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Sustainable Architecture in Domestic Liquid Waste Management for Environmental Health

Ghina Rizqandi Q.A[1*], Ela Nurdiawati[2]
[1,2] Faletehan University, Banten, Indonesia

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ABSTRACT

Harjatani Heritage Estate is a residential area located in Margatani Village, Serdang, Kramatwatu, Serang Regency. One of the main issues in this housing area is the poorly organized wastewater drainage system, caused by inadequate drainage flow in the surrounding environment, which has the potential to pollute the area with domestic wastewater. Domestic wastewater, commonly referred to as greywater, originates from household activities such as bathing, washing, and kitchen use. Waste management, both domestic and industrial, remains a serious environmental challenge in Indonesia. One alternative approach to addressing this issue is through natural wastewater management integrated into sustainable architectural planning for environmental health. This study employs a qualitative research method using observational techniques and data analysis. The analysis includes site conditions, surrounding environmental characteristics, and landscape planning as an application of sustainable architecture principles, supported by AutoCAD-based design exploration and interviews with local community representatives. The results indicate that landscape planning plays a significant role in supporting sustainable architecture as an environmentally responsive solution for domestic wastewater management.

Corresponding Author:

Ghina Rizqandi Q.A
Architecture Program, Faculty of Science & Engineering, Faletehan University, Banten, Indonesia 15419
Email: ghinar1909@gmail.com

1. INTRODUCTION

Margatani Village experiences environmental pollution caused by poorly managed domestic wastewater from household activities, resulting in clogged drainage, frequent flooding during the rainy season, unpleasant odors, and potential health risks[1] [2][3] . Based on the statement, research is needed on "Sanitation Planning as Domestic Wastewater Management[4] in Housing in the Margatani Village Area, Kramatwatu, Serang. Case Study: Harjatani Heritage Estate Housing.

Sustainable architecture can create healthy and environmentally friendly buildings and environments. Sustainable environments emphasize the protection and conservation of nature and efforts to reduce the negative impacts caused by human activities. This includes ecosystem preservation, reducing greenhouse gas emissions, and protecting biodiversity. In architecture, it is an important aspect that must be considered in designing buildings. In addition to planning sanitation facilities [5] such as toilets and hand washing facilities, there are several things that need to be considered related to sanitation in architecture such as: Drainage and

wastewater disposal systems in buildings must be well designed, to ensure that wastewater is disposed of efficiently and safely so as not to pollute the surrounding environment[6] :

- Architectural design must consider efficient water use, such as the use of water-saving sanitation equipment. In addition, rainwater collection for use in sanitation purposes such as toilet flushing or watering plants.
- Architectural design must take into account cross ventilation to ensure good air circulation in the building, thereby reducing the risk of disease spread and maintaining indoor air quality.
- Architectural design must consider the ease of cleaning and maintenance of sanitation facilities. Building materials that are easy to clean, surfaces that are resistant to moisture, and spatial arrangements that facilitate access for cleaning and maintenance of sanitation equipment.

According to Paola Sassy [7], there are the Principles of Sustainable Architecture, such as:Land Use dan Ecology, Energy,Water, Material, Health, Material,and Community.

2. METHOD

Harjatani Heritage Housing is one of the areas located in Margatani Village, Serdang, Kramatwatu which has 55 families. The assumption is that each family consists of 4 family members. The condition of domestic waste (household) in Margatani Village is quite bad and quite polluting the environment.

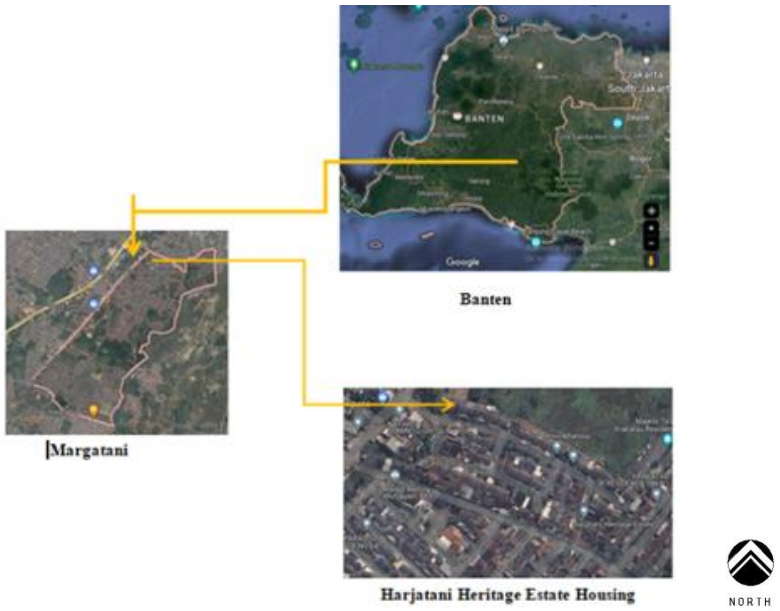

Figure 1. Research Location, Harjatani Heritage Estate Housing
(source: processed by author from Google Maps)

The tools and materials used in this study included writing tools for documentation, a measuring tape and ruler for recording dimensional data, a meter tape for measuring longer distances, a compass for determining orientation and direction, a camera for visual documentation of site conditions, and a map of the Harjatani Heritage Estate housing area to support spatial analysis and location referencing.

The type of research used in this study is qualitative research with observation, and interviews with local community officials, Analysis of the environmental condition space program in accordance with the facilities and infrastructure needed.

The data required in this study consists of primary data and secondary data. Primary data is obtained by analyzing problems in accordance with the aspects of sustainable architecture and the profile of the Harjatani Heritage Housing Area, Margatani Village, Serdang, Kramatwatu, Serang. Secondary data is obtained from the Analysis of the Housing Environment Area and Harjatani Heritage Serdang-Serang, Banten. After the data analysis was carried out, a spatial Analysis of the Design of Liquid Waste Management Architecture was carried out in the Harjatani Heritage Estate housing area also using Auto Cad software.

3. RESULTS AND DISCUSSION

3.1. View Analysis

Based on the view analysis in the area, there is water pollution and increased water discharge caused by the flow of domestic household wastewater and blocked water channels. This can be seen in the following image.

Figure 2. Domestic Wastewater Pollution
Harjatani Heritage Estate Housing (source: author)

3.2. Analysis based on the theory of Sustainable Architecture principles

Aspects of sustainable architecture use the Principles of Sustainable Architecture (Paola Sassi 2006) [8] there are 6 Principles of Sustainable Architecture, such as; Land Use and Ecology Analysis, Energy, Water, Material, Health, and Community.

3.2.1. Land Use and Ecology Analysis

Strategic Issues in Land Use & Ecology are; Use of brownfield sites,Reuse of existing buildings, Appropriate density, Investment in landscaping, public transport, new pedestrian routes, Effects on micro-climates. Here is the Analysis Table of Land Use and Ecology:

Tabel 1. Land Use and Ecology Analysis (source: author)

Land Use and Ecology	Problem Analysis	Sustainable Architecture
1. Use of brownfield sites	the existence of abandoned land	Architecture Landscape Planning
2. Reuse of existing buildings	The existence of the existing Security Post Building which is no longer in use	Reuse [9] the Security Post Building for another function
3. Appropriate density	There is still space/land that has not been used	Architecture Landscape Planning and public support facilities[10]
4. Investment in landscaping	This empty land/space is still not in use	Landscape arrangement with green open space [11] vegetable planting, planning of reservoirs and reservoir pools as a result of liquid waste pollution
5. Public transport	Public transportation is available in the area (public transportation and online motorcycle taxis)	Planning a Shelter as a transit place to wait for public transportation
6. New pedestrian routes	Route to Research Area (Sustainable Architectural Plan) does not exist yet, The absence of the Role of Sustainable Architecture causes Impacts on the microclimate; clogged water channels cause increased water discharge and	Landscape planning in the form of routes and footpaths

	during the rainy season cause flooding and liquid waste pollution.

3.2.2. Energy Analysis

Natural ventilation, passive solar energy, and planting vegetation were applied to enhance comfort and reduce energy consumption. Water circulation and storage were optimized for environmental efficiency[12] . Here is the Table of Energy Analysis;

Tabel 2. Energy Analysis (source: author)

Energy	Problem Analysis	Sustainable Architecture
1. Renewable energy sources	Domestic liquid waste that is not disposed of properly can be caused by water pollution and air pollution.	Planning good circulation of liquid waste disposal, planning water storage tanks and ponds for rainwater harvesting [13]
2. Use of natural ventilation	The existing security post building and the planning of the water reservoir require natural ventilation for further monitoring as well as for lighting and air conditioning.	The existing security post building and the planning of the water reservoir require natural ventilation for further monitoring as well as for lighting and air conditioning.
3. Use of passive solar energy [12]	There is a lot of sunlight coming towards the research area because it is still an empty space or land that has not been used.	Landscape planning with planting vegetation as an environmental filter so that the surrounding environment is not too hot.[11]
4. User-Friendly Building Management Systems	Domestic liquid waste circulation management is very poor due to poor circulation (clogged water channels).	Planning of reuse and recycling systems for water[14] and existing buildings
5. Exploiting the constant ground temperature	As a result of land being empty for too long, it can cause environmental damage, the land is not well managed.	Sustainable Landscape Planning with Vegetation Planting (Garden Planning) [11]
6. Use of planting for shading and cooling	land Eksisting is an empty space or land that has not been used	Landscape planning with planting vegetation as an environmental filter to make the surrounding environment cool. [15]

Based on the Land Use-Ecology Analysis and Energy Analysis, data was obtained in the form of Site Plan Images, Topography, Existing Wastewater Channels in the Area.

1. Existing Area

a. Site Plan Existing
The area of research is ± 430 meters squere area according to the figure 3.

b. Topography Existing
The Topography Eksisting include: Eksisting Ground, Eksisting Building (Security post), new Buliding (New Security Post), and Get Entrance Housing.

3.2.3. Water Analysis

Wastewater management included planning new channels, reservoirs, and rainwater harvesting to reduce flooding and water pollution. Here is the Table of water analisys;

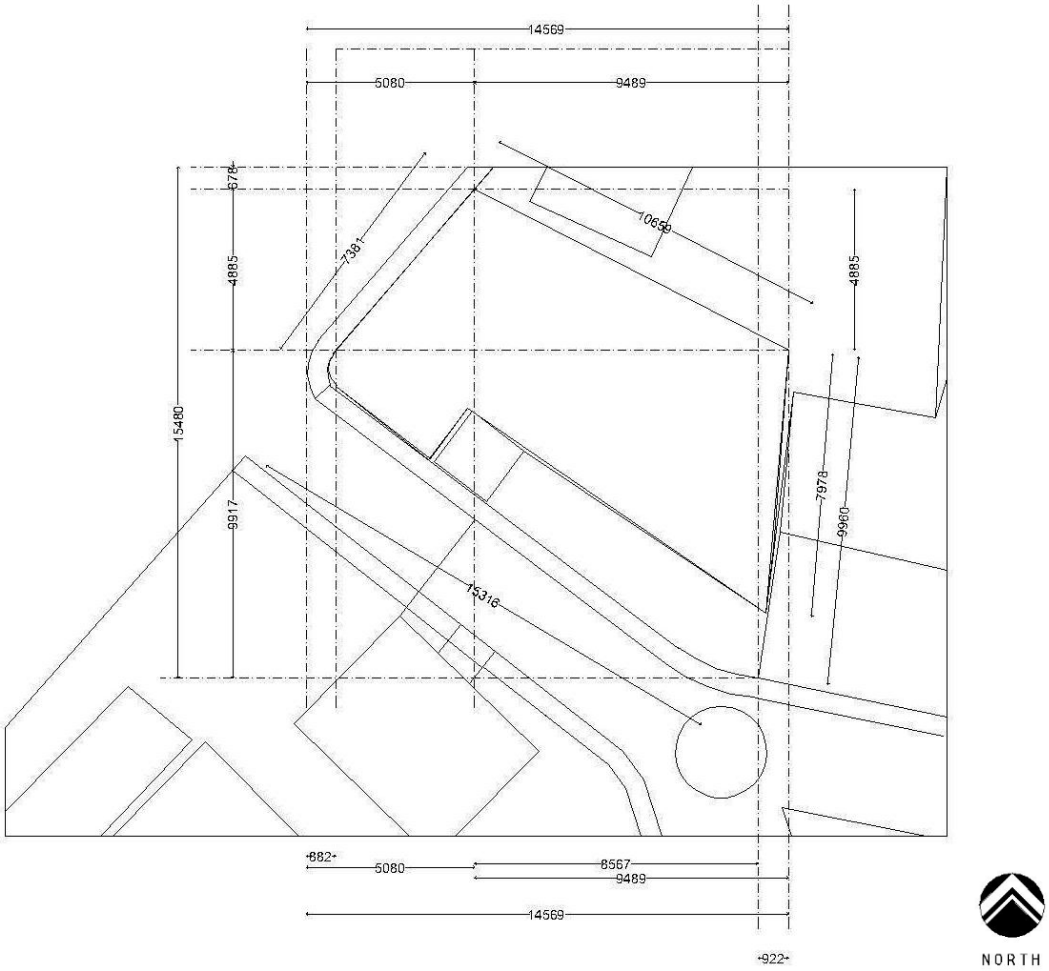

Figure 3. Eksisting Site Plan (Source: Author)

Figure 4. Topography Existing (Source: author)

Tabel 3. Water Analysis (source: author)

Water	Problem Analysis	Sustainable Architecture
• Comfort for building inhabitants	Domestic liquid waste that is not managed properly can cause water pollution and air pollution The impact of poor water circulation causes increased rainwater discharge and liquid waste.	Planning good circulation of liquid waste disposal, planning water storage tanks and ponds for rainwater harvesting [13] .
• Maximum use of natural light	The impact of poor water circulation causes increased rainwater discharge and liquid waste.	Planning good circulation of liquid waste disposal, planning water storage tanks and ponds for rainwater harvesting [16] .
• Minimizing rain water run off	The impact of poor water circulation causes increased rainwater discharge, resulting in flooding during the rainy season	

Based on water analysis, data was obtained in the form Eksisting of household wastewater circulation Analysis;

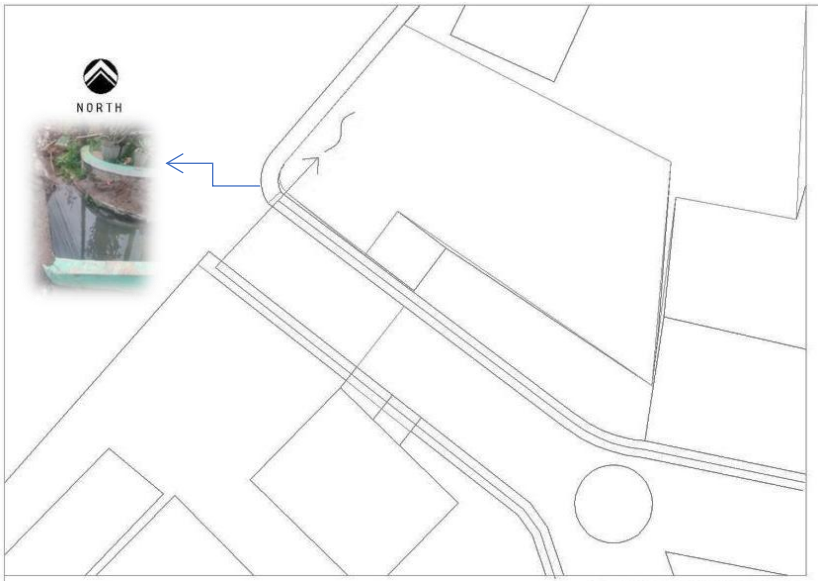

Figure 7. Household wastewater circulation Analysis (Source: author)

From Figure 7, we can see the drain is blocked so it flows into the gutter. Increased water discharge can flow towards vacant land and can cause flooding.

3.2.4. Material Analysis

Sustainable and recycled materials were applied for construction, including clay bricks and recycled furniture, ensuring durability and environmental safety. Here is the Table of Material Analysis:

Tabel 4. Material Analysis (source: author)

Material	Problem Analysis	Sustainable Architecture
• Conservation of natural resources	Planning a reservoir building requires building materials that are strong, environmentally friendly, but also resistant to liquids (waterproof), so you can use building materials that are natural resources such as clay and materials that can be recycled.	Use of bricks (made from clay) in planning the walls of a reservoir building [18]
• Use of recycled materials		Use of furniture in the garden (landscape planning area) using recycled materials such as plastic waste[19]
• Low embodied energy materials		Sand Spandek Roof [20], [21]
• Renewable materials from a verifiable source		Brick wall
• No ozone-depleting chemicals		Sand spandex roof, brick walls

3.2.5. Health Analysis

Measures included maintaining indoor air quality, sanitation facilities, and user comfort through proper layout and maintenance. Here is the Table of Health Analysis;

Tabel 5. Health Analysis (source: author)

Health	Problem Analysis	Sustainable Architecture
• Comfort for building inhabitants	Poor water drainage circulation has an uncomfortable impact on health because it causes water pollution and air pollution.	Pay attention to Sustainable Architectural Planning by paying attention to user comfort and the environment by planning water reservoirs and pools as well as landscaping.
• Maximum use of natural light	There are existing buildings that have not been reused with glass opening materials.	Reuse existing buildings with different functions and maintain glass materials and pay attention to ventilation.

3.2.6. Community Analysis

Local communities and stakeholders were involved in planning and managing wastewater and landscape areas, fostering awareness and participation. Here is the Table of Community Analysis;

Tabel 6 Community Analysis (source: author)

Community	Problem Analysis	Sustainable Architecture
• Consultation with the local community • the design professions	Consultation, socialization, and consensus have been carried out by community officials up to stakeholders (sub-district government officials) regarding the clogged water channels, but until now no solution has been found.	Discussions, socialization, and consensus have been carried out by community officials up to stakeholders (sub-district government officials) regarding clogged water channels, but until now no solution has been found.
• Mixed development	The development of a mixed building requires a very large area of land, while	Landscape planning according to its function

	this empty land is estimated to only be used for planning related to Sustainable Architecture.	
• Contribution to the economic and social well-being of the community	This research land has not contributed to economic and social welfare.	Planning Community Based (surrounding community) in landscape management including liquid waste circulation, Reuse the old Security Post Building as a Small Prayer Room
• Amenity of the wider area	There is no community involved other than local community officials. Local officials such as Security complain that the nearest place of worship is not yet available around the site area, the presence of security on rotating duty requires the nearest place of worship.	
• Visual amenity space	This research space does not yet provide facilities that encompass activities or planning related to the role of sustainable architecture.	Landscape planning according to its function
• Aesthetic excellence	This research area has not shown aesthetic advantages related to the Role of Sustainable Architecture.	
• Collaborative enterprise involving all the design professions	This research area has not yet involved experts based on the design theme.	Local communities work together with Academics, Architectural Planning Consultants and Contractors as providers of goods and services to address environmental problems in the Research area

Based on the analysis above (Tabel 3,4,5, and 6), the Sustainable Architectural Role Planning is obtained in the form of; Reuse (Reuse of old buildings / old Security Post) which can be used for small prayer rooms, Mini Bus Stop Planning as access for people using Public Transportation, Landscape Planning, New wastewater channels, and Reservoirs and ponds based on the following information:

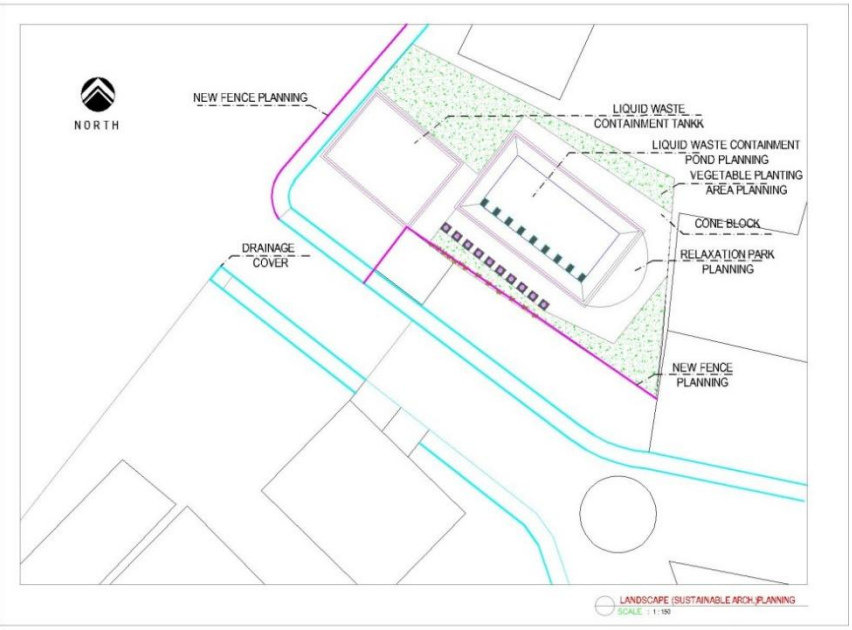

Figure 8. Landscape Planning (Source: author)

a. Landscape Planning

1. Softscape; in the form of natural elements such as planting vegetation with planting types of vegetables as a natural investment.
2. Hardscape; in the form of planning a reservoir and a wastewater reservoir that can also function as rainwater harvesting that can be reused, Fence Planning and Drainage Cover Planning as aesthetics and Architectural Role functions.

b. New Wastewater Channel

From the discussion of the analysis of water channel problems, it is necessary to plan a new wastewater channel as shown in the following image.

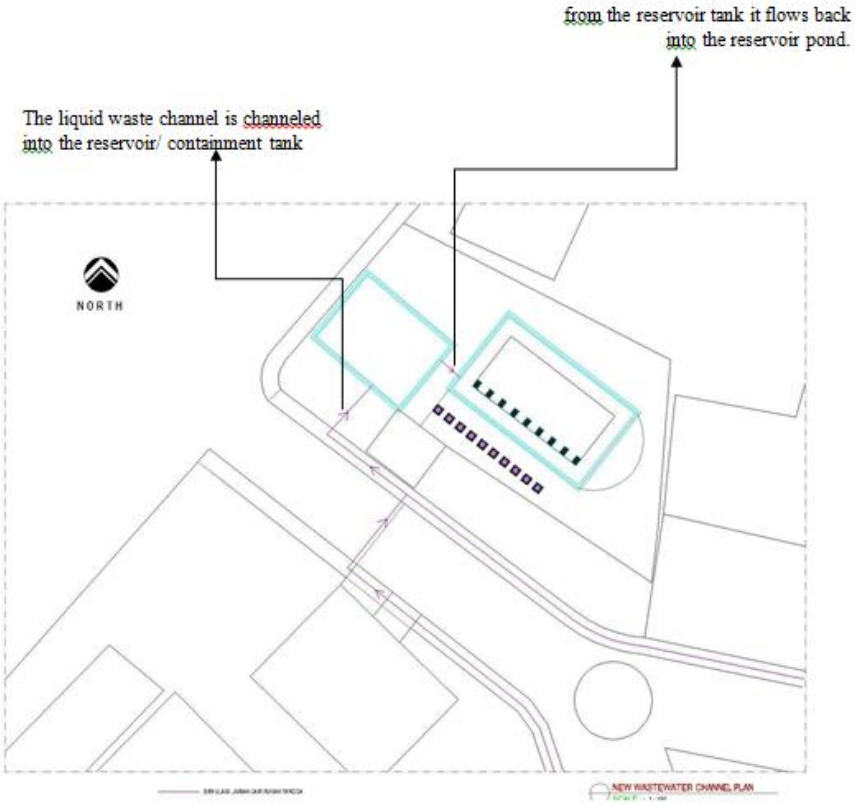

Figure 9. New Wastewater Channel (Source: author)

3.3. Critical Reflection

The proposed sustainable architectural strategies are conceptually appropriate, their implementation depends on land availability, financial support, and long-term maintenance by local authorities and the community. In the long term, integrated wastewater management and landscape-based solutions have the potential to improve environmental quality and public health; however, their sustainability depends on continuous community participation and system maintenance.

4. CONCLUSION

The problem of domestic liquid waste that has the potential to pollute the air, land, and air can be resolved through the application of sustainable architecture principles, including landscape planning (softscape and hardscape), waste and rainwater management, reuse of existing buildings, and the provision of public facilities based on community participation. In addition, sustainable architecture is implemented through the reuse of existing buildings, the provision of public facilities to support transportation, and a community-based approach by involving the community in environmentally conscious landscape management.

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Notes on contributors

Ghina Rizqandi Q.A is an Assistant Professor and tenure lecturer at Architecture Program, Faculty of Science & Engineering, Universitas Faletehan (UF). She was appointed lecturer in the institution in 2022. She went to pursue her master degree in Tourism Planing Architecture majoring at Universitas Gadjah Mada (UGM), Indonesia. Her research interest covers the topic of Architecture Planning, Architecture Sustainable, Health Architecture and Tourism Planning Architecture in Indonesia. She can be contacted at email: ghinar1909@gmail.com

Ela Nurdiawati is an Assistant Professor and tenure lecturer at Public Health Program, faculty of health sciences, Universitas Faletehan (UF). She was appointed lecturer in the institution in 2019. She went to pursue her master degree in Departement of Public Health majoring at Universitas Indonesia (UI), Indonesia. Her research interest covers the topic of Public Health, Health Promotion in Indonesia. She can be contacted at email: elanurdiawati@gmail.com