A framework of artificial intelligent for investment assessment in coastal and small island area, relate to disaster risk

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Abstract. Coastal areas and small islands in Indonesia have reliable investment feasibility potential. The location of small islands that must be developed must assess the ecosystem's carrying capacity and the environment, including disaster risk. Research on investment feasibility based on disaster risk is necessary to support small islands' investment plans and development. This area is known as a vulnerable and potentially high risk from natural or human-made disasters. The research conducted in the Kepulauan Seribu will adopt digital technology to assess the eligibility criteria as the start of an investment step. The intervention of digital technology on investment feasibility assessment in line with the digital era in the Industrial Revolution 4.0. The outputs of the research are (1) investment feasibility indicators in coastal areas and small islands based on disaster risk; (2) strengthening systems and institutions related to investment feasibility assessment in coastal areas and small islands; (3) the prototype of smart system technology for assessing investment feasibility in coastal areas and small islands based on disaster risk as part of the adaptation of revolution 4.0 to support the policy of integrated electronic business licensing services.

Keywords: artificial intelligent; coastal area; disaster risk; investment assessment; small island

1. Introduction

As the largest archipelagic country globally, Indonesia has the potential for coastal and small islands that have not been utilized optimally and sustainably [1]. Coastal and small islands have several functions as follows ecology, economy, and politics. Ecologically, coastal, marine, and small islands ecosystem [2], also play a role in global climate change, hydrological and bioeconomic cycles, absorbing
waste, sources of biodiversity, alternative energy sources, and other life support systems that potential to increase their vulnerability [3]. Economic benefits, small islands are habitats that have high biological productivity, as resource-based tourism locations and settlements. Meanwhile, small islands have defense and security functions from a political perspective, especially small islands in border areas.

During these several decades, most of the small islands have not become development priorities. Small islands characterized by high vulnerability due to natural changes and disasters are why the slow emphasis. Besides, it has high endemic species due to limited carrying capacity, so it must be appropriately managed. Another problem in the management and development of small islands is land-biased development policies, making it difficult for small islands to grow for investment. The following conditions have also driven the slow growth in development and investment: (a) most of the small islands are underdeveloped areas; (b) lack of basic facilities and infrastructure such as water, electricity, and connecting transportation between small islands and large islands; (c) the potential for conflict over territorial boundary violations; (d) lack of data and information related to small islands, and (e) the high potential risk of disasters from natural factors, climate change [4] and human influence.

Government policies through the Ministerial Decree No. 39 of 2004 concerning general guidelines for investment in small islands and the Job Creation Law No. 11 of 2020 also encourage development and investment efforts on small islands to develop immediately. To support this policy, it is necessary to accelerate the investment process in coastal areas and small islands by considering the sustainability of resources and disaster risk [5]. It is essential to prepare assessment criteria to facilitate investment efforts and instruments based on industrial technology 4.0 (artificially intelligent).

Investment needs to strengthen the fulfillment, therefore, this study aims to 1) develop investment eligibility criteria, 2) compile an application-based investment system model or design, 3) prepare a prototype for an artificially intelligent system (application), and 4) carry out testing of indicators and applications. This paper discusses investment criteria and a prototype design model that considers disaster aspects.

2. Material and methods

2.1. Research area
A feasibility study for investment in coastal areas and small islands was carried out in the Thousand Islands. This study integrates disaster risk as a consideration by government policy. The criteria were assessed, then compiled in an algorithm with a structured approach as the basis for preparing the application. This application is needed to support the acceleration of investment licensing mechanisms in coastal areas and small islands.

2.2. Data collecting
The data collected for investment criteria include primary and secondary data. The data consists of data on business status and type of business, carrying capacity of the environment, potential and risk of disasters, and the community and institutional systems’ socio-economic conditions. The collection was carried out by direct observation and measurement at the research location, conducting in-depth interviews with the help of a questionnaire, and conducting focus group discussions (FGDs) with related parties. Meanwhile, secondary data were obtained from various local government agencies, villages, non-governmental organizations, and the private sector.

This disaster risk-based coastal and small island investment framework is a consideration in the future investment process. For this reason, the first stage of the research carried out begins with compiling all investment indicators from each aspect. All the indicators are defined, weighted, and then are input indicators in the system created. The assessment process can be carried out online when conducting the data collection and data analysis using Android-based technology. Therefore, this research will be prepared until a prototype of the investment model is available.

The selection of criteria and indicators is an effort to classify small islands with high economic value for investment. The objective of the standards and indicators is that each small island has the capacity
and capability to support investment development. So that, it can make it easier for investors when they already know the small island feasibility. In detail, the types and sources of data needed in this study to compile the criteria in table 1.

**Table 1.** Types and sources of data needed in research.

| No | Purpose of research activity                                                                 | Type of data                                                                 | Source data                  | Data analysis                  |
|----|-----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|-------------------------------|--------------------------------|
| 1  | Evaluating indicators of investment feasibility in coastal areas and small islands based on disaster risk | 1. Coastal and small island carrying capacity [1]  
2. Compliance with RZ/RTRW /and licensing  
3. Level of disaster vulnerability [5]  
4. Physical and infrastructure conditions as well as the availability of infrastructure [6]  
5. Socio-economic conditions | Primary and secondary data | Descriptive statistic |
| 2  | Strengthen systems and institutions related to investment feasibility assessment in coastal areas and small islands | 1. Mapping the potential vulnerability of coastal and small islands and disaster risks  
2. Designing the investment feasibility appraisal prototype | Primary and secondary data | Description statistic, Geographical Information System (GIS) |
| 3  | Designing a smart system technology prototype for investment feasibility assessment in coastal areas and small islands based on disaster risk | 1. Preparing smart invest for enumerators to assess investment worthiness  
2. Preparing HR enumerators that are adaptive to smart invest  
3. System evaluation and strengthening | Primary and secondary data | Experts judgment and technology information system |

**Figure 1.** Model of criteria feasibility valuation of small island investment.
2.3. Valuation matrix

The formulation of the investment criteria is carried out by analyzing each parameter in the domains of government (Gov), natural resources (NR), business and social economy (BSE), infrastructure (IF), and risk and disaster (RD). Then each domain is described through several key parameters that determine the feasibility assessment. The final result of each parameter then becomes the basis for determining the assessed investment index. The domain determination matrix and criteria are presented in the following network model (figure 1).

The function of the small islands investment model is the integration function of all the parameters obtained. Furthermore, each domain determines definitive criteria that generally apply in coastal areas and small islands being developed. This criterion is one of the essential findings in achieving the first objective of this research.

3. Result and Discussion

3.1. Domain and criteria

The criteria derived from five main domains consist of (1) suitability of RZ/RTRW and licensing [7]; (2) the carrying capacity and load capacity (CC-LD) of the environment in small islands; (3) the level of disaster vulnerability in small islands [5]; (4) physical conditions and availability of supporting infrastructure on the island [5]; (5) the community’s socio-economic conditions. Each domain is then derived into the parameters to be assessed, which is then carried out by determining the score of each value obtained.

Its value determines each criterion from the domain from the data collected during the feasibility assessment. Determining the criteria for each domain aims to classify small islands with high economic value for investment development and risk-vulnerability [8]. The objective of the criteria is expected that each small island has the capacity and capability to support investment development. Criteria from each domain, which is then determined, are presented in table 2.

| No | Domain                          | Criteria                                                                 |
|----|--------------------------------|--------------------------------------------------------------------------|
| 1  | Investment suitability to masterplan | Location suitability to masterplan and zonation                          |
|    |                                | The allocation of small island in masterplan                             |
|    |                                | Management status of small island                                        |
|    |                                | Property right and certification                                         |
|    |                                | Proportion area for investment                                           |
|    |                                | Land suitability land use in small island                                |
| 2  | Environmental carrying capacity | Water carrying capacity                                                  |
|    |                                | Availability and sufficient of water                                     |
|    |                                | Coastal substrate type                                                   |
|    |                                | Sensitivity area of small island from pollutant                          |
|    |                                | Coral reef coverage                                                      |
|    |                                | Island physiology                                                        |
|    |                                | Water transparency                                                       |
|    |                                | Frequency disaster                                                       |
|    |                                | Availability of fuel or local source energy                              |
|    |                                | Availability food source and cereal in small island                      |
|    |                                | Number of biotas that harvest                                            |
|    |                                | Potency and diversity of species                                          |
|    |                                | Safety and protection from impact                                         |
| 3  | Risk and Disaster               | Abrasion risk                                                            |
|    |                                | Flood and puddle on the coast area                                       |
|    |                                | The extra cost for abrasion and natural disaster impact                   |
|    |                                | Tsunami potency and frequency                                            |
|    |                                | Drought in the dry season                                                |
| No | Domain                        | Criteria                                                                 |
|----|-------------------------------|--------------------------------------------------------------------------|
| 3  | Infrastructure and physical status | Hurricane and storm                                                        |
|    |                               | Climate change and high temperature                                      |
|    |                               | Flood and subsidence                                                      |
|    |                               | High wave                                                                 |
|    |                               | The extra cost for natural mitigation                                     |
|    |                               | Island land area                                                          |
|    |                               | High-level area                                                           |
|    |                               | Distance from the main island                                              |
|    |                               | Typology of coastal elevation                                             |
|    |                               | Width of coral reef                                                       |
|    |                               | Width of beachline                                                        |
|    |                               | Coastal slope                                                             |
|    |                               | Current speed                                                             |
|    |                               | Kind of street in the island                                              |
|    |                               | Distance from the main island                                              |
|    |                               | Availability of port or jetty                                              |
|    |                               | Availability public facility                                               |
|    |                               | Availability of freshwater and installation                               |
|    |                               | Availability of power plan                                                |
|    |                               | Communication and internet service                                        |
| 4  | Social economy                | Population (ind)                                                          |
|    |                               | Density of population                                                     |
|    |                               | Education of the population                                               |
|    |                               | Local economy sector                                                      |
|    |                               | Distance to the center of economic activity                               |
|    |                               | Distance to the center of administration and government                   |
|    |                               | (island to district office)                                               |
|    |                               | Accessibility to island                                                    |
|    |                               | Availability transportation                                               |
|    |                               | Sistem transportation management                                          |
|    |                               | Feasibility and amenity of transportation                                 |
|    |                               | Frequency and transportation to the island                                 |
|    |                               | Transportation cost of trip to the island                                  |
|    |                               | The ratio of a potential area on the island to the total area             |
|    |                               | History of island                                                          |
|    |                               | Number of historical monument and ancient sites                           |
|    |                               | Local culture and custom                                                   |
|    |                               | Security                                                                  |

3.2. Assessment of the feasibility of coastal and small island investment
The method used to calculate the value of coastal and small island investments' risk-based investment feasibility is the scoring technique. The assessment scores for each variable on each criterion ranged from 1-5. The higher the score on each criterion, the more feasible it is to invest in these coastal areas and small islands. Assessment of investment feasibility is composed of two values. The first is the value from the assessor (independent person), and the second is the value of the evaluator (government).

3.2.1. Weighting by the assessor. Before using the small investment index (SII) index formula, the survey questionnaire used a Likert scale with a score of 1-5. Provided that, the higher the score, the higher the investment feasibility value of the island. The total score for each criterion is (total score/number of questions). The formula used to assess the feasibility of investing in coastal areas and small islands refers to the SII (Small Investment Index) formula, but the criteria and weighting that will be modified are based on the results of focus group discussions and expert judgments as below [9]:

\[
SIII=a(ZSI)+b(CCI)+c(DVI)+d(ID)+e(SI)
\]  (1)
SIII is small island investment index; ZSI is suitability index to RZ/RTRW/licencing (zonation suitability index); \(a\) is weight of ZI; CCI is carrying capacity index; \(b\) is weight of CCI; DVI is disaster vulnerability index; \(c\) is weight of DVI; \(II\) is infrastructure index; \(d\) is weight of \(II\); \(SI\) is socioeconomic and culture index; and \(e\) is weight of SI.

3.2.2. Weighting by the evaluator. The evaluator uses indicators that have been developed by the Ministry of Marine Affairs and Fisheries in the investment assessment of small islands in Indonesia [10]. The investment feasibility assessment refers to the feasibility document based on the commitment document for the utilization of small islands issued by the Ministry of Maritime and Marine Affairs (MMMA) with a modification to the calculation of the eligibility criteria. There are two types of evaluation, such as for foreign investment (PMA) and small islands less than 100 km\(^2\) (PPK <100 km\(^2\)). The scale used in each investment feasibility assessment indicator in small islands is the Likert scale method (0-1) with two layers. The classification that the higher the score, the higher the investment feasibility value of small islands. The two-layer assessments are: 1) validated document onto 3 criteria such as no complete (score = 0); less complete: (score = 0.5); and not complete (score = 1), and 2) feasibility document, onto 2 criteria such as not feasible (score = 0) and feasible (score = 1) [10].

The score for each indicator is the multiplication of document validation and document eligibility. After that, the indicator score results were used to assess each criterion, PMA (see table 3), and PPK <100 km, provided that the indicator score = (total score/number of questions)\(\times\)10) (see table 4). The weighting for each criterion is as follows (table 3 and 4).

The total score for the evaluator uses the following formula:

\[
\text{Score of evaluator} = (\text{score of indicator } A \times \text{weight of } A) + (\text{score of indicator } B \times \text{weight of } B) + \cdots + (\text{score of indicator } H \times \text{weight of } H)
\]

Table 3. The weighting of commitment for the utilization of small island for foreign investment.

| No | Commitment                                                                 | Weight (%) |
|----|---------------------------------------------------------------------------|------------|
| A  | Explanation of the business plan and type of activity                    | 20         |
| B  | Map of the location of land and water utilization accompanied by area and  | 5          |
|    | geographic coordinates                                                   |            |
| C  | Strategies for providing public access                                    | 5          |
| D  | Technology transfer plan                                                  | 5          |
| E  | Cooperation plans with Indonesian participants                            | 5          |
| F  | Plans to transfer shares gradually to Indonesian participants              | 5          |
| G1 | Consideration of ecological aspects                                       | 15         |
| G2 | Consideration of socio-cultural aspects                                   | 7.5        |
| G3 | Consideration of economic aspects                                        | 7.5        |
| G4 | Review of national defense and security aspects                           | 5          |
| H  | Recommendations from regents/mayors containing:                           | 20         |
|    | - basic consideration                                                    |            |
|    | - strategic, technical, statutory regulations                            |            |
|    | - notes/conditions                                                       |            |
Table 4. Weighted commitment recommendation for location permit with an area of fewer than 100 km².

| No | Commitment                                                                 | Weight (%) |
|----|-----------------------------------------------------------------------------|------------|
| A  | Explanation of the business plan and type of activity                       | 20         |
| B  | Map of the location of land and water utilization accompanied by area and geographic coordinates | 10         |
| C1 | Consideration of ecological aspects                                         | 15         |
| C2 | Consideration of socio-cultural aspects                                     | 12.5       |
| C3 | Consideration of economic aspects                                          | 12.5       |
| D  | Follow the rules for land area in PPK and waters according to statutory regulations | 10         |
| E  | Right of land ownership                                                     | 20         |

3.2.3. Investment feasibility weighting. Before calculating the total score for the investment assessment of coastal and small island feasibility, the surveyor's score must be normalized in the value range 1-10 with the following method. Appraisal value = (Likert scale score/range)×10. After the score from the evaluator is obtained, the total score is obtained by the formula:

\[ \text{Total Score} = (\text{Evaluator Score} \times 0.65) + (\text{Evaluator Score} \times 0.35) \]  

The eligibility criteria for coastal and small island investment shall follow the following conditions, namely not feasible (total value less than 7), feasible with any requirement (total value between 7–8.5), and feasible for value \( \geq 8.5 \).

3.3. Hypothetic model for smart investment

After determining the criteria and index for assessing small island investment, an application system model is prepared to facilitate rapid assessment. This application is based on information technology (artificially intelligent) applied quickly in the field's assessment process. The 4.0 technology revolution is vital for measuring government performance, especially in evaluating investment plans in coastal areas and small islands. 

Nazeer et al. (2017) suggest using machine learning methods or artificial intelligence for the more accurate and efficient routine monitoring and evaluation of the coastal environment, investment, and social community [11].

Therefore it is crucial to design a prototype, which we call “Smart Invest,” so that an appropriate investment feasibility system is formed in assessing the feasibility of investment based on disaster risk. Smart Invest is an application prepared for enumerators to evaluate the feasibility of investing in coastal and small islands. The eligibility criteria have been studied by integrating disaster risk. Recently artificial intelligence are making it integrate machine learning capabilities into numerical modeling systems [12]. So that the OSS system prepared by the government but needed any improvement criteria. The investment appraisal process system design is then designed as follows in figure 2.

With this prototype model, a network application is designed as a feasibility assessment instrument and tool [12] so that the appraisal process can take place quickly and precisely when there is an investment plan. The integration of machine learning capability into numerical modeling system to bridge the gap and lessen [13] the government program and investor to coastal and small island development [14]. Figure 2 above is a conceptual framework for defining investment feasibility criteria onto machine system as a governance system on coastal and small island management [15]. Besides that, its integration of multi-dimension on coastal and small island investment increases the database quality [16].

The smart investment must support liveability dimensions in the coastal area to ensure resilience, safety, and sustainability as prescribed by the SDG 11 [16]. In the end, this program is a strategy to improve data governance [17] to built better future management on the coastal and small islands.
Figure 2. Hypothetic artificial intelligent system on an assessment of coastal and small island investment (Smart Invest).

4. Conclusion
The process of adapting information and technology in the development and investment of coastal areas and small islands is very urgent. To ensure sustainability, the criteria built must consider the long-term sustainability aspects of both resources and ecosystems. With this in mind, this study formulated 62 indicators for evaluators and 18 indicators for evaluators. The integration model between the evaluation criteria and the evaluator becomes the final criterion for investment eligibility. Then it is revealed to be a smart system design and model integrated with 4.0 technology or applications.

Acknowledgment
We would like to thank the Ministry of Education and Culture for supporting this research. This is the first year of study in 2 years of research implementation in 2020-2021.

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