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FEASIBILITY AND SUITABILITY ASSESSMENT MODEL FOR SMALL ISLAND DEVELOPMENT SITES BASED SOCIAL-ECOLOGICAL SYSTEMS APPROACH: MAPPING THE MOST INFLUENCED FACTORS AND INTEREST OF THREE PILLAR PARTNERSHIP

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Abstract

This research was conducted to map the most influenced factors and interests of three pillars of partnership to index the feasibility and suitability assessment model for small island development sites based on the framework of the social-ecological system (SES). The mapping was conducted based on a literature survey, describing connectivity between the SES component and the pillar of collaborative partnership. The SES component consists of resources, users, public infrastructure providers, and public infrastructure, meanwhile, three pillars consist of public, private, and people. SES plays an important role in determining the feasibility and suitability of small island development sites. The component small island becomes the priority factor influenced the most to determine the feasibility and suitability assessment, followed by the user component and related ecosystem component, meanwhile, the component SES of public infrastructure becomes the lowest index. The small island is usually far from the main island and the inhabitants depended on the resources surrounding areas, besides they are intra-depending and supporting each other. Those components were very influential to the component value of the resources and users measured. This mapping would be helpful for many other stakeholders related to the small island development programmers, especially for indexing feasibility and suitability for which island is more eligible to be selected and developed furthermore.

Keywords: Coastal management, Small island development, Small island stakeholders, Sustainability, Sustainable development.

1. Introduction

The social-ecological system (SES) is an approach that links and balances the sustainability of ecological systems and social systems to be able to provide benefits for the welfare of society [1]. SES ensures the sustainability of ecology, social and economic [2-5]. Human life depends on ecosystems. However, the pattern of growth and public consumption has increased the pressure on the ecosystem [2]. Environmental degradation has caused a loss of biodiversity [1, 6]. Ecosystems are also threatened by over-utilization [6, 7]. The influence of household activities at various levels and pressures will encourage disturbances in the system [7]. A direct assessment of the maximum limit of pressure on the ecosystem although can be tolerated but still needs to test its resilience [2] and the conservation can frame the resources. Thus, they remain following their carrying capacity [8]. The interaction of ecological, economic, and social factors in ecosystem changes will have social-economic consequences [9]. Also, fundamental changes in the social-economic sub-systems will change the ecosystem [1]. However, there is a general difference in knowledge about ecosystem function and ecological limits to social-economic activities [10]. Conservation is also necessary to develop appropriate indicators [11]. Conservation is just an effort that has legitimacy and can be carried out by local governments. Thus, the environment can be maintained [1]. However, this program is usually still top. Thus, it has its opportunities and challenges, especially during its implementation [7].

Small islands in Indonesia have different characteristics even though they have a mutual benefit relationship [2, 11]. The development of small islands is often a unique battle between prioritizing the interests of economic, social, or ecological sustainability [3]. Therefore, small island development requires a directed and suitable approach. The development of small islands needs an SES approach, and it is expected to have a positive and better impact as much as possible on the welfare of coastal and small island communities [12]. A feasibility and suitability study for small island development site based on the SES approach needs to be carried out to ensure the sustainability and success of the development program that would be conducted. This study maps the most influential factors and interests of the three pillars of collaboration to measure the feasibility and suitability assessment model for small island development sites based on the SES approach. Novelties of this research are (i) a combination of SES and three pillars of partnership and (ii) a mark for influence factors in assessing sustainable development sites.

2.Literature Review

SES is the systems approach describing the proximity of human systems and their interaction patterns with the environment [13]. Although there are still many debates on approaches to viewing the interrelationships of human systems and ecosystems [14], until now there has been no single or generally accepted approach to formulate the interrelationships between social and natural systems. The ecosystem is defined as biological components interacting with each other in the system, including human components although it is still not easy when humans are classified as biological components as humans also have culture [13]. The concept of SES is very important and suitable for management approach considering that the characteristics and dynamics of coastal and marine areas are interrelated dynamics. Thus, the two main systems make up coastal areas and the ocean moves dynamically in a magnitude similarity [1, 14]. The small island ecosystems management cannot only be approached by looking at the problems and threats to the diversity of coastal and marine ecosystems [15] but also needs to be equipped to the sources of threats which are partly contributed by anthropogenic sources, as well as their impact on the human systems that depend on these ecosystems [12, 16]. The framework of SES consists of four main components of the system, i.e.: (i) a resource unit; (ii) resource users, (iii) resource infrastructure; and (iv) a resource infrastructure provider [14, 17]. Components (i) and (iv) are influenced by the presence of the associated ecosystem, while components (ii) and (iii) are influenced by the socioeconomic and political environment [17].

3. Method

The selection of small island development sites is carried out by taking into account every element that is interrelated in the SES of a small island [16]. The suitability and feasibility of the location should consider the sustainability aspects [18]. Thus, the welfare of small island communities can be guaranteed, sustainable, and optimal between generations [19]. The feasibility and suitability of small island development sites based on SES can at least be seen from the coexistence of the three pillars of development cooperation which reflect the balance of fulfilling the interests of public, private, and community. This pattern of cooperation is known as a public-private-people, PPP partnership [20]. Data and information in mapping the most influential factors and interests of the three pillars of collaboration for the feasibility and suitability assessment of small island development sites based on SES are collected based on a literature survey related to various measurements that can describe connectivity between SES [17] and the three pillar of collaborative partnership. Assessment of ecosystem services is also integrated as a blended part in viewing the SES of small islands [1]. In addition, the identification of the factors that influence the feasibility and suitability assessment of small island development sites is also carried out [18]. Furthermore, the identification of the components of the interests of the three pillars of development cooperation is carried out [20].

4. Results and Discussion

4.1. Influential Factors in the Assessment of Feasibility and Suitability of Small Island Development Sites

Factors that influence the determination of indicators of feasibility and suitability of small island development sites based on SES include natural resources and ecosystems, facility, human resources, accessibility, tourist sites, local wisdom, island governance, clean water, security, social capital, carrying capacity, strategic position, natural disasters, people's purchasing power, energy, telecommunications network, state sovereignty, capacity, food, budget allocation, the national defence, conservation, investment interest, and mineral [18]. Small islands do have a high dependence on fossil fuels for energy, water, and food production [21]. Therefore, it is not surprising that energy, water, and food supply are issues raised as influential indicators in determining the feasibility and location of small island development [18]. Natural resources, education, infrastructure, and the carrying capacity of the island are highlighted as influential factors in determining the intended indicators to assess the feasibility and suitability of a small island development site [22]. A social, economic, and ecological sustainability framework can be used to map small island development indicators [23]. In the framework of social sustainability, place several related factors, such as population, education, security, health, migration, and poverty [17]. In the economic framework, it is mapped into several factors including income, supply, transportation, and infrastructure. As for the ecological sustainability framework, these include water supply, waste management, environmental quality, conservation, energy and minerals, fishery production, and carrying capacity [23]. Several environmental indicators influencing the determination of the feasibility and suitability [24], including natural resources, habitats, coastal and marine ecosystems, carrying capacity, and pollution. The fluctuations in the amount of tourism, limited economic independence, unique characteristics of biodiversity and culture, scarce resources, and fragile and sensitive ecosystems are recognized as several factors that influence the vulnerability of small islands, as well as in addition the importance of small island infrastructure and means of accessibility [25]. Meanwhile, the island's diversity, ecology, tourism spots and destinations, attractions, accessibility, supporting services, and tourism activities provide an important description of several factors related to determining indicators of feasibility and suitability. Millennial tourists who usually visit are productive generations who come from various big cities within and outside the country. Overall, the opinions of the experts who were nominated as expert respondents and several opinions of researchers as mentioned in several references above, show that the SES as an important role in determining the feasibility and suitability of small island development sites [18]. This is indicated by several factors in the network of interrelationships between components of SES [19]. Thus, they can be determined as factors that influence the feasibility and suitability of the location as the purpose of conducting this research.

4.2. The Network of Interrelationships between Components in a Small Island Social-Ecological System

The existence of a relationship between the small island component (SIC) and the public infrastructure component (PIC) can be affected by the presence of the related ecosystem, REC [17]. Meanwhile, the relationship between the user component (UC) and the public infrastructure provider component (PIPC) can be also influenced by the socio-economic and political environment, SPEC [20]. Description a mock-up of the interrelationships between all components SES of small island are (1) linkage attribute SIC–UC is the connectivity between small islands and users which is usually bridged by the interaction of the use of small islands by humans, such as providers of fish, biota, food, recreation, fishing ground, wave protection, and so on; (2) linkage attribute UC–PIPC is the connectivity between users and public infrastructure providers which is usually marked by a relationship between public infrastructure providers and users of resources; (3) linkage attribute PIPC–PIC is the connectivity between public infrastructure providers and public infrastructure which is usually characterized by a relationship between the public infrastructure provider and the public infrastructure that has been built; (4) linkage attribute PIC–SIC is the connectivity between public infrastructure and small islands which is usually marked by the interaction of small island functions that are useful for public infrastructure; (5) linkage attribute SIC–UC–PIC is the connectivity between small islands and users which is affected by the existence of public infrastructure, such as fish auction landing (TPI), ports, ship docking, and so on; (6) linkage attribute UC–PIC is the connectivity between resource users and public infrastructure which is usually characterized by a relationship between public infrastructure that has been built by public infrastructure providers that are of direct benefit to resource users; (7) linkage attribute SPEC is the connectivity which describes external factors in the form of socio-economic-political conditions that affect users (7a) and public infrastructure providers (7b), such as population growth, regional economy, inflation and other policies; and (8) linkage attribute REC is the connectivity which describes the existence of external factors (the presence of other ecosystems) that affect small island (8a) and providers of public infrastructure (8b), such as the existence of terrestrial ecosystems, mangrove, seagrass and coral reef which also have ecosystem services and functions that physically and bioecologically affect small island component and social-ecologically influences public infrastructure. Based on the network of linkages between components in small island SSE and the influence analysis between components, it can be determined the priority factors of the six SES's small island components that have the most influence on the feasibility and suitability of small island development sites based on this SES. Table 1 shows the mapping of the most influenced factors to determine the feasibility and suitability small island development site. SIC is the priority factor that could influence the most to determine the feasibility and suitability assessment of small island development sites based on the SES approach (see Table 1). SIC has the highest index of 0.3424, while the PIC has the lowest index 0.0670. Each priority factor (see Table 1) is categorized based on the interest of three pillar partnerships: public interest, private interest, and people interest [21]. The SIC consists of clean water (public), accessibility (public), carrying capacity (public), energy (private), telecommunication network (private), investment interest (private), mineral (private), and strategic position (public) when the UC consists of community's purchasing power (people), local wisdom (people), social capital (people), and human resources (people). Then, the PIPC consists of budget allocation (public) and small island governance (public). Meanwhile, the PIC is a facility (public). On the other side, SPEC consists of a natural hazard (public), security (public), state sovereignty (public), and national defines (public); and the REC consist of natural resources and ecosystem (public), conservation (public), tourism spot (private) and food (private). Priority index (PI), as well as mentioned in Table 1, is determined by multiplying the number of each influence factor with 0.70 as a justifying weight of natural capital of their linkage attribute among its component added with the number of available references multiplied with 0.30 as a justifying additional weight that showed how valued them among the selected researcher who publishes their work around the world. This calculation is shown in Equations (1) and (2):

$$PI^{i} = \frac{1}{n}\sum_{j=1}^{n} PIC^{i,j} \tag{1}$$

$$PIC^{i,j} = \frac{1}{m}\sum_{j,k,l=1}^{n,m}\{(PF^{i,j,k} * w^{i,j,k}) + (PF^{i,j,l} * w^{i,j,l})\} \tag{2}$$

where PI^{i} is the priority index of the component i; i is the sequence of SES components (SIC, UC, PIPC, PIC, SPEC, and REC); n is the total number of SES components; $PIC^{i,j}$ is the priority factors a priority index j as sub-component in the component i; j is the sequence of SES sub-component (priority factor); m is the total number of SES sub-component; $PF^{i,j,k}$is the influence factor to linkage attribute k of priority factors in the priority index j as sub-component in the component i; $PF^{i,j,l}$ is the supporting references l of priority factors in the priority index j as sub-component in the component i; k, l is the sequence of justifying weight (natural capital of linkage attribute and supporting reference); $w^{i,j,k}$ is the justifying weight of natural capital of their linkage attribute among its component to linkage attribute k of priority factors in the priority index j as sub-component in the component

i ($w^{i,j,k} = 0.70$); and $w^{i,j,l}$ is the supporting references l of priority factors in the priority index j as sub-component in the component i ($w^{i,j,l} = 0.30$).

This study is important since human life depends on ecosystems, and human also changes the ecosystem [26-28]. Understanding this study can be applied in realistic condition, especially facing SES.

Table 1. Mapping priority as the most influential factor.

SES	Priority Factors	Influence Factors to Linkage Attribute [17]	Supporting References	Priority Index
SIC	Clean water	(1) (4) (7a)	[17, 21, 23]	SIC= 0.3424
	Accessibility	(1) (4) (7a)	[17, 23, 25]	
	Carrying capacity	(1) (4) (7a)	[17, 22-24]	
	Energy	(1) (4) (7a)	[17, 21, 23]	
	Telecommunication network	(1) (4) (7a)	[17]	
	Investment interest	(1) (4) (7a)	[17]	
	Mineral	(1) (4) (7a)	[17, 21, 23]	
	Strategic position	(1) (4) (7a)	[17]	
UC	Community's purchasing power	(1) (2) (5) (6) (8b)	[17, 23]	UC= 0.2553
	Local wisdom	(1) (2) (5) (6) (8b)	[17, 25]	
	Social capital	(1) (2) (5) (6) (8b)	[17, 23, 25]	
	Human resources	(1) (2) (5) (6) (8b)	[17, 22, 23]	
PIPC	Budget allocation	(2) (3) (8a)	[17]	PIPC= 0.0685
	Small island governance	(2) (3) (8b)	[17]	
PIC	Facility	(3) (4) (5) (6) (7b)	[17, 22, 23, 25]	IPC= 0.0670
SPEC	Natural hazard	(8a) (8b)	[17, 24]	SPEC= 0.1098
	Security	(8a) (8b)	[17, 23]	
	State sovereignty	(8a) (8b)	[17]	
	National defence	(8a) (8b)	[17]	
REC	Natural resources and ecosystem	(7a) (7b)	[17, 22, 24, 25]	REC= 0.1569
	Conservation	(7a) (7b)	[17, 23-25]	
	Tourism spot	(7a) (7b)	[17, 25]	
	Food	(7a) (7b)	[17, 21, 23]	

5. Conclusion

A framework of SES is very powerful for determining the feasibility and suitability of small island development sites. The framework mapped the integrated and combinative indicator of sustainable small island development and the interest of three pillars of collaborative partnership. The algorithm model should be indexed using a simple combinative scale of Likert, aggregation, and summarizing.

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