Infrastructures for the development on Bawean Island, Gresik, East Java-Indonesia

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Abstract. The main problem of settlement in small islands is the lack of basic infrastructures. Government has realized the need of infrastructure development for the settlement in small islands through the Presidential Decree. However, the development of infrastructure must follow the characteristics of its potential and constraints as an island. Bawean Island is a small island with an area approximately 190 km² that is located in the Java Sea and in the north of Surabaya, which the capital of East Java, Indonesia. The soil morphology of Bawean is mountainous, and high and low hilly. So, it is necessary to identify the infrastructure in Bawean Island to facilitate the design of island according to its soil morphology. This research used qualitative method that is a direct survey by staying in Bawean Island. The data collection is by interviewing local people and supplemented with theories of islands. It is expected that the complete data about Bawean Island’s infrastructure can create spatial design of Bawean Island.

1. Introduction

Island is a mass of land that is formed naturally, surrounded by water and always located/emerging from tides. Indonesia has the fourth longest coastline in the world that is 95,181 km. This marine richness brings a great potential of Natural resources. The sea consists of components of biological resources and non-biological with a variety and high economic value. However, behind this great potential are hidden unresolved problems that related to coastal settlement. Coastal areas in Indonesia are on the island. Coastal settlements are generally underdeveloped, lack of environmental quality and infrastructure, and its conditions that are similar to underdevelopment. So, it is required the management of marine, coastal and small island resources through the activities, management, and development of conservation area and island type) [8]. Some characteristics of small islands that can be a constraint of development are:

1. The small-size and isolated island. The facilities and infrastructure are very expensive, and lack of reliable human resources. The size of island is not the problem if the goods and services that produced and consumed by its local people exist on the island. However, if the population drastically increases, it needs goods and services from outside the island.

2. The difficulty and inability to reach economic of scale that is optimal and profitability (in terms of administration, production, and transportation).

3. The availability of natural resources and environmental services such as freshwater, vegetation, soil, coastal ecosystems and wildlife will ultimately determine the
carrying capacity of a small island system in support of human life, inhabitants, and all its development.

4. The productivity of natural resources and environmental services (such as erosion control) in every space unit (location) in the island and located around the island (such as coral reef ecosystems) and coastal are closely linked to each other.

5. The local culture of agriculture is sometimes contrary to development activities such as tourism which has recently been regarded as a sacred deity (panacea) for the development of small islands, but in some small islands, the culture brought by foreign tourists is unsuitable with local customs or religions.

Based on all those constraints, it does not mean that small island cannot be built or developed. However, the development pattern must follow the ecological rules. The overall development level should not exceed the carrying capacity of the island. The cross-sectoral impact should be minimized according to island’s ecosystem. Besides, every development activities of business that will be developed on an island should meet the optimal and profitable economic scale and following the local culture. The case study will discuss Bawean Island. A small island is an island that has an area of less than or equal to 10,000 km$^2$. Bawean is a small island in Java Sea located 150 km north of Surabaya as the capital of East Java, Indonesia. Bawean Island has a round shape with 15 km in diameter and the area is approximately 190 km$^2$.

The name ‘Bawean’ came from Sanskrit phrase $ba$ (light) $we$ (sun) $an$ (is) that means having the sunlight. Based on the legend, some sailors catch a glimpse of light around the island. These sailors (according to the legend in 1350) came from the Majapahit Kingdom that was trapped by a storm in the Java Sea and stranded on Bawean Island at sunrise. In Negarakertagama ancient book, that the island was named Buwun. The history of Bawean Island is recorded as follows:

1. In the early Middle Age that is in the 15th century, ships that sailed in Java Sea are often used ports on Bawean Island.
2. Mass conversion of islanders to Islam began after the death of the local king in 1601, King Bebileono who liked animism, and the arrival of Sheik Maulana Umar Mas’ud from Java.
3. Dutch sailors first visited Bawean during their trade expedition to Java led by Cornelis de Houtman on January 11, 1597. Their expedition ship, Amsterdam, was damaged off the Bawean coast.
4. In 17-18th centuries, the island was regularly visited by ships from the Dutch East India Company, which strengthened its colonialist position in the Malay
archipelago, and in 1743 was officially under its control. At that time, Bawean island did not have great natural resources. So, Bawean island is only a resting place for ship which sail between Java and Kalimantan.

Figure 3. Bawean Island from the Sea
Source: Documentation of Yanita Mila Ardiani

Bawean Island that has an area less than 1000km² is included into the small island. There are many small sandy islands encircling Bawean Island but only some of the largest as inhabited satellite islands, namely Selayar, Selayar Noko, Noko Gili, Gili Timur (East Gili) and Nusa. The research problem of this research is identifying the condition and the infrastructures on Bawean Island. The benefit gained from this research is the contribution to the arrangement of areas and infrastructure in small islands. Moreover, the practical benefit of this research is obtaining information for future research on the typology of settlement arrangement and model for small islands that based on sustainable architecture.

2. Research Methods
This research used qualitative method with descriptive analytical that aimed to find, analyze, and describe infrastructure in small island clusters in Indonesia. The data analysis method is done by descriptive analysis, based on the interview results by looking at the dominant similarities and differences and looking at the distribution and frequency of each variable. Regarding time constraints, this research was performed in Bawean Island in Gresik. In collecting required data, survey and observation method were used. Survey method is used to obtain data related to socio-cultural and economic conditions as well as the pattern of public space usage. Then, observation method used was used to obtain the physical and non-physical images as well as characteristics of coastal settlements including the condition of infrastructure and housing facilities.

3. Results and Discussion
The definition of infrastructure has many versions. According to American Public Works Association [7], infrastructure is physical facilities that are developed or needed by public agencies for government functions such as water supply, electric power, waste disposal, transportation and similar services to facilitate social and economic goals. So, infrastructure is physical systems needed to meet basic human needs in the social and economic sphere. Technically, infrastructure has its own meaning and definition that is a physical asset designed in the system to provide important public services. Infrastructure itself can be divided into three major sections:

1. Physical hard infrastructures:
   - Water supply system, including dam, reservoir, transmission, treatment, and distribution facilities.
   - Wastewater management systems, including collection, treatment, disposal and reuse systems.
   - Solid waste management facilities.
Transportation facilities, including highways, railways and airports. These include lamps, signals, and control facilities.
- Public transit system.
- Electrical systems, including production and distribution.
- Natural-gas processing facilities.
- Flood, drainage, and irrigation facilities.
- Navigation and traffic/waterways facilities.
- Public buildings such as schools, hospitals, police stations, firefighting facilities.
- Housing facilities.
- Parks, playgrounds and recreational facilities, including stadiums.

2. Non-physical hard infrastructures that related to the function of public utility such as the availability of clean water including water installation and pipeline transports; power supplies, telecommunication networks (telephone and internet) and energy supplies ranging from petroleum, biodiesel and gas and its distribution pipes.

3. Soft infrastructures. It is also called an institutional that includes various values (work ethic), norms (especially those that have been developed and codified into law and legislation) and the quality of public services provided by various parties, especially government.

In finding what constitutes Indonesia's national standard for a residential environment in one RW (community association), or according to the number of people, it must be seen the basic housing data:

- 1 RT (neighborhood association): consists of 150-250 people.
- 1 RW (community association): (2,500 people) consists of 8-10 neighborhood associations.
- 1 village (≈area): (30,000 people) consists of 10-20 community associations.
- 1 sub-district: (120,000 people) consists of 4-6 sub-districts.
- 1 city: consists of at least 1 district.

3.1. Facilities in Bawean Island according to SNI (Indonesia’s National Standard)

1. Educational Facilities
   The planning of educational facilities should be based on educational objectives.

   **Table 1.** The needs of educational and learning facilities base on planning.

   | No | Type of facilities | No. of residents (people) | Facility Needs Per Unit | Standard (m²/ people) | Criteria | Description |
   |----|--------------------|---------------------------|-------------------------|-----------------------|----------|-------------|
   |    |                    |                           | Floor Area Min. (m²)   | Land Area Min. (m²)  | Radius   | Location and completion |
   |    |                    |                           | 500                    | 36 m²                 | 0.28     | At the center of the neighborhood. Not crossing the highway. Join with the park so it become a group of activities |
   |    | 1. Kindegarten     | 1,250                     | 216                    | 0.28                 | 500 m²   | 2 group of students (one group consist of 60 students) can join with other facilities Requirement should be |
   |    |                    |                           | including housekeeper per house |                     |          |             |
   |    | 2. Elementary      | 1,600                     | 633                    | 1.25                 | 1000 m²  |             |
3. Junior High School 4,800 2,282 9000 1.88 1000 m²
   It can be reached by public transport. Become one area with sports field. It does not always have to be at the center of the neighborhood based on calculations with the formulas number 2, 3 and 4. It can be combined with other educational facilities (such as elementary, junior high school and senior high school) in one complex.

4. Senior High School 4,800 3,835 12,500 2.6 3000 m²
   At the center of the neighborhood. Not crossing the highway.

5. Library 2,500 72 150 0.09 1000 m²
   Source: SNI 03-1733-2004 Procedures for Neighborhood Settlements Planning that Integrated with Urban Centers

Table 2. The needs of educational and learning facilities in Bawean Island

|                  | Elementary | Junior High School | Senior High School | Higher Education (Private) |
|------------------|------------|--------------------|--------------------|---------------------------|
| Public Elementary School | Public Junior High School | Public Senior High School |
| Private Elementary School | Private Junior High School | Private Senior High School |

2. Support Facilities of Transportation Infrastructure
   Currently, Bawean has an airport. Bawean residents can commute easily using small planes (Airfast) from Surabaya, East Java. The route is open for two times a week, on Tuesday and Thursday. This flight was opened in February 2016. Moreover, this infrastructure can increase the tourism sector in Bawean Island. The resident no longer needs to travel by ship that takes 8 hours.
Until now, ship is also transportation to travel to Bawean Island. If people ride a foil jet ship, it takes 5 hours. However, it takes longer with regular passenger ship that takes 8 hours. The port of passenger ship is differentiated with the port of the freighter ship (Roro Ship). Roro Ship’s port is on the east side of the passenger port. The port is only opened when the Roro Ship comes. The Roro Ship takes the sea toll lane proclaimed by the government. Besides those two ports, there is a port for the wooden boat that takes people to small islands around Bawean that are Gili and Noko Islands.

3. Health care facilities
   In Bawean island just build one Hospital for one big island

### Table 3. Data of transportation infrastructure support facilities.

|          | Airport | Harbour |
|----------|---------|---------|
|          | ![AirportMap](image1.png) | ![HarbourMap](image2.png) |

### Table 4. The needs of healthcare facilities.

| No.   | Type of Facilities                        | The number of residents (people) | Facility Needs Per Unit | Standard (m²/ people) | Criteria | Location and completion | Description |
|-------|------------------------------------------|---------------------------------|-------------------------|-----------------------|----------|-------------------------|-------------|
|       |                                          |                                 | Floor Area Min. (m²)    | Land Area Min. (m²)   | Radius   |                          |             |
| 1.    | Center(s) for pre- and postnatal health care and information | 1.250 36 60 0.048 500 | At the center of the neighborhood. Not crossing the highway. | At the center of the neighborhood. Not crossing the highway. | 1000 m²  |                          | It can be joined with the community hall or housing facilities |
| 2.    | Rural health clinics                      | 2.500 150 300 0.12 1000 m² | At the center of the neighborhood. Not crossing the highway. | At the center of the neighborhood. Not crossing the highway. | 4000 m²  |                          | It can be joined with the community hall |
| 3.    | Maternity Clinic                          | 30000 1,500 3000 0.1 4000 m² | At the center of the neighborhood. Not crossing the highway. | At the center of the neighborhood. Not crossing the highway. | 4000 m²  |                          | It can be reached by public transport |
4. Auxiliary Public Health Center 30000 150 300 0.006 1.500 m² It can be reached by public transport. It can be joined with the village hall.

5. Community Health Centre 120000 420 1000 0.008 3000 m² It can be reached by public transport. It can be joined with the sub-district hall.

6. General Outpatient Clinic 5000 18 - - 1.500 m² It can be reached by public transport. It can be joined with the sub-district hall.

7. Pharmacy 30000 120 250 0.025 1.500 m² It can be reached by public transport.

Table 5. The needs of healthcare facilities.

| Community Health Centre | Hospital |
|-------------------------|----------|

Source: Private digitalization of Yanita Mila Ardiani

3.2 Infrastructures in Bawean Island according to SNI (Indonesia’s National Standard)

3.2.1 Road Infrastructure

Inter-village highways in Bawean Island have been well built. It spreads from Tambak sub-district to Sangkapura sub-district. The width of the main highway is 4-5 meters so it can be passed by two cars. However, the road to enter the village is only enough for one car with the width is approximately 3 meters.
3.2.2 Water and Energy Infrastructure

The water source on Bawean Island comes from the primary forest in the mountains, such as Mount Nangka, Mount Bengkoang, and Mount Dedawang. Also, the water source comes from Lake Katsoba. The natural water source on Bawean Island is Kuduk-kuduk Falls or Lancar Falls. However, the water discharge is decreasing. Bawean’s residents use groundwater for bathing and drinking water. There is no PDAM (local water company) on Bawean Island. The suggestion for the future is water conservation because it can avoid drought, or use technology that can turn seawater into drinking water.
Figure 6. Data of Water Sources in Bawean Island.
Source: Gresik Regional Government 2015

The management of electrical energy is concentrated in one substation in Sangkapura sub-district. Electricity is divided into diesel energy and energy using premium. It is expected in the future that the electricity on Bawean Island is more sustainable so that Bawean resident can seek electrical energy in their homes with solar panels. In 2000, the resident was given a subsidy in the form of solar panel. So, they can turn the solar panel into electrical energy for each house on Bawean Island, but due to poor maintenance it discontinued.

4. Conclusion
The planning principles in the management of coastal area and small islands are:
1. It is an integral and/or complementary part of the regional development planning system.
2. Integrating activities between government and local/regional government, between sectors, between government, business and society, between terrestrial ecosystems and marine ecosystems, and between science and management principles
3. Done according to the bio geophysical conditions and potentials of each region, as well as the dynamics of socio-cultural development of the regional and national.
4. Involving local communities and other stakeholders.

On Bawean Island, an adequate highway infrastructure has been built around the island. Also, the transportation has been facilitated by the airport. Health facilities have been above SNI (Indonesia’s National Standard) because the existed of hospital in Tambak sub-district. The arrangement pattern of small island makes Bawean Island can improve the income and create new job opportunities in Tourism sector.

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