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Complex Solutions Collaborative-Based Mangrove Ecosystem Management Model for Development Ecotourism in South Coastal East Java Indonesia

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ABSTRACT

Natural resources are vital for sustainable development and the livelihood sustainability of nations. However, environmental crises persist, posing threats to sustainability. Unsustainable management of natural resources not only damages the environment but also causes economic losses. Effective natural resource management aims to optimize ecosystem functions and benefits, ensuring sustainability. Mangrove ecosystems, crucial for coastal areas, face pressures from human activities and climate change. Ecotourism emerges as a conservation strategy, offering economic benefits while preserving the environment. Yet, ecotourism development in mangrove areas encounters challenges, necessitating a collaborative-based management model. This research aims to develop a complex and sustainable mangrove ecosystem management model for ecotourism development on East Java's south coast, Indonesia. The methodology involves expert interviews and data analysis using PROMETHEE and FsQCA approaches. In conclusion, this research contributes to the development of an integrated and comprehensive mangrove ecosystem management model for sustainable ecotourism development. Recommendations include policy support, community involvement, and infrastructure planning to enhance sustainability. Collaboration among government, communities, and stakeholders is vital for effective implementation, aiming for sustainable ecotourism management on East Java's south coast.

1. INTRODUCTION

Natural resources play an important and strategic role in the sustainable development and livelihood sustainability of a nation and country. For Indonesia, natural resources are one of the pillars of the economy, contributing to state revenue and employment absorption, as well as providing spillover effects to other sectors, including the tourism sector. However, environmental crises remain a phenomenon that never ceases in the struggle of thought and escalating intensity. The grand design that places the economy as the paradigm of development poses a threat to environmental sustainability. In fact, the world's ecosystems have experienced a decline in area and an increase in habitat quality over the past 50 years [1]. The pattern of unsustainable and exploitative natural resource management also has the potential to cause significant economic losses in addition to environmental damage. Therefore, natural resource management aims to optimize the overall functions and benefits of ecosystems, which are crucial in life. Thus, if ecosystem functions can be optimized very well in their management, it is hoped that the ecosystem will be sustainable and the surrounding community can enjoy the benefits of the ecosystem itself. Broadly speaking, the implementers or users of environmental services who must maintain environmental sustainability in ecosystem resource management are institutions and communities that do not conflict with the law [2].

The tourism sector is one of the sectors demanded to appreciate the potential of local resources. This sector is also one of the major contributors to foreign exchange for the Indonesian state. Since 2008, the Indonesian Government has been promoting tourism in Indonesia through the Visit Indonesia program, introducing the diversity and uniqueness of Indonesia's natural environment and culture, which have been internationally recognized [3].

Mangroves are one of the important ecosystems ecologically, especially in coastal areas. In the southern coastal region of East Java, Indonesia, the mangrove ecosystem serves as a critical habitat for various marine species, a natural barrier against coastal erosion, and a vital resource for the livelihoods of local communities. However, in some areas, including along the south coast of East Java,

Indonesia, the mangrove ecosystem is under significant pressure due to human activities such as illegal logging, unsustainable fishing, and coastal development. In addition, climate change has also had serious impacts on the balance of mangrove ecosystems [4]. The local communities in this region, particularly fishermen, rely heavily on the mangrove forests for their daily sustenance, making the degradation of these ecosystems a threat to both the environment and their economic well-being. On the other hand, ecotourism has become the main focus in efforts to conserve and manage mangrove ecosystems. Ecotourism offers the potential to generate economic income for local communities while preserving the environment. However, the development of ecotourism in mangrove areas often faces complex challenges related to ecosystem management, community participation, infrastructure development, and sustainability [5, 6].

The purpose of this study is to develop a collaborative-based mangrove ecosystem management model that addresses these challenges and supports sustainable ecotourism development in the south coast of East Java, Indonesia. In this context, a complex collaborative-based mangrove ecosystem management model is needed for sustainable ecotourism development on the south coast of East Java, Indonesia. The model must take into account various dimensions, including environmental, social, economic, infrastructure, institutional, conservation, technological, and regulatory sustainability [7].

Previous research has been conducted to identify challenges in mangrove ecosystem management on the south coast of East Java and efforts to develop ecotourism in the region [8]. Some previous studies have highlighted issues such as environmental degradation, conflicts of interest between conservation and development, and the role of local communities in natural resource management [9-11]. In addition, some studies have explored the potential of ecotourism in the region and efforts by government and non-governmental organizations to develop sustainable management models [12, 13]. However, previous research tends not to embrace a collaborative approach involving various stakeholders in holistic mangrove ecosystem management. Moreover, there is still a lack of understanding of the complexity of challenges facing ecotourism development, especially in the context of the south coast of East Java. Therefore, further research is needed to develop a complex and sustainable collaborative-based mangrove ecosystem management model for ecotourism development in the region.

The specific objectives of this study are: to investigate the integration of mangrove ecosystem conservation aspects with sustainable ecotourism development and to examine the role of policies and regulations in ecotourism development. Although efforts have been made to develop collaborative-based mangrove ecosystem management models for ecotourism development on the south coast of East Java, in-depth research is still needed to explore several gaps. First, the lack of in-depth understanding of integrating mangrove ecosystem conservation aspects with sustainable ecotourism development needs to be further investigated. Second, the participation of local communities in decision-making and implementation of ecotourism programs has not been fully understood. Third, the relationship between infrastructure development and its impact on the mangrove ecosystem needs to be further explored to design infrastructure that supports ecotourism without sacrificing environmental sustainability. Fourth, the role of policies and regulations in supporting ecotourism development in the region needs to be clarified through further research.

Finally, a comprehensive and in-depth evaluation of the performance of collaborative-based mangrove ecosystem management models is also needed to understand the success, weaknesses, and potential development of these models in the future. By exploring these gaps, research will be able to provide deeper insights and more effective solutions in the development of ecotourism on the south coast of East Java, Indonesia.

2. LITERATURE REVIEW

Community-based ecotourism management has emerged as a sustainable approach to tourism development, integrating local communities in conservation efforts while promoting economic growth. One crucial aspect in this management model is risk communication (RC), which facilitates the exchange of information between stakeholders regarding potential risks associated with ecotourism activities. Effective RC strategies enable communities to make informed decisions, enhancing safety measures and minimizing environmental impacts. Cognitive risk perception (CRP) plays a pivotal role in shaping individuals' understanding of risks associated with ecotourism activities. It involves the cognitive appraisal of potential hazards and their likelihood of occurrence. Studies have shown that enhancing CRP through educational programs and awareness campaigns leads to better risk management practices among local communities, thereby safeguarding both tourists and the environment [14].

Affective risk perception (ARP) complements CRP by examining individuals' emotional responses to perceived risks. Emotions such as fear or concern can influence decision-making processes and behavior regarding ecotourism participation. Effective management strategies should address ARP by fostering trust and confidence among community members, thereby promoting responsible ecotourism practices. environmental concern (EC) is a key determinant of community involvement in ecotourism management [15, 16]. High levels of EC are associated with greater support for conservation initiatives and sustainable development practices. By nurturing EC through educational programs and community engagement, ecotourism managers can foster a sense of environmental stewardship among local residents, leading to more sustainable tourism practices.

Environmental responsibility (ER) and environmental moral obligation (EMO) are closely related concepts that emphasize individuals' ethical duties towards the environment. Integrating ER and EMO into community-based ecotourism management frameworks encourages responsible behavior among tourists and residents alike. By promoting values of environmental stewardship and respect for natural resources, ecotourism initiatives can mitigate negative impacts and enhance long-term sustainability. Social influence (SI) plays a significant role in shaping individuals' attitudes and behaviors towards ecotourism. Peer pressure, cultural norms, and community dynamics influence decision-making processes regarding tourism participation and environmental stewardship [17].

Leveraging positive social influences through community-based initiatives and collaborative decision-making processes can strengthen support for ecotourism development while fostering a sense of collective responsibility towards

conservation goals. In conclusion, effective management of community-based ecotourism requires a multifaceted approach that integrates risk communication, environmental perception, and social dynamics. By addressing cognitive and affective risk perceptions, nurturing environmental concern and responsibility, and leveraging positive social influences, ecotourism managers can promote sustainable development and ensure the long-term viability of ecotourism initiatives.

3. METHODOLOGY

3.1 Research site

This research was conducted at community-based ecotourism sites located in East Java (Figure 1). The study focused on six observation points: Clungup Beach, Tiga Warna Beach, Gatra Beach, Sapana Sanctuary, Mini Beach, and Watu Pecah Beach within the Clungup Mangrove Conservation (CMC) Tiga Warna Ecotourism area. The selection of this specific location is driven by its unique combination of ecological significance and active community involvement in sustainable tourism practices. CMC Tiga Warna not only showcases a diverse mangrove ecosystem that attracts tourists, but it also represents a successful model of community-based ecotourism, where local stakeholders collaborate effectively to promote both environmental conservation and socio-economic development.

3.2 Respondent selection technique

The information gathering for this research involved several expert respondents who were directly involved and deliberately selected due to their expertise and specific knowledge (purposive sampling) [18]. These respondents were chosen based on their direct involvement in ecotourism and mangrove ecosystem management along the south coast of East Java, ensuring that they possess relevant insights and experiences that are critical to the study's objectives. Respondents are individuals considered to be well-informed about the issues related to the research problem and willing to provide information.

Their selection was purposeful to ensure the data collected reflected the practical realities of the region, enhancing the study's credibility. The number of population members selected purposively is based on the objectives of the research, considering that respondents have a direct relationship and involvement in the research area. The total number of respondents in the sustainability management analysis was 110, comprising 10 individuals from the Department of Tourism and Culture, 10 from the Department of Forestry, 10 from the Department of Environmental Affairs, 10 from the Department of Marine Affairs and Fisheries, 3 from Village Government, 7 academics, 10 economic actors, 20 tourists, and 20 from the local community around the ecotourism area. These individuals were selected based on their expertise, practical experience, and relevance to the study area. Selected respondents must have in-depth knowledge in the field related to mangrove ecosystem management for community-based ecotourism development. Some considerations in selecting expert respondents include: (1) having experience and competence in research, (2) holding positions and having expertise in the research field, and (3) having high credibility and residing in the research area.

3.3 Data collection technique

Research data were collected directly at the research site through structured observation and interviews with respondents using a research questionnaire instrument. In this study, observations and questionnaires were conducted to obtain causal condition data forming success in mangrove ecosystem management for ecotourism development. Therefore, the type of questionnaire used in this study is a closed-ended questionnaire consisting of questions and a number of answer alternatives. In answering the questions, respondents are bound by the given answers.

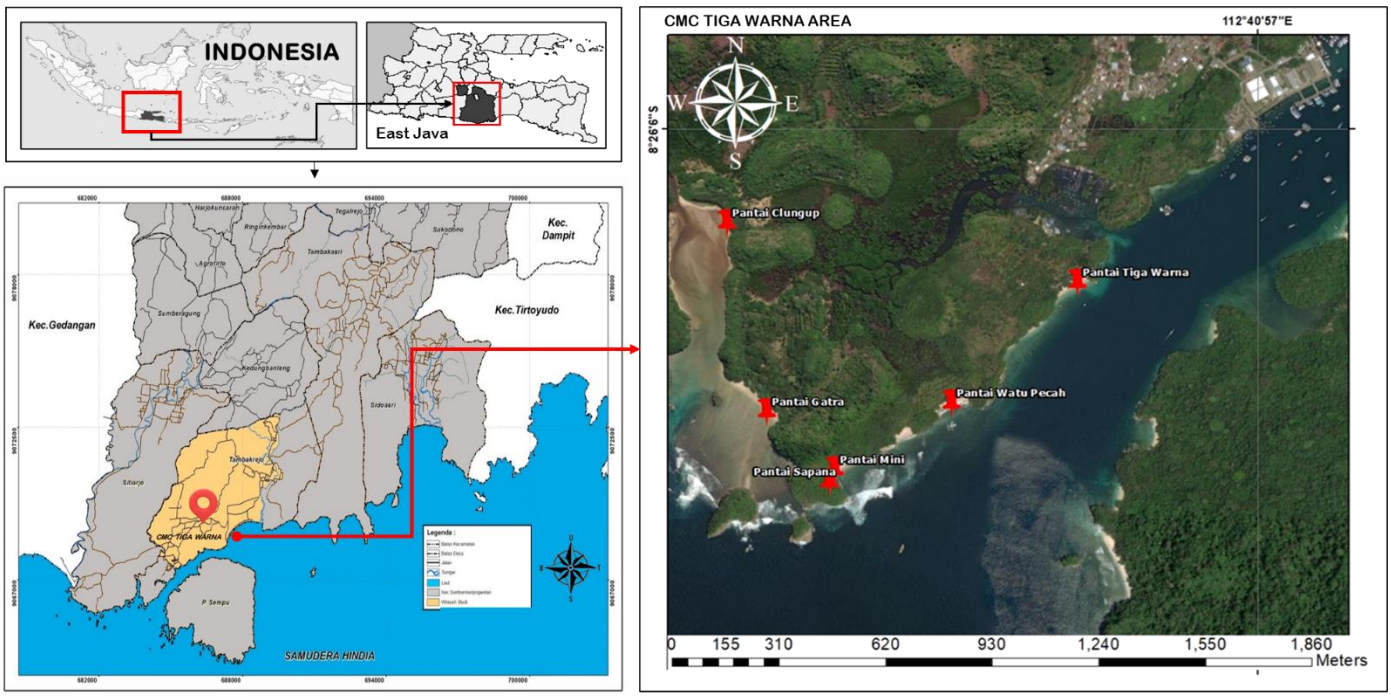


Figure 1. Research site

3.4 Data analysis

In this study, data analysis was conducted using the PROMETHEE (Preference Rangking Organization Method for Enrichment Evaluation) and FsQCA (Fuzzy-set Qualitative Comparative Analysis) approaches. The PROMETHEE approach was applied to rank and prioritize alternative solutions in the management of mangrove ecosystems for sustainable ecotourism development by evaluating multiple conflicting criteria, such as environmental, social, economic, infrastructure, institutional, conservation, technological, and regulatory dimensions (Figure 2). The method is particularly useful in decision-making processes where trade-offs between different factors must be considered, and it helps to identify the most balanced and feasible options for the study region [19, 20], while FsQCA is employed to identify complex solutions by examining the combination of causal conditions that lead to particular outcomes, such as the successful implementation of ecotourism models in mangrove areas (Figure 3). FsQCA allows for the analysis of different pathways that may lead to the same outcome, reflecting the diverse realities and challenges faced in different parts of the south coast of East Java [21].

No.	Description	Mathematical	Symbols Denoted
1	Problem formulation: Identify alternatives and criteria of the alternatives	$(a, b),\ f_j$	(a, b) denoted alternatives, f_j denotes criterion
2	Determination of deviations based on pair-wise comparison	$d_j\ (a, b) = f_j\ (a) - f_j\ (b)$	$d_j\ (a, b)$ denoted the difference between the evaluation of alternatives a and b on criterion f_j
3	Application of the preference function	$P_j\ (a, b) = f_j\ [d_j\ (a, b)], j = 1, \ldots., k$	$P_j\ (a, b)$ denoted the preference of alternative a with regard to alternative b on each criterion as a function of $d_j\ (a, b)$
4	Calculation of an overall or global performance index	$\forall\ a, b\ \in A$ $\pi\ (a, b) = \sum_{j}^{k} P_j\ (a, b)\ w_j$	$\pi\ (a, b)$ of a over b (from 0 to 1) is defined as the weighted sum$P_j\ (a, b)$ for each criterion, and w_j is the weight associated with j criterion
5	Calculation of positive and negative outranking flow	$\emptyset^{+}(a) = \frac{1}{n-1} \sum_{x \in A} \pi\ (a, x)$ $\emptyset^{-}(a) = \frac{1}{n-1} \sum_{x \in A} \pi\ (a, x)$	$\emptyset^{+}(a)$ denoted the positive outranking flow for each alternatives, whereas $\emptyset^{-}(a)$ denoted the negative outranking flow foe each alternative
6	Calculation of net outranking flow (complete ranking)	$\emptyset(a) = \emptyset^{+}(a) - \emptyset^{-}(a)$	$\emptyset(a)$ denoted the net outranking flow for each alternative
7	Sensitivity analysis of the weighting of the criteria	Using GAIA Platform	Final ranking and conclusion

Figure 2. The general steps of the procedure of PROMETHEE

Therefore, it is necessary to test both approaches for necessary and sufficient conditions. Consistency tests for necessary conditions are conducted to determine the degree when the membership score in the outcome (Yi) is consistently less than or equal to the membership in the causal condition (Xi) or $Yi \leq Xi$. In other words, the outcome is a subset of the causal condition. The threshold value for consistency testing for necessary conditions is 0.75. Meanwhile, consistency tests for sufficient conditions measure the degree when the membership in the outcome is consistently greater than or equal to the membership in the causal condition $(Yi \geq Xi)$, or they measure how often a causal condition appears and becomes a superset of the outcome. The following is the research analysis flow:

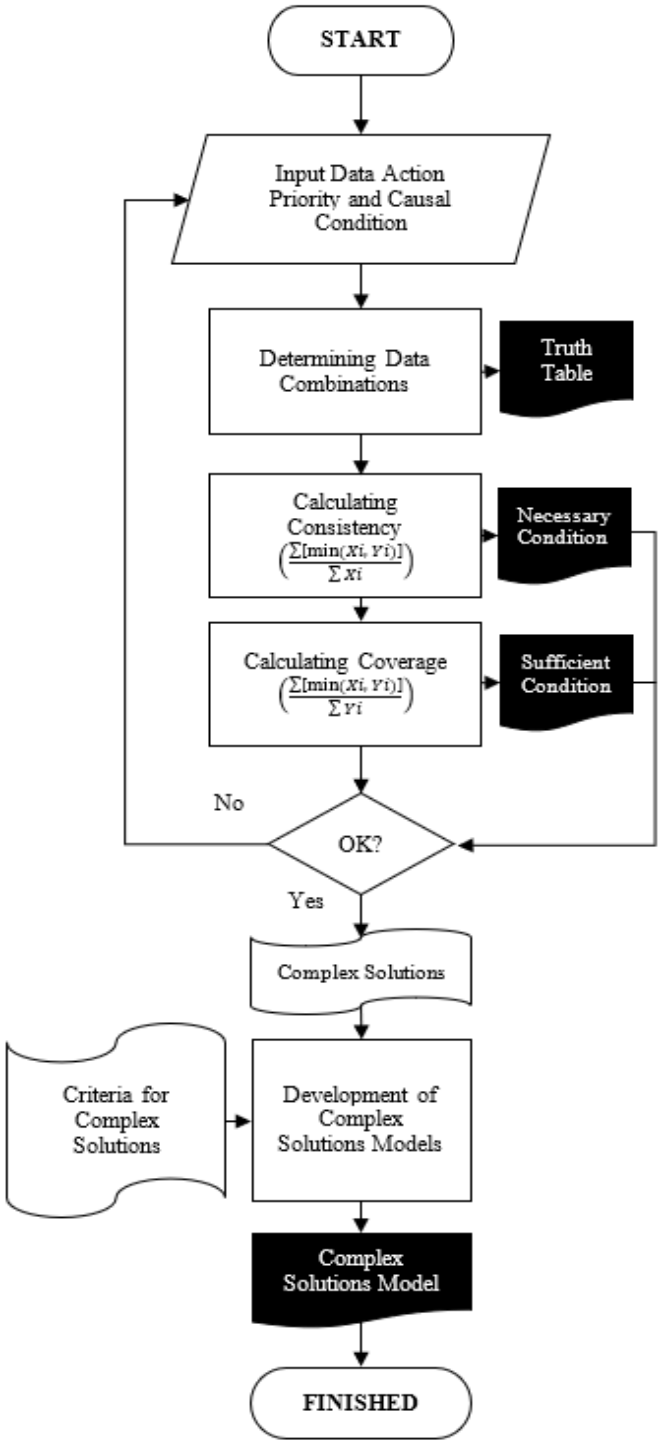


Figure 3. Data analysis of FsQCA

Table 1. Dimensions and research variable

Dimensions	Variables
Environment	Environmental protection and management planning
	Utilization of natural resources in accordance with environmental capacity
	Pollution control and/or environmental damage mitigation
	Environmental sustainability
	Consistency of environmental quality
	Tourism suitability
	Natural beauty
	Cleanliness of tourist attractions
	Carrying capacity
Social	Community participation
	Respect for the social-cultural and religious values of communities surrounding the area
	Community empowerment
	Local business opportunities
	Employment opportunities in the tourism sector
	Community welfare
	Social conflicts
	Community knowledge
	Harmony among stakeholders
Economic	Driving regional economic development
	Accelerating economic development
	Local revenue
	Sustainable ecotourism efforts
	Ecotourism industry growth
	Benefits of the ecotourism industry
	Conservation budget
	Facilities budget
Infrastructure	Corporate social responsibility (CSR) by managers
	Public facilities
	Health facilities
	Worship facilities
	Public transportation access to tourist locations
	Road access to ecotourism locations
	Travel routes
	Number of attractions
	Attraction appeal
	Land availability
Institutional	Role of NGOs
	Institutional activity
	Growth of institutions/community groups
	Task distribution
	Decision-making authority
	Education and information
	Coordination among managers
	Coordination of managers with relevant departments
	Governance system
Conservation	Preservation of natural capabilities
	Balanced natural resource utilization
	Preservation of ecological processes
	Continuous rehabilitation efforts
	Maintaining the integrity of the area according to natural landscapes
	Avoiding extinction risks
	Considering the potential and carrying capacity of the area
	Ecosystem protection
	Biodiversity conservation
Technology	Level of marketing technology proficiency
	Ability to implement environmentally friendly technology
	Database technology development capability
	Ecotourism information accessibility
	Online ecotourism marketing

Dimensions	Variables
	Digital advertising
	Institutional databases
	Tourism databases
	Ecosystem databases
	Availability of legal instruments
	Local-level regulations for ecotourism management
	Transparency in policies
	Availability of legal oversight
	Number of local security personnel
Regulatory	Legal counseling on natural resource management
	Policy harmonization
	Compliance with tourism management documents
	Implementation of management according to management documents

Source: [11, 19, 22-24]

3.5 Research framework

The complex solution model for community-based ecotourism management is a framework that presents a holistic and integrated approach to managing destinations sustainably with various complex aspects. Through this model, ecotourism management in the area is confronted with multidimensional challenges, such as environmental, social, economic, infrastructure, institutional, conservation, technological, and regulatory dimensions (Table 1). This model aims to provide comprehensive and sustainable solutions to optimize tourism potential and ensure that management is carried out while considering sustainability dimensions in a balanced manner.

By implementing the complex solution management model, it is hoped that sustainability in tourism management can be achieved, providing long-term benefits to local communities, the environment, and visitors. (Figure 4) presents a conceptual framework for the success of Community-Based Ecotourism Management (CBEM) influenced by two theories: Terror Management Theory and Norm Activation Model (NAM). At the center of the framework is CBEM Success (CBEMs), surrounded by action priorities that serve as essential steps to achieve success. Factors such as Risk Communication (RC), Cognitive Risk Perception (CRP), and Affective Risk Perception (ARP) derive from Terror Management Theory, emphasizing the importance of risk perception and communication in community-based ecotourism management.

Meanwhile, the factors from the Norm Activation Model (NAM), including Environmental Concern (EC), Environmental Responsibility (ER), Environmental Moral Obligation (EMO), Social Influence (SI), and Pro-environmental Behavior (PeB), illustrate the impact of moral responsibility, environmental awareness, and social norms in promoting pro-environmental behavior. The combination of risk perception and pro-environmental behavior creates pathways to the successful management of community-based ecotourism through structured priority actions.

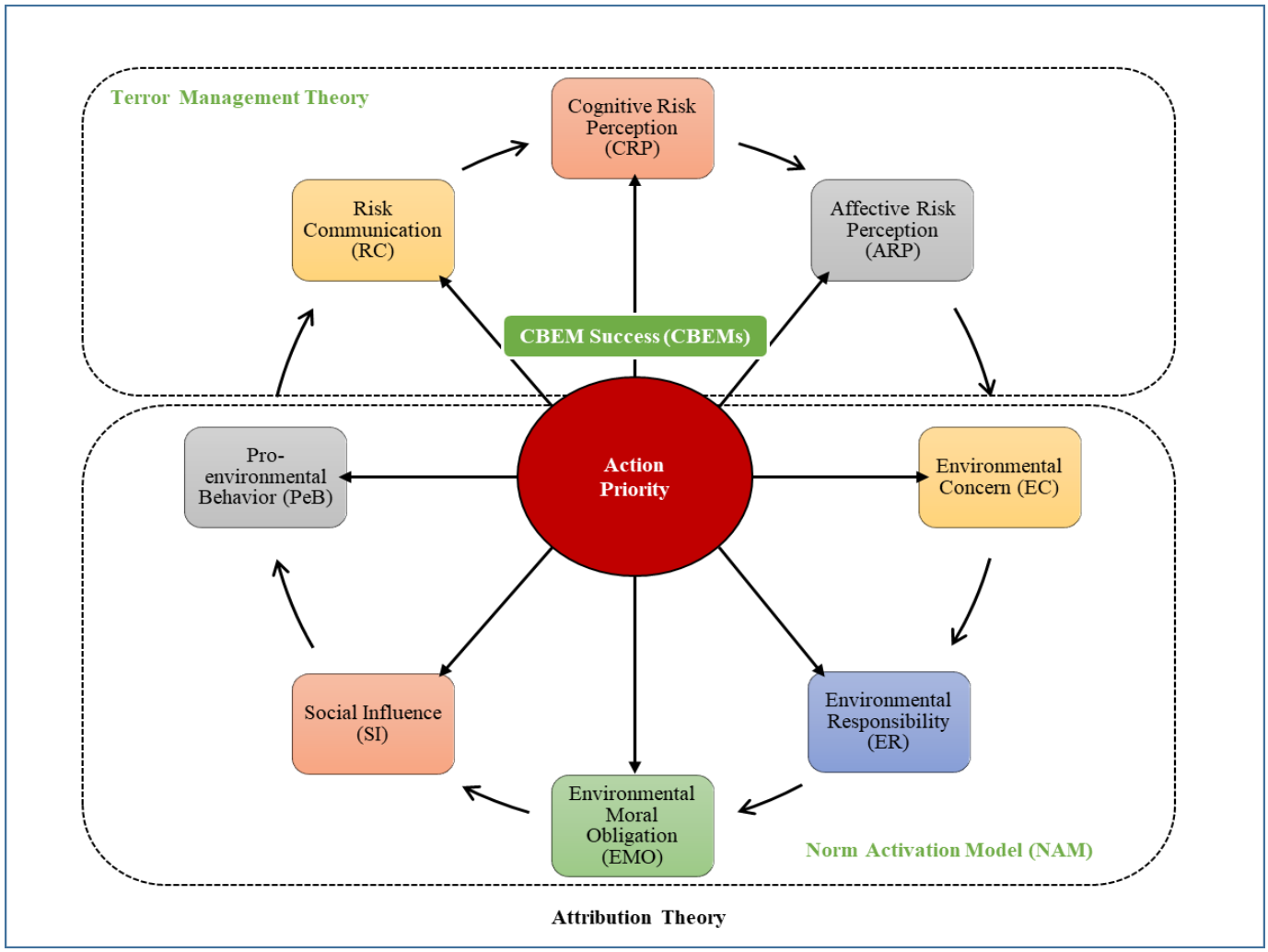
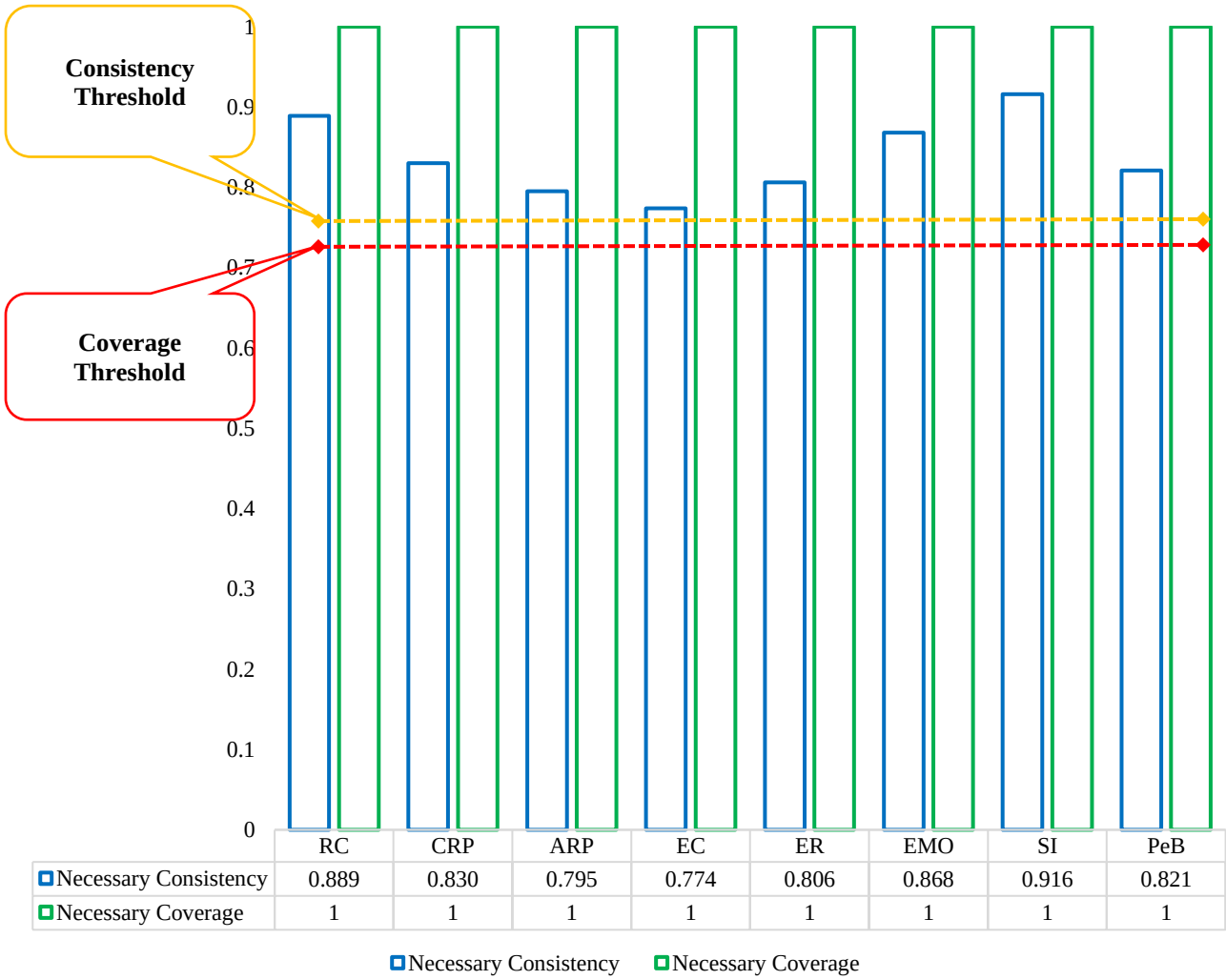


Figure 4. Research framework

4. RESULT

4.1 Necessary and sufficient condition

Presenting consistency and coverage scores of necessary conditions for the occurrence of successful community-based ecotourism management phenomena. Consistency scores measure how often the causal condition is required for the outcome to occur, while coverage scores represent the extent to which the causal condition contributes to the occurrence of the outcome. Eight causal conditions have consistency scores above the threshold of 0.75, namely risk communication (RC), cognitive risk perception (CRP), affective risk perception (ARP), environmental concern (EC), environmental responsibility (ER), environmental moral obligation (EMO), social influence (SI), and pro-environmental behavior (PeB) (Figure 5).



	RC	CRP	ARP	EC	ER	EMO	SI	PeB
Necessary Consistency	0.889	0.830	0.795	0.774	0.806	0.868	0.916	0.821
Necessary Coverage	1	1	1	1	1	1	1	1

Figure 5. Necessary and sufficient condition

A consistency score above 0.75 indicates that these conditions are frequently present when successful community-based ecotourism management occurs, confirming their necessity in the model. This means that these eight causal conditions meet the necessary condition requirement, indicating that they are necessary for the occurrence of successful community-based ecotourism management phenomena in implementing priority management actions. The coverage test results (or consistency test for sufficient conditions) indicate that all individual causal conditions have scores above the threshold of 0.70 [25]. This means that the presence of these causal conditions is sufficient to cause the occurrence of successful community-based ecotourism management phenomena**.** Coverage scores, in this case, indicate that these conditions sufficiently explain the occurrence of successful management outcomes. A score above 0.70 suggests that these conditions are not only necessary but also have a significant impact on the success of the management actions, covering a substantial portion of the observed outcomes.

4.2 Action priority

Analysis of priority actions for community-based ecotourism management yields 24 priority actions, predominantly dominated by actions from the social dimension such as (1) improving community welfare, (2) increasing employment opportunities in the tourism sector, (3) enhancing local business opportunities, (4) increasing community participation, and (5) reducing social conflicts (Figure 6). These actions align closely with the conditions identified as necessary for success, reinforcing the practical importance of addressing social factors in ecotourism management.

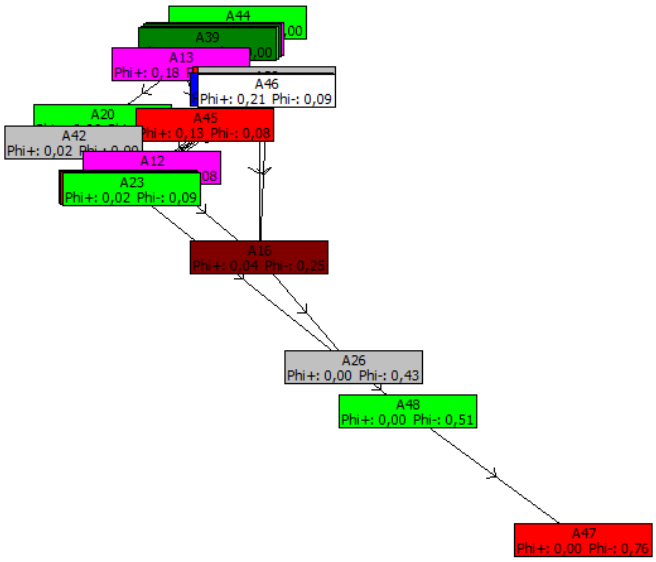


Figure 6. Action priority

4.3 Complex solutions

The data processing results using FsQCA through the QuineMcCluskey algorithm produce a truth table for complex solutions. The FsQCA output, which connects the outcome of the phenomenon of successful management ecotourism with eight causal conditions, namely risk communication (RC), cognitive risk perception (CRP), affective risk perception (ARP), environmental concern (EC), environmental responsibility (ER), environmental moral obligation (EMO), social influence (SI), and pro-environmental behaviour (PeB), yield a solution consistency score of 1.000. This means that all causal conditions identified are perfectly consistent with the successful occurrence of community-based ecotourism management, providing strong support for their relevance in the model. A solution consistency score of 1.000, well above the threshold of 0.75, shows that these conditions are always present when the outcome is observed, thus verifying their sufficiency.

Form Table 2, the solution consistency score above the threshold of 0.75 indicates a very strong relationship between all pathways of causal conditions and the phenomenon of successful community-based ecotourism management. The solution coverage score of 0.731 indicates that 73.10% of priority management actions have been covered in the overall solution of combination pathways of causal conditions that emerge. This score exceeds the minimum threshold of 0.70 mentioned [26]. However, study [27] states that, unlike the consistency measure with a minimum threshold, there is no minimum threshold value set for solution coverage. While consistency ensures the validity of the relationship between the causal conditions and the outcome, coverage represents the empirical significance, meaning how much of the outcome can be explained by the identified causal conditions. A coverage score of 0.731 means that the majority of successful outcomes can be traced back to these conditions, making the model both comprehensive and highly relevant to practical management scenarios. From these two test indicator results, it can be concluded that all pathways of combination causal conditions have met the sufficiency condition requirements, thus effectively explaining the occurrence of management success outcomes.

Table 2. Complex solutions

Path	RC	CRP	ARP	EC	ER	EMO	SI	PeB	Raw Coverage	Unique Coverage
fzRC*fzCRP*~fzARP*fzEC*fzER*fzEMO*fzSI	O	O	~	O	O	O	O		0.23289	0.0517544
fzRC*fzCRP*fzARP*fzEC*fzEMO*fzSI*fzPeB	O	O	O	O		O	O	O	0.55241	0.0304825
fzRC*fzCRP*fzARP*fzER*fzEMO*fzSI*fzPeB	O	O	O		O	O	O	O	0.60263	0.0807017
fzRC*fzARP*fzEC*fzER*fzEMO*fzSI*fzPeB	O		O	O	O	O	O	O	0.55526	0.0333334
fzCRP*fzARP*fzEC*fzER*fzEMO*fzSI*fzPeB		O	O	O	O	O	O	O	0.53508	0.0131580
Solution Coverage	0.731									
Solution Consistency	1.000									

Note: O (Indicates core causal condition), ~ (negate - indicates unmet causal condition), while "empty" indicates the causal condition that doesn't have to exist.

5. DISCUSSION

5.1 Priority of community-based ecotourism management

The prioritized actions in community-based ecotourism management highlight the importance of a holistic and sustainable approach to management. In the environmental dimension, emphasis is placed on maintaining environmental quality consistency, cleanliness of tourist attractions, and carrying capacity for the protection and preservation of the natural environment. On the social side, the main focus is on improving community welfare, job opportunities, community participation, and resolving social conflicts to create a sustainable and harmonious social environment. In terms of economics, efficient budget allocation for nature conservation, infrastructure development, and local economic empowerment are crucial steps. Meanwhile, in the infrastructure dimension, improving worship facilities, health facilities, and road accessibility is the top priority to enhance comfort, safety, and accessibility for visitors and the local community [2, 28-30].

Moreover, it is important to consider the dimensions of institutions, conservation, technology, and regulations as vital pillars in ecotourism management. In the institutional dimension, enhancing coordination between managers and relevant authorities is prioritized. The conservation dimension emphasizes ecosystem rehabilitation and efforts to prevent species extinction. In the technology dimension, enhancing the ability to implement environmentally friendly and marketing technologies is the primary focus. As for the regulatory dimension, the importance of legal education, policy harmonization, and compliance with ecotourism area management documents is stressed [31-34]. By integrating priority actions from these eight dimensions, community-based ecotourism management can achieve holistic sustainable goals. A holistic and collaborative approach to ecotourism management is expected to strengthen

environmental preservation, enhance local community welfare, and provide fair economic benefits to local and global communities [35, 36].

5.2 Complex solutions pathway

The complex solutions in meeting the phenomenon of successful community-based ecotourism management consist of 5 pathways. From the results (Figure 7), it can be observed that the causal conditions of environmental moral obligation (EMO) and social influence (SI) always appear in every complex solutions pathway. This means that the sense of moral concern for the environment and social influence from the surrounding environment can act as causal conditions for success in implementing priority actions in community-based ecotourism management, thereby achieving management success based on sustainability dimensions.

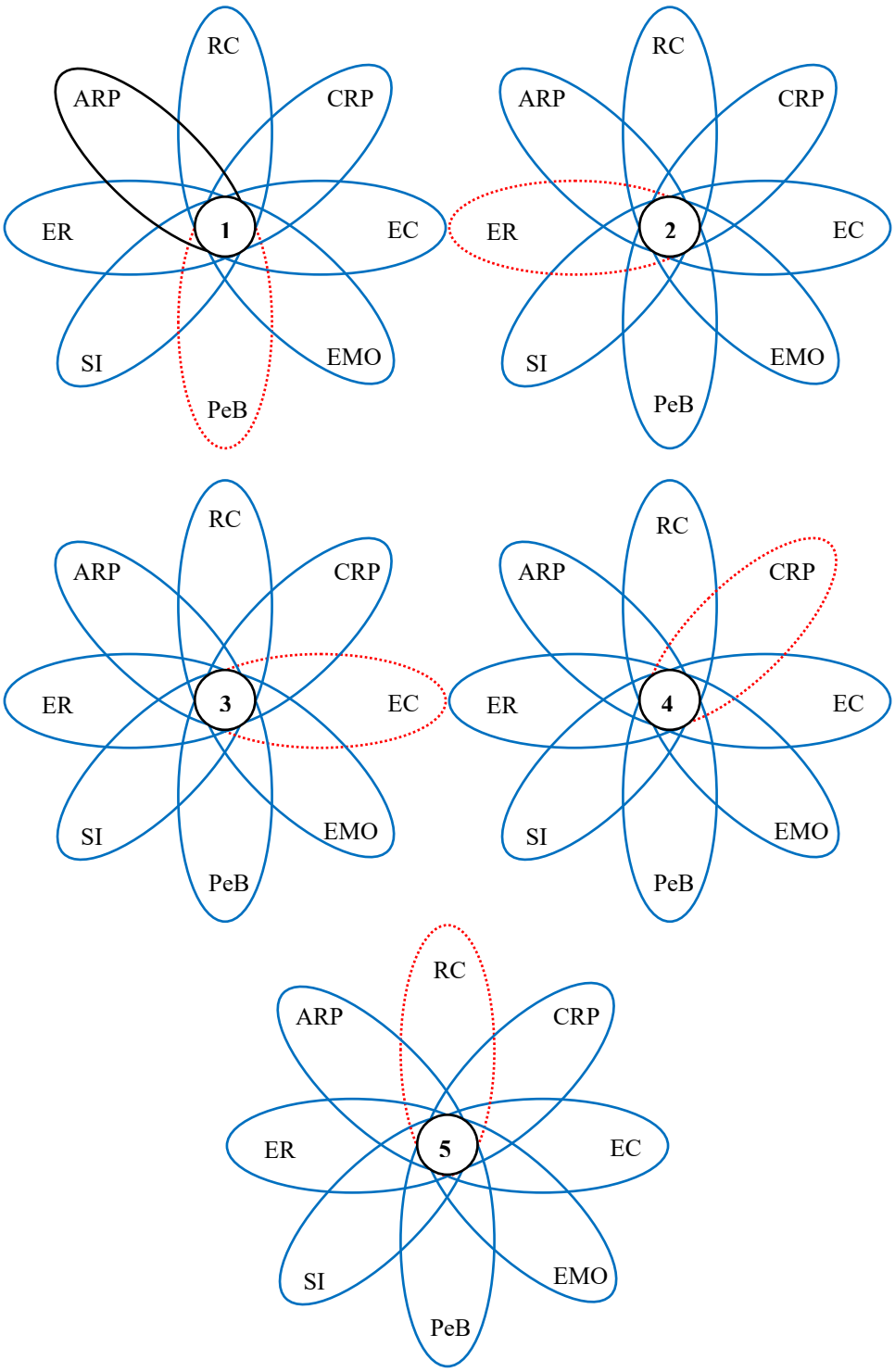


Figure 7. Complex solutions pathway

Note:

: *Core Condition - The essential factors or elements that must be present for success*

: *Absence Condition - Describes the scenario where necessary elements are missing, leading to potential*

: *failure Edge Condition - The boundary or extreme situations that test the system's limits*

In the first pathway, the complexity of successful community-based ecotourism management is influenced by several factors, including priority management actions involving high levels of risk communication (RC), cognitive risk perception (CRP), environmental concern (EC), environmental responsibility (ER), environmental moral obligation (EMO), and social influence (SI). Effective communication about environmental risks to stakeholders, accurate understanding of risks by individuals, environmental concern from all involved parties, strong environmental responsibility, moral obligation towards the environment, and motivating social influence are key factors reinforcing successful ecotourism management efforts. However, in this first pathway, where affective risk perception (ARP) is low and pro-environmental behavior (PeB) is absent, it's still possible to achieve management success. This is because even though individuals may not emotionally perceive risks or directly engage in pro-environmental behaviors, other factors contributing to management success, such as effective communication, strong understanding, and significant social support, are still strong enough to support sustainable management practices and successful environmental conservation [16, 37]. Thus, while factors like ARP and PeB may be important in some contexts, this first pathway shows that other factors related to effective management can also play a significant role in achieving environmental conservation goals.

In the second pathway, the success of community-based ecotourism management is highly influenced by priority management actions with high levels of risk communication (RC), cognitive risk perception (CRP), affective risk perception (ARP), environmental concern (EC), environmental responsibility (ER), environmental moral obligation (EMO), social influence (SI), and pro-environmental behavior (PeB). Effective communication about environmental risks, strong understanding of risks by individuals, emotional support for environmental conservation, high environmental concern, environmental responsibility, strong social influence, and environmentally supportive behavior are key factors reinforcing ecotourism management efforts. However, in this second pathway where environmental responsibility (ER) is absent, it's still possible to achieve management success. This is because even though direct responsibility towards the environment may not be internalized by individuals or groups involved, other factors related to effective management, such as effective communication, strong understanding, significant social support, and high pro-environmental behavior, are still strong enough to support sustainable management practices and successful environmental conservation [38]. Thus, while environmental responsibility (ER) may be an important factor in some contexts, this second pathway shows that other factors related to effective management can also play a significant role in achieving environmental conservation goals.

In the third pathway, the success of community-based ecotourism management is highly influenced by priority management actions with high levels of risk communication (RC), cognitive risk perception (CRP), affective risk perception (ARP), environmental responsibility (ER), environmental moral obligation (EMO), social influence (SI), and pro-environmental behavior (PeB). Effective communication about environmental risks, strong understanding of risks by individuals, emotional support for environmental conservation, direct responsibility towards the environment, moral obligation towards the environment, strong social influence, and environmentally supportive behavior are key factors reinforcing ecotourism management efforts. However, in this third pathway where the level of environmental concern (EC) is absent, it's still possible to achieve management success. This is because even though the level of environmental concern may not be sufficiently high, other factors related to effective management, such as effective communication, strong understanding, significant social support, strong environmental responsibility, moral obligation towards the environment, and high pro-environmental behavior, are still strong enough to support sustainable management practices and successful environmental conservation [17]. Thus, while environmental concern (EC) may be an important factor in some contexts, this third pathway shows that other factors related to effective management can also play a significant role in achieving environmental conservation goals.

In the fourth pathway, the success of community-based ecotourism management is highly influenced by priority management actions with high levels of risk communication (RC), affective risk perception (ARP), environmental concern (EC), environmental responsibility (ER), environmental moral obligation (EMO), social influence (SI), and pro-environmental behavior (PeB). Effective communication about environmental risks, emotional support for environmental conservation, high environmental concern, strong environmental responsibility, moral obligation towards the environment, strong social influence, and environmentally supportive behavior are key factors reinforcing ecotourism management efforts. However, in this fourth pathway where cognitive risk perception (CRP) is absent, it's still possible to achieve management success. This is because even though individuals may not have a deep cognitive understanding of environmental risks, other factors related to effective management, such as effective communication, strong emotional support, high environmental concern, strong environmental responsibility, moral obligation towards the environment, strong social influence, and high pro-environmental behavior, are still strong enough to support sustainable management practices and successful environmental conservation [15]. Thus, while cognitive risk perception (CRP) may be an important factor in some contexts, this fourth pathway shows that other factors related to effective management can also play a significant role in achieving environmental conservation goals.

In the fifth pathway, the success of community-based ecotourism management is highly influenced by priority management actions with high levels of cognitive risk perception (CRP), affective risk perception (ARP), environmental concern (EC), environmental responsibility (ER), environmental moral obligation (EMO), social influence (SI), and pro-environmental behavior (PeB). Although risk communication (RC) is absent in this pathway, management success is still possible because other factors involved in the management process have significant impacts. High cognitive and affective risk perceptions, strong environmental concern, environmental responsibility and moral obligation, strong social influence, and high pro-environmental behavior can provide a solid foundation for sustainable management practices. Even though risk communication (RC) is absent in this pathway, information about environmental risks can still be conveyed through alternative means such as direct experience, observation, or informal sources. With strong

support from other factors, such as interpersonal communication and social influence, awareness and actions to protect the environment can still be realized [14]. Therefore, even though risk communication (RC) is absent, this pathway indicates that other factors supporting environmental awareness and pro-environmental actions can play a crucial role in achieving the success of ecotourism management.

5.3 Complex solutions model for community-based ecotourism management (CBEM)

The research findings elaborate that complex-solutions for community-based ecotourism management must have a clear legal foundation. Furthermore, actor grouping is divided based on their status and role in the social structure. The numbering on Figure 8, signifies the development foundation of ecotourism starting from the smallest scope, which is the local community stratum, then leading to the formation of a management institution named Yayasan Bhakti Alam Sendang Biru (Bhakti Alam Sendang Biru Foundation) that oversees the management of CMC Tiga Warna Ecotourism. The number one (1) represents the institutional scope, signifying that the impact of relationships has given birth to new capacities by providing binding interaction concepts. The number two (2) is occupied by seven communities such as KTH (Forest Farmer Group), LKDPH (Village Cooperation Institution for Forest Development), POKMASWAS (Community Group for Fisheries Supervision), POKDARWIS (Awareness Tourism Group), LMDH (Village Forest Community Institution), Karang Taruna (Youth Organization), and HNSI (Indonesian Fishermen Association), which have produced concepts bridging the interaction between institutions and similar community groups in efforts to maintain sustainability and the success of ecotourism destinations through collaboration and coordination among stakeholders. Furthermore, the establishment of the CMC Tiga Warna Foundation also impacts the formation of other communities such as economic actors and visitors.

The number three (3) is occupied by government and academic institutions. These five government and academic institutions are evidence of the highest centralist hierarchy. The interaction concept within this hierarchy is called linking interaction. Strong interactions will create harmony among stakeholder networks. Stakeholders in ecotourism management implementation face opposition to sustainable management. Therefore, key variables and sustainability status become the basis for determining management actions. Each management action will be evaluated based on effectiveness, efficiency, sufficiency, benefits, responsiveness, and future reliability criteria to produce priority actions [13, 39, 40]. These management actions are undoubtedly based on sustainability dimensions. This complex solutions model offers a framework for addressing management issues based on their forming dimensions. An interesting finding in this model is that ecotourism management solutions must integrate various sustainability dimensions such as environmental, social, economic, infrastructure, institutional, conservation, technology, and regulatory dimensions that affect holistic and sustainable ecotourism management [41].

The integration results within this complex solutions model are further detailed into priority actions. In the environmental dimension, maintaining and preserving environmental quality consistency, cleanliness of tourist attractions, and carrying capacity become the focus of priority actions. This demonstrates that the model recognizes the importance of maintaining consistent environmental quality, preserving cleanliness of tourist attractions, and understanding environmental capacity limits to ensure destination sustainability [42]. Meanwhile, in the social dimension, priority actions include improving community welfare, job opportunities, local business opportunities, community participation, and reducing social conflicts. This reaffirms that the model emphasizes the importance of considering the welfare and participation of local communities and creating sustainable economic opportunities [43].

The economic dimension includes increasing conservation budget allocations and facilities, highlighting the importance of adequate budget allocation for nature conservation and infrastructure development supporting ecotourism. In the infrastructure dimension, the model emphasizes improving worship facilities, health facilities, and road access to ecotourism locations, indicating awareness of the basic needs of visitors and local residents, as well as the importance of comfort and safety in accessing destinations [44]. The institutional dimension highlights the need to improve coordination between destination managers and related agencies, as well as the importance of effective governance systems to ensure integrated and sustainable management. In the conservation dimension, emphasis on activities to maintain or increase sustainable rehabilitation efforts, prevent species extinction, and balance nature management demonstrates commitment to preserving biodiversity and ecosystem sustainability [45].

On the technological side, the model indicates the ability to enhance the application of environmentally friendly technology, mastery of marketing technology, and use of institutional databases, emphasizing the importance of technology in improving ecotourism management efficiency and effectiveness [46]. Lastly, the regulatory dimension highlights the need to increase legal education activities related to natural resource management and policy harmonization to create a supportive legal environment for sustainable ecotourism management [47].

This complex-solutions model not only offers priority actions to address existing issues but also suggests how these priority actions can be effectively implemented by all stakeholders involved to achieve management success. In this model, to achieve management success based on priority actions, five pathways are proposed. The first pathway involves enhancing risk communication (RC), cognitive risk perception (CRP), environmental concern (EC), environmental responsibility (ER), environmental moral obligation (EMO), and social influence (SI), despite affective risk perception (ARP). The second pathway involves enhancing risk communication (RC), cognitive risk perception (CRP), affective risk perception (ARP), environmental concern (EC), environmental moral obligation (EMO), social influence (SI), and pro-environmental behavior (PeB). The third pathway involves enhancing risk communication (RC), cognitive risk perception (CRP), affective risk perception (ARP), environmental responsibility (ER), environmental moral obligation (EMO), social influence (SI), and pro-environmental behavior (PeB). The fourth pathway involves enhancing risk communication (RC), affective risk perception (ARP), environmental concern (EC), environmental responsibility (ER), environmental moral obligation (EMO), social influence (SI), and pro-environmental behavior (PeB).

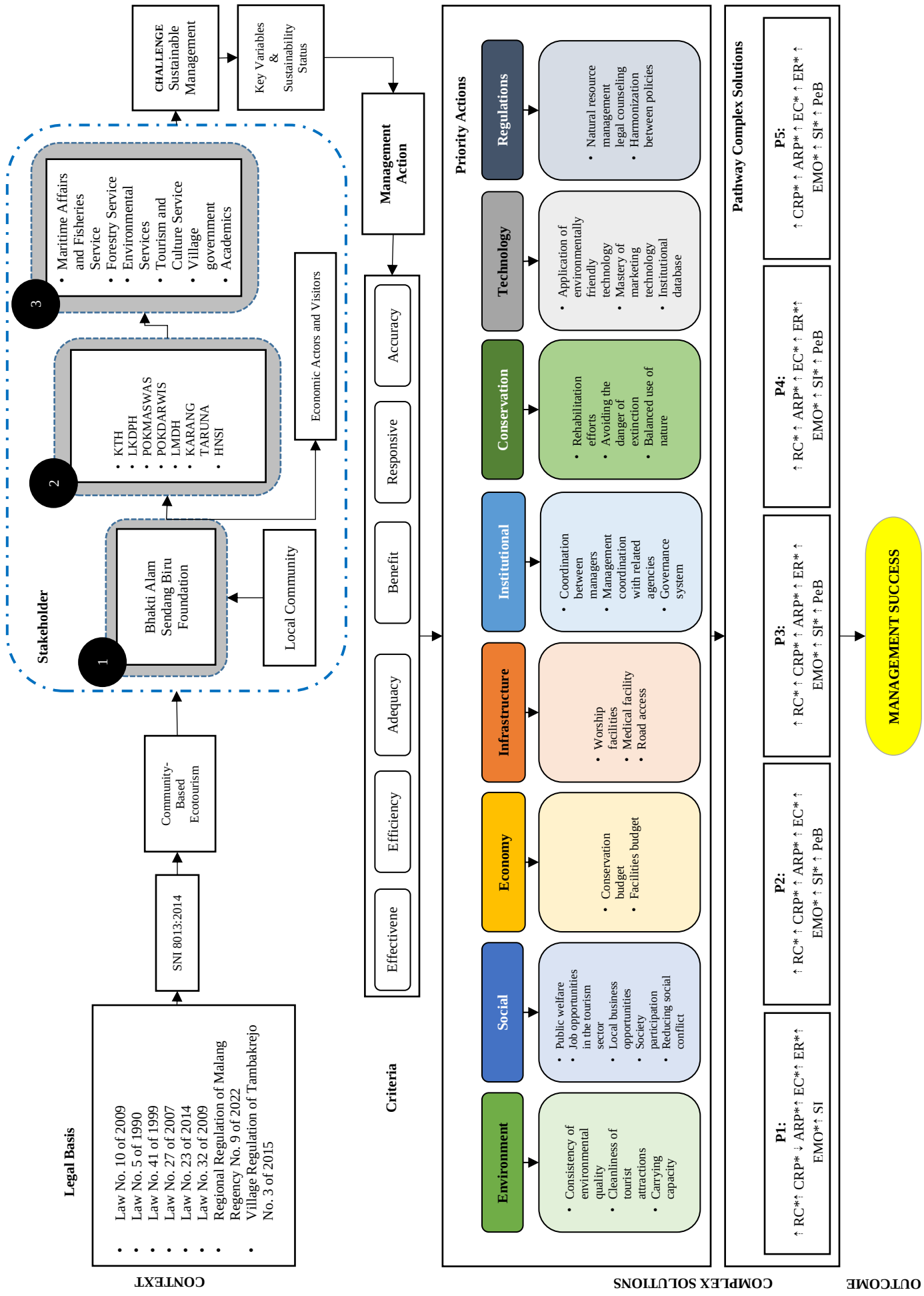


Figure 8. Compex solutions model for CBEM

Finally, the fifth pathway involves enhancing cognitive risk perception (CRP), affective risk perception (ARP), environmental concern (EC), environmental responsibility (ER), environmental moral obligation (EMO), social influence (SI), and pro-environmental behavior (PeB). From this model, it can be observed that the causal conditions of environmental moral obligation (EMO) and social influence (SI) consistently appear in every pathway of complex solutions [4, 21]. This implies that the moral concern for the environment and social influence from the surrounding environment are dominant causal conditions in shaping the success of community-based ecotourism management.

The interesting thing about this finding is that it shows that the complex solutions model generated is characterized by integrated linkage. Integrated linkage emphasizes the importance of understanding and treating community-based ecotourism as a complex system, where each stakeholder, management dimension, priority action, and causal condition interact and impact each other. For example, environmental sustainability can affect the well-being of local communities, and conversely, the well-being of communities can affect environmental sustainability through their economic activities. Of course, this is inseparable from the role of stakeholders and the influences of causal conditions that affect the success of community-based ecotourism management.

5.4 Policy implication

There's a need to underscore the importance of continually enhancing community-based ecotourism management across various dimensions to achieve overall better sustainability. Despite strong commitments to environmental preservation and conservation, improvements are still necessary in the social, economic, technological, and regulatory dimensions. In the social dimension, greater efforts are required to involve and consider the needs and interests of local communities in decision-making related to ecotourism management. This ensures a more inclusive approach and strengthens local community involvement in maintaining destination sustainability. On the other hand, the economic dimension needs to be reinforced to ensure fair and environmentally friendly economic benefits for local communities, while also promoting sustainable economic growth. Emphasis should also be placed on technological development and regulatory harmonization to support effective and sustainable ecotourism management. Thus, this research provides guidance for managers to continually improve their management practices, focusing on dimensions that need improvement, to achieve better overall sustainability.

The holistic approach to ecotourism management, considering various involved dimensions including environmental, social, economic, infrastructure, institutional, conservation, technological, and regulatory aspects, is crucial. There's a need for greater focus on the social dimension in community-based ecotourism management. Priority actions from the social dimension, such as community welfare, employment opportunities in the tourism sector, local business opportunities, community participation, and reduction of social conflicts, dominate management priorities. Additionally, the regulatory and technological dimensions also need further attention to enhance the effectiveness of ecotourism management. However, even lower-priority actions still contribute to achieving the goals of conservation and sustainable ecotourism development, as well as strengthening local communities and visitor satisfaction. Therefore, it's important to consider all management actions while providing additional focus on the social dimension and efforts to improve regulatory and technological dimensions to enhance the overall effectiveness ecotourism management.

The complex solutions model highlights the importance of developing a community-based ecotourism management model with a clear legal basis and involving actor grouping according to the existing social structure. The complex solutions model not only provides solutions to existing problems but also provides a framework for integrating priority actions in community-based ecotourism management while considering various sustainability dimensions. These implications indicate that the implementation of the complex solutions model can significantly contribute to improving the effectiveness of ecotourism management by promoting increased environmental moral obligation (EMO) and social influence (SI) in achieving management success. Additionally, this model illustrates a holistic and integrated approach to ecotourism management, reflecting the importance of cooperation and involvement of all stakeholders to achieve better sustainability in community-based ecotourism management, also referred to as integrated linkage.

6. CONCLUSIONS AND RECOMMENDATION

The research highlights the importance of developing an integrated and comprehensive community-based ecotourism management model. Findings underscore that ecotourism management solutions must be based on clear legal foundations and involve grouping actors according to existing social structures. The generated complex solutions model provides a holistic framework, considering various sustainability dimensions such as environmental, social, economic, infrastructure, institutional, conservation, technological, and regulatory aspects. The integration of these dimensions is then translated into priority actions covering various aspects, from environmental preservation to the local community's social welfare. The implications of these findings imply a greater emphasis on key success variables and a holistic approach in designing policies and management strategies. Moreover, it is crucial to enhance management across various dimensions to achieve overall sustainability. Additionally, further focus on social, regulatory, and technological dimensions is necessary to improve management effectiveness. The complex solutions model offers an integrated and holistic approach to ecotourism management, emphasizing the importance of cooperation and involvement of all stakeholders to achieve better sustainability in community-based ecotourism management. Based on the research findings, it is recommended that the government and stakeholders actively participate in the development and implementation of an integrated and comprehensive community-based ecotourism management model. Concrete steps may include establishing clear legal frameworks to support ecotourism management and organizing involved actors according to existing social structures. Emphasizing key success variables is also crucial in formulating policies and management strategies, considering environmental, social, economic, infrastructure, institutional, conservation, technological, and regulatory aspects. Moreover, improvements across various dimensions are necessary to achieve better overall sustainability, with additional focus on

social, regulatory, and technological dimensions. Collaboration among the government, community, and private sector is also essential to effectively implement this complex solutions model, aiming to achieve sustainable goals in community-based ecotourism management.

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