Townhouse with the Application of Hydroponics in Lebak Bulus

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Abstract. This townhouse design aims to create the pattern of hydroponic application to the townhouse units and its supporting facilities through a sustainable urban neighbourhood approach that focuses on urban green space. The research applies the phenomenological approach, and data analysis was conducted based on David Rudlin's theory (1999) that includes analysis of urban texture aspect, circulation analysis and analysis of greening. To deepen the analysis, both on residential systems and hydroponic systems, the research is also equipped with insights gained from comparative studies and literature studies.

Keywords: townhouse, hydroponics, urban farming, urban green space, Lebak Bulus

1. Introduction

Urbanization which means the phenomenon of population movement from villages to cities has become a trend among Indonesian people. A significant number of village residents flocked to move to the city with the hope of getting a more decent life. In Indonesia, no other destination drew larger interest of villagers to move than the capital, Jakarta. The rapid rate of urbanization in Indonesian cities presents challenges in the provision of sustainable settlements which are supported by proper infrastructure. In the city of Jakarta where growth is steadily increasing, the existing use of available land becomes more competitive. One of the impacts felt from the phenomenon of urbanization is the high demand for decent and adequate living in the city.

The rise of the current trend of urban farming in Jakarta is due to the flagship program of the provincial government. The Jakarta Provincial Government determined to make the capital city as a pilot example of urban farming, and they intended to develop this project to create added economic value by encouraging the community to utilize the idle land and to make maximum use of the limited land available. Jakarta's Deputy Governor Sandiaga Uno stated that "The existence of urban farming aims to maintain the stability of prices of basic commodities in the procurement of food, in addition to that the program can also open many agricultural jobs and provide education to the public regarding the use of green open space"[1].

Hydroponics is a method of growing plants in water-based nutrient-rich solutions. Hydroponics do not use soil. Instead, the root system is supported with inert media such as perlite, rock wool, clay pellets, peat moss, or vermiculite. The basic idea of hydroponics is to let plant roots come in direct contact with nutrient solutions and have access to oxygen, which is essential for plant growth [2]. There are several types of hydroponics systems, as illustrated in the Figure 1 below.
The area in the region Jakarta that will be studied in the research is the Lebak Bulus area in Cilandak, South Jakarta. The Cilandak area is home to many clusters of townhouses, which are deemed to be the type of residential building with limited land space. This condition is suitable for applying the hydroponics technique in carrying out urban farming practice. The location of townhouses in Cilandak is shown in Figure 2.
2. Design Method
This study of townhouse design project with the application of hydroponics is using qualitative methods employing descriptive analysis and the phenomenological approach. These methodologies are applied with the aim of describing the meaning of a life experience to some people about a concept or phenomenon [3].

2.1. Data Collection Method
The data for the study is categorized into two, the primary data and the secondary data. The primary data are obtained from direct observations at the site on Jl. Karang Tengah Raya. The observations are meant to gather the information regarding site's location, the data of land use, community activities, environmental conditions, and others. The secondary data are obtained from various academic sources such as journals, printed media, online media, which are related to the design of townhouses and hydroponic systems. The gathered information will be used to enrich the understanding of the issues being studied.

2.2. Data Analysis Method
Analysis on the collected data will be carried to assist the design process. The study will implement several type of analysis to get the complete understanding on the studied object of study, which consist of the site analysis of regions, site analysis of residential, and the hydroponic analysis [5].

3. Results and Discussion

3.1. Site Analysis of Regions
The site analysis will first observe the region, where three types of circulation are identified. The forms of the circulation are displayed and described in Table 1 below.
| Type                  | Illustration                                                                 | Analysis                                                                                                                                 |
|-----------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Circulation Analysis  | + Gives a unique impression on the circulation of townhouses, more suitable for housing with an urban neighbourhood approach  |
| Loop shape            | + Not monotonous                                                            | - The maximum capacity of the residential unit, not as much as the grid shape                                                         |
| Circulation Analysis  | + Circulation looks unique                                                   | + Not monotonous                                                                                                                          |
| Cul De Sac shape      | - More suitable for large sites                                             | - Too much leftover land                                                                                                                  |
| Circulation Analysis  | + Clear circulation                                                          | - Not suitable for the concept of urban neighbourhood                                                                                     |
| Gridiron shape        | - Less attractive form of circulation                                        | - Too monotonous                                                                                                                          |

From the three shapes of circulation explained above, it can be concluded that each has advantages and disadvantages. The form of circulation which is deemed suitable for the townhouses with the concept of sustainable urban neighborhoods is the loop shape, which creates a back-to-back type of townhouse which is also considered fit the upper middle-class.

3.2. Site Analysis of Residential
The site analysis of residential consist of several aspects, which include the analysis of buildings against the sun path as shown in Table 2, the analysis of building mass against view as shown in Table 3, and the mass analysis of residential buildings against deficiency as displayed in Table 4.
### Table 2. Analysis of Buildings against the Sun Path

| Data | Analysis |
|------|----------|
| ![Diagram 1](image1.png) | The color difference in the shape of the building mass determines the function of the building mass. |
| ![Diagram 2](image2.png) | The function of the clubhouse building is given a setback so that sunlight can enter the room on the ground floor, in addition it also provides space at the back of the type a unit to be able to utilize the light entering the house. |
| ![Diagram 3](image3.png) | Giving the roof a gable roof form, so that the afternoon sun does not get too into the house, but it also provides eaves for filtering heat from the outside into the room. |

Each period of the building is given the form of a gable roof. Besides to reduce heat during the day, the similarity of the shape of the roof is likened to be in harmony with other building functions, only for the difference will later be distinguished from the slope and magnitude of the roof dimensions.

### Table 3. Analysis of Building Mass against View

| Data | Analysis |
|------|----------|
| ![Diagram 4](image4.png) | The arrow symbol is the potential of the view owned by each occupancy group and the building mass. |
| ![Diagram 5](image5.png) | Judging from the potential view that each building has, it will be given a function of green open space in the form of a community garden (blue) as shown in the picture beside which serves as a container for social interaction and catchment areas. |
From the form of circulation and the placement of the building's function, a potential view is created which will later be utilized as a green open space with a design in the form of a community garden that serves as a forum for social interaction between residents and also as a catchment area.

**Table 4. Mass Analysis of Residential Buildings Against Deficiency**

| Residential Unit Data Type A | Analysis |
|------------------------------|----------|
| From the schematic image above, the Type A building mass is created by providing space in the back in the form of voids and on one side of the building to facilitate air exchange circulation which creates cross circulation in order to reduce room temperature during the day. |

| Residential Unit Data Type B | Analysis |
|------------------------------|----------|
| From the schematic drawing above, the Type B building mass is created by providing space in the back and one side of the building in the form of voids to facilitate air exchange circulation which creates cross circulation in order to reduce room temperature during the day. |

| Residential Unit Data Type C | Analysis |
|------------------------------|----------|
| From the schematic drawing above, the Type C building mass is created by providing openings at the rear of the building and openings on one side of the building facade to create cross circulation within the building in order to reduce room temperature during the day. |

In each type of residential unit will be designed in a form of openings with a number of openings, the dimensions of the size and placement are adjusted to the needs of users who are expected to create cross circulation in the room to reduce the temperature of the room in the building during the day.

3.3. **Hydroponic Analysis**
The hydroponic analysis involves comparing the advantages and disadvantages of several hydroponic systems as displayed in Table 5 [4].
Table 5. Comparison of Hydroponic Systems [4]

| System Type      | Advantages                                                                 | Disadvantages                                                                 | Type of Plant                   |
|------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------|
| Wick system      | Low cost                                                                   | Heavy system because it is full of media                                      | Tomato                         |
|                  | Easy installation                                                         | Passive water conditions cause sedimentation                                | Pakcoy                         |
|                  | Easy maintenance                                                          | For large scale need an aerator                                               | Lettuce                        |
|                  | Flexible                                                                   |                                                                               | Chili and paprika              |
|                  | Saving electricity                                                        |                                                                               | Spinach                        |
|                  | Can be planted with lots of vegetables                                     |                                                                               | Kale                           |
|                  |                                                                           |                                                                               | Strawberry                     |
| Ebb & flow system| Low cost                                                                   | Wasteful of water                                                            | Mustard                        |
|                  | Medium installation level                                                 | Weight system                                                                | Lettuce                        |
|                  | Easy maintenance                                                          | Must often check the density of water                                         | Pakcoy                         |
|                  | Flexible                                                                   | Vulnerable to foul disease                                                   |                                |
|                  | Saving electricity                                                        |                                                                               |                                |
| Drip Irrigation system| Moderate difficulty level                                      | Applied on a commercial scale                                                | Tomato                         |
|                  | Low cost and easy to obtain                                                | One system is only one plant                                                  | Japanese cucumbers             |
|                  | Save water and nutrition                                                  | Heavy and full media system                                                   | Japanese eggplant              |
|                  |                                                                           | Intensive control of water                                                    | Paprika                        |
|                  |                                                                           | Wasteful maintenance                                                          | Watermelon                     |
|                  |                                                                           |                                                                               | Melon                          |
|                  |                                                                           |                                                                               | Strawberry                     |
|                  |                                                                           |                                                                               | Chili                          |
| Floating Raft System | Low cost                          | Plant growth is quite slow                                                   | Kale                           |
|                  | Easy installation                                                         | Prone to spoilage                                                            | Spinach                        |
|                  | Easy maintenance                                                          |                                                                               | Lettuce                        |
|                  | Flexible                                                                   |                                                                               | Pakcoy                         |
|                  | Saving electricity                                                        |                                                                               | Caisim                         |
|                  | Can be left traveling                                                     |                                                                               |                                |
| Nutrient Film Technique System | Nutritional needs are fulfilled properly                       | Vulnerable to disease                                                         | Lettuce                        |
|                  | One installation can be planted with more than one type                    | High maintenance                                                              | Pakcoy                         |
|                  | Easy and fast installation                                                | Rely on electricity                                                           | Mustard                        |
|                  |                                                                           | Installation is quite difficult                                               | Kailan                         |
| Aeroponics System | Nutrition and water supply is quite good                                   | Installation is quite difficult                                               | Chinese mustard                |
|                  | Save water                                                                 | Maintenance is difficult                                                      | Green mustard                  |
|                  | The quality of the product produced is better                             | Rely on electricity                                                           | Indian mustard                 |
|                  | Do not depend on the season                                               |                                                                               | Green Bok Choy                 |
|                  |                                                                           |                                                                               | Head Lettuce                   |
|                  |                                                                           |                                                                               | Butterhead Lettuce             |
|                  |                                                                           |                                                                               | Leaf lettuce                   |
|                  |                                                                           |                                                                               | Romaine Lettuce                |
| Deepwater Culture | The system is very simple                                                | It’s hard to keep the temperature under 21°                                  |                                |
|                  | Easy maintenance                                                          | Vulnerable to decay                                                           |                                |
|                  | Need less nutrition                                                        |                                                                               |                                |

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From the analysis, it can be decided the type of system that best meet the townhouses requirements of implementing urban farming as illustrated in Table 6.

### Table 6. Hydroponic Analysis of Residential Units

| Hydroponics Against Occupancy | Analysis |
|-------------------------------|----------|
| Hydroponic System Type:       | Floating Raft System |
| Types of Hydroponic Plants:   | Mustard, Lettuce, Spinach, Kale |
| Will be placed on the facade and on one side of the building. |

| Hydroponics Against Regions | Analysis |
|-----------------------------|----------|
| Hydroponic System Type:     | Drip Irrigation System |
| Hydroponic Plant Type:      | Tomato, Chili, Cucumber |
| Later it will be placed in each community garden. |

Hydroponics are placed on each residential unit; the type of plant will be distinguished based on the direction of the building facade. For buildings facing the north and south direction will use plants that do not require direct sunlight throughout the day, while buildings facing the east and west direction will use plants that have resistance to direct sunlight throughout the day so that they can be used as well building buffers to reduce the heat generated by the East and West sunlight.

### 4. Conclusions

Based on the results of the analysis that has been done, a site plan and mass composition of a townhouse area are formed with the application of a hydroponic system in each unit. On top of that, this residential facility is also equipped with additional facilities in the form of a Club House, children's play area, and a comfortable pedestrian to support the outdoor activities of the residents. The front entrance of the townhouse will also be facilitated with shops that come in modern and eye-catching design. There are three types of residential units in this townhouse. There are 25 units of Type A with the building area of 163 m², 32 units of Type B with a building area of 110 m², and six units of Type C with a building area of 102 m².

The application of circulation patterns applied in this townhouse uses a loop pattern, because it can create clear accessibility, besides having sufficient open space also in accordance with the concept of sustainable urban neighbours, this townhouse also uses the type of back-to-back townhouse, where the
structure the walls are attached to both the back and side walls and the building block has two fields with each unit having its own entrance.

From the results of the analysis of soft materials that have been carried out based on the types of plants that can grow in the lowlands, especially Jakarta, here are some types of plants used for hydroponic systems, namely mustard greens, lettuce, tomato, kale, and spinach. Meanwhile, the Ketapang Kencana Putih, Japanese Bamboo (*Dracaena surculosa Lindl*), Babylon Willow (*Salix babylonica*), Taiwan Beauty (*Cuphea hyssopifolia*), and kemuning are some types of plants that can be suitably used for residential landscaping.

References

[1] Online: [http://jakarta.bisnis.com/read/20171228/77/721758/sandiaga-dorong-program-urban-farming-di-penjuru-jakarta](http://jakarta.bisnis.com/read/20171228/77/721758/sandiaga-dorong-program-urban-farming-di-penjuru-jakarta)

[2] Online: [http://www.fullbloomhydroponics.net/hydroponic-systems-101/#ixzz58flUpyAg](http://www.fullbloomhydroponics.net/hydroponic-systems-101/#ixzz58flUpyAg)

[3] Creswell J W 1998 *Qualitative inquiry and research design: choosing among five traditions* (London: Sage Publications)

[4] Halim J 2016 *Enam Teknik Hidroponik* (Jakarta: Penebar Swadaya)

[5] Rudlin D F, Falk N 1999 *Building the 21st century home 2nd ed.* (Oxford: Architectural Press)