiency in fishermen's navigation practices. In addition, this study aims to develop a model that integrates local wisdom with mathematical principles to support the economic sustainability of coastal communities. Another objective is to contribute to the development of mathematics learning based on local culture, which is relevant to the context of daily life of coastal communities [25], [26].

2. RESEARCH METHOD

This research design uses a quantitative approach with a survey method. Data analysis was conducted using Partial Least Squares Structural Equation Modeling (SEM-PLS) to test the relationship between latent variables, namely traditional navigation knowledge, utilization of ethnomathematics, and the success of traditional fishermen's operations. This approach was chosen because it is able to identify direct and indirect relationships between variables and supports model analysis with a relatively small sample size [27]-[29].

The population in this study were traditional fishermen who live in the coastal areas of Indonesia. The sampling technique used the purposive sampling method, with the first criteria, fishermen who have been actively carrying out traditional fishing activities for at least 5 years, second using traditional navigation knowledge in their operations, and finally practicing mathematical principles in sea activities [30], [31].

The instrument used was a closed questionnaire with a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire was designed to measure.

Table 1. Traditional Navigation Knowledge Indicators

Indicator	Statement
Understanding Direction Based on Natural Phenomena	1. Ability to read the direction of the wind based on the position of the sun. 2. Ability to determine direction using the position of the stars at night. 3. Understanding of seasonal wind patterns (e.g. land breeze and sea breeze).
Ocean Current Reading Techniques	1. Ability to identify ocean currents that are beneficial for navigation. 2. Knowledge of the types of local currents that often occur in local waters. 3. Ability to estimate water depth based on wave color or characteristics.
Interpretation of Weather Conditions	1. Ability to recognize signs of weather changes through changes in clouds, wind, or air pressure. 2. Understanding of seasonal weather patterns, such as the rainy season and the dry season. 3. Knowledge of the dangers of extreme weather and strategies to avoid them.

Knowledge About Fishing Grounds	1. Understanding of strategic locations for fishing based on traditional experience. 2. Ability to identify productive areas based on environmental characteristics (e.g., presence of seabirds). 3. Knowledge of the best time to fish at a particular location
Experience and Practical Skills	1. Frequency of use of traditional navigation in seafaring activities. 2. Mastery of traditional navigation techniques compared to the use of modern technology. 3. Ability to teach or transfer traditional navigation knowledge to others

Table 2. Ethnomathematics Utilization Assessment Indicators

Indicator	Statement
Distance and Direction Calculation	1. Ability to estimate distance using traditional tools (e.g. measuring rope or direct observation). 2. Accuracy in determining direction of travel using star positions or other natural phenomena. 3. Utilization of simple geometric principles in determining position at sea.
Determining Travel Time	1. The ability to calculate travel time based on the position of the sun or changes in ocean waves. 2. Utilization of the tidal cycle to determine the best time to go to sea. 3. Use of traditional tools, such as hourglasses or shadows of objects, to estimate time.
Fishing Gear Management	1. Knowledge of spacing between fishing gear (e.g., nets or fish traps) based on certain patterns. 2. Ability to manually calculate boat loads and capacities to ensure catch efficiency. 3. Utilization of mathematical principles in selecting optimal locations for placing fishing gear.
Application of Mathematical Patterns in Navigation	1. Understanding of mathematical patterns related to wind direction or ocean waves. 2. Using repetition or cycles in planning ocean voyage routes. 3. Applying simple calculations to predict changes in weather or waves.
Traditional Mathematics Skills in Fishermen's Operations	1. Ability to use manual calculations to determine optimal catches. 2. Application of mathematical-based strategies to maximize boat fuel usage. 3. Understanding of ratios and proportions used in dividing catches or other resources.

Table 3. Indicators of Success of Traditional Fishermen Operations

Indicator	Statement
Quantity and Quality of Catch	1. The number of daily fish catches that meet the target economic needs. 2. The quality of the catch (freshness and types of fish that are of high value in the market). 3. Consistency of the catch during a certain period.
Time and Resource Efficiency	1. Time spent searching for fishing locations compared to the results obtained. 2. Efficiency of fuel use while at sea. 3. Effective use of time in the process of going to sea, from preparation to returning to land.
Continuity of Operations	1. The level of ability to fish sustainably without damaging the marine environment.

	2.	The use of environmentally friendly fishing techniques and maintaining fish populations.
	3.	Availability of adequate fishing equipment that can be used in the long term.
Fisherman's Satisfaction	1.	Level of satisfaction with the catch that supports the family's economic needs.
	2.	Satisfaction with the effectiveness of navigation techniques and traditional methods used.
	3.	Level of pride in preserving traditional fishing traditions.
improving economic welfare	1.	Daily or monthly income that meets the basic needs of the family.
	2.	Ability to save or invest in new fishing equipment.
	3.	Improvement in the quality of life of fishing families from the results of fishing operations.

Table 4. Validity and Reliability Test of Instruments Tested Using Average Variance Extracted (AVE) and Competitive Reliability (CR)

Variables	Indicator	Factor Loading	AVE	CR	Information
Traditional Navigation Knowledge	Understanding direction based on natural phenomena	0.72, 0.81, 0.76	0.60	0.85	Valid and Reliable
	Ocean current reading techniques	0.78, 0.80	0.62	0.83	Valid and Reliable
Utilization of Ethnomathematics	Interpretation of weather conditions	0.79, 0.74	0.59	0.81	Valid and Reliable
	Calculation of distance and direction	0.76, 0.80	0.61	0.83	Valid and Reliable
	Determining travel time	0.77, 0.78	0.60	0.82	Valid and Reliable
	Fishing gear management	0.81, 0.74	0.62	0.84	Valid and Reliable
	Integration of local knowledge and modern mathematics	0.78, 0.80	0.62	0.83	Valid and Reliable
Success of Traditional Fishermen Operations	Quantity and quality of catch	0.82, 0.79	0.65	0.85	Valid and Reliable
	Time and resource efficiency	0.78, 0.76	0.60	0.82	Valid and Reliable
	Fisherman's satisfaction	0.79, 0.81	0.64	0.84	Valid and Reliable

Factor loading is a measure that describes the relationship between statements in a questionnaire and its indicators, where a factor loading value above 0.7 is considered to meet the validity requirements. This value indicates the extent to which each statement in the instrument can significantly represent a particular indicator. Meanwhile, Average Variance Extracted (AVE) is used to measure the convergent validity of each latent variable, with an AVE value above 0.5 considered valid. This indicates that the latent variable is able to explain more than half of the variance of the indicators that measure it. On the other hand, Composite Reliability (CR) is a measure that assesses the internal consistency of an instrument, where a CR value above 0.7 indicates that the instrument has a good level of reliability. Thus, if the factor loading, AVE, and CR values meet the established criteria, then the instrument can be considered valid and reliable for use in research [32], [33].

Data were collected through field surveys using questionnaires distributed directly to respondents. Researchers also conducted surveys in the form of short interviews and direct observations to ensure that respondents understood each statement. Data analysis was carried out in three stages, the first Validity and Reliability Test, Using AVE to measure convergent validity and CR to measure the internal consistency of the instrument. Structural Model Analysis (Inner Model) Testing the relationship between latent variables using path coefficients, t-values, and p-values. Model Fit Testing Ensuring that the research model meets the fit criteria using parameters such as R-square [34], [35].

3. RESULTS AND DISCUSSION

This study aims to identify the relationship between traditional navigation knowledge, the use of ethnomathematics, and the success of fishermen's operations. The focus of the study is directed at how these variables are interrelated and contribute to increasing the results and efficiency of fishermen's activities. Data were collected through instruments designed based on specific indicators for each variable. In the Traditional Navigation Knowledge variable, the indicators used include understanding directions based on natural phenomena, techniques for reading ocean currents, and interpretation of weather conditions. This variable is considered as one of the important elements that reflect the ability of fishermen to utilize local knowledge in the navigation process.

Furthermore, in the variable of Ethnomathematics Utilization, the study focuses on the aspects of calculating distance and direction, determining travel time, managing fishing gear, and integrating local knowledge and mathematics. These indicators represent the extent to which fishermen combine local knowledge with mathematical concepts to improve the effectiveness of their operations. The variable of Fishermen's Operation Success is measured through indicators of the quantity and quality of catch, efficiency of time and resources, and the level of fishermen's satisfaction. This variable is used to evaluate the impact of traditional navigation knowledge and ethnomathematics on the final results of fishermen's operations. Before the data was analyzed further, validity and reliability tests were conducted to ensure that the instruments used were able to measure the intended concepts consistently and accurately. The results of the validity and reliability tests will then be the basis for supporting the findings and interpretation of the results of this study.

Table 4. Validity and Reliability Test

Variable	Indicator	Factor Loading	AVE	CR	Information
Traditional Navigation Knowledge	Understanding direction based on natural phenomena	0.72, 0.81, 0.76	0.60	0.85	Valid and Reliable
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	Interpretation of weather conditions	0.79, 0.74	0.59	0.81	Valid and Reliable
Utilization of Ethnomathematics	Calculation of distance and direction	0.76, 0.80	0.61	0.83	Valid and Reliable
	Determining travel time	0.77, 0.78	0.60	0.82	Valid and Reliable
	Fishing gear management	0.81, 0.74	0.62	0.84	Valid and Reliable
	Integration of local knowledge and mathematics	0.78, 0.80	0.62	0.83	Valid and Reliable
Fisherman Operation Success	Quantity and quality of catch	0.82, 0.79	0.65	0.85	Valid and Reliable
	Time and resource efficiency	0.78, 0.76	0.60	0.82	Valid and Reliable
	Fisherman's satisfaction	0.79, 0.81	0.64	0.84	Valid and Reliable

Traditional navigation knowledge contributes significantly to the success of fishermen's operations with a path coefficient of 0.45. This shows that a deep understanding of the direction, ocean currents, weather, and strategic fishing locations that are inherited from generation to generation is an important asset for fishermen. By using traditional navigation techniques, fishermen are able to determine safe routes, minimize the risk of extreme weather, and find productive fishing locations. These results are in line with previous literature that highlights the importance of local wisdom in maintaining the economic sustainability of coastal communities. This traditional knowledge, in addition to helping fishermen increase their catch, also plays a role in maintaining the sustainability of the marine ecosystem through more environmentally friendly fishing techniques.

The use of ethnomathematics has a significant influence on the success of fishermen's operations with a path coefficient of 0.36. Ethnomathematics allows fishermen to utilize mathematical principles hidden in local practices, such as calculating distance, direction, time, and managing fishing gear. For example, fishermen use tidal cycles and mathematical patterns of wind or ocean waves to determine the optimal time and location to go to sea. This finding strengthens the argument that ethnomathematics can bridge local wisdom and modern science, creating an innovative and practical approach to solving operational problems of traditional fishermen.

Table 5. Structural Model Test Results (Path Coefficients, T-Statistic, P-Values)

Variabel Independen	Variabel Dependen	Path Coefficient	T-Statistic	P-Value	Information
Traditional Navigation Knowledge	Fisherman Operation Success	0.45	3.21	0.002	Significant
Utilization of Ethnomathematics	Fisherman Operation Success	0.36	2.81	0.005	Significant

The structural model shows that both independent variables together explain 60% of the variation in the success of fishermen's operations. This confirms that the integration of traditional knowledge and the use of ethnomathematics has a major impact on the success of fishermen's operations. These results indicate that although modern technology has been widely used in the fisheries sector, the value of local wisdom remains relevant and can even be an important complement in facing modern challenges, such as climate change and environmental degradation.

Table 6. Model Fit Test (R-Square)

Dependent Variable	R-Square
Fisherman Operation Success	0.60

The results of the model fit test show that the dependent variable of Fishermen's Operation Success has an R-Square value of 0.60. This value indicates that 60% of the variation in Fishermen's Operation Success can be explained by two independent variables, namely Traditional Navigation Knowledge and Utilization of Ethnomathematics. The remaining 40% is influenced by other factors not included in this research model.

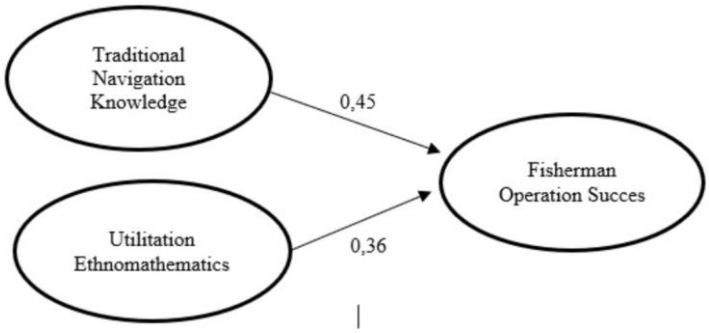

Figure 1. Structural Model Chart (Path Model)

This path model describes the relationship between latent variables, namely Traditional Navigation Knowledge, Utilization of Ethnomathematics, and Success of Fishermen's Operations. This model shows a direct influence of Traditional Navigation Knowledge on the Success of Fishermen's Operations with a path coefficient of 0.45. In addition, Utilization of Ethnomathematics also has a direct influence on the Success of Fishermen's Operations with a path coefficient of 0.36. The path model diagram illustrates this relationship through connecting lines between latent variables, with path coefficient values displayed along each path, providing a clear visualization of the strength and direction of the relationship between variables. This model provides important insights into the factors that influence the success of fishermen's operations, especially from the aspects of traditional knowledge and the application of ethnomathematics [36], [37].

This research makes an important contribution in promoting traditional values and culture-based approaches as a way to improve the welfare of coastal communities. By understanding how local wisdom such as traditional navigation and ethnomathematics can be effectively applied, community development policies and programs can be designed to support the sustainability of maritime culture and improve the quality of life of fishermen [38]-[40].

The findings also provide a basis for further research to explore the integration of modern science and local wisdom in other sectors. For policy makers, the results of this study indicate the importance of investing in culture-based training for traditional fishermen, which not only preserves traditions but also increases their capacity to cope with global change. In addition, policies that support the preservation of maritime culture and the development of locally-based technologies need to be prioritized to ensure social, economic and environmental sustainability.

This study reveals that both traditional navigation knowledge and the use of ethnomathematics have a significant influence on the success of traditional fishermen's operations in Indonesia. These results support the hypothesis that local wisdom and a culture-based scientific approach can improve the effectiveness and efficiency of fishermen's activities [41], [42].

Based on previous research, there is a gap analysis of this research. That the research "The Influence of Traditional Navigation Knowledge and Utilization of Ethnomathematics on the Success of Traditional Fishermen's Operations" and the research "Ethnomathematics in Mathematics Learning through the Traditional Game of Makkudendeng" show that ethnomathematics is effective in improving the achievement of activities in their respective fields. Both emphasize the importance of the contribution of local culture as a practical approach to success. In the navigation research, the ethnomathematics approach helps fishermen improve operational efficiency, catches, and economic sustainability. Meanwhile, in the makkudendeng research, this approach increases students' interest in learning by 29.65% and strengthens their understanding of basic mathematical concepts. Both studies also show how the integration of traditional knowledge and modern scientific principles can provide optimal benefits, both in professional and educational contexts [43]-[45].

However, there is a significant gap in the orientation of the findings of these two studies. Navigation research focuses on increasing productivity and economic sustainability of coastal communities with broad implications for marine resource management and preservation of maritime culture. In contrast, makkudendeng research is oriented towards the micro-context of education, which has a direct impact on students' interests and understanding in the classroom. Navigation research highlights the social relevance in environmental and economic sustainability, while makkudendeng contributes to the preservation of local traditions through children's education. This gap shows the great potential of ethnomathematics in various sectors and underlines the need for further exploration for more synergistic and sustainable applications [46]-[48].

Based on the gap analysis, the novelties that can be proposed for this research include the integration of traditional navigation knowledge and ethnomathematics into the formal training curriculum for young fishermen, creating continuity between the transfer of local cultural knowledge and modern science-based education. In addition, the research can adopt modern technology, such as digital map-based applications that utilize traditional navigation data to improve fishermen's operational efficiency. Evaluation of the long-term impact of this application on the economic, social, and environmental sustainability of coastal communities is also important to provide deeper insights. Other novelties include the exploration of ethnomathematics applications in marine resource management or the development of environmentally friendly fishing technologies, as well as the development of multidisciplinary models that integrate ethnomathematics with marine science, ecology, and technology. This innovative approach not only enriches academic literature, but also provides real impacts in facing the challenges of modernization, preserving local culture, and supporting the sustainability of coastal communities.

This research has significant implications in various aspects. From an economic perspective, the research results can be the basis for improving the operational efficiency of traditional fishermen through the integration of local navigation knowledge and ethnomathematics principles, which can ultimately increase income, optimize marine resource management, and support the economic sustainability of coastal communities. In terms of social and cultural aspects, this research helps preserve traditional knowledge and local culture that are threatened with loss due to modernization, while strengthening the cultural identity of fishing communities and motivating the younger generation to appreciate and practice local wisdom. From a policy perspective, the findings of this research can be used as recommendations for policy makers to develop training programs for fishermen based on ethnomathematics, including environmentally friendly fishing technologies rooted in traditional knowledge. In the realm of education, this research opens up opportunities to design formal training curricula for fishermen by combining traditional navigation knowledge and modern mathematical approaches, thus providing real contributions to the development of the non-formal education sector that is relevant to the needs of coastal communities [49], [50].

This study has several limitations that need to be considered. First, the scope of the study area is limited to traditional fishermen in certain areas, so the results may not fully represent traditional fishermen throughout Indonesia who have different cultural variations and navigation practices. Second, the data collection method that relies on interviews and surveys can cause respondent bias or inaccuracy in collecting information, because it is based on individual perceptions. Furthermore, this study only focuses on the influence of traditional navigation knowledge and the use of ethnomathematics, while other factors such as the use of modern technology, fisheries policies, or marine ecosystem conditions have not been analyzed in depth. Finally, this study is cross-sectional and does not evaluate the long-term impact of the integration of traditional knowledge and ethnomathematics on the economic and social sustainability of fishermen.

For further research, several recommendations can be considered to expand and deepen this study. First, expanding the research area to other coastal areas with different maritime cultures and navigation practices will provide more comprehensive insights into the relevance and effectiveness of ethnomathematics in various cultural contexts. In addition, the use of longitudinal data is recommended to evaluate the long-term impact of the

application of traditional navigation knowledge and ethnomathematics on the sustainability of fishermen's operations. Future research can also examine the potential for integrating modern technology, such as GPS devices based on traditional data, to support fishermen's operational efficiency without ignoring cultural values. A multidisciplinary approach, combining marine science, ecology, and economics, is also important to understand the influence of other factors on the operational success of traditional fishermen. This study can be a basis for designing training programs that combine traditional navigation, ethnomathematics, and modern technology, as well as providing recommendations for policy makers to support the preservation of maritime culture and the economic sustainability of fishermen. In addition, comparative research comparing the effectiveness of ethnomathematics with other modern methods will also provide important contributions in evaluating the advantages of a culture-based approach. By considering these limitations and recommendations, future research is expected to provide broader and deeper contributions to support the economic, social, and cultural sustainability of coastal communities.

4. CONCLUSION

This study confirms that Traditional Navigation Knowledge and the Utilization of Ethnomathematics have a significant role in the success of traditional fishermen's operations in Indonesia, with path coefficients of 0.45 and 0.36 respectively, explaining 60% of the variation in fishermen's success. Traditional navigation knowledge, as part of local wisdom, helps fishermen determine direction, read ocean currents, predict the weather, and choose fishing locations, while ethnomathematics allows for the optimization of fishing strategies through the application of culturally based mathematical principles. The integration of these two aspects is an effective solution to improve the effectiveness and efficiency of traditional fishermen's operations while supporting the economic and social sustainability of coastal communities. This study also provides a basis for the development of culture-based policies and training programs to preserve maritime traditions and face global challenges such as climate change and exploitation of marine resources.

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