Sustainable Hybrid Village: Regeneration of Settlement in Jatinegara, Indonesia

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Abstract. Over the past few decades, cities have experienced severe social and economic pressures, which have a disproportionate impact on the urban environment. As a result, the quality environment has decreased, which is characterized by increased CO2 emissions and energy operating costs. Sustainable city development is considered as a step to create a pleasant environment for the community. Therefore, this research is essential to do to regenerate settlements in improving urban quality. This study aims to find a model for developing sustainable hybrid settlements in densely populated areas. The research method with the simulation method uses the Urban Modeling Interface device with three parameters. The modeling results obtained a Floor Area Ratio (FAR) value of 0.43 with a total land area of ±427,233 m². The FAR value produces an operational energy value of 3,983 kwh / m²/year and an embodied energy value of 216 kWh / m²/year. This value is very high from 240 kWh / m²/year as a standard for energy use. The amount of mobility in the aspect of walkability is 21-68, and 21-69 for the value of Bikeability. The results of this simulation indicate that the residential area in Jatinegara is not yet sustainable.

1. Introduction
Sustainable development does not only consider the present, but sustainable development must review and ensure that there are no losses to be borne by future generations. The importance of the concept of sustainable development is related to two crucial issues: food and energy [1]. For this reason, in the 2016 New Urban Agenda Habitat III all countries are committed to improving and equitable access to essential services, sustainable mobility and public space and the growth and regeneration of effective settlements; 2) Strengthening the climate and improving the urban environment: reducing greenhouse emissions and improving air quality and resource efficiency and protection of ecological assets for energy supply [2].

There are many meanings related to sustainable development. If further elaborated, sustainable means maintaining the existence of ecosystems and providing human needs. Whereas, city development means improving the quality of life by exploiting resources and destroying nature [3]. Sustainable development is development that can meet the needs of the present without ignoring the ability of future generations to meet their needs [4] so that progress continues to use sustainable concepts. To optimize the function of efficient settlements from economic, social, and environmental aspects, one strategy that can be
developed is the development of the idea of hybrid settlements. The settlement regeneration is increasingly seen as one of the primary means of fostering environmental and social sustainability and improving the quality of life in contemporary urban environments [5].

2. Theoretical framework

2.1. Hybrid Architecture
The concept of hybrid architecture is one branch of the characteristics of Post-Modern Architecture, namely Stylics. The hybrid design method proposed by Jencks (1978), with hybrid language, namely "mix old pattern and new technics or transition and choice," Kurokawa (1991) stated it as hybridization and Venturi (1966) referred to as hybrid alone[6]. In the context of permeability theory, hybrid is determined as a multi-layer, multi-function feature of urban space. The other meaning is no clear separation between public and private; buildings and facilities that make up structures are combined by multilevel public spaces where virtual perception is also significant as well as its information capacity and transformation capacity.

In terms of formal composition, hybrid buildings are classified into three categories: Fabric hybrid, Graft hybrid, and Monolith hybrid. The formal composition of the hybrid Graft expresses programmable, volumetric, or through height functions. Hybrid and Monolith hybrid fabric types both embody the expression of program components in sustainable building envelopes[5]. Each hybrid form classified is the result of a composition that expresses the function of the program or suppresses it. The expression or repression of programmed elements depends on the relationship of the building to its immediate environment. In other words, it is enough to mix three or more individual buildings to stack high buildings. While the term 'hybrid building' has appeared in various architectural media or blogs in recent years. Hybrid buildings cover the context of the city and architecture itself, which are characterized by high program complexity.

2.2. Sustainable Development
As a new concept presented after the construction of industrial cities around the world, sustainable city development replaces the emptiness and lack of metropolitan development theory. It sets new methods and techniques for healthy city development. The United Nations World Commission initially introduced the concept of sustainable development on Environment and Development (WCED) in 1987, which defines it as a pattern of development that meets the needs of the present generation without compromising the ability of future generations to meet their needs own needs [7].

Sustainable city development is the coordinated development of three central systems: economic, social, and environmental [8]. Xu and Zhang (2001) state that sustainable development in cities maintains harmony between environmental support, financial benefits, and social progress [9]. This coordinated development can be achieved by promoting social equality, quality of environment, and economic growth [10]. Yang and Shi (2016) propose that sustainability in urban development involves changes in population, resources, and governance. Therefore, a sustainable city cannot be built without robust urban infrastructure, adequate and affordable housing, and a livable environment. One of the issues raised in facing these global challenges is a change in the development paradigm that is more environmentally friendly. This concept is known as sustainable development. An interesting definition of sustainable development is given by the Brundtland Report (1987), which states that the current development process should not interfere with the needs of future generations, a concept of sustainability [7]. "... developing that meets the needs of the present without compromising the ability of future generations to meet their own needs" Brundtland Report (1987)

Much research has been done to define sustainable and sustainable cities, while achieving sustainability is always challenging to understand, especially how to balance the links between the three pillars of sustainability. Bringing people out of poverty is the only way for all urban development, Glaeser (2011) states that human capital makes cities prosper, because educated people share knowledge and give birth to innovations that increase productivity [11]. As such, they expand urban wealth and
attract more investment, which creates more employment opportunities. As a result, cities continue to
develop as developers build more office buildings and residences. However, this kind of economic
development promotes the consumption of resources, which are not environmentally sustainable from
an environmental perspective.

2.3. Regeneration
Urban regeneration involves the revitalization of depressed urban areas, through actions such as: 1)
rehabilitation of historic areas; 2) improvement of living conditions in residential areas; 3)
redevelopment of public spaces: squares, parks, city furniture and so on; 4) modernization of urban
infrastructure: water, gas, electricity, transportation infrastructure. This complexity project, such as
sustainable urban regeneration, can only be achieved through collaboration between institutions,
universities, urbanists, associations, and environmental builders of rehabilitation measures based on
social, economic, and technical aspects. Social reasons, there are: improvement in quality of life,
adaptation of buildings and housing to our needs; improve the image of a residential or district area;
improve social relations networks and security perceptions [12]. One effort to improve the quality of
settlements is by redesign.

The essential principles of city regeneration are;
1) the need to establish clear and measurable goals of the city's regeneration process and under the
objectives of sustainable development;
2) adequate analysis of local conditions;
3) the need for efficient use of available natural, economic, and human resources;
4) participation and cooperation among stakeholders, which leads to the improvement of the physical
condition of the building, social structure, economic base, and environmental conditions [13].

From a theoretical study of hybrid architecture theory, sustainable settlements, and regeneration, they
have the same indicators of success, namely in terms of economic aspects, social aspects, and
environmental aspects. The purpose of the concept of hybrid architecture in the preparation of settlement
model’s application is to create sustainable cities. Sustainability has three main pillars, namely,
economic, social, and environmental. In this research, sustainability is meant to minimize energy use
and minimize negative impacts on the environment. If related to the three pillars of sustainability, in the
economic aspect, minimizing operational energy can reduce costs in operating a building. While on the
social aspect, increasing mobility will certainly affect social values in society.

If it is associated with one of the values of environmental sustainability, then it aims to preserve the
environment in the future. These four aspects Floor area ratio, operational energy, embodied energy,
and mobility greatly affect the quality of the environment both for the present and for the future. If not
considered and studied more deeply will result in excessive energy use and result in a high negative
impact on the environment. To simulate, calculate, and calculate Floor area ratio, operational energy,
embodied energy, and mobility in detail, optimal and in faster time requires a computer software. The
appropriate software to simulate and calculate the sustainability of an area is UMI. UMI, which is a
plug-in from Rhinoceros software, can produce calculations on Floor area ratio, operational energy,
lifecycle energy, and mobility, both visually and in value. To carry out these calculations, UMI requires
some data, such as a three-dimensional model of the area, including the building, the building materials
used, to the microclimate in the area to be simulated.

3. Research Methodology
This study aims to create a model of sustainable settlements in urban areas, so that it becomes a pilot
area for other areas, which is based on the affordability of operational costs, mobility, and environmental
quality in residential areas in East Jakarta. This research was conducted with a rationalistic deductive
approach with quantitative methods in the framework of modeling. Quantitative methods are used to
record physical objects at the location, research objectively in numeric display, then rationally
analyzed through simulations with the Urban Modeling Interface Program. The rationalistic approach in this study
is based on a theoretical framework built from the study of previous research results and theories related to the research theme.

This research is divided into two stages, namely 1) reviewing the principles of hybrid architecture, and examining the principle of sustainable settlements; 2) evaluate the empirical conditions of the area of settlements in Jatinegara East Jakarta. Observed conditions serve as modeling data inputs to obtain the value of settlement sustainability. Examines the principles of hybrid architecture and sustainable settlements as a basis for elaborating consistency and flexibility. The research delineations are as follows:

![Figure 1. Research Area, Settlement Around Jatinegara Market](image)

The principle of sustainable settlements as a basis for elaborating and applying into models for assessing the sustainability of settlements. Furthermore, examining the experimental condition of the Jatinegara settlement area is based on the importance of understanding field conditions to determine the potential and problems to provide recommendations for improving the quality of the settlement environment, to determine principles and strategies according to the regional context. In the existing modeling, quantitative methods are used by creating 3D models on the Rhinoceros 5.0 device and then simulating it with the Urban Modeling Interface program to measure the sustainability of the area. Variables input in Rhinoceros 5.0 software: area, building area, building height. Variables input in the Urban modeling interface (UMI): building function, type of building material, wall to window ratio (WWR).

### 4. Discussion and Analysis

#### 4.1. Floor Area Ratio (FAR)

FAR is a comparison between the total floor area of each building to influence the total sunlight reception in each building and the number of people who occupy the area. The modeling results obtained a Floor Area Ratio (FAR) value of 0.43 with a total land area of ± 427,233 m², higher than the total floor area of each building. The area is almost fifty percent of the total floor area. Comparison of open areas smaller than the built environment is a negative value in this area. FAR value will affect, among others, the size of the people occupying the area, another thing that affects is the amount of at least the sun's reception in each building in the area.

An open area without buildings from the total area allows the reception of good sunlight for buildings in the study area. Sunlight can enter without being hindered by the imagery of buildings that are nearby because the location is not too close together. Buildings that get sunlight make it possible to maximize natural lighting to minimize the use of lights during the day. Minimal use of lights will help save electrical energy in buildings.
The FAR value in the existing condition is classified as low because the buildings in this research area are almost 90% of the buildings are two-story buildings. Besides, these buildings are scattered throughout the study area.

4.2. Operational Energy
Operational energy is the energy used in building operations as long as the building is used. The operational energy results obtained by entering data about material, building construction, and building operational time as well as climate data of the research location. Data that can be entered, namely Conductivity, density, and specific heat. Operational energy is the amount of energy needed for building operational needs during the building is used. The energy requirements include cooling energy, equipment energy, lighting energy, total energy, and total zone window transmitted.

In the most significant cooling energy research area is Jatinegara Mester Market, the average annual value of buildings in the study area is 2,026.64 kWh / year. Cooling energy is the energy needed to cool buildings. The size and the ratio of the window and wall of the building. Building orientation also influences the size of cooling energy. Building orientation that faces the majority of windows in the west will tend to be hotter. The most significant energy equipment is Jatinegara Mester Market. This building has an average per year than other buildings that is equal to 759,992 kWh / year. Energy equipment is the calculation of the energy needed to operate electronic equipment that uses electrical energy used in a building. The higher the value of energy equipment, the more electronic equipment used in buildings. The most prominent energy lighting is Jatinegara Mester Market. This building has an average per year than other buildings that is equal to 8879.4 kWh / year. Lighting energy the energy needed by buildings for lighting systems in every room. The value of lighting energy will vary between premises and other buildings. It depends on the size of the building, the building envelope, the building orientation, and the ratio of the windows and walls. Lighting energy in the market building is the highest and most prominent of the other buildings in the research area.
4.3. Lifecycle
The embodied energy discussed is represented energy and embodied carbon, both of which cannot be separated. When the embodied energy is high, the embodied carbon will also be substantial. Embodied energy is the energy used for the process of making building materials, the distribution process, and the construction process when the building is built. The higher the energy used, the greater the CO2 emissions produced. Sustainability is not only about durable materials, but durability is the use of a material that uses the least amount of energy in the manufacturing process so that it does not harm the environment.

![Figure 4. Lifecycle Energy Value from UMI Simulation Results](image)

Based on simulations using UMI, the average value of embodied energy at the location is equal to Embodied Energy 16,569.45 kWh / m² / Year and Embodied Carbon 1,170,433 Kg CO2 / m² / Year. This value is quite large because the majority of buildings in the research area are small buildings and the average height of two to three floors. Year and for office buildings is 170 kWh / m² / year. Based on the results of UMI simulations on the value of embodied energy, it was found that buildings with small area sizes tend to have higher embodied energy values compared to buildings with large areas. Based on the results of UMI simulations on the amount of embodied energy, it was found that buildings with small area sizes tend to have higher embodied energy values compared to buildings with large areas.

4.4. Mobility
Mobility in a particular area can be interpreted as the ease of reaching each of these facilities on foot or by bicycle. The mobility that is simulated following the existing conditions, shown in the picture below:

![Figure 5. Lifecycle Energy Value from UMI Simulation Results](image)

The zero-point region has an unsatisfactory mobility value of 21-69. Where if an area has a mobility value of less than 50, then the area is still dependent on vehicles in reaching one facility to another facility because the area is not integrated. Sustainable area is a compact area, where one facility and other facilities can be integrated so that they do not require a lot of energy in reaching them. If energy from mobility can be reduced, it can reduce CO2 emissions generated from motor vehicles to reach these facilities. Some ways to increase the value of mobility are by shooting the various facilities provided in the area and opening access between facilities as much as possible, besides the convenience in achieving access between these facilities also needs to be considered.
5. Conclusion and Recommendation

The conclusions of this study are:

1. The modelling results obtained a Floor Area Ratio (FAR) value of 0.43 with a total land area of $\pm 427,233$ m² and with a total building of 468 Units.

2. The FAR value produces an operational energy value of 3983 kwh / m² / year and an Embodied Energy value of 216 kWh / m² / year. This value is very high from 240 kWh / m² / year as a standard for energy use. The mobility value is 70% walkability and bike-ability with values above 68/100, so Somewhat Walkable, and 30% walkability and bike-ability with values above 21/100-42/100, So Car-dependent.

The results showed that the residential areas in the Jatinegara region were not yet sustainable. The recommendations of this study are:

1. In connection with the FAR of 0.43 in the Balimester Jatinegara Settlement area, the government is still able to carry out development related to the rearrangement of buildings, increasing the height of buildings up to the FAR 1.0 limit.

2. In connection with energy, to have more energy-efficient for new buildings to be erected to regenerate dense settlements in Jatinegara, it is recommended to use environmentally friendly materials that can reduce operational energy.

3. To improve the walkability of the area, it necessary to have a connection between one building and another and the diversity of facilities in an area so that people who are active in the area will more easily reach facilities that are supporting their activities.

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