

ICRP 2019

4th International Conference on Rebuilding Place

DUTCH DWELLING DESIGN IN ADAPTING THE WARM- HUMID CLIMATE IN INDONESIA

Laina Hilma Sari (a)*, Zahriah (b)

*Corresponding author

(a) (b) Architecture Department, Syiah Kuala University, Darussalam, Banda Aceh, 2311, Indonesia,
laina_hilma@unsyiah.ac.id

Abstract

Dutch colonial remained some of their dwellings in Indonesia that the Indonesian army has functioned some of them as houses or guesthouse. Meanwhile, some others occupied by the local people have been renovated to be a hostel, cafe, and shops and also demolished to be contemporary building design for various functions. In Banda Aceh, the dwellings resided by the army has been claimed by the heritage council to be part of heritage conservation buildings. As the houses perform the vibrant characters of tropical architecture in a warm, humid climate, this study aims to analyse the design, including the house layout, building materials, and apertures types. The data was collected through observations, field measurement, and interview with the owner. In this case, one typical Dutch house in Kuta Alam, Banda Aceh becomes a study case. The study found that most of the houses that are stilt and made from timber are built in large lot with different zoning of main activities and services. The window size is large in jalousie type and designed in cross ventilation. The roof is clay tile with high ceiling. This study will enrich the way to improve the house design in a warm, humid climate for achieving natural comfort such as sufficient daylight and acceptable naturally thermal comfort and hence reducing the energy use.

© 2019 Published by Future Academy www.FutureAcademy.org.UK

Keywords: Dwelling, tropical architecture, Aceh.



This is an Open Access article distributed under the terms of the Creative Commons Attribution-Noncommercial 4.0 Unported License, permitting all non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

1. Introduction

Tropical architecture is an architectural work designed to modify the warm, humid climate which has high relative humidity to be thermally comfortable (Karyono, 2013). In general, the principles of tropical architecture design are such as a pitched roof with large apertures; full shade for protection against sun radiation and rainwater splash; and large windows designed in cross ventilation for emerging the natural ventilation. Tropical architecture also works well with stilt house model that is useful for avoiding moisture from groundwater (Hardiman, 1992; Kumurur & Tampi, 2018) as well as for flooding mitigation. Building orientation is also significant in warm, humid climate design, where indirect sunlight through reflection is preferable to avoid severe direct sun heat and glare. Lightweight building materials with low conductivity value is also preferred (Krishan, 2001). All of the approaches would give sufficient daylight, which is nicely shaded and thus could provide natural thermal comfort. Concerning building design, the Dutch colonial did consider the tropical climate in building their dwellings in Indonesia. The Dutch colonized Indonesia for about 350 years, which then remained some of their old buildings. From history, we know that in the early 20th-century Dutch colonial had their buildings adhered to European and French styles. But after the 1900s, architectural design was developed by combining a modern architecture that emerged in the Netherlands and humid tropical climate conditions in Indonesia. Some Dutch colonial buildings take traditional local elements to the architecture (Handinoto, 1996; Ardiyanto, Djunaedi, & Ikaputra, 2015). The buildings with those styles are called Indische Empire Style which performs the architectural style developed in the Dutch East Indies (now Indonesia) between the mid-18th century and the end of the 19th century. In Banda Aceh, Dutch left their dwellings with the Indische-style which are currently utilized as an official residence as well as the office of the Iskandar Muda Kodam army. Since 1991 the Dutch colonial housing complex including *pendapa* gubernatorial, BI, Baperis, and telephone centers in Banda Aceh have been designated as national cultural heritage areas. However, some of the housing occupied by Acehnese commoners have been modified or demolished. If the houses are well maintained, they can be durable and become history proof. The Dutch dwellings look strong, still well stand and perform the tropical building design character. In anticipation of the extinction of the houses, this study aims to evaluate the Dutch dwelling design, including the house layout, building materials, and apertures types. The evaluation is also supported by documentation of measurable architectural images which intends to preserve the historic colonial occupancy so as not to lose its age. This research is also expected to provide recommendations to Architects to apply the character of tropical architecture in various building designs. It supports the improvement of environmental issues through environmentally friendly and energy-efficient buildings.

1.1. Dutch Dwelling and Tropical design principles

The Dutch-designed dwellings after the 18th century apply some specific characters. During this period, several professional architects presented their ideas to use traditional architectural elements in the design of modern buildings of Dutch colonial architecture. In this era, the Dutch did build structures in their colonies by incorporating local climate (van Roosmalen, 2013; Kurniawan, Salain, Dwijendra, & Rajendra, 2019). Previously, the pioneers of this trend are Henri Maclaine Pont and famous architect and city planner Thomas Karsten. These two architects can be considered as pioneers who developed the

architectural character of "Indische" (Akihari, 1990). Some of the buildings have been built by the architects, namely: office buildings, schools, hospitals, stations, museums, markets, theaters, and homes. This design is applied to mixed architecture, traditional and modern architecture, which is called indische style house. The house is generally built along the river with a spacious lot and shaded with thick trees like Asam Jawa Trees. The house design was raised about one to one and a half meters above the ground. The typology was dissimilar to Javanese colonial houses, which were generally built of stone and on the land. Raising the floor might have been to avoid flooding during the rainy season. The early twentieth-century houses display some standard features of the Indies-style country houses. The house reveals unusual attention to local conditions, primarily climate, and material. Moreover, the Dutch architects considered on the architectural form as well as the aesthetic of the local-traditional house. The houses have large verandas at the front, and the floors are raised above the ground (Figure 1). The concept of Acehese traditional house was adopted by the Dutch architects. The type of house construction allowed cooling breezes to pass underneath while it kept the dwelling high enough to avoid flooding during the rainy season. This type of house became the primary model emulated throughout Banda Aceh during the Dutch occupation. Having had verandahs and raised the floors allow the cool. Moist air to be drawn up through the slatted floor and verandah to reduce the hot currents created from heated roof space. Indonesia is a humid-tropical country. It has tremendous tropical forest which is characterized with, a relatively high air humidity which can be up to 90% and high rainfall. The average temperature can be up to 38°C during the rainy season (Hardiman, 2013; Santosa, 2001). The buildings in tropics should meet the requirement of thermal comfort by considering the environmental factors such as sun rays, airspeed, rainfall, and air humidity (Frick, & Suskiyatno, 1998). The Dutch colonial concerns the warm, humid climate in building their dwellings. The design includes large apertures, cross ventilation, and high ceiling. Sun orientation is also essential to be considered in providing sufficient daylight without excessive heat radiation (Sumalyo, 1993; Pane & Sianipar, 2018).



Figure 01. Front facade of the Dutch Dwelling with spacious lot

2. Problem Statement

The problems are the limited case surveying the detail of the Dutch dwelling design, while a few of them are not maintained or even demolished. Therefore, this study figures out the design of Dutch dwelling, which is rich in tropical design character.

3. Research Questions

- The research question is that simple that what the character of tropical design applied in Dutch dwelling.

4. Purpose of the Study

This research indicates how the Dutch applied the character of Architecture in the past. In particular, aspects of residential design that is observed are design, type, and size of openings, building plan patterns, building skin sizes such as ceiling height and type of material used for floors, walls, and roofs. The pattern of residential arrangement is also observed to find out the Dutch strategy in presenting a comfortable microclimate in the humid tropical climate of Banda Aceh.

5. Research Methods

This study uses qualitative methods which gather some data from interviews, observations, and documents. We did the observations through the dwelling design, including house layout, building material, and aperture design. We interviewed the army accompanying us to survey the house as well as read the literature supporting the research.

6. Findings

The Dutch dwelling that we survey is in Kuta Alam built on the wide lot nearby Krueng Aceh river (Figure 2). From the history and the interview, we recognize that all Dutch dwellings in Aceh were constructed nearby the river. In the old age, the river is significant for transportation accessibility as well as for water supply, which can be a reason for the Dutch colonial in erecting their dwellings.

The Dutch housing complex includes the military hospital and the troops housing. The house that we survey is in military leader housing row, which some of them has been utilized as a military guesthouse.






-  Dutch/ military hospital
-  Troops dwelling
-  Survey area

Figure 02. Survey location

6.1. House layout and design

The houses are commonly semi-detached houses that are built as pairs in which each house's layout is a mirror image of the other's (Figure 3). The master bedroom and all master rooms are located at the front site, while the service rooms such as kitchen washing area and maid bedrooms are at the rear. The separated zones allow sufficient daylight and air circulation across the rooms. The house is characterized by a long corridor connecting the master area with service area. Having the floor raised up to 1,3 meter above the ground, the master area is built with wooden stair at the front and at the rear for the accessibility. However, the service area built-in grounded type (Figure 6).

The idea of stilt house is probably due to the use of timber as the floor material which needs loft space for avoiding direct contact to the ground. As previously mentioned, lifting the floor also allows the cooling breezes to pass underneath while it kept the dwelling high enough to avoid flooding during the rainy season (Figure 4 and 5) . The wooden wall is 3,7 m high, which is supported by the reinforced brick foundations.

The house has spacious verandah which allows the creation of shades for breezing the air. The gable roof which has tilt 300 is designed with large overhang surrounding the house which protects the wooden wall and the apertures from the rainwater splash as well as for cooling down the microclimate. The overhang of the verandah was designed with gutter avoiding rainwater splashing the verandah (Figure 7).

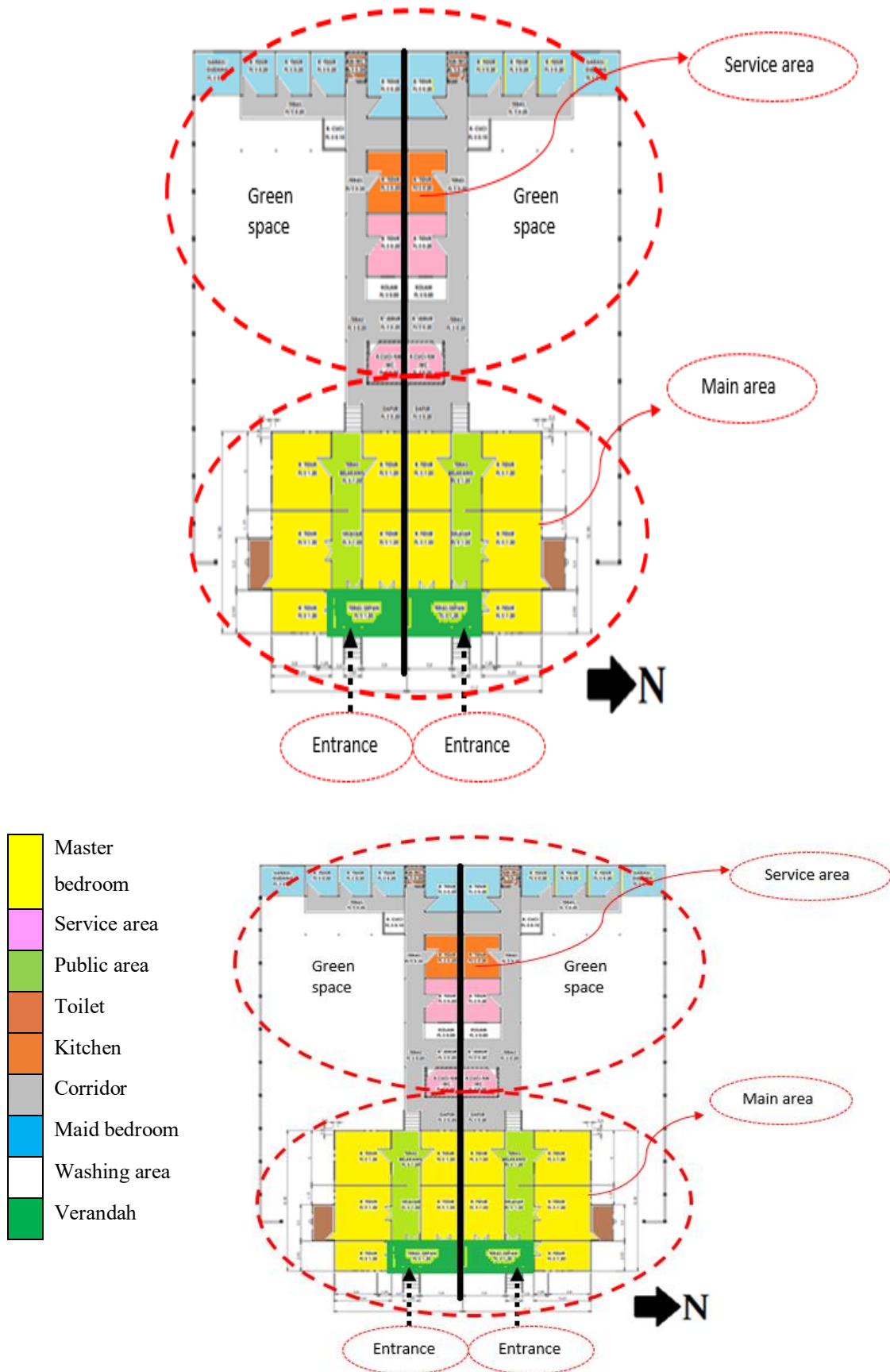


Figure 03. Semi-detached house lay out



Figure 04. Front elevation



Figure 05. Rear elevation

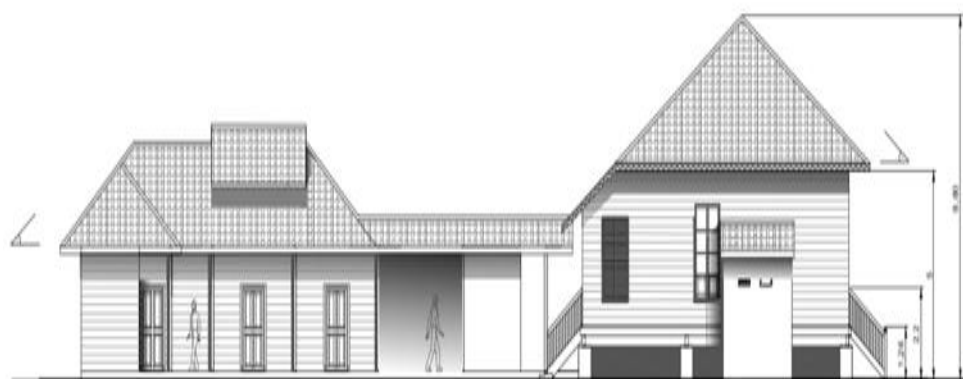


Figure 06. Side elevation



Figure 07. Rainwater gut around the fascia of verandah overhang

6.2. Aperture design

Window is closed. The window in each room also allows the daylight to come through (Figure 8). There is excellent attention on the kitchen where the roof at the middle is lifted, creating upper apertures for circulating out the hot air from the kitchen. The service zones at the rear have the openings facing the outside directly yet away from the public zone (Figure 9). This condition is good in circulating out the air through service rooms such as a bathroom, toilet, kitchen, and washing area. The door in the master zone is also designed in double casement with superior ventilation — the remaining doors in service zones designed in single oriel type.



Figure 08. Window and door designs



Figure 09. Kitchen roof and façade

6.3. Buildings materials

The house is made from timber wall supported by a reinforced brick column. The wooden structure runs throughout the wall and the roof. The roof tile installed at the roof is branded with 'Pannen Fabriek van Echt Limburgh' which is made from the clay of Mass River in Holland (Echter Landj, 2017). Ceramic tile with the characteristics of tropical buildings has advantages over natural differences compared to other materials. The roof tile is typically 22 x 29 cm. Some types of brands in this building are similar in shape and size. There are approximately ten brands installed from buildings that are currently 137 years old (Asramaganting, 2015).

Clay roof works well in reducing the mean radiant temperature due to the lower surface temperature of the clay compared with metal roof (Anumah & Anumah, 2018) (Figure 10). Clay tile roof meet the criteria for good building material such as weather resistance, secure against wind and atmospheric precipitation, good sound insulation, durability, environmentally friendly and fire safety (Romanova &, Skanavi, 2017). Therefore they probably became the reason for Dutch to install the clay roof into the roof (Figure 11).



Figure 10. The clay tile roof installed in the Dutch dwelling roof

Wooden plank of the wall was layered with fine sands at the outer side. Based on the interview, this layering intends to protect the wooden plank from fungus or termites due to the excessive humidity in tropics. This treatment can probably be the reason for the overall of the wooden structures to look good despite the wood quality that is first-class wood.



Figure 11. The clay tile roof installed in the Dutch dwelling roof

The dwellings are uniquely designed with an ornament which appears on the fascia of the overhangs of the verandah. The floor beam at the outer side and the stairs are also designed with embellishments. We observed that all spots and facades were designed carefully and very detailed.

From all the observation reports, we underline the following criteria of Dutch housing applying warm, humid climate that would be beneficial to be considered in the current practice (Table 1).

Table 01. Dutch dwelling characteristics

Design	Column Heading
Lay out	In large lot, with different zoning of main activities and services
Apertures	Large size in jalousie type, and cross ventilation position
Roof	Clay tile Pitch roof with high ceiling
Floor	Timber floor in Stilt house style
Wall	Timber wall coated with fine sand

Based on the survey, some modifications have been carried out to the apertures. Some of them are sealed with glass. The use of solid glass causes some rooms are actively cooled with air conditioner. Some spots area are additionally roofed with corrugated zinc sheet, which increases the high air temperature surrounding the room. Flashing back to the theory, the original character tropics design of the house would bring the adaptive thermal comfort. The surrounding microclimate also has significant use in creating inside comfort. Therefore, we also should consider the greeneries to be planted surrounding the building for helping the creation of cooling breeze circulating into the house.

7. Conclusion

This study evaluated the architectural design of the Dutch dwelling concerning the warm-humid climate. The Dutch colonial built homes adopting the local character. The tropical climate which can be good lesson learns are the zoning of house layout which separates the primary and service area. It is useful for supplying good daylight and thermal comfort. The stilt house is a smart design for avoiding flooding and allowing breezing air upward from the down loft. Cross ventilation across the rooms with jalousie type windows are quite useful for maintaining air supply for 24 hours. Lightweight construction, which is dominantly made from timber is the way for reducing excessive heat transmission from outside. This approach is a good lesson learned for the modern house for being adaptable with warm-humid climate.

Concerning all of the unique characters as the adaptation of the warm-humid climate, the house should be gently treated to maintain the historical values. The basic principle of conservations requires the careful and minimum alteration of historic fabrics for minimizing the risk of significant loss (Harun, 2011). In this case, the Dutch house is unique in the house layout, building materials, and apertures, including window and door types. For any case of old material replacement, the new material must be compatible with the original, which is similar strength, texture, scale, and form (Suryono, Sudikno, & Salura, 2013).

Acknowledgments

We acknowledge Syiah Kuala University for funding this research through ‘Hibah Penelitian Lektor’. We also thank all the contributors i.e., Architecture students of Syiah Kuala University that have collected the data and drawn the architectural drawing of the Dutch Dwellings as the research documentation.

References

- Akihari, H. (1990). *Architecture & Stedebouw in Indonesie 1870–1970*. De Walburg Pers: Zutphen.
- Anumah, L., & Anumah, J. J. (2018). Clay Roofing Tile: A Cool Roof. *Open Journal of Science and Technology*, 1(1), 1-3. <https://doi.org/10.31580/ojst.v1i1.151>
- Ardiyanto, A., Djunaedi, A., & Ikaputra, J. A. S. (2015). The Architecture of Dutch Colonial Office in Indonesia and the Adaptation to Tropical Climate, 5, 1-6.
- Asramaganting. (2015). Retrieved from <http://asramagantingheritage.blogspot.com/2015/04/dari-stoompannen-hingga-kho-sim-kong.html>

- Echter Landj. (2017). Retrieved from <https://www.echterlandj.nl/lezing-keramische-industrie-echt-en-de-valk/>
- Frick, H., & Suskiyatno, F. B. (1998). Dasar-dasar eko-arsitektur: konsep arsitektur berwawasan lingkungan serta kualitas konstruksi dan bahan bangunan untuk rumah sehat dan dampaknya atas kesehatan manusia [The basics of eco-architecture: the concept of environmentally sound architecture and the quality of construction and building materials for healthy homes and their impact on human health]. Penerbit: Kanisius.
- Harun, S. N. (2011). Heritage Building Conservation in Malaysia: Experience and Challenges. The 2nd International Building Control Conference, *Procedia Engineering* 20, 41-53.
- Hardiman, G. (1992). Investigasi Sistem Ventilasi Alami untuk Perbaikan Iklim Dalam Ruangan Bangunan Rumah yang Nyaman di Jawa / Indonesia. (Doktoral Doktor), Universitas Stuttgart.
- Handinoto. (1996). *Perkembangan kota dan arsitektur kolonial Belanda di Surabaya, 1870-1940*. Diterbitkan atas kerjasama Lembaga Penelitian dan Pengabdian kepada Masyarakat, Universitas Kristen PETRA Surabaya dan Penerbit ANDI Yogyakarta.
- Hardiman, G. (2013). Adaptasi Tampilan Bangunan Kolonial Pada Iklim Tropis Lembab (Studi Kasus Bangunan Kantor PT KAI Semarang), *Jurnal Modul Jurusan Arsitektur FT. Undip*, 13(1).
- Karyono, T. H. (2013). Arsitektur dan Kota Tropis Dunia Ketiga: Suatu Bahasan Tentang Indonesia.
- Krishan, A. (2001). *Climate Responsive Architecture*. New Delhi: Tata Mc Graw-Hill. Lippameier, George. 1994. *Bangunan Tropis*. Jakarta: Erlangga.
- Kurniawan, A., Salain, P. R., Dwijendra, N. K. A., & Rajendra, I. G. N. A. (2019). The Effect of Dutch Colonial Architecture on Palace in Bali, Indonesia, *Journal of Social and Political Sciences*.
- Kumurur, V. A., & Tampi, D. M. (2018, March). The Dutch colonial architecture of buildings in Manado's Old City: A response to the coastal tropical climate. In *IOP Conference Series: Earth and Environmental Science*, 129 (1), 12-30.
- Pane, I. F., & Sianipar, R. A. (2018). The Influence of Nieuwe Bouwen Architecture on Dutch Colonial Building in Medan City. *DIMENSI (Journal of Architecture and Built Environment)*, 45(1), 37-44.
- Romanova I., & Skanavi, N. (2017). The selecting of roofing material for pitched roofs by the analytic hierarchy process. *MATEC Web of Conferences*.
- van Roosmalen, P. K. (2013). Confronting built heritage: Shifting perspectives on colonial architecture in Indonesia. *ABE Journal. Architecture beyond Europe*, 3.
- Santosa, M. (2001). Harmoni Lingkungan Tropis Lembab: Keberhasilan Bangunan Kolonial, *Dimensi Journal, Dimensi Journal of Architecture and Built Environment*, 29(1).
- Sumalyo, Y. (1993). *Arsitektur Kolonial Belanda di Indonesia*, Gajah Mada University Press.
- Suryono, A., Sudikno A., & Salura, P. (2013). Conservation of Dutch Colonial Architecture Heritage, *Journal of Basic and Applied Scientific Research*, 3(8), 418-422.