Communal space design in kampong Wonosari Semarang as an effort toward a low carbon tourism kampong

Erni Setyowati, Indriastjario, Isti Astetika Sara
Architecture Department, Universitas Diponegoro, Semarang, Indonesia.

Corresponding e-mail: ernisetyowati@arsitektur.undip.ac.id

Abstract. Known as the Rainbow Kampong, the kampong Wonosari is a kampong in the Randusari sub-district, a district within a region of the South Semarang District. Previously known as a slum kampong, people have named the kampong to become the Rainbow kampong due to the thematic kampong program which was accelerated by the Mayor of Semarang city in 2016. The kampong has two RW (Rukun Warga) with a population of more than 3,000 inhabitants. Based on the population data of Randusari sub-district, the RW #3 of the Kampong Wonosari has 1,724 inhabitants divided into 10 RTs (Neighborhood Groups). With this high level of population density the existence of communal space is very important. Refer to the number of households and the low carbon concept, the kampong could reduce the carbon dioxide emission as much as 21.3689% by re-designing the communal spaces.

Keywords: the kampong Wonosari, communal space design, low carbon concept

1. Introduction
Slum areas in the cities have become a recent global issue among the cities’ efforts to eradicate poverty and slum conditions in urban area. The Indonesian Minister of public works and people housing responds this global challenge by launching several programs related to the kampong or village improvement and parts of the city. The Kampong Improvement program became the ministry's first program followed by the RP2KPKP, a program established as an Action Plan to prevent and improve the urban slum settlements quality. Regarding the Low carbon eco development, the Ministry has choosen several kampongs and villages as pilot projects which are distributed in many cities in Indonesia including Semarang city. Becoming as a capital city in Indonesia, Semarang has accelerated the low carbon city improvements as well as what have been conducted in several cities[1]–[3]. The city government of Semarang has issued thematic kampong program as an effort to improve slum kampong condition in Semarang. One of many cases of slum area accelerated by the government of Semarang city is the kampong Wonosari. The problem of the kampong Wonosari are that having no open communal space within the kampong area and the densely populated circumstance.

Since the study conducted by Zhang et.al. discussed the the low carbon tourism development in China which underlined that the concept covered the main body of low carbon model and low carbon travel for urban development, they did not discuss about calculation of the carbon emission however[4]. Meanwhile, Li et al. discussed a fundamental thinking and urban development of low carbon town in China[5]. Although they argued the concepts in a comprehensive way, but there is no real calculation of the carbon emission in their discussion[5]. Unlike Li et al. research, previous studied had discussed green concepts of capital cities by reducing carbondioxide emission[6]–[8]. Bengers’ study argued for the low carbon concept on the city of Adelaide, Australia. Although Adelaide city has an abundant of...
renewable energy and many government policy related to the environmental aspects, it had deficiently reactions to the low carbon development concept in city [9]. A number of studies discussed about the low carbon cities, but they have not discussed the detail of calculation of carbon footprints in their studies[10]–[12]. Refer to those studies conducted by urban scientists, it can be concluded that the low carbon city concepts have been discussed in either macro or micro scoupe. To support the low carbon city development, many studies discussed the macro policy of the local government to minimize the low carbon footprint in cities[13]–[15]. The low carbon eco development is not only expressing macro and micro discretion to improve rurals, urbans, villages, kampong and cities, but it is also encouraging efforts to convert natural resources into energy and waste management policy. For example, the research carried out by Bong et al., deliberated about waste composting and economic aspects of palm crude oil which indicated the interesting findings related the amount of GHG emission as much as 71.64% [16]. Like previous research[2], [3], this study not only highlights the communal open space design and densely populated circumstances of the kampong Wonosari, it also calculated the carbon dioxide concentration in the kampong.

Located in the heart of city which is closed to the famoust heritage building of ‘Lawang sewu’ as shown in Figure 1(a), the kampong ‘Rainbow’ Wonosari in Semarang has several Rukun Warga (abbreviated as RW). Refer to the government regulation, a group of thirty to one hundred household stands for Rukun Tetangga or RT depend on area of perimeter, while a group of four until ten RTs becomes one RW or Rukun Warga. The perimeter of this current research is located in RW #3 which has ten RTs. This perimeter tends to have a very densely populated as ilustrated in the Figure 1. The yellow dash line in the figure 1 stands for the borderline of the kampong perimeter in this study.

2. Methods
Accomodating several steps covering determining the perimeter area, visual observation, discussion with inhabitants, presentation of proposed design and estimation of carbon dioxide concentration, this study is using both quantitative and qualitative approaches. In the quantitative method, this research used carbon footprint calculation consisting Primary, Secondary and Material Carbon Footprint which
is abbreviated as PCF, SCF and MCF respectively to enumerate the quantity of Carbon Footprint in the Rainbow kampong [17], [18]. From the initial observation, there were 89% of houses utilize 12 kilogram LPG and only 11% use kerosene for cooking everyday. Furthermore, as much as 450 KWh spend in each household to enumerate the SCF, while the MPC was counted from the house model having 21 sqm floor plan with three types of structures (stone, traditional brick and hollow cement brick). Refer to previous studies, the Carbon footprints were calculated as equations 2.1. to 2.3. [18], [19].

\[ P_{co} = F_{co} \times EFCO_2 \times NCF_{LPG}. \]  
\[ B_{co} = EF_{kerosene} \times FC_{kerosene} \times NCV_{kerosene}. \]

\[ EF = SCF \times NCF \times CEF \times Oxidation \ factors \times 44/12. \]

EF is carbon dioxide concentration, the electricity usage in mass unit/MWh. The Specific Fuel Consumption is abbreviated as SFC, while the Net Calorific Factor (NCF) is the energy content/ mass unit of fossil fuel volume (TJ/tonnes fuel). The Factor of Carbon Emission is abbreviated as CEF in (tonnes CO₂/TJ), and the oxidation factors is also usually abbreviated as Oxid.

3. Results and Discussion
Many studies discussed about poverty and slum in cities[20]–[22].. Several of them stated about the efforts to minimize poverty through the government policies[23]–[25], the rest studies observed the society approaches which is based on upstream point of view [26], [27]. Housing in Favela hills, Rio de Janeiro was observed by Lerner and Frisch [27], [28] continued by urban acupuncture which was proposed to cover waste management of trash and garbage, pathways, public open spaces and houses[29], [30].

Table 1. Condition and hope of society in kampong Wonosari

| The components of the kampong | Existing condition | Hope of society |
|--------------------------------|--------------------|----------------|
| Waste Sanitation               | • There is no sufficient garbage collecting point.  
                                 | • There is no waste management either for grey or black water. | • Centre of garbage collecting point.  
                                                                 | • Waste management and recycling system. |
| Drinkable water                | • Only a few of communal whells. | • More clean water from communal whells. |
| Electricity                    | • The inhabitants’ need to reduce daily electricity with alternative energy | • Electricity energy from Semarang River. |
| River circumstance             | • Housings and stalls are too close to river. | • There should be pedestrian path along the river. |
| Neighborhood                   | • There is no green open spaces.  
                                 | • House of environment is still under construction.  
                                 | • No playground for children. | • More green open spaces.  
                                 | • Should have communal space.  
                                 | • Need verticalization to add more open spaces. |
Table 1 reveals efforts to develop the kampong covering clean water, waste, sanitation, electricity and possibility to alter the Semarang river for electricity energy by micro-hydro power. The community participation is always needed to improve the kampong to be better. The table 2 describes the number of inhabitants, households and the percentage of inhabitants on gender and age.

Figure 2. Existing condition of Kampong Wonosari: (a,b) The narrow pathways; (b) no sitting facilities; (c) The kampong pathway up-hill is needed to be widened; (d) key map; (e) House of environment; (f) housing and stalls are too close to the river; (g) mosque in the centre of kampong.

The Wonosari is delimited by Dr. Soetomo street and Semarang river in the west, Junior High School of Domenico Savio in the north, and the Bergota tomb area in the east. From the observation and interview with inhabitants, the Table 1 describes condition of the kampong and the inhabitant expectations, while the factual conditions of the kampong Wonosari is illustrated in the Figure 2. The narrow concrete paths within the kampong could be only accessed by motor cycle (Figures 2.a-c), while the Figure 2.f. describes there is no distance between flower stalls and the river. The Figure 2.e and 2.g show house of environment and mosque respectively.

Figure 3 illustrates the condition of the kampong, while the Table 2 describes the composition of the population which consists of 80% ages under 50 years old and 53% under 30 years old. Because the young population is greater compare to the old generation, the potential for community participation is very high. The vertical housing strategy is needed to minimize densification and to create more additional green open spaces [31], [32]. And regarding the strategy, the vertical housing concept should be executed as green as possible. Research by Setyowati et al. introduced the modular housing system that could be implemented in the kampong [33], [34]. To calculate the carbon dioxide emission in Kampong Wonosari, it was used the 21 m^2 house type model as described in Table 3.
Table 2. Inhabitants number of kampong Wonosari

| RT  | Families | Inhabitants |
|-----|----------|-------------|
| 01  | 42       | 166         |
| 02  | 23       | 93          |
| 03  | 39       | 155         |
| 04  | 47       | 187         |
| 05  | 52       | 209         |
| 06  | 52       | 209         |
| 07  | 47       | 189         |
| 08  | 39       | 156         |
| 09  | 45       | 179         |
| 10  | 45       | 181         |
| Total | 431       | 1,724       |

Table 3. The Material Carbon Footprint average in each square metres

| House (sqm) | Structure       | Carbon footprint each House(tonnes) | Average MCF/ House (tonnes) | Carbon footprint/ square metre (tonnes) | Average MCF/ Square metre (tonnes) |
|-------------|-----------------|-------------------------------------|-----------------------------|----------------------------------------|-----------------------------------|
| 21 square metres | Traditional-brick | 2.0385 | 2.0185 | 0.0971 | 0.0961 |
|             | Hollow Concrete  | 2.0156 |                   | 0.0959 |                   |
|             | Stone            | 2.0013 |                   | 0.0953 |                   |

As a result on Table 3 and 4, the number of traditional brick, hollow cement, and stone houses are 326, 96 and 11 units respectively. Furthermore, on explaining the enumeration of the MCF, Table 3 reveals the MCFs’ mean in both per house and each sqm. The result shows that the MCF average in the kampong is 2.0185 per household or 0.0961 tonnes in each square metre (see Table 3). The PCF could be enumerated refer to the data in which 89% of households (338 households) utilize 12 kilogram liquid petroleum gas and only 11% of houses (43 units) utilize rock oil for daily needs (as listed on Table 4) [18].

Table 4. Total of families using LPG or kerosene and type of house in Wonosari

| RT* | House holds | Fuel consumed | Type of house structures |
|-----|-------------|---------------|--------------------------|
|     |             | LPG | Kerosene | Traditional-Brick | Hollow cement | Stone |
| #01 | 42          | 38  | 4       | 32                | 9              | 1     |
| #02 | 23          | 20  | 3       | 18                | 5              | 0     |
| #03 | 39          | 35  | 4       | 31                | 8              | 0     |
| #04 | 47          | 44  | 3       | 36                | 10             | 1     |
| #05 | 52          | 46  | 6       | 40                | 11             | 1     |
| #06 | 52          | 49  | 3       | 39                | 12             | 1     |
| #07 | 47          | 43  | 4       | 36                | 10             | 1     |
The reduction percentage of carbon footprint of the Kampong Wonosari - Semarang 21.3689%
From the results, it was found that the SCF was 0.2637 tonnes of CO$_2$/household/month. Meanwhile for the MCF, the 21 sqm type model was used to calculate the average MCF per square metre. Two studies observing a modest building model and calculation of CO$_2$ emissions have been carried out [18], [19]. In their research, Sudjono dan Yudhi concluded that carbondioxide concentration was in line to area of house, volume, building materials and the comprehensiveness of construction[19], while Astari observed PCF and SCF in an housing in the city of Jakarta [17], in addition, Seo and Hwang indicated building lifecycle consisting construction process, manufacture, operating procedure and building demolishing [18]. Considering the results, the carbondioxide concentration in each square metre was 102.3156 tonnes. In the last enumeration of the Rainbow kampong carbon footprint, the existing and planned ground-building floor area were 16,895.530 square metres and 12,536.480 squaremetres respectively (see the next Figure 4 followed by the Table 6). The result of carbondioxide concentration per square metre was 102.3156 tonnes, the enumeration of the total carbondioxide concentration at Kampong Wonosari in existing and planned condition were 3,076.6440 tonnes and 2,419.1969 tonnes respectively. In conclusion, there was rate of carbon concentration reduction as much as 21.3689 % (see Table 6).

Figure 4: Location of open spaces in the kampong Wonosari, Semarang, (a). Key map; (b,c,d) open spaces locations.

Open space for gathering and the proposed widening of the gate to enjoy the Semarang river is illustrated in Figure 4 a-d. In the picture, several open spaces locations have been implemented such as sitting groups in front of flower stalls on the roadside of Dr. Soetomo, widening the bridge area at each gate to Wonosari village and the gathering area in front of the neighborhood mosque in the center of the village. Refer to the previous research [2], considering the calculation of carbondioxide procedures, recalling the strategies on improving slum kampong and eradicating poverty in cities, this
Current research proposed the spatial planning condition especially on creating the greenery open spaces in the Rainbow kampong of Wonosari in Semarang as illustrated in the Figure 5.

![Figure 5](image)

(a) The real condition; (b) The planned condition after vertical housing concept

Finally, spatial planning related to the proposed open spaces and improvement strategy of the kampong Wonosari refer to previous research[2], [18], [19] are illustrated in Figure 5. The Figure 5.a reveals the existing condition map of kampong Wonosari, while the Figure 5.b describes the sprawl of proposed open spaces, communal sanitation and possibility of implementation of the micro-hydro power plants as water wheels along the Semarang river in the western part of the kampong Wonosari.

4. Conclusion

Through the enumeration of carbondioxide concentration and and designing additional communal spaces, it was found the carbon emission reduction at about 21.3689 %. With the calculation of carbon footprint of kampong Wonosari, it was found out that the existing carbondioxide concentration was 3,076 tonnes in each month, while the total carbondioxide concentration on the planning condition was 2,419 tonnes per month. By the new spatial planning, the kampong Wonosari will have much more greenery spaces that could contribute much more oxygen to the kampong. Improving slum tourism kampong to be Low Carbon tourism kampong should consider several aspects covering: understanding the problems and solving the problem by enhancing inhabitants participatory; establishing the concept of “Community Based Tourism”; enhancing and designing the communal open spaces to widen the green open spaces and to reduce the CO₂ emission; reviving the renewable energy hidden in the kampong and improve the energy capacity by proposing alternative energy; checking the proposed projects with the resources available and open dialog with inhabitants; finalizing the concept and designing the blue print by re-synchronizing regulation issued by the local government.

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