
Effect of Population Density and Urban Intensity on Building Typology in South Krembangan Area

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Abstract. Surabaya is the second largest city in Indonesia and is part of East Java. Surabaya has a strategic location and was utilized by the Dutch Colonial Government as one of the main ports. The Kalimas River served as the trading artery of Surabaya. Surabaya was broadly divided into three dominant areas: the European district, the Chinatown district, and the Arab district, all of which are delineated by the Kalimas River. Krembangan Selatan Village is of particular interest for research due to the presence of many colonial-style buildings and the shift from a historical trading area to a residential area. To understand the influence of population density and urban intensity on building typology, a qualitative descriptive analysis was conducted by observing building typology and the year of construction which helped in determining how population density and intensity affect building typology in the Krembangan Selatan area. Urban Intensity was assessed by calculating the building volume divided by 300. The highest intensity group consists of residential areas with buildings in a typical style of the 1960s. Density calculations were made by comparing the area to Semarang, as both areas were influenced by the Dutch colonial Government. This occurred because Semarang's Old Town area still maintains its urban tissue as a historical area dominated by public buildings, in contrast to Krembangan Selatan, which is dominated by service providers, educational facilities, and residential buildings.

Keywords: Intensity, Density, Typology, Colonial, and Surabaya City

1. Introduction

The South Krembangan area is a historic area in Surabaya and has important historical value (Puspita & Dharmatanna, 2024). There has been no study of the impact of population density and urban intensity on the area. With population growth and urbanization continuing to increase, it is important to understand how these factors affect the characteristics of historic buildings. This research aims to analyze how population density and urban intensity affect the evolution of historic district characteristics. By focusing on the relationship between population growth and urban change and building typology, this research hopes to provide insights into how historic districts evolve in an evolving urban environment. It is hoped that this research can provide guidance to stakeholders in planning heritage preservation policies while adapting to population growth and urban development, maintaining the integrity of the Historic District while accommodating current and future needs.

Every city has different geographical and topographical conditions. The uniqueness of these conditions forms the character of a city (Lee & Jacoby, 2011). For example, Surabaya City is divided into several historical areas. The colonial area as one of the locations that has a uniqueness that characterizes the area. In the pre-colonial period around the 14th century according to historians where the city of Surabaya was still part of the Majapahit kingdom, at that time Surabaya was famous as a port city at the tip of the island of Java, in 1275 during the reign of King Kertanegara formed a colony for his troops and made the Surabaya area a settlement for his soldiers (Faber, 1931). The name Surabaya was found in the Trowulan inscription in 1358 for the first time and is located on the banks of the Brantas River (Moehkardi, 2021). The beginning of Surabaya as a trading city when the Portuguese came

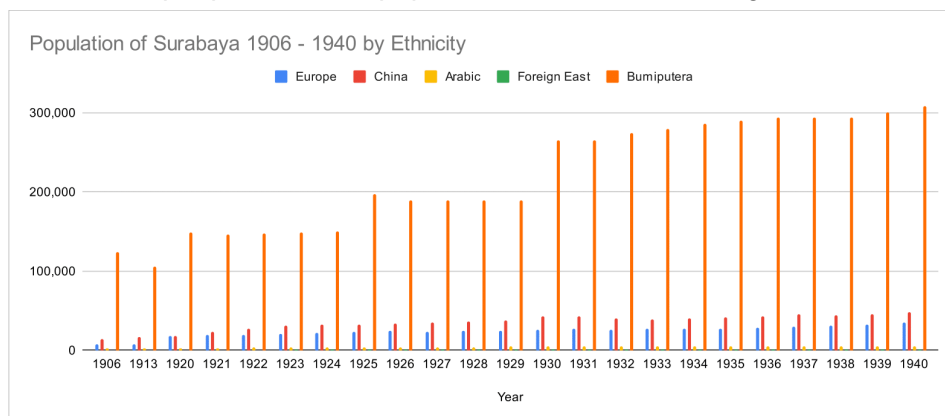
to buy spices from indigenous traders, the entry of Portuguese traders into Surabaya in 1612 (Narendro & Suryawan, 2016). In 1743 Surabaya fell into Dutch hands because of the Mataram - VOC agreement. In 1808 Wiliam Deandles as governor general made Surabaya a small European city (Wiretno, 2019) and Surabaya became a port city because there was a kalimas river estuary which became the lifeblood of trade in Surabaya. The area in Surabaya is divided into 3 parts, namely the Colonial Area, Chinatown area and Arab area. The Kalimas River divides the European area from the Chinatown area and the Arab area.

Significant economic growth from the colonial period in 1870 where economic growth was characterized by rapid growth in large-scale private trade in plantations, several large companies such as HVA (Holland Vereeniging Amsterdam) on Jl. Merak; INTERNATIO (Internationale Credit en Handelvereeniging Rotterdam) and Borsumij (Borneo Sumatra Maatschpic) had their offices on Jl. Rajawali which was formerly Heerenstraat street; NHM (Nederland Handels Maatschappij) on Karet Street (Hartono & Handinoto, 2007). This growth was accompanied by changes in population density and urban intensity that had a direct impact on the city of Surabaya. Some of the things that influence the emergence of settlements include rapid population growth, the movement of people from villages to cities, and increasing land prices (Rizki Satriaji, 2018). Surabaya city experienced an increase in trade and agricultural industry in 1906 as the beginning of the industrial revolution (Andana, Afhimma, & Ashiva, 2021). The development of Surabaya city from 1257 to 1906 can briefly be seen in table 1.1.

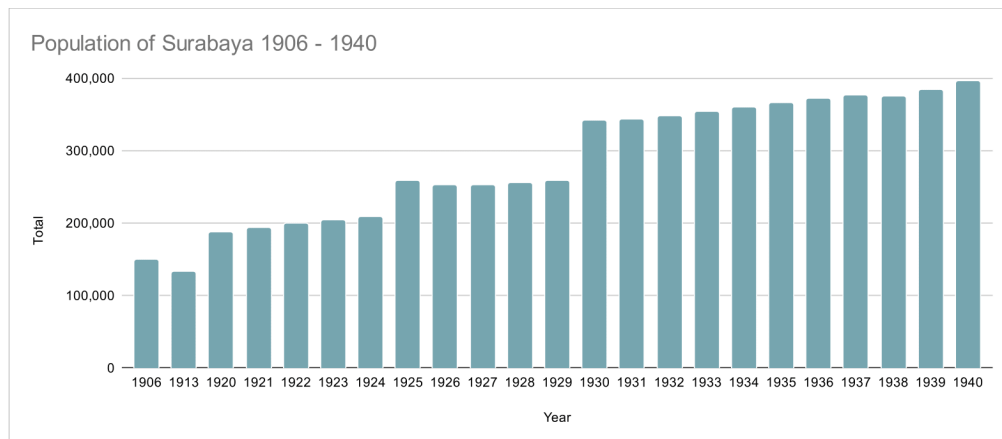
1275	1358	1612	1808-1811	1870	1906
King Kertanegara made the Surabaya area a settlement for soldiers.	Surabaya was still a village and was located on the banks of the Brantas River and had a harbor.	Trade boomed in Surabaya. Portuguese traders bought spices from indigenous traders.	The reign of Governor General Herman Willem Daendels and made Surabaya a small European city.	The fort in Surabaya was demolished due to the increasing urbanization and birth rate that required a place to live.	The agricultural industry developed rapidly because it had entered the industrial revolution. Surabaya City became a city of trade and industry

Table 1. 1 The development of Surabaya city from 1257 to 1906.

The increase in trade and agricultural industry went hand in hand with changes in population density and building density. According to the literature, before the mid-19th century there were three major ethnic groupings of the population: Europeans, foreigners and Bumiputra.(Basundoro, 2012), while from 1906 to 1940 it was grouped by ethnicity. There are 5 major ethnicities in the city of Surabaya, namely Europeans, Chinese, Arabs, foreigners and native people, the total population can be seen in Figure 1.1 .



(a)



(b)

Figure 1.1. Population Growth in Surabaya, 1906 - 1940 (redraw from Von Faber, 1936; Gemeente Soerabaja, 1941; Bureau van Statistiek Soerabaja, 1932)

In that era, the location in question was the current south Kerembangan area. After independence, the European area (Krembangan) was no longer inhabited by Europeans because many chose to return to their countries (Aini, 2015). Until now, what remains in the colonial area are only a few buildings that have been built since the Dutch colonial era, especially in the Kerembangan area at this time. Meanwhile, Kembang Jepun Street is a symbol that shows that Chinese people have an important role in building the city's economy (Wulandari, 2017). While the Arab village or often called Kampung Ampel at this time there are still many ancient colonial buildings with the characteristics of the Arab village, which are not found in other villages (Triwik Alfia Ningrum, 2015). Nowadays, the city of Surabaya has developed to the south and slowly the function of the Kalimas River as a trade artery has shifted to become a tourist spot.

The issues that followed the development of the colonial area in South Krembangan include: First, undeveloped and damaged areas. The colonial area is known as a historic area but due to the times it is dominated by trade and service activities. The historic area is no longer developed and only a few buildings still retain their colonial architectural forms. Second, cultural heritage buildings are a minority. Cultural heritage areas are no longer prominent in the colonial area because service provider buildings, settlements, education and worship dominate the area. The colonial area has undergone a change where it was once known as a trade and historical area and now it has changed into a residential area. Colonial area is one of the historical areas in Surabaya. The colonial area studied covers the area below Rajawali Street to Indrapura Street. Around the area there are still many buildings with Dutch architectural styles although some buildings have shifted functions. The morphological development pattern of the South Krembangan area occurs continuously until now. Morphological development began since Indonesia was not yet independent until the 20th century. To analyze the morphological development of the area, certain years were chosen. Some of the years analyzed include 1892, 1925, 1943 and 2022. Table 1.2 shows that the development of buildings in the Colonial area is quite rapid and has filled most of the area.





Year	1892	1925	1943	2022
Building Development				

Table 1.2 Morphological Development of Krembangan Selatan Sub-district
 Analysis, 2023

In addition, the study area is also dominated by educational facilities, religious facilities and service providers. Most of the area is dominated by settlements due to the growing population. There are small roads that connect between blocks to facilitate user mobility. The level of population intensity is influenced by the activities carried out by residents in an area. Improving intensity and density can help improve the quality of the area so that the density in the colonial area as a historic area can be balanced. Considering the above issues, this research will discuss the intensity and density of the population that affects the typology of buildings in the Colonial area. The density of population and buildings causes the emergence of new standards for residents to adapt their housing conditions to cultural needs (Remali, Salama, Wiedmann, & Ibrahim, 2016) . Indirectly it will affect the typology of the building. This research is considered necessary to find out the development of the Colonial area in Surabaya over the past few years will remain a densely populated residential area or develop into a commercial area like the old city of Semarang which is dominated by service provider buildings and know the buildings that become the identity of the area to be preserved because it has a history since the 17th-18th centuries.(Udjianto Pawitro, 2015)

2. Methods

The research method carried out is a qualitative descriptive method where five steps are taken. The first step is to determine the research location. The selected location is the northern part of Surabaya city. South Krembangan sub-district was chosen because it is a colonial area that still maintains historical buildings. The second step determined the boundaries of the study area. The boundaries of the study area are rajawali road in the north, kalimas river in the east, Indrapura road in the west and Kebon Rojo road in the south. The boundaries were chosen to focus on areas that are densely populated and located in historic areas. The third step is to examine the effect of urban density and intensity, then the step taken is to determine the land that can be used with the aim of making the land boundary of the observed area for residential, commercial, industrial, local parks, and open spaces, streets. The fourth step is to identify special areas, which aims to group special areas and label them to determine their function because special areas are not included in the intensity calculation. The fifth step is to identify urban types to identify areas that look homogeneous to map urban intensity. Identifying urban intensity with color codes from the highest intensity to the lowest intensity. Diagram 2.1 shows the research process from selecting the location to identifying the link between population density and urban intensity with building typology.

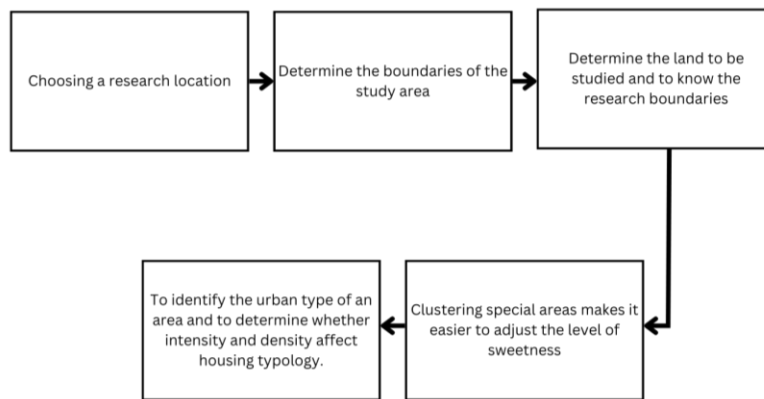


Diagram 2.1 . Chart of Research Methods Analysis, 2023

3. Discussion

The South Krembangan area is bordered by other urban villages. In the north, it borders North Krembangan Village, in the east it borders Bongkaran Village, in the south it borders Bubutan Village, and in the west it borders Kemayoran Village. (“Kel. Krembangan Selatan | Bagian Pemerintahan Dan Kesra,” n.d.) In the study area, a land use map is needed which can be seen in Figure 3.1 which aims to determine the dominant building functions in the area. As for Figure 3.2 , it can be seen that the functions of educational buildings, settlements, government offices, worship buildings and cultural heritage, with different layers according to the function of the building, it will make it easier to analysed the location of settlements and commercial locations.



Figure 3.1 . Land Use Map of South Krembangan Area

Source : <https://petaperuntukan-dprkpp.surabaya.go.id/>(“Peta RDTR Surabaya” n.d.)





Figure 3.2 . Land Use Map of South Krembangan Area

Source : <https://petaperuntukan-dprkpp.surabaya.go.id/> ("Peta RDTR Surabaya" n.d.)

Over time there are several disturbances that can change the existing condition of the area, therefore, resilience must be carried out which means the ability of an element to maintain a stable state when a disturbance occurs, and to return to the same stable state after the disturbance ends. (Romice, Porta, & Feliciotti, 2020) . Resilience is a must-have for every city so that in the event of significant events, there is the ability to return to a stable state.

3.1. Building Typology

Densely populated colonial areas have diverse building types. Urbanism is a theory that applies various principles, such as the investigation of the most fundamental things, rules for composing an architectural composition, and production tools to establish new benchmarks in the application of the most fundamental concepts in a building, to explain the science of type and typology in the urban context (Zahra & Antaryama, 2020) . While the typology is the study of types by categorizing and classifying them to produce types. From these categories and types, diversity and uniformity can be seen. The typology discussed in this study is the typology of style. Genre typology is the categorization of buildings in terms of their character and typical architectural forms. (Daryanto, 2016). Buildings in the lower colonial area are dominated by residential areas with a height of 1-2 floors as can be seen in Figure 3.3, while public buildings have a larger scale reaching 5 floors. The basic shape of the building is dominated by square and rectangular shapes. The typology of residential houses in the colonial area still maintains the architectural style of 1900.



Figure 3.3 . Map of Land Use in South Krembangan Area and modern architectural style, transitional architectural style, indistinct architectural style, indistinct architectural style in south kerembangan area (clockwise)
Google Street View, 2023

Building functions in the study area include service provider buildings, education, religion, residential, government, and lodging. Figure 3.4 shows the facades of public buildings around Rajawali Street which is the main street of the colonial area and there are

many public buildings that still retain their original facades.



Figure 3.4 Building Facades Around Rajawali Street
Google Street View, 2023

Based on the literature study, there are 3 typologies of Colonial Area Buildings. The first typology is the Indische Empire style of architecture (18-19th century), according to Handinoto. (Sholih, Sardjono, & Harsritanto, 2021). The Indis style of architecture existed until 1890. Some of the characteristics that indicate a building with an Indis architectural style are that the arrangement of rooms has a full symmetry plan, the main room has a direct connection with the front porch and back porch, has a front garden and back garden, and has a front porch with a large size and a row of Roman-style columns. Figure 3.5 shows examples of building styles that have architectural styles before the transition and during the transition.



Figure 3.5 Building Typology Before Transition 1840-1890 and During Transition 1890-1915 (left to right)
Google Street View, 2023

The second typology is the Transitional Architectural Style (1890-1915), where the Transitional Architectural Style was quite short from 1890-1915 Handinoto (Sholih et al., 2021) stated that some of the characteristics that show buildings with Transitional architectural styles are having a front porch and back porch, having a pavilion next to the house, not using pillars in the Roman style, and using additional ventilation on the roof called a dormer. The third typology is the Modern Colonial Architectural Style (1915-1940), as we know the Modern Colonial Architectural Style existed until 1940. According to Handinoto (Sholih et al., 2021) Some characteristics that show buildings with a Modern architectural style are using a "Clean Design" building appearance, the use of terraces is reduced using concrete as the main construction and walls only as a partial cover of the roof using concrete deck. Figure 3.6 shows buildings that have different construction times.

1915-1980



1980-2022



Figure 3.6 a . Building Typology After the Transition Period; b. Building Typology After the Transition Period
Google Street View, 2023

The study of urban evolution is a theme introduced by the British School of Urban Morphology. The study aims to demonstrate the relationship between cultural assets and the territories they inhabit by tracing and mapping the morphological periods of urban development. (Marques de Sousa Safe & De Alvarenga Pereira Costa, 2016)

3.2. Density of Population

Population density in an area can be influenced by many things. The definition of population density is the ratio of buildings or uses to the units of physical space they occupy. In other words, the number of people or units (such as housing units or businesses) in a given area, which is usually measured in terms of people per hectare or units per hectare. (Romice et al., 2020) To find out the development of population density, calculations were made using data from 2019-2021. In Table 3.1, the calculation is done by converting the area unit into HA and then divide the total population by the area. To find out whether the population density falls into the high or low category, it can be seen in Table 3.2.

Year	Area	Total Population	Population Density
2019	84	15.619	186
2020	84	14.373	171
2021	84	14.313	174

Table 3.1. Population density development in 2019-2021 (presented from Krembangan in figures 2020, 2020; Krembangan in figures 2021, 2021; Krembangan in figures 2022, 2022)

Area Classification	Kepadatan			
	Low	Medium	High	Very Dense
Population Density	< 150 people/ha	151 - 200 people/ha	201 - 400 people/ha	> 400 people/ha
Reduction of land requirement	-	-	15% (Maximum)	30% (Maximum)

Table 3.2 . Classification of Population Density
SNI03-1733-2004

The population density in the South Krembangan sub-district is medium. This is the result of a calculation of 174. Density is caused by the increasing number of population growth. The highest population density is in the yellow area which consists of residential areas. Lots in the Krembangan area are crowded with settlements, service provider buildings, inns, and government offices. The population density affects the typology of the buildings which causes the buildings in the colonial area to be clustered together. The building style has also changed due to new functions that have emerged over time. The increasing population density causes the colonial area to be dominated by residential areas so that cultural heritage in the area gradually becomes a minority and its presence is not prominent because the area is not well developed so that some colonial heritage buildings begin to be damaged and empty. If this situation is allowed, the element will experience extinction and can affect the identity of the area. The influence of density on building typology means that there is no more distance between buildings as shown in Figure 3.7 and some residences increase the building area by increasing the number of floors. The transitional architectural style that has a front yard is starting to disappear due to limited land so that residents put plants on the 2nd floor of their houses.



Figure 3.7 . Modern building typology
Google street view, 2023

Kota	2019	2020	2021	2022
Semarang	4,854	4,425	4,431	4,441
Surabaya	8,707	8,795	8,612	8,633

Table 3.3 Comparison of population density of Surabaya and Semarang
Source : BPS Surabaya and BPS Semarang
(“Dinas Penataan Ruang Kota Semarang” n.d.)

The population density in the North Semarang sub-district as shown in Figure 3.8 is high because when converted to people/hectare it reaches 1,018,671. The South Krembangan area in Surabaya is much denser. This can be seen from the different functions of the area and the different urban layers. Semarang's Old Town retains cultural heritage buildings and makes persistent elements to maintain the city's identity. Density in the Old Town area does not affect the typology of the building because the function of the building is public so that the population in the area is not permanent so there is a possibility that the building and urban tissue of the area can be maintained.

3.3. Urban Intensity

Intensity is when uses include both residential and non-residential activities and spatial units include all urban spaces, both public and private, enclosed and open, the comparison reveals specific indicators. Intensity has a major role in the evolution of urban form (Romice et al., 2020). One way to calculate the urban intensity of an area is to multiply the building area by the height (number of floors (3m)), and divide the resulting total building volume by a

constant 300. (Romice et al., 2020). The calculation is done by dividing the building typology into several groups as listed in table 3.3. The grouping is divided into 5 with different time spans.

Year	Building Area	Building Height	Coefficient	Urban Intensity
1840 - 1890	6.389	8	300	170,4
1890-1915	40.357	4		1935
	11.378	6		
	6.340	8		
	1915-1960	18.072		
12.784	4			
3.419	8			
1960-1980	5.628	3		3.220
	14.242	4		
	71.598	6		
	2.211	9		
	5.288	12		
	13.894	14		
	1.580	20		
1980-2000	79.968	3		1.919
	27.172	4		
	22.194	5		
	19.393	6		
2000-2022	136.426	4		1.819

Table 3.3 Calculation of Urban Intensity in South Krembangan Area
Analysis, 2023

In the 1960-1980 period, settlements began to be built, causing the intensity numbers to spike as shown in table 10 and the population density in an area to become too dense and not in accordance with existing regulations. Referring to Romice, Porta, & Feliciotti regarding intensity, the classification of low and high groups is not stated. Based on the analysis seen in Figure 13, the division into 3 groups is carried out: First, a group that tends to be low has an intensity below 1000 (pink), Second is a group that tends to be dominant has an intensity of 1000-3000 (yellow) and the 3rd is a group that tends to be high has an intensity above 3000 (blue). The calculation of intensity is based on the typology of buildings built with different time spans. Analysis with the Urban Fringe Belts of Alan Wick in Figure 3.10 is carried out by analyzing the typology of buildings in an area according to the year they were built and making a map to find out the location of the buildings.

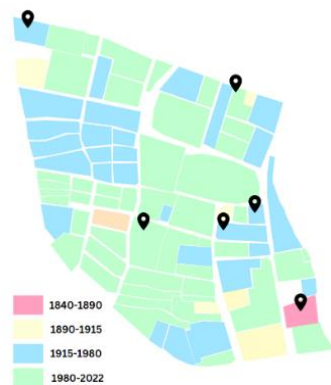


Figure 3.9 . Grouping of Buildings Based on Style Analysis,2023

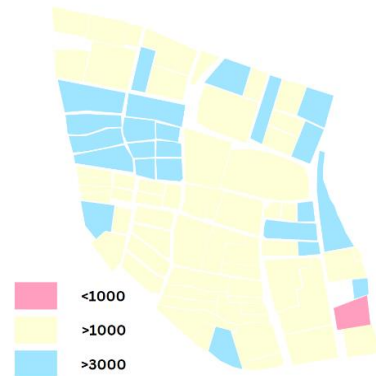


Figure 3.10 Colonial Area Urban Intensity Map Analysis,2023

3.4. Comparison of Areas

A comparison was made between the old city area of Semarang, which is dominated by colonial heritage, and the southern Krembangan area, which is included in the Dutch colonial area, which can be seen in Figure 3.11. Both areas were influenced by the Dutch, but the development that occurred had significant differences. The southern Krembangan urban tissue has changed from a historical and trading area to a high-density residential area, an educational area and is dominated by service providers and trade.

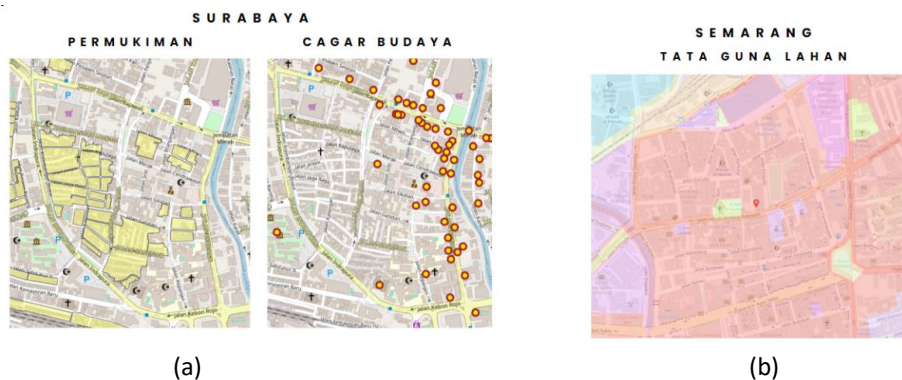


Figure 3.11 a.Map of High Density and Location of Cultural Heritage in Colonial Area (left to right)

Source : <https://petaperuntukan-dprkpp.surabaya.go.id> ("Peta RDTR Surabaya" n.d.) dan

b. Land Use Map of Semarang Old Culture City

Source : Onemap Semarang,2023("Dinas Penataan Ruang Kota Semarang" n.d.)

Semarang's Old Town maintains its urban tissue as a historic area dominated by public buildings. Semarang's Old Town was neglected but the government is trying to restore the area as a historic area with a touch of colonial architecture by revitalizing it since 2014. Unlike Surabaya, which was used as a residential area from the beginning, causing the urban tissue of the historic area to be lost.

Semarang's urban layer cannot be applied to Surabaya due to differences in activities, density, functions and city structure. In addition, Surabaya has a more complex urban layer when compared to Semarang due to the many changes that have occurred.

4. Conclusion

Building density affects the typology of each building. This encourages changes to the building facade and causes changes to the building typology. The building typology in the colonial area is dominated by 2-storey buildings and has a basic square and rectangular shape. The architectural style before the transition period can still be seen from some elements that still exist in buildings such as the use of curved elements and buildings without tritisan. One of the things that influence building typology is urban intensity. The intensity in the Colonial area is quite diverse, divided into 3 groups, namely groups that tend to be low, tend to be dominant and tend to be high. Areas that are included in the high group are densely populated residential areas that affect the calculation of intensity because the buildings are built close together without distance. The density in the South Krembangan area is very dense because most of the area is used as a residential area so that the results obtained are 1,373,000 people/hectare and including very dense based on SNI standards and when compared to the Old Town Semarang area which has similarities because both are affected by colonial population density figures reach 1,018,671 people/hectare. This shows that the character of South Krembangan and Kota Tua Semarang are different. Semarang's Old Town is a historic area and devoted to tourism in contrast to Surabaya where cultural heritage buildings are a minority and dominated by residential buildings and service providers. Intensity and density affect building typology. Due to the increasing density, there are several buildings that build upwards due to limited land. This affects building typology and changes in height will increase building intensity because the calculation of building height is also taken into account. The building typology of the transition era that used to have a front porch and back porch is no longer due to the increasing density so that more and more built-up area is needed. The building typology has developed and changed due to the influence of intensity and density that continues to move. Some pre-1900s building styles still survive and are mostly located in dense residential areas. The character of the South Krembangan Colonial Area has a different morphological development from that of Semarang's Old Town Area due to its higher density. In addition, the old city area of Semarang can be a historic and tourism area because the colonial heritage buildings are still maintained and revitalized in contrast to the South Krembangan area where cultural heritage buildings are a minority. Through the research conducted, it can be utilized for making a master plan for the area in the future.

Suggestions that can be made for the development of the South Krembangan area for the Surabaya City Government to develop the city based on the needs of user activities, add green open areas to support the needs of users and provide a balance between built-up areas and green open areas, maintain elements that are still persistent in the Colonial area so that the identity and characteristics of the city are not lost, and examine more deeply the population density data more specifically so that research related to population density in the colonial area can be more accurate.

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