Urban *kampung* and household energy consumption in Bandung, Indonesia

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Abstract. This paper aims to understand the energy consumption of a type of urban form known as urban *kampung* in Bandung, Indonesia. The high building density characteristic of urban *kampung* often considered as a more energy efficient urban form. This paper tries to explore it by comparing the energy consumption and behaviour of people living in urban *kampung* with the energy consumed by those who live in organised settlements in form of vertical housing/flats (*rumah susun*). A questionnaire survey was conducted to 200 households living in the three neighbourhoods in Bandung, which represented the two types of urban form. The preliminary result shows that the energy consumption of urban *kampung* is slightly lower but somewhat similar compared with the vertical housing. The parcel size are probably the factor that affected this result, since the other components such as electricity bill, cooking fuel, and transportation expenditure do not express any difference within the two types of urban form. This study provides insight for policy-maker and city planners on the benefit of urban *kampung* to achieve a more energy efficient city. The city government might consider the strategy of revitalising and improving the urban *kampung* before converting them into vertical housing.

1. Introduction

A decade ago, the proportion of people living in urban areas exceeded fifty percent globally. Although higher population concentration is often regarded to be more energy efficient, urban areas consumes more energy compared with rural areas. One urban characteristic that might explain the high energy consumption is the building density. Since building energy use has a significant share in the total energy use, therefore the building density, types, and sizes in an area is an important factor to determine the energy consumption. The three building components mentioned above are often regarded as urban form. The relationship between different urban forms and energy consumption are well established in many studies [1-5]. Among other things, these studies concluded that the high-density urban form can achieve better energy efficiency. This is one of the reason why more city governments are geared towards building vertical housing and flats replacing the landed houses. However, in developing country like Indonesia, there is a *kampung* settlements, that not only represent its own unique urban form, but also has a long history in shaping the Indonesian cities.
In Bahasa Indonesia, urban *kampung* is a high density settlements that organically developed in the inner city. These urban *kampungs* are often parts of slum and squatter areas, with high density small houses, lack of basic sanitation and drainage, and mostly located at or around downtown. In 2015, the national government started the KOTAKU program, translated as City Without Slum program in major cities in Indonesia, including Bandung City. The Bandung City Masterplan outlined that the downtown area is not allocated for residential use, but only for commercial use and mixed-use [6]. This means that the residential use need to be transformed into at least a mixed-use (i.e. shop houses). Currently, there are several spots of slum area in the downtown of Bandung, and they are in the form of urban *kampung*. Although the City Government has a plan to demolish all the urban *kampung* downtown, the characteristic of urban *kampung* itself might contributes to reach a more energy efficient city.

Urban *kampung* is a unique type of settlements in Indonesian cities that often seen as slum area, squatter, and poor. Yet, that is not always the case. Some features in urban *kampung* such as, among other things, population density and land efficiency, are in line with compact city’s principles [7-8]. The form of urban *kampung* can be considered as a compact urban form that could consume less energy. There is a need to investigate the energy consumption in urban *kampung*. This study aims to understand and compare the household energy consumption patterns between urban *kampung* and the planned urban form.

The physical patterns, layouts, and structures that make up an urban center are collectively called the urban form. Urban form is dynamic and always changing. There are two types of urban form based on the way it is grew [9]: 1) organic urban form, the unplanned and unorganised urban form; and 2) planned urban form – the organised urban form. Urban *kampung* is a type of organic settlement, so it is included into organic urban form.

*Kampung* actually means a village that usually refers to a settlement located in the rural areas. However, when urbanization occurred and the villagers moved to the city, they usually occupy empty patches of land in the city because the city itself cannot provide a decent or formal housing. Therefore, urban *kampung* grew within the city’s boundaries [10]. The uniqueness of urban *kampung* is in the way of the citizens behave are still the same as they live in the rural area specifically in terms of social interactions and traditions. In brief, urban *kampung* can be defined as Indonesian unique settlement within the city’s boundary that physically unorganised, densely populated, and socially still holds village values.

Urban *kampung* has some characteristics [11], first it is a place where the majority of the urban poor are living in, sometimes under slum and squatters condition. Second, the economic activities vary and are usually informal. The diversity also exist in ethnicity since mostly of the citizens are migrants from various village. Next, houses in urban *kampung* mostly are built by homeowners themselves without the help of architects or experts. Community and social interaction in urban *kampung* is high, dynamic and vibrant. In some cities, economic activities in urban *kampung* give significant contribution to the city’s economy. For example, *Kampung* Batik, tourist *kampung*, Chinatown, Heritage *Kampung*, etc.

In order to show energy consumed in the urban *kampung*, this paper compares it with the energy consumption in the organised urban forms existed in Bandung, Indonesia, namely the organised settlements in form of vertical housing or known as *rumah susun*. These two urban forms – the unorganised and the organised - are existed in Bandung, a city that started to have rapid high-rise building constructed and also mass public transportation development in the near future.

2. Methodology

Bandung City has 680 areas that considered as urban *kampung* [12]. This study tries to understand the energy consumption in urban *kampung* by comparing the energy expenditure of households living in urban *kampung* with those living in planned settlements. The type of planned settlements selected is the vertical housing (Rusun), which also considered as a type of compact urban form. A total of 200...
Questionnaires were distributed in 3 areas in Bandung City. Among the three areas, we took two urban kampung (Kp. Braga and Kp. Astana Anyar) and compare them with the organised settlement in flats (Rusun) Sarijadi. The reasons the two kampungs were selected are because of their strategic location near the city center, and the socio-economic level are somewhat similar with those living in the Rusun. Energy consumption is highly dependent on socio-economic level of the households, therefore in order to avoid this bias, we chose those who has similar socio-economic level. The components investigated were the amount spent for monthly electricity, energy for cooking, and transportation. The result was analysed using descriptive statistic.

![Figure 1. Distribution of samples in the study area.](image)

Figure 1 depicts map of the study area of the research. A hundred households were surveyed in Sarijadi Flats, meanwhile in Braga and Astana Anyar there are 50 households which were surveyed. Simple random sampling technique was used to distribute the questionnaires because the population is homogeneous in terms of socio-economic level and house conditions, also the size of the areas are small (1-2 Ha).
Table 1. The profile of the selected study area.

| Name          | Location | Average lot size | Average Density | Urban form | Street pattern | Land config. | use | Social Economy |
|---------------|----------|------------------|-----------------|------------|----------------|--------------|-----|----------------|
| Astana Anyar  | Downtown | 70.62m²          | 142 houses/ha   | Landed – unplanned | Irregular      | Surrounded by mixed-use; close to main facilities | Low-middle income |
| Braga         | Downtown | 16.65m²          | 600 houses/ha   | Landed – unplanned | Irregular      | Surrounded by mixed-use; close to main facilities | Low-middle income |
| Sarijadi      | Periphery| 36 m² (flats)    | 64 units/0.3 ha | Vertical – planned | Grid           | Residential areas, close to neighbourhood facilities | Middle income |

Major economic activities in Astana Anyar and Braga are informal sectors such as hawkers, small cart seller, small shops; whereas in Sarijadi there is not many informal activities since it is a housing complex.

3. Results and Discussions

Based on the samples, there are several results obtained such as the energy consumption based on electricity expenditure, cooking expenditure, and transportation expenditure. The preliminary result of electricity expenditure showed by Table 2.

Table 2. Monthly electricity expenditure

| Income (Rp) | Kp. Astana Anyar | Kp. Braga | Sarijadi Flats |
|-------------|------------------|-----------|----------------|
|             | 1                | 2         | 3              | 4              | 5            | 6            | 1    | 2    | 3    | 4    | 5    | 6    |
| ≤2,5 Mil    | 10               | 7         | 1              | 1              | 2             | -            | 9    | 6    | 1    | 1    | -    | 32   | 12   | -    | -    | -    | -    | -    |
| >2,5 Mil    | 3                | 7         | 8              | 3              | 6             | 2             | 20   | 6    | 4    | 2    | 1    | -    | 28   | 27   | 1    | -    | -    | -    | -    |
| Total       | 13               | 14        | 9              | 4              | 8             | 2             | 29   | 12   | 5    | 3    | 1    | 0    | 60   | 39   | 1    | 0    | 0    | 0    |
| %           | %                | %         | %              | %              | %             | %            | %    | %    | %    | %    | %    | %    | %    | %    | %    | %    | %    |

Legend (Rp):  
1 = 0 – 100.000  
2 = 100.001 – 200.000  
3 = 200.001 – 300.000  
4 = 300.001 – 400.000  
5 = 400.001 – 500.000  
6 = > 500.000

Majority of the households in Kampung Braga and Sarijadi Flats pay very low for monthly electricity (less than 10% of the monthly income). Household electricity expenditure in Astana Anyar are more varies compared with those in Braga and Sarijadi Flats. The preliminary result of cooking expenditure and transportation expenditure are showed in Table 3.
Table 3. Household cooking expenditure

| Income (Rp) | Kp. Astana Anyar | Kp. Braga | Sarijadi Flats |
|-------------|------------------|-----------|----------------|
|             | 1 2 3 4 5 6      | 1 2 3 4 5 6| 1 2 3 4 5 6   |
| ≤2,5 Mil    | 17 3 - 1 - -     | 8 6 - 2 - 1 | 34 10 - - -  |
| >2,5 Mil    | 15 5 4 - - 5     | 9 20 4 - - - | 46 9 1 - - -  |
| Total       | 32 8 4 1 0 5     | 17 26 4 2 1 0 | 80 19 1 0 0 0 |
| %           | 64% 16% 8% 2% - 10% 34% 52% 8% 4% 2% - 80% 19% 1% - - - |

Legend (Rp):
1 = 0 – 100.000
2 = 100.001 – 200.000
3 = 200.001 – 300.000
4 = 300.001 – 400.000
5 = 400.001 – 500.000
6 = > 500.000

Most of the respondents spend around 5-10% of their income on cooking expenditure. Majority of the households in Kampung Braga spend a little bit more energy for cooking purposes compared with those in Astana Anyar and Sarijadi.

The transportation modes used by the residents in Astana Anyar, Braga and Sarijadi Flats, and the preliminary result of transportation expenditure by private and public transportation in that areas are presented in Table 4, Table 5, and Table 6 respectively.

Table 4. Household transportation modes

| Income (Rp) | Kp. Astana Anyar | Kp. Braga | Sarijadi Flats |
|-------------|------------------|-----------|----------------|
|             | 1 2 3 4 5 6      | 1 2 3 4 5 6| 1 2 3 4 5 6   |
| ≤2,5 Mil    | 11 7 3 3 5 9     | 10 32 2   |                |
| >2,5 Mil    | 11 15 3 2 29 2   | 6 29 21   |                |
| Total       | 22 22 6 5 34 11  | 16 61 23  |                |
| %           | 44% 44% 12% 10% 68% 22% 16% 61% 23% |

Legend:
1 = Public transportation
2 = Private motorised
3 = Walking/cycling
Table 5. Households transportation expenditure for private vehicles

| Income (Rp) | Kp. Astana Anyar | Kp. Braga | Sarijadi Flats |
|-------------|------------------|-----------|----------------|
| ≤2,5 Mil    |                  |           |                |
| 12          | 6                | 3         | -              |
| 6           | 1                | 2         | 3              |
| 5 Mil       | 9                | 5         | 2              |
| >2,5 Mil    | 1                | -         | -              |
| 22          | 15               | 3         | -              |
| 6           | 1                | 2         | 3              |
| 1           | 2                | 1         | 2              |
| %           | 48               | 22        | 20             |
| %           | %                | %         | %              |
| %           | %                | %         | %              |

Legend (Rp):
1 = 0 – 100.000
2 = 100.001 – 200.000
3 = 200.001 – 300.000
4 = 300.001 – 400.000
5 = 400.001 – 500.000
6 = > 500.000

Majority of households in Braga and Sarijadi Flats own private motorized vehicle for daily use. Respondents in Astana Anyar use private and public modes evenly. Respondents in Sarijadi walk/cycle more often than those in Astana Anyar and Braga. Respondents in Braga spend up to Rp 300,000/month for transportation cost, which is quite high because it dwell around 10-15% of their income and Braga is located near the city center. Whereas people in Astana Anyar and Sarijadi spend less for transportation.

Table 6. Households transportation expenditure for public transportation

| Income (Rp) | Kp. Astana Anyar | Kp. Braga | Sarijadi Flats |
|-------------|------------------|-----------|----------------|
| ≤2,5 Mil    |                  |           |                |
| 16          | 3                | 1         | -              |
| 6           | 1                | -         | -              |
| 32          | 2                | -         | -              |
| >2,5 Mil    | 21               | 3         | 3              |
| 5 Mil       | 24               | 7         | -              |
| Total       | 37               | 6         | 4              |
| %           | 12%              | 8         | -              |
| %           | %                | %         | %              |

Legend (Rp):
1 = 0 – 100.000
2 = 100.001 – 200.000
3 = 200.001 – 300.000
4 = 300.001 – 400.000
5 = 400.001 – 500.000
6 = > 500.000

The table shows that majority of the respondents in three areas spend less than Rp 100,000 monthly for public transportation. This is considered quite low which also means that they rarely used public transportation. The public transportation in this study is also included the online transportation using vehicle-sharing app.

Based on the initial analysis, there are several main points that can be discussed. Among three areas surveyed, two are urban kampungs located downtown (Astana Anyar and Braga), whereas one is
vertical housing complex located near the city boundary (Sarijadi). The socio-economic (income) level is quite similar with each other. Majority of respondents use private motorized vehicles daily.

Monthly electricity expenditure are mostly around Rp 100,000, which not so high considering the per capita electricity consumption in Indonesia 2018 is 1,064 KWh/year [13] or around Rp 115,000/month. However, households in Astana Anyar spend more varies for electricity, mostly up to Rp 200,000/month. This could be the outcome of a more various electricity appliances ownership, and also few houses in Astana Anyar is functioned as small shops. The parcel or house size also might be the cause of this result. Electricity in urban kampung houses usually falls under the low installed capacity (450 VA and 900 VA), that fall under the subsidised category.

Respondents in Braga spend a little high for cooking purposes compared with the other areas. Probably because Braga is located well within downtown and commercial area, and some of the residents are taking this opportunity to open a small shops in their houses (hawkers) some also still use kerosene instead of LPG.

Transportation expenditure of households in Braga is quite high compared with the other two areas. Which a little anomaly for a location that sit in the downtown. Location-wise, the HH in vertical housing Sarijadi is somewhat spend lower transportation cost eventhough it is located far from downtown. A more concerning result is that the expenditure for public transportation are very low in all areas, which could means that it is rarely used.

4. Conclusion

Overall, the energy consumption in urban kampung is not so different with vertical housing. We have compared two types of urban form in three areas that are considered as compact form and under similar socio-economic level. Overall, the energy consumption in urban kampung is not so different with vertical housing. On the contrary, the transportation expenditure between different urban forms seems to be similar. This is because the high number of private vehicles use in all types of urban form. Households that live in proximity to the city center or daily activity places are also using private vehicles instead of public transportation.

Although the result is still early, but it is safe to assume that urban kampung can be considered as a type of compact urban form that has potential as a low energy urban form. It appears that with certain treatment, the urban kampung can have impact to energy consumption almost at the similar with the vertical housing form. However, since the electricity consumption of urban kampung dwellers are similar with those living in flats, it can also be the reason for the local government to continue their policy on having 0% or urban kampung in the city center and convert them into flats that will increase the size of open space and create a cleaner city image. There might be policy implications to the KOTAKU program (city without slum), that tries to transform every urban kampung in big cities into a rather formal housing.

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