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Analysis of digital-based sustainable fishermen cooperative risk management in Pangandaran Regency

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ABSTRAK

Introduction

Fishermen's cooperatives face various external challenges such as fish price fluctuations, climate change and environmental damage.

Objectives

This research analyzes the risk management of digital-based fishing cooperatives in Pangandaran Regency in the context of implementing the Blue Economy.

Method

This research uses a mixed methods approach with a sequential explanatory design. Quantitative data was obtained through a survey of 233 members of the Minasari Village Unit Cooperative (*Koperasi Unit Desa* abbreviated KUD in Bahasa Indonesia), while qualitative data was collected through interviews and case studies.

Results

The research results show that the implementation of a cloud computing-based Management Information System (MIS) has the potential to strengthen risk management and support better governance in cooperatives.

Implications

MIS can also increase transparency and operational efficiency, support the implementation of Blue Economy principles, and encourage the long-term sustainability of cooperatives through real-time data management and system integration.

Originality/Novelty

This study contributes to studies on digitalization of cooperatives to strengthen adaptation to complex environmental and economic challenges in the digital era.

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INTRODUCTION

In an era of increasingly complex external environmental uncertainty, fishing cooperatives face significant challenges in maintaining the sustainability of their business due to factors such as fish price fluctuations, vulnerability to natural disasters, and climate change (Kasim et al., 2023; Rambo, 2017). These factors pose a real threat to the business continuity of fishing cooperatives (Gavilanes et al., 2023). To achieve the vision of a sustainable Blue Economy, responsive and comprehensive risk management is needed to reduce the negative impact of these external environmental factors (Ibourk & El Aynaoui, 2023). For example, Malaysian consumer cooperatives during the COVID-19 pandemic faced challenges such as reduced income and supply shortages, which they overcame through business innovation, government assistance, and technology adoption (Zakaria et al., 2022). Likewise, the aquaculture feed industry is exploring alternatives such as black soldier fly (magot) larvae to address fluctuations in fish feed prices and supplies (Kari et al., 2023). In addition, the resilience and sustainability of cooperatives in economic challenges can be strengthened by diversification and development of Business Continuity Plans (Bartolome et al., 2022). A study of smoked fish marketing practices in Nigeria also recommended the formation of cooperatives to facilitate access to financial resources (Abolagba et al., 2023). These examples emphasize the need for fishing cooperatives to adopt innovative strategies and utilize technology to manage risks effectively and sustainably in the context of the Blue Economy.

A number of previous studies have highlighted the role of fishing cooperatives as providing significant contributions to socio-economic empowerment and market access for their members, as proven by studies in various regions. For example, the close relationships in the Pa'belle fishing community in Luwu Regency show the role of social capital in economic progress (Bidayani et al., 2023). Similarly, in India, Self-Help Groups (SHGs) and the Tamil Nadu State Apex Federation of Fisheries Cooperatives (TAFCOFED) have demonstrated how cooperatives and SHGs can empower fishing communities by ensuring access to credit and facilitating better market access (Chen & Huang, 2023). These cooperatives not only improve the economic conditions of fishermen but also serve as platforms for sharing knowledge and resources, thereby increasing their resilience to external changes such as climate change and market dynamics (Bidayani et al., 2023; Zairion et al., 2024). However, previous research mostly focused on the socio-economic domain for implementing the Blue Economy in fishing cooperatives. Therefore, further research that focuses on analyzing the risk management of digital-based sustainable fishing cooperatives in the context of implementing the Blue Economy becomes relevant to complete the understanding of the complex dynamics in the marine and fisheries sector.

This research aims to analyze the risk management of digital-based fishing cooperatives in Pangandaran Regency in the context of implementing the Blue Economy on the southern coast of West Java. Acceleration of the implementation of the Blue Economy in southern West Java, especially in Pangandaran Regency. Pangandaran Regency, in implementing the Blue Economy, faces challenges commonly experienced by coastal communities in Indonesia. These challenges include environmental degradation, overfishing, and climate change which require sustainable approaches to balance the use and conservation of marine resources (Hakim et al., 2023; Rudi, 2023; Susandi et al., 2024). The Blue Economy concept emphasizes the sustainable use of marine resources to improve livelihoods and economic growth while maintaining the health of marine ecosystems (Susandi et al., 2024). This acceleration is also in line with sustainable development goals and efforts to mitigate the impacts of climate change. The increasingly complex conditions of uncertainty in the external environment require fishing cooperatives to adopt a responsive and comprehensive risk management approach. By utilizing cloud-based applications and big data analytics, fishing cooperatives can collect, analyze and utilize data efficiently to identify, evaluate and respond to the risks they face. This approach not only allows fishing cooperatives to overcome existing challenges but also makes a significant contribution to the development of responsive and adaptive risk management practices to support the accelerated implementation of the Blue Economy on the southern coast of West Java.

LITERATURE REVIEW

Risk Management

Risk management is a systematic process of identifying, analyzing, assessing and controlling the risks faced by an organization to minimize the negative impact that could occur on organizational goals (Ameer, 2018; Aven, 2016; Bromiley et al., 2015; Torabi et al., 2016). In fishing cooperatives, risk management functions to ensure that the cooperative is able to overcome various challenges, both from personnel, technological, social and sustainability aspects. Risk management includes the following:

- Personnel Risk: Level of member involvement in cooperative activities, satisfaction with services provided, as well as member training and development.
- Technology or System Risk Technology or System Risk: Use of digital-based systems, frequency of disruptions in cooperative operational processes, data security, and time for recording business activities.
- Social Risk: Cooperative reputation, participation in welfare activities, and involvement with stakeholders.
- Sustainability Risk: Profitability of cooperative activities, operational performance and innovation carried out by cooperatives.

Management Information System (MIS)

Management Information Systems (MIS) are systems used to manage, integrate and store important data of an organization efficiently, allowing easy access to information needed for decision making (Md. M. Ali, 2019; Grover et al., 2018; Intezari & Gressel, 2017; Knauer et al., 2020; Ren, 2022). In the context of fishing cooperatives, MIS enables real-time management of finances, member data and facilities and supports better governance.

Management Information Systems includes five dimensions (Md. M. Ali, 2019):

- Financial Management: Online and real-time input of financial transactions, automation of financial reports, and automatic calculation of income and expenses based on transaction data.
- Member Data Management: Input member and savings data online and in real-time.
- Facility Use: Recording of cooperative facilities and real-time data for decision making.
- Data Integration: Integrating financial transaction data with member data and securing access to member data.
- Security and Privacy: Protect data with passwords and limited access controls.

Blue Economy

Blue Economy (Wuwung, McIlgorm, & Voyer, 2024) is a concept of sustainable economic development in the marine and fisheries sector, with the aim of maintaining a balance between economic growth, environmental sustainability and social welfare (Choudhary et al., 2021; Eikeset et al., 2018; Martínez-Vázquez et al., 2021; Spalding, 2016; Wuwung et al., 2024). In fishing cooperatives, implementing the Blue Economy involves environmentally friendly, efficient and innovative fishing practices to support sustainability.

Blue Economy consists of three main dimensions (Wuwung et al., 2024):

- Economic Pillar: Efficiency and sustainability of fisheries production, diversification of businesses other than fisheries, and supply chain efficiency that reduces carbon emissions.
- Environmental Pillar: Marine conservation efforts, adoption of environmentally friendly technology, reduction of marine pollution, and training of fishermen regarding practices that reduce negative impacts on the environment.
- Social Pillar: Welfare of fishermen through increasing income, providing training and education programs, as well as improving occupational health and safety.

Good Corporate Governance

Good Corporate Governance (GCG) is the principles of good governance which aim to increase transparency, accountability and responsibility in managing an organization (Adegbite, 2015; Cahyandito & Pau, 2017; Mahrani & Soewarno, 2018;

Rodriguez-Fernandez, 2016; Sofyani et al., 2020). GCG aims to ensure that fishing cooperatives are managed efficiently and fairly, so that they can maintain the trust of members and stakeholders.

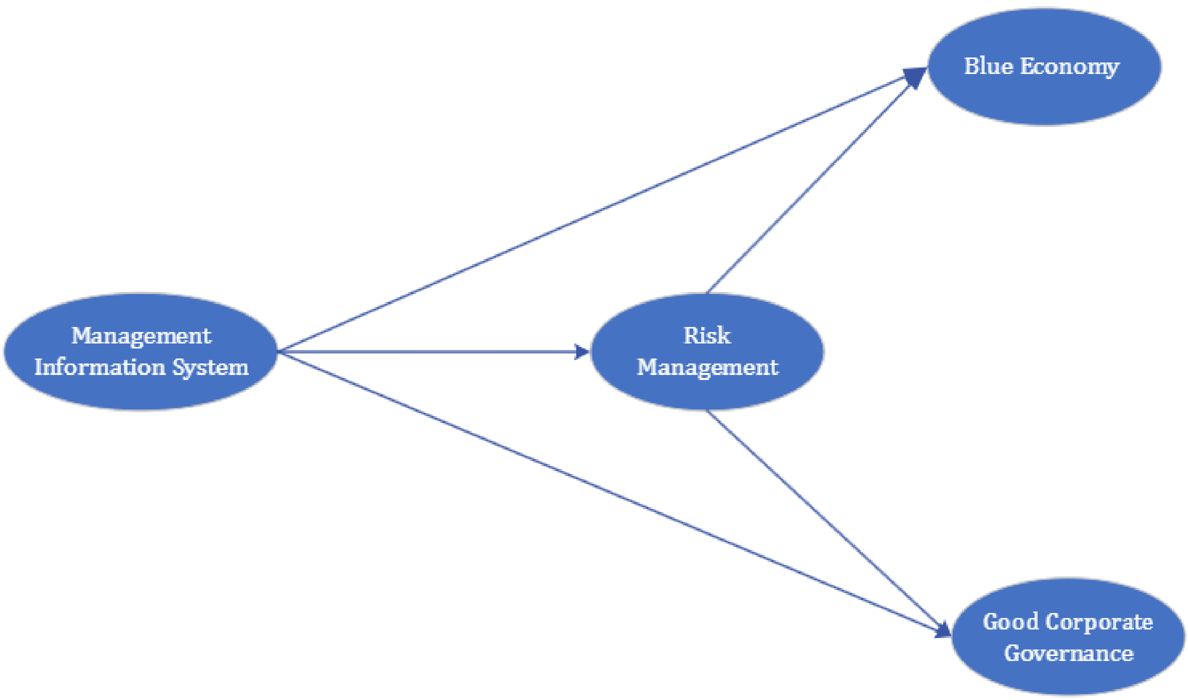
Good Corporate Governance includes the following aspects (Cahyandito & Pau, 2017):

- Transparency: Open delivery of financial-related information and easy access for members to cooperative information.
- Accountability: The management is accountable for the operations and finances of the cooperative, as well as the existence of a clear audit mechanism.
- Responsibilities: Compliance with environmental and fisheries regulations and cooperative commitment to social responsibility.
- Independence: Independent decision making without outside intervention.
- Fairness: Fair treatment of all members, including the distribution of profits and decision-making rights.

The structural relationship model between variables taking into account the indicator aspects can be described as follows:

Figure 1

Management Information System, Risk Management, Blue Economy, GCG Correlation Structure Model



Source: Authors' analysis.

METHOD

This research uses a mixed methods approach with a sequential explanatory design (Li et al., 2015; Subedi, 2016) to understand the risk management of digital-based sustainable fishing cooperatives in Pangandaran Regency, with a focus on accelerating the implementation of a digital-based Blue Economy. The research sample was the Village Unit Cooperative (KUD) of Minasari fishermen, Pangandaran Regency, which was selected based on representative criteria, including geographical locations in sub-districts in Pangandaran Regency. Apart from that, the size of the cooperative is also an important criterion. The sample selected was 233 KUD Minasari members with cooperative assets > IDR 2 billion. This research uses the Proportionate Stratified Random Sampling method, which allows random samples to be taken from each stratum based on the proportion of the population in each stratum (Iliyasu & Etikan, 2021).

This research was conducted in two main phases: quantitative phase and qualitative phase. In the quantitative phase, data will be collected using questionnaires or online surveys to measure indicators such as the level of adoption of digital-based risk management and its effectiveness in supporting the Blue Economy. Data analysis was carried out using the Partial Least Squares (PLS) method via the SmartPLS application version 4.1.0.0 (Hair et al., 2019). The results of this phase will be statistical data that illustrates the influence of external factors on the sustainability of fishing cooperatives. This phase is followed by a qualitative phase which aims to explore the quantitative results through in-depth interviews, case studies and observations to provide deeper insight into the challenges and strategies used by fishing cooperatives in managing risk. Informants in the qualitative phase will involve KUD Minasari stakeholders in Pangandaran Regency, including cooperative administrators, fishermen, local partners, as well as local government parties who play a role in the regulation and development of fishing cooperatives.

RESULTS

Descriptive Analysis Measurement of these indicators is carried out quantitatively, namely by giving scores to respondents' perceptions of various aspects of each indicator. Overall, respondents' perceptions of variables related to Digital-Based Sustainable Fishermen's Cooperative Risk Management Analysis based on the most answers are presented in Table 1.

Based on descriptive analysis of fishing cooperative risk management variables, overall, the risks faced are in the poor to moderate category with an average score of 2.647. Personnel risk dimensions, such as involvement in cooperative activities, service satisfaction, and training and development, received relatively poor scores, indicating the need for increased involvement and development of human resources. Technological or system risks are also in the same category, especially in the use of digital-based systems, data security, and recording time, which indicates an urgent need for technological strengthening. On the other hand, social risk shows moderate results, with reputation, participation and stakeholder engagement at a fairly good level, although there is still room for improvement. The sustainability risks related to profitability, operational performance and innovation also still need to be improved, because they are currently in the poor to moderate category.

Table 1

Risk Management Index at Minasari Fishermen's Cooperative Members, Pangandaran Regency

Risk Management Variables		
Dimensions	**Indicators**	**Average**
Personnel Risk	1. Level of Involvement in Cooperative Activities	2.592
	2. Satisfaction of Cooperative Services provided to Fishermen	2.472
	3. Training and Development carried out by the Cooperative	2.489
Technology or System Risks	1. Use of digital-based systems	2.485
	2. Frequency of disturbances in the process of cooperative activities	2.554
	3. Data security and auctions	2.545
	4. Time for recording cooperative business activities	2.515
Social Risk	1. Reputation in Cooperatives	3.063
	2. Participation in welfare activities	3.045
	3. Engagement with stakeholders	3.067
Sustainability Risk	1. Profitability of cooperative activities	2.554
	2. Operational Performance	2.494
	3. Innovation carried out by Cooperatives	2.532
Total		2.647

Source: Primary data. Authors' estimation.

In this context, the urgency of establishing a digital-based operational risk management application in the form of a Management Information System (MIS) becomes very important. This application will not only help manage risk more efficiently, but also support better cooperative governance by utilizing digital technology. Through MIS, cooperatives can monitor, analyze and respond to risks in real-time, increasing transparency, accountability and operational effectiveness. With proper implementation, MIS will strengthen the sustainability of cooperatives and support the achievement of good governance, which is important for fishing cooperatives in facing complex challenges in the digital era and in implementing the Blue Economy.

Table 2

Management Information System Index at Minasari Fishermen's Cooperative Members, Pangandaran Regency

Management Information System Variables		
Dimensions	**Indicators**	**Average**
Financial Management	1. Financial transactions can be entered online, and transaction data can be stored in real-time	3.014
	2. Financial reports can be generated automatically, including income, expense and balance reports	3.044
	3. Total income and expenses can be calculated automatically based on existing transaction data	3.022
Member Data Management	1. Member data can be entered online, and member data can be stored in real-time	2.541
	2. Member savings can be entered online, and savings data can be saved in real-time	2.567
Use of Facilities	1. The facilities used can be entered online, and facility data can be stored in real-time	2.597
	2. Real-time data can be accessed by users for decision-making	2.562
Data Integration	1. Financial transaction data can be integrated with member data and sales/purchase data automatically	2.502
	2. Member data can only be accessed by authorized people and cannot be shared with other parties without permission	2.588
Security and Privacy	1. The data entered can be protected with a password and limited access	2.485
	2. Member data can only be accessed by authorized people and cannot be shared with other parties without permission	2.592
Total		2.683

Source: Primary data. Authors' estimation.

Based on descriptive analysis of Management Information System (MIS) variables in KUD Minasari, Pangandaran Regency, this system as a whole is in the poor to moderate category with an average score of 2.683. In the financial management dimension, the results show that even though financial transactions and reports can be managed digitally and automatically, performance is still at a moderate level. Member data management and facility use also show poor to moderate performance, indicating that the system does not fully support real-time data recording and effective decision making. On the other hand, aspects of data integration and privacy security also still require improvement, especially regarding stricter management of data access and protection of cooperative member information, both of which are still at a poor level.

These results strengthen the urgency of establishing a digital-based operational risk management application to improve the governance of fishing cooperatives. This application will facilitate better data integration, tighter security protection, and real-time financial and operational management, all of which are critical to supporting cooperative sustainability. With a more sophisticated information system, cooperatives can reduce operational risks, which are currently classified as poor to moderate, and support more transparent, efficient and accountable governance. The implementation of a strong MIS will also contribute to the creation of good governance in KUD Minasari Pangandaran Regency which will ultimately support the acceleration of the implementation of the blue economy in the coastal areas of Pangandaran Regency.

Table 3

Blue Economy Index at Minasari Fishermen's Cooperative Members, Pangandaran Regency

Blue Economy Variables		
Dimensions	**Indicators**	**Average**
Economic Pillars	*Efficiency and Sustainability of Fisheries Production*	
	1. Efficiency in using fishing practices that do not damage marine ecosystems	2.549
	2. Activities that encourage the use of environmentally friendly fishing gear	2.588
	3. Activities promote sustainable fish farming practices	2.442
	Economic Diversification	
	1. Business development activities other than fisheries or alternative processing of marine products	3.198
	2. Activities to increase the added value of marine products through innovation	3.133
	Supply Chain Efficiency	
	1. Efficient logistics management using environmentally friendly technology	2.300
	2. Carbon emission reduction activities in the marine product distribution supply chain	2.373
Environmental Pillar	*Preservation Efforts*	
	1. Activities support marine conservation programs and maintain fisheries ecosystems.	3.091
	2. Active efforts to reduce marine pollution from fishing and processing activities	3.009
	Use of Environmentally Friendly Technology	
	1. Adopt Technology that minimizes negative impacts on the marine environment	2.476
	2. Training fishermen to use fishing gear that reduces bycatch.	2.558
	Sustainable Tourism	
	1. Ensuring environmentally friendly marine tourism practices.	2.369
	2. Preserving marine resources through educating tourists.	2.515
Social Pillar	*Fishermen's Welfare*	
	1. Fishermen's income has increased and is more stable thanks to the implementation of the blue economy.	2.455
	2. Providing assistance and protection programs for members facing economic difficulties.	2.343
	Education and Training	
	1. Providing training to fishermen regarding sustainable fishing	2.403

Blue Economy Variables		
Dimensions	**Indicators**	**Average**
	practices	
	2. Fishermen get access to good education about marine technology and sustainability.	2.382
	Health and Safety	
	1. Supporting the health and safety of fishermen through the provision of facilities and training.	2.391
	2. Help reduce the risks of working at sea through the adoption of safer technology.	2.335
Total		2.574

Source: Primary data. Authors' estimation.

Based on descriptive analysis of the Blue Economy variable which includes three pillars (economic, environmental and social), the overall average score of 2.574 indicates poor to moderate results. Even though business diversification in developing marine products achieved a score of 3.198 (moderate), supply chain efficiency and carbon emission reduction were still low with a score of 2.300 (poor). The environmental pillar shows commitment to marine conservation and the use of environmentally friendly technology with an average score of 3.091 (moderate), but sustainable tourism practices still require improvement with a score of 2.515 (poor to moderate). On the social side, fishermen's welfare and training programs and sustainability education are in the poor to moderate category with scores between 2.455 and 2.403. In this context, the urgency of establishing a digital-based operational risk management application is very important to improve the governance of fishing cooperatives. This application will strengthen data integration, increase security, and enable real-time financial and operational management, so that cooperatives can reduce risk and support transparency, efficiency and accountability. Effective implementation of a Management Information System (MIS) will not only contribute to good governance, but also strengthen commitment to blue economy principles and support long-term sustainability in coastal areas such as Pangandaran Regency.

Table 4

Good Corporate Governance Index at Minasari Fishermen's Cooperative Members, Pangandaran Regency

Good Corporate Governance Variables		
Dimensions	**Indicators**	**Average**
Transparency	1. Open submission of financial-related information	3.001
	2. Ease of members accessing cooperative information	2.554
	3. Clarity of information about cooperative strategic policies	2.549
Accountability	1. Management's responsibility for cooperative operations and finances	3.014
	2. Periodic audit or financial inspection mechanism	3.044
	3. Management carries out its duties in accordance with applicable rules and regulations	3.022

Good Corporate Governance Variables		
Dimensions	**Indicators**	**Average**
Responsibility	1. Compliance with environmental and fisheries regulations	2.541
	2. Cooperative commitment to sustainable fishing practices	2.567
	3. Cooperative social responsibility towards society and the environment	2.597
Independence	1. Decision making is carried out without outside intervention	2.562
	2. Cooperatives are managed professionally and independently	2.502
	3. There is no domination from outside parties in managing the cooperative	3.022
Fairness	1. Fair treatment for all cooperative members	2.588
	2. Profit sharing is carried out transparently and evenly	2.485
	3. Members have equal rights in decision making	2.592
Total		2.709

Source: Primary data. Authors' estimation.

Based on descriptive analysis of the Good Corporate Governance (GCG) variable in KUD Minasari, Pangandaran Regency, the overall average score reached 2.709, indicating poor to moderate results with variations in performance in each dimension. In the transparency dimension, although the open delivery of financial information received a score of 3.001 (moderate), ease of access for members to cooperative information and clarity of strategic policies were still classified as poor with scores of 2.554 and 2.549 respectively. On the accountability side, all indicators show better results with an average score of 3.014, reflecting good management accountability for operations and finances as well as the existence of an audit mechanism. However, in the responsibility dimension, the average score of 2.541 to 2.597 indicates the need for improvement in compliance with environmental regulations and cooperative social responsibility. The independence dimension also shows poor to moderate results with a score of 2.502, while in the fairness dimension, although fair treatment for all members reaches 2.588, the distribution of profits and decision-making rights still needs improvement with scores of 2.485 and 2.592. Overall, there is an urgent need to strengthen GCG practices in KUD Minasari through the implementation of an effective management information system, in order to increase transparency, accountability and independence, as well as support the sustainability of cooperatives in the context of the blue economy.

In testing the outer model, there are two tests of measuring instruments, namely validity testing and reliability testing in terms of convergent validity and discriminant validity. Convergent validity is a test that shows the relationship between reflective items and their latent variables. The measurement of latent variables is indicated by the magnitude of the loading factor value. The provisions for decision making regarding the loading factor value are that the optimal value is > 0.7, but if the loading factor value obtained is < 0.4 then the indicator must be eliminated.

Table 5

Convergent Validity Value

Variable	Indicator Code	Loading factor	Results
Risk Management	RKB1	0.771	Valid
	RKB2	0.815	Valid
	RKB3	0.838	Valid
	RP1	0.733	Valid
	RP2	0.767	Valid
	RP3	0.811	Valid
	RS1	0.750	Valid
	RS2	0.758	Valid
	RS3	0.747	Valid
	RTS1	0.748	Valid
	RTS2	0.764	Valid
	RTS3	0.759	Valid
	RTS4	0.753	Valid
Management Information System	ID1	0.885	Valid
	ID2	0.843	Valid
	KP1	0.853	Valid
	KP2	0.841	Valid
	PDA1	0.709	Valid
	PDA2	0.687	Valid
	PF1	0.908	Valid
	PF2	0.912	Valid
	SPK1	0.742	Valid
	SPK2	0.754	Valid
	SPK3	0.688	Valid
Blue Economy	EDE1	0.643	Valid
	EDE2	0.689	Valid
	EERP1	0.898	Valid
	EERP2	0.908	Valid
	EKPP1	0.887	Valid
	EKPP2	0.749	Valid
	LPB1	0.815	Valid
	LPB2	0.715	Valid
	LTRL1	0.924	Valid
	LTRL2	0.749	Valid
	LUP1	0.656	Valid
	LUP2	0.659	Valid
	SKK1	0.885	Valid
	SKK2	0.877	Valid

Variable	Indicator Code	Loading factor	Results
	SKN1	0.893	Valid
	SKN2	0.830	Valid
	SPP1	0.892	Valid
	SPP2	0.905	Valid
	GA1	0.738	Valid
	GA2	0.735	Valid
	GA3	0.682	Valid
	GK1	0.903	Valid
	GK2	0.881	Valid
	GK3	0.876	Valid
	GKW1	0.833	Valid
Good Corporate Governance (GCG)	GKW2	0.837	Valid
	GKW3	0.844	Valid
	GT1	0.888	Valid
	GT2	0.68	Valid
	GT3	0.737	Valid
	GTA1	0.735	Valid
	GTA2	0.710	Valid
	GTA3	0.903	Valid

Source: Primary data. Authors' estimation.

Based on data from factor validity analysis, all indicators of the variables studied show valid loading factor values, with most indicators having values above 0.7, which shows a strong relationship between the indicators and their respective latent variables. On variables Risk Management, all indicators (RKB1 to RTS4) have loading factor values between 0.733 to 0.838, indicating that they are significantly reliable for measuring risk management dimensions. For variables Management Information Systems, indicators such as ID1 (0.885) and PF2 (0.912) show very strong validity, although some indicators (PDA1 and PDA2) have lower values but are still valid. In variables Blue Economy, the indicators EERP1 (0.898) and EERP2 (0.908) show a very strong relationship, while several indicators such as EDE1 (0.643) and LUP2 (0.659) are close to the minimum limit but remain valid. On the other hand, for variables Good Corporate Governance, most indicators have loading factors above 0.7, with GK1 (0.903) and GT1 (0.888) showing very strong validity, although GA3 (0.682) is below the value of 0.7 but is still accepted in the research context. Overall, the results of the analysis show that all variables studied have good validity, providing a strong basis for continuing further analysis and implementation of the proposed system in the context of fishing cooperatives in KUD Minasari, Pangandaran Regency.

Table 6

Construct Validity and Reliability

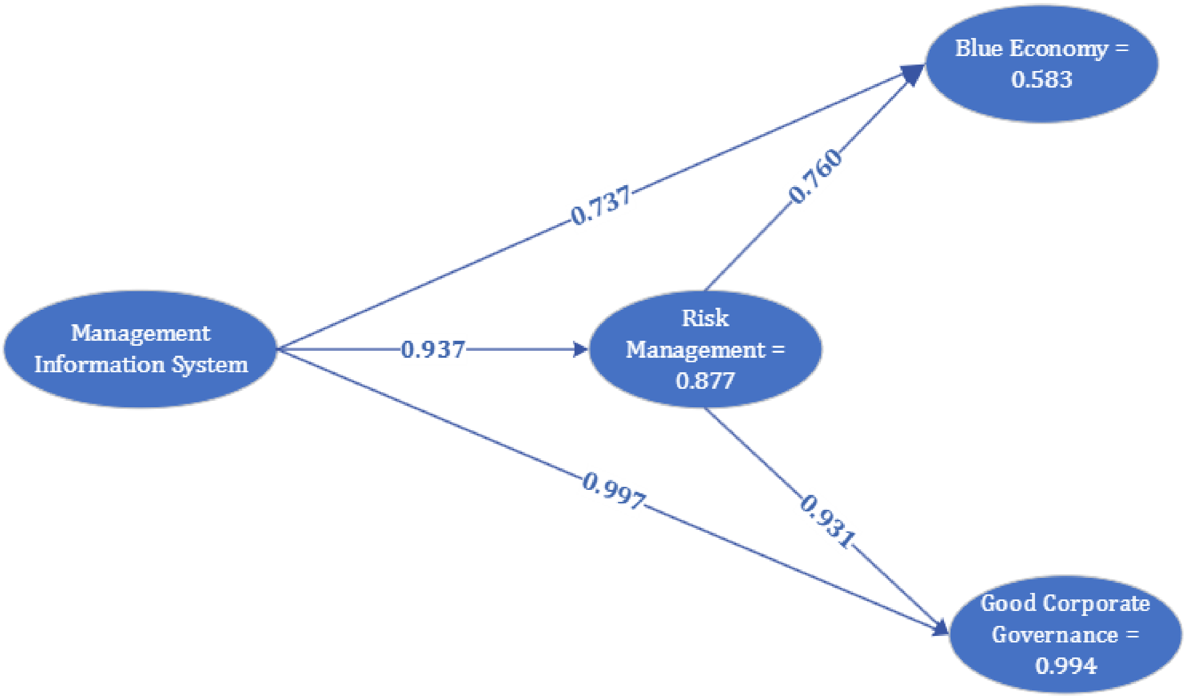
Variables	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Blue Economy	0.972	0.972	0.975	0.675
Good Corporate Governance	0.960	0.964	0.964	0.645
Management Information System	0.945	0.950	0.953	0.65
Risk Management	0.943	0.944	0.950	0.594

Source: Primary data. Authors' estimation.

Based on the results of the reliability analysis shown by the value Cronbach's alpha, composite reliability, and average variance extracted (AVE), all variables studied showed a very good level of reliability. Variable Blue Economy has a Cronbach's alpha value of 0.972, composite reliability (rho_a) 0.972, and rho_c 0.975, and AVE 0.675, indicating that the indicators used to measure this variable are very consistent and valid. Variable Good Corporate Governance (GCG) also showed good results with Cronbach's alpha 0.960, rho_a 0.964, rho_c 0.964, and AVE 0.645, which shows that GCG measurements are reliable. Furthermore, Management Information Systems had a Cronbach's alpha of 0.945, rho_a of 0.950, rho_c of 0.953, and AVE of 0.650, which also indicates a high level of consistency. Lastly, variables Risk Management showed Cronbach's alpha values of 0.943, rho_a 0.944, rho_c 0.950, and AVE 0.594, which, although slightly lower, are still within acceptable limits. Overall, the results of this analysis show that all variables studied have very good reliability, providing confidence that the measurements carried out in the context of fishing cooperatives in KUD Minasari Pangandaran Regency can be relied upon for further analysis.

Figure 2

Summarized Structural Model



Source: Primary data. Authors' estimation.

Next, a structural model (inner model) was tested to see the relationship between constructs. Figure 2 summarizes the results of the evaluation of the structural research model. Evaluation of the PLS structural model begins by looking at the coefficient of determination or R-square of each latent dependent variable. The R-Square coefficient of determination (R^2) tests the structural model for each dependent variable. The following are the results of the coefficient of determination test from this research:

Table 7

R-Square Test Results

Variables	R-square	R-square adjusted
Blue Economy	0.583	0.579
Good Corporate Governance	0.994	0.994
Risk Management	0.877	0.877

Source: Primary data. Authors' estimation.

Based on the Table of Determination Coefficient (R-Square) values for endogenous variables Blue Economy is as big as 0,583, which shows that Management Information System (MIS) as an independent variable has an influence of 58,3% to Blue Economy (dependent variable), while the remainder is equal to 41,7% influenced by other variables not tested in the research. For variables Good Corporate Governance (GCG), the R-square value reaches 0,994, shows that MIS has a very significant influence of 99,4% to GCG, until only 0,6% The variation in GCG is influenced by other factors not studied. Lastly, on variables Risk Management, R-square of 0,877 shows that MIS has an effect of 87,7% to Risk Management, with 12,3% the rest is influenced by other variables not tested. Overall, the results of this analysis show that the model applied to measure these variables is quite strong, with GCG being the most capable of explaining the variability in the data, while the Blue Economy and Risk Management also show significant contributions.

Table 8

Path Coefficient

Variables	**O**	**M**	**STDEV**	**|O/STDEV|**	**P**
Management Information System -> Blue Economy	0.201	0.200	0.163	1.232	0.218
Management Information System -> Good Corporate Governance	1.015	1.016	0.019	53.126	0.000
Management Information System -> Risk Management	0.937	0.937	0.009	102.609	0.000
Risk Management -> Blue Economy	0.571	0.573	0.160	3.564	0.000
Risk Management -> Good Corporate Governance	-0.020	-0.020	0.020	0.959	0.338

Source: Primary data. Authors' estimation. Notes: O = original sample; M = sample mean; STDEV = standard deviation; |O/STDEV| = *T* statistics; P = P values.

- Management Information System → Blue Economy: The path coefficient of 0.201 with a T-statistic of 1.232 and a p value of 0.218 indicates that this relationship not statistically significant at the general level of significance ($p < 0.05$). This means that the information management system does not have a significant influence on the blue economy in this model.
- Management Information System → GCG: The path coefficient is very strong at 1.015, with a T-statistic of 53.126 and a p value of 0.000. This shows that the relationship between the information management system and GCG very significant statistically, with a large positive effect.
- Management Information System → Risk Management: This relationship has a very strong path coefficient of 0.937, T-statistic of 102.609, and p value of 0.000, which means this relationship very significant statistically. Information management systems have a large positive influence on risk management.
- Risk Management → Blue Economy: Path coefficient of 0.571, T-statistic of 3.564, and p value of 0.000 indicates that risk management has significant positive influence towards the blue economy.
- Risk Management → GCG: This relationship is weak and not significant statistically, with a path coefficient of -0.020, T-statistic of 0.959, and p value of 0.338. This means that risk management does not have a significant influence on GCG in this model.

DISCUSSION

Relevance to Management Information System (MIS)

In descriptive analysis, the Management Information System in KUD Minasari has a poor to moderate score with an average of 2.683. MIS's performance in financial aspects, member data management, as well as data security and integration show that the system is not functioning optimally to support overall cooperative governance. This is consistent with the results of path analysis, where Management Information Systems have a significant influence on GCG (Good Corporate Governance) and Risk management, but not on the Blue Economy. Although better implementation of MIS can strengthen governance (GCG) and risk management, this system has not yet made a significant contribution in supporting the Blue Economy directly, because its implementation is still not optimal, especially regarding digital technology that supports cooperative operational efficiency (Sugiyanto & Rahayu, 2018).

Relevance to Risk Management

Descriptive analysis shows that the risk management faced by fishing cooperatives is in the poor to moderate category (average score 2.647). Especially in the personnel and technology risk dimensions, these results highlight the need for improvements in human resource management as well as strengthening the use of digital technology. In the path analysis, Risk Management has a significant influence on the Blue Economy (path coefficient 0.571, significant). Implementing better risk management will support the development of the blue economy. This means that strengthening risk management in fishing cooperatives—especially in technological aspects and personnel involvement—can help increase their contribution to the Blue Economy, especially in facing challenges related to digital technology, profitability, and sustainability (Hodgson et al., 2019).

Relevance to Good Corporate Governance

Descriptive results for GCG in KUD Minasari show an average score of 2.709 (poor to moderate). The dimensions of transparency and accountability show improvement, but the dimensions of responsibility and independence are still low. In path analysis, Management Information Systems have a very significant influence on GCG (path coefficient 1.015, very significant). Increasing the implementation of MIS will strengthen GCG in fishing cooperatives. Better MIS can help improve transparency, accountability, and regulatory compliance, which are important in supporting the sustainability cooperatives in the context of the blue economy (Fleming et al., 2020).

Relevance to the Blue Economy

Descriptive analysis of the Blue Economy shows that, overall, fishing cooperatives are still in the poor to moderate category (score 2.574). Although there has been some progress in diversifying marine products and commitment to environmental conservation, aspects of supply chain efficiency and sustainable tourism practices are still weak. In path analysis, Risk Management has a significant influence on the Blue Economy, while Management Information Systems does not have a direct significant influence. Improving risk management, especially related to cooperative technology and operations, is very important to encourage cooperatives to adapt to Blue Economy principles. A stronger MIS will help to better support the management of these risks, so that ultimately cooperatives can contribute more significantly to the sustainability of the Blue Economy (Burgess et al., 2018).

Constraints of the Traditional KUD Minasari System and the Role of Digitalization in Supporting the Blue Economy

Based on the results of interviews with related parties at KUD Minasari, it was found that the fish auction process is still carried out traditionally using a manual transaction recording system, where each auction transaction is recorded in a ledger or physical archive. This creates various operational obstacles, such as delays in data management and the risk of loss or damage to important records. In addition, non-real-time recording makes cooperative administrators face difficulties in obtaining accurate and timely data, thereby slowing down the evaluation and decision-making process. The inability to monitor auctions in real-time also hinders the optimization of risk management and good governance. Stakeholders emphasize the importance of digitizing Cooperative operational processes. The implementation of a cloud computing-based Management Information System (MIS), which allows automatic recording, access to data at any time, and accelerates more efficient decision making is a must (Kwek et al., 2019). Thus, it is hoped that this digitalization can increase transparency, accountability, and support better and more sustainable cooperative governance.

Cloud Computing as a solution for urgent digital applications at KUD Minasari can be integrated with a broader context related to operational systems and risk management which are currently still in the poor to moderate category. In this case, cloud computing can be the right digital solution, especially to improve efficiency, security and operational performance cooperatives (Cámara et al., 2015).

Efficiency and Scalability

Cloud computing allows KUD Minasari to adopt digital applications without having to invest heavily in physical IT infrastructure. By using cloud solutions, cooperatives can access auction software in real-time from various devices, both on land and at sea, thereby speeding up the transaction process and data recording. In addition, storage and computing capacity can be adjusted as the cooperative's operations grow, allowing the system to remain efficient and flexible despite an increase in the number of transactions or data managed (Harris et al., 2015). A cloud-based auction system can increase the speed and accuracy of auctions carried out by KUD Minasari. Transactions made by fishermen and traders can be recorded directly in the system, speeding up the distribution of catches, and minimizing errors in manual recording.

Data Security and Privacy

One of the main problems found in descriptive analysis is that data security and integration in cooperatives are still weak. With the adoption of cloud computing, cooperatives can take advantage of the high level of security provided by cloud service providers. Cloud platforms are usually equipped with security features such as data encryption, strict access control, and protection against cyber attacks, so they can overcome risks related to data leaks and privacy of member information (Sun, 2019). By implementing cloud computing, KUD Minasari can strengthen the data protection of fishermen and cooperative members. Financial information, personal data and auction transactions will be safer and can only be accessed by authorized parties. It also supports improving Good Corporate Governance (GCG) through better transparency and accountability.

Accessibility and Real-time Monitoring

Cloud computing allows real-time access from anywhere as long as there is an internet connection (H. S. Ali & Sridevi, 2024). In the context of KUD Minasari, where many transactions are carried out directly at the auction location, direct data access via the cloud will speed up the decision-making process and operational monitoring. All parties involved, from cooperative administrators to fishermen, can see the latest information about auction status, prices and catches without having to be in a physical location. The cloud-based auction system allows KUD Minasari to monitor and manage auction activities more efficiently and centrally. All transactions carried out will be immediately updated in the system, which can be accessed by administrators to manage logistics, distribution and payments more quickly.

Collaboration and Integration

Cloud computing enables better system integration among various cooperative departments. For example, the auction system can be integrated with financial management and member management. Auction result data can be directly updated in the accounting system, so that financial management becomes more automatic and accurate. Apart from that, financial reporting can also be done more efficiently, reducing manual errors and increasing transparency in financial reporting to cooperative members. With cloud computing, cooperatives can more easily integrate various functions on one platform, which supports risk management and better decision making. This is critical to increasing accountability and efficiency, which are key to stronger GCG implementation (H. S. Ali & Sridevi, 2024).

Reduction of Operational Costs

Cloud computing reduces the need for large investments in IT infrastructure, such as servers and hardware. With a pay-as-you-go model Cooperatives will only pay for the cloud resources they use, significantly reducing operational costs (Shirzad & Musliu, 2024). Cooperatives also don't have to worry about maintenance costs or hardware updates, because it's all managed by the cloud provider. These savings allow KUD

Minasari to allocate resources to other areas that require attention, such as developing fishing capacity or improving auction infrastructure.

Cloud Computing to Support the Blue Economy

In an interview with the cooperative, it was revealed that KUD Minasari has begun conducting training for fishermen regarding fishing practices in accordance with Blue Economy principles, as well as building mangrove forests on the sea coast near the auction site. However, these efforts are still not optimal because there is no structured periodic conservation process. By implementing cloud computing-based applications, cooperatives can carry out continuous monitoring of the condition of mangrove forests, marine environmental management, and fishermen's activities so that conservation programs can run more effectively. This technology not only supports better and more sustainable governance but also strengthens KUD Minasari's commitment to Blue Economy principles, which focus on economic growth, environmental sustainability, and social welfare. Cloud computing allows fishing cooperatives to adopt sustainable practices more easily and efficiently, while reducing their carbon footprint because it does not require a large physical IT infrastructure, in line with environmentally friendly principles. Additionally, the cloud-based system enables real-time monitoring of data such as seafood productivity, marine environmental quality, and supply chain efficiency, so cooperatives can take more proactive action to support long-term sustainability (Sanusi et al., 2024).

Cloud computing features that will be useful for KUD Minasari in sustainable monitoring of mangrove forests include:

- Real-Time Data Collection: Cloud computing allows real-time data collection from various sensors or devices installed in mangrove forest areas. Data such as soil moisture, water quality and ecosystem conditions can be accessed at any time, making it easier to monitor the condition of mangrove forests without the need for intensive physical inspections.
- Remote Monitoring: With a cloud system, cooperatives can monitor the condition of mangrove forests from anywhere. This technology supports monitoring through digital dashboards that are accessed online, thereby enabling continuous monitoring even remotely.
- Early Warning System: Cloud computing can be equipped with automation features that provide early warning regarding drastic changes in the mangrove forest environment, such as increasing pollution levels or decreasing water quality. This allows for quick preventative action before damage occurs.
- Data Integration and Continuous Analysis: With the cloud's ability to integrate multiple data sources, these systems can provide deeper analysis, such as mangrove growth trends, restoration levels, and ecosystem changes. This analysis will help in data-based decision making and identify areas that require more attention.

- Cloud-Based Reporting: Cloud-based applications can generate regular automated reports on the condition of mangrove forests and the effectiveness of conservation programs. This report can be accessed by various stakeholders to evaluate and improve sustainability strategies.
- Long Term Data Storage: The cloud provides large storage capacity to maintain mangrove conservation data archives over the long term. This is important for monitoring ecosystem change trends and planning future restoration steps.

With these features, cloud computing will really help KUD Minasari in ensuring that mangrove forest conservation efforts can be managed efficiently and sustainably.

CONCLUSION

Based on the research results, it can be concluded that risk management at KUD Minasari is still in the poor to moderate category, with the need for improvement in human resource management, technology and operational sustainability. The results of the descriptive analysis show that the Management Information System (MIS) in cooperatives is still in the poor to moderate category, with an average score of 2,683, while risk management has an average score of 2,647, which also indicates the poor to moderate category. Likewise with the application of Blue Economy principles which has an average score of 2,574. From the analysis of the relationship between variables, it was found that Management Information Systems have a significant influence on Good Corporate Governance (GCG) and Risk Management, but do not have a direct significant influence on the Blue Economy. Additionally, Risk Management has a significant impact on the Blue Economy, highlighting the importance of better risk management to support sustainability. For this reason, implementation is recommended cloud computing as a digital solution that can improve real-time recording, facilitate continuous monitoring, and support better governance. Implementation of this technology will strengthen risk management, increase transparency, and support long-term sustainability according to the principles Blue Economy, especially in mangrove forest management and sustainable fisheries activities.

Author Contributions

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Investigation	M.T.A., R.F.B, H.D, & F.H.R	Visualization	M.T.A., R.F.B, H.D, & F.H.R
Methodology	M.T.A., R.F.B, H.D, &	Writing – original draft	M.T.A., R.F.B, H.D, & F.H.R

Project administration	F.H.R M.T.A., R.F.B, H.D, & F.H.R	Writing – review & editing	M.T.A., R.F.B, H.D, & F.H.R

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Institutional Review Board Statement

The study was approved by Al-Ghifari University Bandung, Indonesia.

Informed Consent Statement

Informed consent was obtained before the respondents answered the interview for this study.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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Conflicts of Interest

The authors declare no conflicts of interest.

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