Households electricity consumption patterns in small island – case study: Kepulauan Seribu regency, DKI Jakarta

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Abstract. Kepulauan Seribu is an area off the north coast of Jakarta consisting a relatively large number of small islands. Development of the electricity system here is planned to interconnect among islands. These developments tend to consider more on the supply and not much on the demand of each household. The difference in functions of each island is expected that in the future, planning to increase electricity transmission can be more focused on the pattern of needs as reflected in the consumption patterns and household characteristics. Therefore, this study was aimed to determine the pattern of household electricity consumption based on differences in the island function, and to find out the relationship between household characteristics and that patterns. The characteristics include household income, house building area, number of household members, and building functions. The variables in this study were analyzed using the descriptive spatial analysis and chi-square test. The results of the study showed that the electricity consumption pattern on the island which function in the tourism category was higher than the one in the non-tourism category. The results of statistical tests showed that both of an island tourism categories and non-tourism category the function of the household building has a relationship with electricity consumption.

1. Introduction

Kepulauan Seribu is a group of small islands in the Java Sea, on the north side of the State Capital. The location of the islands is not far from the capital, only 12.98 kilometers from the port of Muara Angke to the nearest island in Kepulauan Seribu [1]. Although it is located close to the city of Jakarta, the nature of the islands which are spread out and can only be reached using sea transportation presents the obstacles in providing electricity [2]. Besides being spread out, these islands also have diverse functions such as the designation of residential areas, tourist category settlements, greening resorts, nature reserves, cultural reserves, and special designation. In developing electricity systems on islands close to the mainland islands, the interconnection between islands is made through 20 kV or 150 kV submarine cables [3]. For the case of Kepulauan Seribu 5 priority islands have been provided with the 2nd circuit of transmission. The addition of one submarine cable circuit is aimed at strengthening and increasing the load in the Kepulauan Seribu.

The difference in the function of the island is expected in the plan to increase electricity transmission in the future to be able to pay attention to the patterns of needs that are reflected in the consumption patterns and household characteristics. Therefore the research questions raised in this study consist of: What is the pattern of household electricity consumption based on the different functions of the islands in the Kepulauan Seribu? and How is the relationship between household characteristics and electricity consumption patterns?.

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To the above respect, electricity consumption is the total amount of end use of all type of electrical equipment (appliances) owned and used by households as measured by KWh [4]. Further, information relating to internal or household characteristics are very necessary to estimate consumption electricity. This is because the matter is related to the ownership and intensity of the electrical appliances, in turn, affect the use of electrical energy [5]. The characteristics include household income, house building area, number of household members, and building functions. The definition of household income used in this study refers to [6] the total total income of family members. House building area will be calculated based on the overall area of the building that is inhabited by one family [7]. The number of household members is calculated based on the number of families living in one building [7]. In this study, the function of the building is divided into 3 classifications, namely residential, homestay, and shop [8].

2. Methodology

2.1 Research Area
This research is about household electricity consumption patterns in Kepulauan Seribu, DKI Jakarta. The Kepulauan Seribu Region consists of 110 small islands. At present, the availability of new electricity is sufficient for 15 out of 110 islands. Of the 15 islands that have been observed, the targets of the research locations are settlement islands with tourist functions covering the Untung Jawa Island, Pari Island, and Tidung Island, whereas the non-tourism is Lancang Island. The choice of location was based on the existence of a plan to add 1 circuit in the context of strengthening and increasing electricity loads in the Kepulauan Seribu.

2.2 The Flow of Thinking
In determining the spatial pattern of household electricity consumption in Kepulauan Seribu, several things needed to be considered, such as total electricity consumption in kWh, island function differences, and household characteristics, as contained in Figure 1. From the value of electricity consumption generated, then classification and visualization are performed based on different island functions. These differences will form a pattern that will then be performed association analysis with household characteristic variables using the chi-square test. These characteristics include household income, house building area, the number of household members and the building functions. Thus, the results will be obtained in the form of electricity consumption patterns and the relationship of each variable. In this study, the null hypothesis (H0) is there is no relationship between electricity consumption with income, house building area, building function, number of household members. The alternative hypothesis (H1) is that there is a relationship between these variables. The level of trust used is 95% and the error tolerance level (Sig) used is 5%.
2.3 Population and Sample
The population referred to in this study are all household building plots. The determination of the sample will be assisted using a grid with a size of 100 m × 100 m. As for the weaknesses of the use of grids that are subjective, on the other hand, it makes it easier for researchers to conduct field surveys and analyzes. The grid used as a sample is a grid that contains parcels of household buildings in it and ignores other grids. In determining the number of samples, from each grid determined proportionally by 10% of the total house building plot, so that the number of samples from each grid may be different. Then to determine the target respondent using a random sampling technique.

2.4 Data Processing
Data processing starts from tabulation, classification, categorization, and visualization in the form of a map of all primary variable data that has been obtained. The data processing carried out in this study are as follows.

2.4.1 Developing income classification map
The classification is made in equal intervals. With the calculation of the highest income figure minus the lowest income figure divided by three classes. Then the resulting income figure is added to the lowest income figure to become first class.

\[(\text{IDR 6,000,000} - \text{IDR 1,000,000}) : 3) = \text{IDR 1,700,000}\] (1)

- Middle to lower classifications: < IDR 2,700,000.
- Middle classification: IDR 2,700,000 - IDR 4,300,000.
- Classification of middle and above: > IDR 4,300,000.

2.4.2 Developing map of the classification of house building area
The classification referred to in the R&D research of the Ministry of Public Works and Public Housing [9]:
- The minimum area of a modest is <36 m².
- The area of medium class houses is 37 - 72 m².
- Large class house area more than 72 m².

2.4.3 Developing map of the classification of the number of household members
Referring to the establishment of the National Population and Family Planning Agency [10], the family size can be classified as:
- Small families are those with family members of less than or equal of 4 people.
- Medium families are those with family members of 5 to 6 people.
- Big families are those with more than 6 people in one house.

2.4.4 Developing a map of building function
The function of house building in this study includes the function of namely residential, homestay and shop.

2.4.5 Developing map of the classification of electricity consumption
The classification is made as an equal interval of:

\[((661.09 \text{ kWh} - 52.89 \text{ kWh}) : 3) = 202.73 \text{ kWh}\] (2)

- Low classification is <256 kWh.
- Medium classification is 256.01 - 458 kWh.
- High classification is > 458 kWh.
3. Results and Discussions

3.1 Income
Income profile on the island of the research area is quite varied, including there are islands with two income classifications and there are islands with three income classifications. The average classification of income types is in the range of middle to lower class income. With inter-class tendencies, forming random distribution at Lancang Island and Pari Island, and clustering on Untung Jawa Island and Tidung Island. The middle-income class tends to be close to the center of activities, such as ports, government offices, health centers, and tourist attractions. An explanation of the results of these income patterns can be seen in Figure 2.

![Figure 2. Map of income in the study area, (a) Lancang Island, (b) Pari Island, (c) Untung Jawa Island, (d) Tidung Island](image)

3.2 House Building Area
The four islands tend to be mostly households with large building area. Referring to Figure 3, the distribution of large building areas on Lancang Island tends to cluster in the Northwest, which has a lower building density than in the Southeast. Large building area groupings also occur in the southeastern part of Pari Island, South of Untung Jawa Island, and the central part on Tidung Island. The distribution pattern is not only influenced by the density difference, but also by the dual function of the house building, for example, those functioned as shops and homestays.
Figure 3. Map of house building in the study area, (a) Lancang Island, (b) Pari Island, (c) Untung Jawa Island, (d) Tidung Island

3.3 Number of Household Member
Based on the results of the study, the number of household members with most of them being small and medium classifications Figure 4. The distribution of closeness between classes tends to form random distribution throughout the study area. The distribution of the number of small household members is most dominant in Pari Island and Lancang Island, while the distribution of the number of household members is in Untung Jawa and Tidung Island.

Figure 4. Map of household number in study area, (a) Lancang Island, (b) Pari Island, (c) Untung Jawa Island, (d) Tidung Island
3.4 Building Function
The dual function of building houses will appear when there are factors that encourage business to do, for example, the availability of tourism activities. The dual functions in question include, as a shop and homestay. From the four research areas, there are differences in the availability of different building functions. At Lancang Island only consists of residential and shop functions, while at Untung Jawa Island, Pari Island, and Tidung Island have three house building functions, namely residential, shop, and homestay. The difference in the availability of the homestay is influenced by tourism activities. On islands that have tourism activities, the distribution of shop building and homestay functions tends to cluster at the center of activities and tourist attractions, as indicated in Figure 5.

![Figure 5](image)

Figure 5. Map of building function in the study area, (a) Lancang Island, (b) Pari Island, (c) Untung Jawa Island, (d) Tidung Island

3.5 Electricity Consumption Pattern
The presence of tourism activities on the island of settlements has an impact on socio-economic conditions, including the community can open businesses such as shops, food stalls, and homestays. The availability of tourism activities will also affect electricity usage assuming tourism operations such as shops and homestays. Therefore, the difference in the availability of tourism activities will form a different pattern of electricity consumption. The difference between electricity consumption is that not all islands have three classifications of electricity consumption. Lancang Island is the only island that has only two classifications, low and medium, as presented in Table 1.

|               | Lancang (non-tourism) | Pari (tourism) | Untung Jawa (tourism) | Tidung (tourism) |
|---------------|-----------------------|----------------|-----------------------|------------------|
| Low           | 79%                   | 58%            | 61%                   | 75%              |
| Medium        | 21%                   | 37%            | 33%                   | 23%              |
| High          | 0                     | 5%             | 6%                    | 2%               |
Electricity consumption on the island which has the function of a tourist island has a higher amount of usage. The average electricity consumption class formed on an island that has a tourism function also shows a greater tendency to have three classes. Whereas the non-tourist islands are only in the low and medium class. So, from this information, island settlements with tourist functions have tended to have higher consumption, as shown in Figure 6.

3.6 The Relationship Between Household Characteristics and Electricity Consumption Patterns

3.6.1 The relationship between income and electricity consumption pattern
Chi-square statistical test results show a relationship between income and electricity consumption on the island of Untung Jawa and Pari Island. Whereas Tidung Island and Lancang Island did not show any relationship between the two. Untung Jawa and Pari Island have Asymp.Sig (2-sided) with values of 0.049 and 0.018. This value is smaller than 0.05 then H0 is rejected. Whereas the other two islands, Tidung Island and Lancang Island, have Asymp. Sig (2-sided) yielding values of 0.202 and 0.085. This value is greater than 0.05, so H0 is accepted.

3.6.2 The relationship between house building area and electricity consumption pattern
Chi-square statistical test results suggest that in the study area no relationship is found between the number of household members with electricity consumption. This is based on Asymp.Sig (2-sided) with values of 0.065 for Lancang Island, 0.371 for Pari Island, 0.512 for Untung Jawa Island and 0.650 for Tidung Island. Th value greater than 0.05, so H0 is accepted. Again, this fact shows that there is no relationship between the two factors.

3.6.3 The relationship between number of household member and electricity consumption pattern
Based on the calculation of the Chi-square test, Asymp.Sig (2-sided) produces a value of 0.313 for Lancang Island, 0.166 for Pari Island, 0.462 for Untung Jawa Island and 0.104 for Tidung Island. Th value greater than 0.05, so H0 is accepted. Again, this fact shows that there is no relationship between the building area and electricity consumption in the entire study area.
3.6.4 The relationship between building function and electricity consumption pattern

Chi-square statistical test results show that there is a relationship between building function and electricity consumption in the three islands of the study area. The three islands are Lancang Island, Untung Jawa Island, and Tidung Island. Asymp.Sig (2-sided) shows the value of 0.004 for Lancang Island, 0.022 for Untung Jawa Island and 0.001 for Tidung Island which smaller than 0.05 so H0 is rejected. This shows that there is a relationship between the function of buildings with electricity consumption. Difference facts occur in Pari Island with Asymp. Sig (2-sided) shows a value of 0.156, which is greater than 0.05. This means that H0 is accepted, or there is no relationship between the two factors so concerned.

4. Conclusions

Electricity consumption on the islands that have a tourism function tends to be higher than the islands without tourism. Based on spatial distribution, moderate and high electricity consumption on islands that have tourism tend to form cluster distribution near tourist objects and public facilities. Statistical test results show that both of an island tourism categories and non-tourism category the function of the household building has a relationship with electricity consumption.

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