Reviving History: Strategies for Sustainable Healthy Settlement on Penyengat Island as a Cultural Treasure

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Abstract. An example of a traditional coastal community imbued with Malay cultural elements may be seen on Penyengat Island, a tiny island in Indonesia's Riau Archipelago Province. The United Nations Educational, Scientific and Cultural Organization (UNESCO) has recommended Penyengat Island as a World Heritage site due to its 46 cultural heritage sites that are dispersed around the island. The increase in population occasionally requires more residential land, so many residents build housing on the remaining sites of cultural heritage buildings on Penyengat Island. This study aims to ascertain the sustainability situation and methods for planning wholesome communities in the coastal regions of Penyengat Island's cultural heritage. The method used was a Multidimensional Scale approach with the Rapid Appraisal-Index Sustainability of Settlement ordination technique to produce an arrangement strategy through a prospective analysis approach. Studies of the literature and field surveys were used to gather data. The sample used in this study was the head of the family with inclusion criteria. The results of the sustainability analysis showed that the value of the ecological dimension index in the range of 51.71 – 60.67 is entirely sustainable at RW1 to RW5. The economic dimension in the field of 40.46 – 48.23 is quite a sustainable status in RW1 to RW5. The socio-cultural size range of 48.97 – 51.78 is entirely sustainable at RW1 locations and RW2-RW5 sites are less sustainable. The institutional, legal dimension in the value range of 50.18-71.24 is entirely sustainable at RW1 to RW5 locations. Green infrastructure dimension in the value range of -0.12 – 6.72 unsustainable at locations R1 to RW5. The prospective analysis showed 11 critical attributes for developing a long-term settlement strategy for the cultural heritage of Penyengat Island's coastal area. The primary strategy for settlement arrangement included (1) Strengthening institutions, governance, and settlement arrangement regulations and (2) Community empowerment. In summary, these two main strategies are critical factors in the sustainability of Penyengat Island as a residential area and cultural heritage that must be preserved. Furthermore, the private sector assumed responsibility for the holistic development of residential areas and cultural heritage on Penyengat Island.

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1 Introduction

Housing health and residential environment are physical, chemical, and biological conditions inside the house in residential environments that allow residents to get optimal health. Harsh characteristics of informal settlements that directly impact health. Proactive and cross-sectoral interventions are urgently needed to sustainably improve urban health and well-being [1]. Adaptability to nature and the environment indicates the density distribution of residential areas. The availability of means of transport and public services influences the speed of the evolution of settlements [2]. The links between urbanism and architecture, including environmental design, mobility, and social interactions, will come together to achieve a more environmentally and socially balanced urban environment. Successful techniques for addressing health, environmental, and mobility challenges in all modern global cities [3]. Public health interventions are urgently needed in residential settings [4].

One of the Sustainable Development Goals (SDGs) specified in Objective 11 is inclusive, safe, resilient, and sustainable cities and settlements. Residential health conditions in China's cities are poor and variable. Cities in the central, northern, and western regions have lower health levels than the eastern region. [4]. Health status disparities between one city and another make cities or settlements less resilient and unsustainable. Innovations are needed to find sustainable urban residential regeneration methods that result in sustainable urban regeneration [4]. Components relative to health problems, social and economic, physical, and environmental factors affect urban health. These comparable components can guide decision-makers in the development of healthy cities [5].

Penyengat Island is located in Penyengat Village, Tanjungpinang City, Riau Islands Province, Indonesia. The United Nations Educational, Scientific and Cultural Organization (UNESCO) has recommended Penyengat Island as one of the world heritage sites in the Riau Islands Province. In general, foreign tourists from Singapore and Malaysia are related to the history of the Malay kingdom in the past. There is a reciprocal relationship between smart tourism and mobility indicators, it can improve the community's economy, the residents' and tourists' quality of life. The goal is to support sustainable communities and livable housing [5]. Decision-makers can use spatial technologies to implement new and improved policies for the territorial development of sustainable cultural heritage[6]. Restoration of national origin and archaeological sites can increase local and international tourism and hospitality [7]. Government policies with public-private partnerships are prepared for tourism sustainability[8].

Environmental health problems related to residential conditions on Penyengat Island also require attention from the government, related to cases of environment-based diseases such as Upper Respiratory Tract Infections and Tuberculosis on this island. Patients who had completed high school had an elevated incidence of tuberculosis, contributing to many side effects. Furthermore, adverse effects were more closely related to patients from lower socioeconomic classes [9]. Water supply has a vital role in TB transmission. Water that does not meet physical, chemical, and biological requirements has the potential to spread mycobacterium tuberculosis bacteria[10]. Public awareness about diarrheal diseases in children is needed because uninhabitable settlement conditions support poor sanitation and hygiene personnel conditions[10].

Waste is also a problem for settlements in coastal areas. Accumulation of waste on beaches and open spaces causes environmental degradation. A coastal community waste management system that involves local wisdom can reduce waste production. Community trust influences behavior in cleaning and burning waste in coastal settlements, thereby providing positive value for the environment and reducing the volume of waste[11]. People

on Penyengat Island still throw waste into the sea due to a need for public awareness of maintaining environmental conservation.

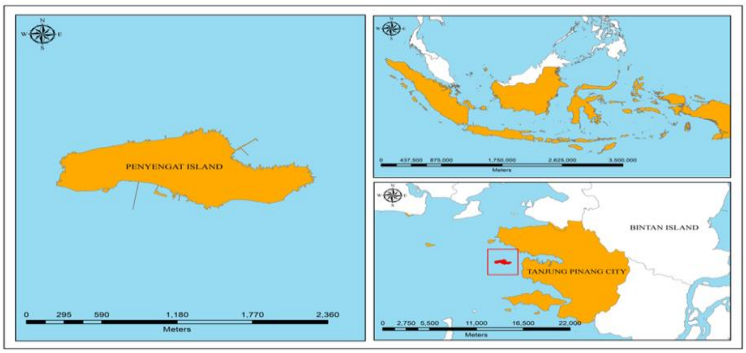
The increase in population occasionally requires more residential land, so many residents build housing on the remaining sites of cultural heritage buildings on Penyengat Island. Settlement structuring strategies can solve many rural areas' economic and social problems. For example, it helps solve the housing shortage problem and reduce the proliferation of slums and informal buildings linked to the scale and irregularity of urban expansion in the City of AL Kufa [12]. Organic social processes are a way to determine the long-term sustainability of the socio-spatial dynamics of a particular region. Social equilibrium can be achieved by dividing urban settlements into spatial units [13]. Respect and friendship between humans and nature are at the core of structuring settlement patterns, always instilling values, attitudes, beliefs, and cultural practices to ensure ecological sustainability[14].

This research examines the sustainability dimensions of healthy settlements in terms of physical and non-physical aspects; this is a differentiator from previous research.. The dimensions measured for the sustainability of healthy settlements have different attributes from previous studies. The attributes used are more focused on health aspects, especially on the ecological dimension and socio-cultural dimension. Previous research only analyzed the sustainability of healthy settlements in coastal areas, while this study further explored the strategy of structuring beneficial settlements in the coastal regions of Penyengat Island. This study's distinctiveness comes from its integration of a sustainability status and plan for advantageous communities in the coastal region of Penyengat Island's cultural heritage.

Environmental health problems related to residential conditions require attention from the government, the public, and the private sector. The significance of Penyengat Island as an international historical tourist destination cannot be understated. However, when settlement is not appropriately planned and managed, it may give rise to a plethora of environmental issues. These problems can ultimately lead to a decline in public health standards and indirectly adversely affect the number of foreign tourists visiting the Island. The ideal community-based coastal area management concept combines and interacts with the ideals of government, community, and local wisdom.

2 Methods

The research is on Penyengat Island in Tanjungpinang City, Riau Archipelago Province, Indonesia (Fig. 1).



Source: Figure by authors based on Central Bureau of Statistics, Tanjungpinang City
Fig. 1: The research area's location on Penyengat Island, Indonesia

The administrative area of Penyengat Island consists of 5 Rukun Warga (RW). The population on Penyengat Island is 2520 people, consisting of 780 families[15]. The sampling method uses a total sample with inclusion and exclusion criteria. The sample used in this study was the head of family with inclusion criteria, among others, willing to be interviewed and asked for information about the state of settlement and cultural heritage conditions on Penyengat Island so that a sample of 317 heads of families was obtained.

Field observations and conversations with Penyengat Island residents were used to collect primary data. Primary data collection on ecological dimensions and green infrastructure through field observations using checklist sheets. Primary data collection on economic, socio-cultural, and institutional legal dimensions through direct interviews with communities and stakeholders. Secondary data sources included demographic, environmental, economic, socio-cultural, and processing data from linked agencies, as well as the findings of prior study on Penyengat Island.

Table 1. Dimensions and Attributes of Sustainable Settlement Arrangement as Cultural Heritage in the Coastal Area of Penyengat Island

Attributes	**Dimension**
(1) Location; (2) Infrastructure; (3) Disease Vectors; (4) Clean Water Access; (5) Household Waste; (6) Garbage; (7) Occupancy Density; (8) Indoor Lighting; (9) Noise; (10) Building Density; and (11) Vegetation Density.	*Ecology*[16]
(1) Community income; (2) Income growth; (3) Income decline; (4) Tourist arrivals; (5) Work type; (6) Job opportunities; (7) Corporate social responsibility funding assistance; (8) Market potential; (9) Reliance on tourism-related activities to support the economy; and (10) Technological innovation promotes the people's economy.	*Economy*[16]
(1) Community involvement in social activities; (2) Community group management; (3) Cooperation implementation; (4) Community knowledge level; (5) Local wisdom; (6) Public health degree; (7) Community perceptions of the distance between cultural heritage and settlement; (8) Community perceptions of housing conditions; (9) Community perceptions of cultural heritage condition; (10) Social conflict; and (11) Government efforts to reallocate settlements.	*Social-cultural*[16]
(1) The government machinery in charge of resolving disputes; (2) The government apparatus in charge of cultural heritage problems; (3) Community organizations that work on settlement problems; (4) Community organizations concerned with issues of cultural heritage; (5) Government officials' education and training; (6) Cross-programs are used to address health issues in settlements and cultural heritage.; (7) Regulations for Cultural Conservation Areas; (8) Regulations for healthy settlement arrangements; (9) Regulations concerning cultural heritage and settlement agreements are being disseminated..	*Legal and Institutional*[16]
(1) Addition of vegetation; (2) Rain gardens; (3) green roofs; (4) Rain barrels (5) Permeable pavements ; (6) Green walls ; (7) Xeriscaping; (8) Hedgerows; (9) Tree Canopy Expansion.	*Green Infrastructure* [16]

Source**:** Table by authors

The ecological dimension consists of 11 attributes, the economic dimension 10 attributes, the socio-cultural dimension 11 attributes, the institutional law dimension 9 attributes, and the green infrastructure dimension 9 attributes (Table 1). Attribute modifications from several related previous studies obtained this attribute. The MDS

(Multi-Dimensional Scaling) approach was used to analyze sustainability utilizing the Rapid Assessment for Fisheries (Rapfish) software, which was modified to become Rapsettle (Rapid Appraisal for Settlement Ecosystem) to analyze the sustainability of healthy settlement [14]. The Rapfish methodology is a study that uses a multidimensional analysis of sustainability and is very useful for policymakers [17]. The attributes used are adjusted into the context of the study being carried out. The grouping of values from the sustainability index was shown in the range of 0 (bad) to 100 (good), consisting of 00.00-20.00 (bad/unsustainable), 20.01-50.00 (less sustainable), 50.01-75.00 (entirely sustainable), and 75.01-100.00 (good/sustainable)[16]. Furthermore, leverage analysis was used to determine factors, while Monte Carlo was used to determine errors' effect in scoring each attribute [17]. The Monte Carlo method is used to calculate the effect of errors on 95% confidence intervals. The MDS index is used to compare the value of this Monte Carlo index. The stress value and coefficient of determination (R^2) establish whether additional qualities are required and reflect the correctness of the dimensions investigated under actual conditions. The strategy for structuring sustainable healthy settlements in the coastal area using a prospective analysis through the Participatory Prospective Analysis software[17]. The prospective analysis will identify the dominant factors (key factors) that influence the structuring of healthy settlements in Penyengat Island. The goal of the prospective analysis is to plan strategic activities that must be made and to determine whether adjustments are required in the future.

Gray correlation analysis was employed in other studies on settlement sustainability to create a multi-criteria decision-making evaluation model. The production environment, living environment, and ecological environment are the three aspects that this study's 20 indicators are built on. These three criteria are used to assess the home environment's sustainability [2].

3 Results and Discussion

Penyengat Island field is in a congested coastal area with residential sections close to cultural heritage structures. The topography generally varies, with the majority being coastal lowlands and the remainder being hills. Additionally, there is an average of 188.1 mm of rainfall daily, with a humidity level of 83% and an air temperature of 27.40 degrees Celsius. Coastal areas are very potential marine tourism assets. Ecotourism can be realized by focusing on marine tourism in coastal areas [18]. Natural conditions on Penyengat Island allow for learning marine tourism and are supported by cultural heritage sites that have become international tourist destinations.

Penyengat Island has 46 cultural heritage sites scattered in several locations. The island can only be reached through motorized boats, for example, water transportation, commonly called "pompong" and non-motorized vessels. In contrast, land transportation facilities are only vehicles with two and three wheels (powered rickshaws). The existing educational facilities are only up to the Junior High School level. Hence, students who wish to continue their education to the next level must cross over to Tanjungpinang City..

The available health facilities are also minimal, including auxiliary health centers and private midwives; residents must cross to the Tanjungpinang City Hospital for emergency cases. Several shops or stalls of residents support the economy. Existing shops or stalls provide the island's residents and tourists with food and drinks. The concept of healthy cities initiated by the World Health Organization is then developed in a healthy city evaluation system that includes a healthy environment, community, health services, economy, and culture [19]. Penyengat Island should adopt a healthy city evaluation system to maintain sustainability as a world-historical tourist destination.

According to related studies, climate change and disaster management are among the factors used to gauge how sustainable tiny islands are [20]. Research conducted on Penyengat Island had different variable categories from research conducted previously. This study does not add disaster management criteria because Penyengat Island is not located in a disaster-prone area; institutional and legal criteria are needed to regulate law enforcement against residents who do not comply with the rules of settlement development with cultural heritage sites.

Table 2. Results of MDS, Monte Carlo, Sustainability Status, and Statistics Analysis

No.	Dimensions	MDS	Monte Carlo	Difference	Sustainability Status	Stress	R^2
1	Ecology						
	RW1	55.77	55.36	0.41	quite sustainable		
	RW2	55.32	55.04	0.28	quite sustainable		
	RW3	57.03	56.30	0.73	entirely sustainable	0.16	0.95
	RW4	51.71	51.60	0.11	quite sustainable		
	RW5	60.37	59.52	0.85	entirely sustainable		
2	Economy						
	RW1	40.46	40.70	0.24			
	RW2	45.85	45.95	0.1	less sustainable,		
	RW3	43.33	43.68	0.35	less sustainable,	0.17	0.94
	RW4	48.23	48.57	0.34	less sustainable,		
	RW5	43.33	43.70	0.37	less sustainable		
					less sustainable		
3	Socio-cultural						
	RW1	51.78	51.59	0.19	entirely sustainable,		
	RW2	48.97	49.19	0.22	less sustainable,	0.19	0.92
	RW3	48.97	48.70	0.27	less sustainable,		
	RW4	48.97	49.13	0.16	less sustainable		
	RW5	48.97	49.04	0.07	less sustainable		
4	Law and Institutions						
	RW1	50.18	50.32	0.14	quite sustainable		
	RW2	71.24	69.65	1.59	quite sustainable	0.21	0.92
	RW3	50.18	50.16	0.02	quite sustainable		
	RW4	50.22	50.26	0.04	quite sustainable		
	RW5	50.22	50.07	0.15	quite sustainable		
5	Green Infrastructure						
	RW1	-0.12	2.91	3.03	unsustainable		
	RW2	6.71	9.63	2.92	unsustainable	0.13	0.95
	RW3	6.72	8.83	2.11	unsustainable		
	RW4	3.92	7.15	3.23	unsustainable		
	RW5	-0.12	3.36	3.48	unsustainable		

Source**:** Table by authors

The index value discrepancy between the MDS analysis and the Monte Carlo analysis results is rather minor (Table 2.) The process is deemed favorable when the scoring errors are minimal, the variability in scoring resulting from differing opinions is limited, The study's stability is consistent, and the likelihood of data entry errors or data loss is reduced.

These factors indicate that the validity of the MDS utilized is sufficiently high to evaluate Penyengat Island's healthy settlement arrangements must be sustained.

As indicated in Table 2, the stress value is less than 0.25, and the R^2 value is close to 1. Consequently, the validity of the analysis's findings can be explained statistically; no additional traits are required because the features that were evaluated fairly reflect the real circumstances. The findings imply that the Rap-Settle approach for determining settlement agreement long-term viability has a high level of confidence. The characteristics utilized can also explain the long-term sustainability of healthy settlements. Furthermore, the Goodness of Fit indicators can be used to evaluate the validity outcomes; at 95% confidence, the stress value and coefficient of determination (R^2) are both precise.

The green infrastructure dimension is unsustainable, as shown in Table 2. Changing the sustainability status of each size requires support from the government, community, and private parties. One of the challenges for sustainable urban development is developing the potential of green infrastructure to address biodiversity loss [21]. The coastal area of Penyengat Island has the potential to create a green infrastructure by replanting mangrove forests to maintain marine biodiversity.

3.1 Leverage Analysis

The goal of leverage analysis is to look at sensitive features that contribute to the long-term viability of the dimensions being examined. The leverage analysis results are obtained from each attribute's Root Mean Square (RMS) value. Determine sensitive characteristics that impact the sustainability of each dimension using a mix of leverage analysis and Pareto analysis. Sorting the RMS value of the findings of the leverage analysis from highest to lowest value, followed by weighting in percentage and cumulatively up to a maximum cumulative value limit of 75%, is how the Pareto analysis is carried out.

3.1.1 Leverage Analysis Of The Ecological Dimension

The findings of the leverage analysis revealed five characteristics that serve as ecological sustainability levers, namely 1) household waste, 2) Indoor lighting, 3) noise, 4) occupancy density, and 5) clean water acces. The household waste attribute has the highest index value compared to other attributes. According to research undertaken in India on industrial and domestic garbage disposal, water quality in coastal areas and watersheds has decreased [22]. The waste management system is integral to an inclusive environment management system. An integrated waste management system is the responsibility of all parties where existing processes, procedures, and resources must follow environmental regulations. A sustainable waste management system is built based on three main dimensions: economic, social, environmental, managed, integrated, and efficient [23]. Handling household waste requires exceptional management, especially on small islands without integrated waste management. Community participation is urgently needed to reduce the production of this household waste.

3.1.2 Leverage Analysis Of The Economic Dimension

Leverage study on the economic dimension yielded five traits that became sustainability levers, including (1) CSR funding, (2) Job Opportunities, (3) Income growth, (4) Technological innovation promotes the people economy, and (5) Tourists arrivals. Increasing economic potential on Penyengat Island requires support from various parties, either government or private. The economics of the people is also greatly improved by assistance from the corporate sector through Corporate Social Responsibility (CSR) funding [24]. Funding mechanisms, legal protection measures, and effective communication are needed to address socio-economic and political issues in forest restoration [25]. Socio-economic implications must be considered in urban planning to

maintain environmental quality [26]. The arrangement of settlements and improvement of historical sites on Penyengat Island will undoubtedly add a tourist attraction to Penyengat Island. Growing tourism will improve the economy of this island while maintaining environmental sustainability.

3.1.3 Leverage Analysis Of The Socio-Cultural Dimension

The sociocultural dimension leverage study yielded four traits that became sustainability levers, including:

1. Community perceptions of the distance between cultural heritage and settlement.
2. Social conflict.
3. Cooperation implementation.
4. Community group management.

The social development innovation strategy on Penyengat Island necessitates enhancing the quality of human resources, as the community anticipates their active involvement across five crucial sectors: infrastructure, health, culture, society, and environment. By embracing community-based social development innovations, the people of Penyengat Island can enhance their self-reliance in striving towards the amelioration of the welfare of people. Health interventions that involve local stakeholders and refer to the values of local wisdom will have an impact on improving the degree of public health [27]. Regarding socioeconomic dimensions, resolving social problems and providing suitable infrastructure, such as roads and settlements, are community needs[28]. Penyengat Island has local wisdom in the form of traces of Malay cultural history in the Strait of Malacca, which connects three countries, namely Indonesia, Malaysia, and Singapore. This traditional wisdom must be protected for Penyengat Island to be preserved as a cultural resource.

3.1.4 Leverage Analysis On The Dimension Of Institutional Law

Leverage analysis on the dimension of institutional law obtained six attributes that became sustainability levers, including:

1. Cross-programs are used to address health issues in settlements and cultural heritage.
2. Government officials' education and training.
3. Regulations for healthy settlement arrangements.
4. Community organizations that work on settlement problems.
5. Regulations concerning cultural heritage and settlement agreements are being disseminated.
6. Community organizations concerned with issues of cultural heritage.

The tourism development strategy must be supported by government policies to be more accessible to the international community[29]**.** Cross-sectoral collaboration is urgently needed between government and transdisciplinary research partners to contribute to designing cross-sectoral actions for settlement health in a way that integrates existing evidence and incorporates health impact evaluation[30]. Many developing countries have not had rules or restrictions to control environmental damage for decades, as developed countries have done[31]. One of the damages to cultural heritage sites on Penyengat Island is caused by residents who build houses on the former site of cultural heritage sites. The increasing number of settlements in the coastal area of Penyengat Island has reduced biodiversity. Law enforcement rules are urgently needed to reorganize existing settlements and cultural heritage sites on the island.

3.1.5 Leverage Analysis On The Dimensions Of Green Infrastructure

Four attributes were found from leverage analysis on the dimensions of green infrastructure, including (1) Hedgerow, (2) Additional vegetation, (3) Tree Canopy Expansion, and (4) Rain gardens. Financing for green infrastructure maintenance is a constraint and obstacle faced in the settlement arrangement sector in urban areas (Bagheri et al., 2021)**.** Regional ecosystem analysis methods obtained based on data on the evolution of urban green spaces, with the help of Geographic Information System technology, aim to visualize these ecological values. The analysis results will be combined with the residential landscape design of urban green spaces [32]**.** Green infrastructure and ecosystem services require strategic planning of urban green areas, spatial planning, and green space management design—Structure [32]. Green infrastructure is one of the strategies to protect open spaces and natural resources [33]. The analysis results show that the condition of green infrastructure on Penyengat Island's unsustainable status requires special attention from the government regarding rules and regulations and community empowerment to create a green environment. Green infrastructure can be used as one of the strategies for decision-makers to manage the sustainability of settlements and cultural heritage on the island.

3.2 Sustainable Strategy for Managing Healthy Settlement on Penyengat Island

The approach for managing long-term healthy settlements on Penyengat Island's coast uses a prospective analysis through the Participatory Prospective Analysis software. Based on the results, 11 determining attributes (Input/Driving) for settlement arrangement strategy in the coastal area of cultural heritage are shown in Table 3. One of the strategies used in managing settlements is to plan spatial infrastructure in informal settlements by involving local communities and non-governmental organizations[34].

Table 3. Influential Attributes in the Arrangement of Sustainable Healthy Settlement in the Coastal Area of Penyengat Island Cultural Heritage

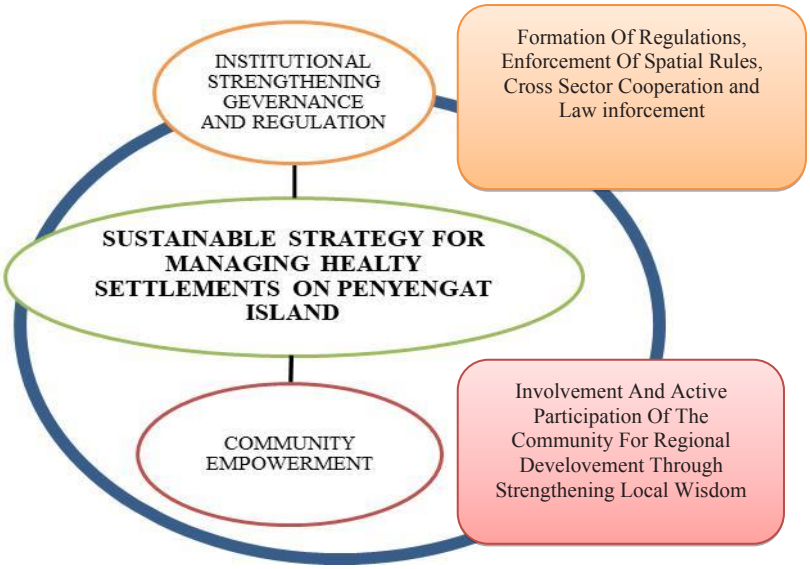
Quadrant	Variable	Influential Attributes
I	Determinant (*Input*/*Driving*)	1. Dissemination of regulations 2. Rain gardens 3. Settlement regulation 4. Tree canopy expansion 5. Addition of vegetation 6. Hedgerow 7. Community group management 8. Handling cross-program problems 9. Community organizations on cultural heritage 10. Community organization on settlements 11. Social conflict
II	Liaison (*Stakes*)	-

III	Bound (*Output*)	1.	Technological innovation
		2.	Number of tourists
		3.	Type of work
		4.	Corporate social responsibility financial support
		5.	Provision of clean water
		6.	Lighting in the house
		7.	Noise
		8.	Increase income
		9.	Density occupancy
		10.	Household waste
		11.	Community perceptions of the distance between cultural heritage and settlement
IV	Autonomous (*Unused*)	1.	Education training
		2.	Implementation of cooperation

Source**:** Table by authors

A strategy and program for structuring healthy settlements in the cultural heritage area of Penyengat Island have been developed based on 11 critical attributes recognized as determinants of success (Tabel 3). Structuring healthy and sustainable settlements requires a more focused and directed structuring strategy based on solid analysis and evidence that supports the development. The 11 attributes in the determinant variables are the basis for the preparation of settlement structuring strategies representing three dimensions: institutional law, green infrastructure, and socio-cultural. The prospective analysis suggested two main strategies in settlement arrangement on Penyengat Island, namely (1) Strengthening institutions, governance, and regulation of settlement arrangement, and (2) Community empowerment in structuring sustainable healthy settlement in the Penyengat Island cultural heritage area, as shown in Figure 2.

The prospective analysis is used to develop mangrove forest sustainability strategies by involving community empowerment, NGOs, universities, local governments, and research institutions with a high level of collaboration (convergence) to support the strategy[28]. The arrangement of a good sanitation area requires support from various parties, including the government and the community. The government must allocate infrastructure budgets while the community actively participates in the form of good sanitation management behaviors [35]. One method for organizing coastal area settlements involves introducing socio-ecological boundaries into the regulatory framework of ecosystem-based management in coastal and marine regions [36]. Policy advocacy and strengthening of laws related to the right to housing are some of the strategies for structuring informal settlements[37] The study results show that the settlement planning strategy on Penyengat Island is in line with previous research.



Source: Figure by authors

Figure 2. Sustainable Strategy for Managing Healthy Settlement on Penyengat Island

4 CONCLUSION

In conclusion, investigating the sustainability state of the layout of healthy settlements in the cultural heritage coastline region of Penyengat Island revealed a satisfactory sustainability status. It was sustainable for ecological and legal/institutional dimensions but less for economic and socio-cultural dimensions. In contrast, the green infrastructure dimension was unsustainable. The prospective analysis showed 11 critical attributes for developing a long-term settlement strategy for the cultural heritage of Penyengat Island's coastal area. The primary strategy for settlement arrangement included (1) Strengthening institutions, governance, and settlement arrangement regulations and (2) Community empowerment. Previous research only analyzed the sustainability of settlements, while this study further explored the strategy of structuring beneficial settlements in the coastal regions. This study's distinctiveness comes from its sustainability status and a plan for beneficial settlements in the coastal region of Penyengat Island's cultural heritage.

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