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Residents' Perceptions of Passive Design Responding to Climate Change in Simple Houses in Depok, West Java, Indonesia

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Abstract

Since the last few years, environmental issues related to global warming and increasing earth surface temperatures have had an influence on various fields. This environmental issue also affects the micro and macro climate. Architecturally, design can respond to changes in microclimate with passive design and active design. Passive design has long been applied to vernacular architecture, namely responding to local conditions in buildings. Meanwhile, active design is related to the latest technology and developments, such as energy-saving technology, as well as the use of natural elements as energy sources. This research uses quantitative methods. Primary data was collected using a questionnaire to determine the tendency of residents' perceptions of passive design. The analysis of this research is descriptive statistics, based on the answers of 35 respondents who live in simple houses in Depok, West Java, Indonesia. The research results showed that respondents' tendency towards passive design was shown in several things, namely: additional elements of the building at the front (canopy) can reduce heat and create shadow areas, the location and size of openings can support natural lighting and ventilation. Openings can be doors, windows, grilles, rosters and other elements. The existence of open space at the front and back of the house can reduce heat and cool the microclimate.

Keywords: climate action, environmental issues, architecture, simple houses, passive design

Introduction

Climate change is a global problem and solutions are still being sought. The beginning of this problem was the increase in earth's surface temperature which was directly or indirectly related to human activities. Evidence of global warming includes the melting of eternal ice, climate change and increasing earth surface temperatures.

Greenhouse gas emissions produced by humans are the main cause of warming that occurred in the second half of the 20th century. In 2007, the IPCC Fourth Assessment Report stated that more than 99% of human-produced emissions caused climate change in modern times. (Anonymous, 2009). In a global movement, namely the Sustainable Development Goals to end poverty, reduce inequality and protect the environment, it is planned with 17 goals which are expected to be achieved by 2030. One of the goals of the Sustainable Development Goals (SDGs) is Addressing Climate Change, namely taking immediate action to combat climate change and impact. (https://www.sdg2030indonesia.org/)

This global problem requires attention and handling from all parties, including society at large. The context in the field of architecture, there are many concepts related to sustainability that are linked to climate, such as bioclimatic concepts, green architecture, zero carbon, passive solar, passive design and several other concepts that attempt to respond to climate problems from an architectural perspective. Handling Climate Change which is the 13th goal, namely Taking immediate action to combat climate change and its impacts. The targets of these objectives are: (1) Strengthening resilience and adaptive capacity to the dangers of things related to climate and natural disasters in all countries; (2) Integrating climate change measures into national policies, strategies and planning; (3) Improving education, awareness and capacity of both humans and institutions regarding climate change mitigation, adaptation, impact reduction and early warning.

Based on these targets and objectives, it is important for the community to participate at the micro level, namely in their homes. Building design can be divided into two, namely passive design and active design. Passive design is an architectural design that responds to the local climate with the shapes, materials and elements that make up the building and its environment. Meanwhile, active design is a design that uses the latest technology for efficiency and energy savings.

Based on the Koppen climate division, Indonesia is included in Climate A, namely the Tropical Climate. One of the characteristics of areas that are in a tropical climate or close to the equator is that they have two seasons, namely rainy and dry. Normally, the rainy and dry seasons have the same time span. However, the reality is that due to climate change, there are also changes in the dry and rainy seasons in tropical regions. Karyono explained that climate change occurs at macro and micro levels. Macro climate change is related to global warming and is felt worldwide. Meanwhile, microclimate changes are related to the local climate, they can be related to humid tropical areas or related to reduced vegetation in the environment, thereby increasing local temperatures. (Karyono, 2016). This research aims to obtain an overview of residents' perceptions of passive design in their residences as a response to climate change. The research population was residents of simple houses in Depok City, West Java, Indonesia. Depok City is part of West Java Province, but borders DKI Jakarta. Climate changes and hot temperatures are also felt by the residents of these simple houses. Even in the 2023 dry season there will be heat and drought in DKI Jakarta area which also extends to Depok, West Java.

Methods

This research uses quantitative methods, which are based on the positivism-deductive paradigm. Bungin (2021) explains that the deductive model will direct researchers to conduct a literature review first as a basis for developing research problems, objectives and hypotheses. Research problems and hypotheses will direct researchers to develop conceptualizations, variables and operational definitions of research. This section will be tested in the field with data.

Identification of variables in this research was obtained from studying various literature from previous research. There are four passive design variables, namely: building orientation, shading, natural air ventilation and space configuration. Each variable is then described in questionnaire questions, with a total of 18 questions. This research uses the Likert scale as a psychometric scale used in questionnaires and is a technique that can be used in evaluating a program or planning policy. The measurement scale in preparing the research questionnaire uses a Likert scale of 1—6 alternative answers to measure respondents' perceptions. Scale 1 for disagree statement to scale 6 for agree statement.

Sugiyono (2018) explains that in quantitative research population is a generalization area consisting of objects/subjects that have certain qualities and characteristics determined by the researcher to be studied and conclusions drawn. Meanwhile, according to Kuncoro, population is a complete group of elements, which are usually in the form of people, objects, transactions, or events that we are interested in studying or making research objects (Kuncoro, 2009). The population of this study were residents of simple houses in Depok, West Java, Indonesia. A sample is a portion of all subjects, objects, variables, concepts, or phenomena in the population studied. This sample was selected using certain procedures and is able to representatively represent the population. (Ashadi, 2018). The samples used in this research were 35 samples.

The data used in this research consists of primary data. Primary data is data obtained directly from respondents, through questionnaires. Primary data collection was obtained directly from the first informant. The distribution of questionnaires was carried out in stages and one by one within certain deadlines to predetermined respondents. The technique for taking or determining samples is by combining purposive sampling and snowball sampling, namely the sampling technique by first determining several respondents with purposive sampling, namely respondents who fall within the scope of the research population, then continuing with snowball sampling by asking for recommendations from each initial respondent. selected based on purposive sampling. The meaning of purposive sampling itself is that the researcher selects a sample based on an assessment of several characteristics of the sample members which are adjusted to the research objectives (Kuncoro, 2009) and snowball sampling is that the initial respondent is selected then subsequent respondents are obtained from the information provided by the first respondent.

Data analysis is a method used to process data. Data processing tools consist of various types, but what researchers use as an intermediary to achieve the objectives of this research is descriptive analysis. Descriptive statistical analysis in this research aims to get an idea of residents' perceptions of passive design to respond to climate change.

Tabel 1. Indicator Table

No	Variable	Code	Indicator	Operational Definition
1	Building Orientation	P1	The direction the house faces can reduce solar heat entering the house	Perception The direction the house faces can reduce solar heat entering the house well

No	Variable	Code	Indicator	Operational Definition
		P2	The direction the house faces can maximize light/sky light entering the house	Perception of the direction facing the house can maximize light/sky light entering the house
		P3	The presence of a terrace	The perception that the presence of a terrace can reduce solar heat entering the house well
		P4	Exterior wall colour	The perception of the colour of the walls of the house can cool the spaces in the house
		P5	The direction the house faces responds to the climate	Perception of the direction of the house and the surrounding elements (terrace, doors, windows, canopy, materials) can respond well to the climate
2	Canopy and Shading	P6	Canopies can reduce solar heat entering the house	The perception of a canopy can reduce solar heat entering the house
		P7	The canopy can create a shadow area	The perception of the canopy can create a shadow area in the house
		P8	The canopy can cool the temperature	The perception of a canopy can cool the temperature inside the house

No	Variable	Code	Indicator	Operational Definition
		P9	Doors and windows are good for reducing heat intensity into the house	Sepsi doors and windows are good for reducing the intensity of heat entering the house
		P10	Doors and windows are good for letting in light	The perception of doors and windows is good for letting light into the house so that during the day there is no need to turn on the lights in rooms with windows
3	Natural Air Ventilation	P11	The house design uses natural air	Perception of house design using natural air throughout the day well
		P12	House design using AC	Perception of house design using AC at night
		P13	Air flow in the house	The perception of air flow in the house can be felt properly according to the occupants' activities
		P14	Doors, windows, roof panels and other openings can circulate air	The perception is that doors, windows, roof panels and other openings can circulate air well
4	Space Configuration	P15	The existence of a yard can respond well to climate change	The existence of a yard can respond well to climate change

No	Variable	Code	Indicator	Operational Definition
		P16	The yard in front can reduce the heat from the sun entering the house well	The yard in front can reduce the heat from the sun entering the house well
		P17	The yard is used as a catchment area and to plant good vegetation	The yard is used as a catchment area and to plant good vegetation
		P18	The yard is used for parking and is paved	The yard is used for parking and is paved (cement, paving, etc.)

Results and Discussion

Climate Classification

The location of this research is located in Indonesia, which is located around the equator. In general, it is known that areas around the equator will have a tropical climate, with the characteristic of having two seasons of almost the same length. However, it can be observed that the intelligence of previous generations that was manifested in traditional architecture took different forms. The tropical climate around the equator apparently has other specific characteristics.

The climate classification that is widely used in the world is the Koppen climate classification. This system was developed by Wladimir Koppen, a German climatologist in 1884, continued in 1918 and 1936. This classification system is based on the concept that plants are the best expression of climate. This system combines monthly and annual-seasonal average temperature and humidity. In its development, Rudolf Geiger collaborated with Koppen so that this classification is also known as Koppen – Geiger. This classification divides climate into five groups, namely group A tropical climate, group B dry climate, group C temperate climate, group D continental climate, and group E polar climate. (Kindangen, 2017)

Based on Koppen's climate classification, Indonesia is in the Tropical Climate group. The tropical climate is characterized by an average temperature of 18 degrees Celsius. Tropical climate (A) is divided into tropical rainforest (Af), tropical monsoon climate (Am), and tropical savanna climate (Aw). (Princess, 2022). A tropical rainforest (Af) climate is characterized by monthly rainfall of no less than 60 mm (2.4 in) in any month. Tropical Monsoon (Am) climate, characterized by rainfall in the driest month of less than 60 mm (2.4 in) but exceeding 4% of annual rainfall. Meanwhile, the tropical savanna climate (Aw) is characterized by rainfall in the driest month of less than 60 mm (2.4 in) and less than 4% of annual rainfall. (https://p2k.stekom.ac.id/ensiklopedia/Klasifikasi_iklim_K%C3%B6ppen)

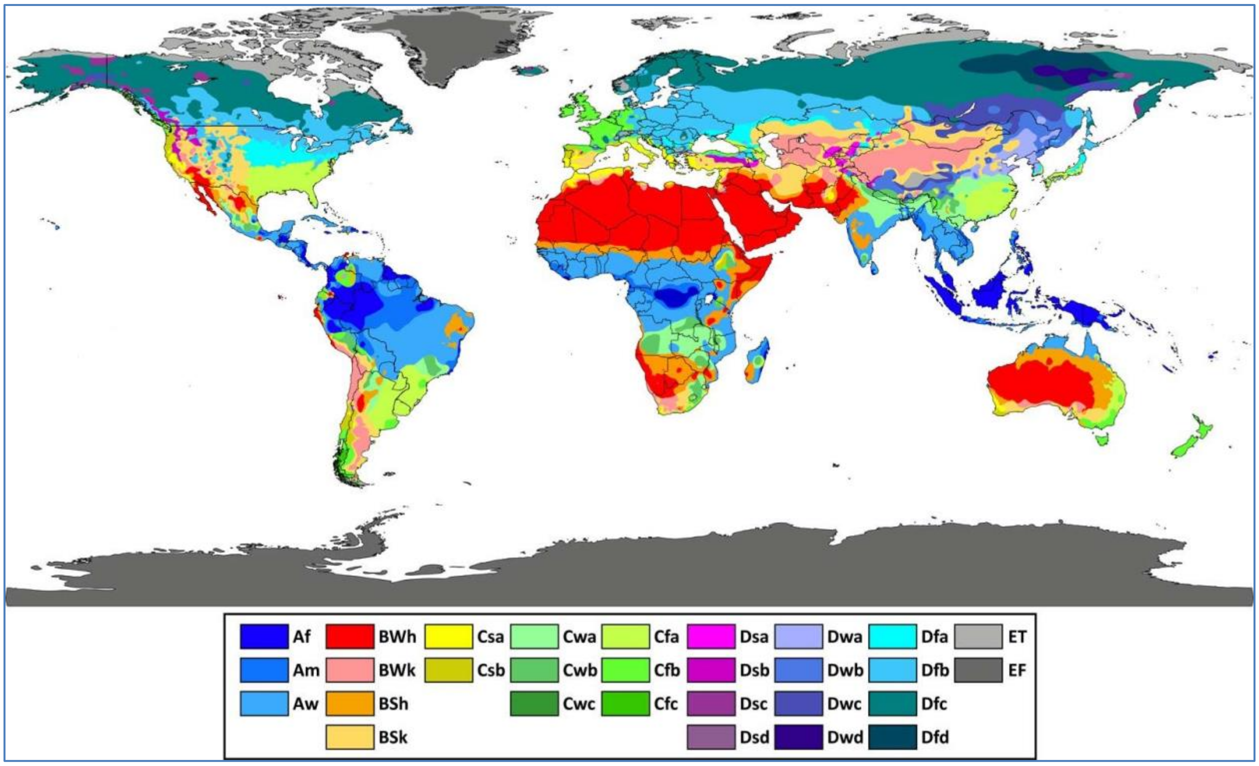


Figure 1. Koppen climate classification

(Source: https://geohepi.hepidev.com/2020/12/14/klasifikasi-tipe-iklim-dan-pola-iklim-global/)

Adaptation of Buildings to Tropical Climates

In the beginning, architecture emerged from humans' efforts to protect themselves from local climate and environmental pressures. That's why several concepts emerged, such as bioclimatic, natural and green architecture. As well as several other concepts related to climate. Architecture is also an embodiment of the harmonization of human work with nature and other considerations such as cosmology. For example, traditional and vernacular architecture in Indonesia. In its development, contemporary architecture seeks to translate and develop local wisdom to achieve comfort in space. Indonesia, which is located in a humid tropical climate in particular, has its own architectural characteristics. The most easily observed response of a building to climate is the presence of wide openings and wide eaves. Wide openings in buildings are the main feature that is easy to observe. These openings are elements that can be used to provide comfort to the occupants. (Kindangen, 2017)

Architecture is a human creation that is related to climate. For example, buildings in tropical climates will have different characteristics from buildings in sub-tropical climates. If we examine it further, humans in their creativity are inspired by nature. Nature provides an example of how animal nests in tropical areas are different from other areas, as are the types of animals that inhabit these areas.

Kindangen also stated that humid tropical climate areas are areas located in the tropics. This climate consists of two climate zones, namely humid areas and dry areas with a diversion zone. In humid tropical climates, the roof is a vital part of preventing direct heat. The slope of the roof is also an important part because it is useful for channeling rainwater. The room is open which allows for smooth flow of wind and ventilation. Meanwhile, in areas that have high humidity due to high rainfall, it will respond by forming stilts or providing distance between the floor surface and the damp ground. (Kindangen, 2017)

Building designs in tropical climates strive to remove some of the heat generated from environmental air temperature and the intensity of solar radiation. Natural methods that can be used to cool buildings are by minimizing solar radiation, determining the correct building orientation, providing sufficient distance from surrounding buildings, and using shading devices to control the entry of solar radiation into the building. Adaptation can also be done through building components such as roofs, walls, window openings and landscapes. The large roof area is also able to shade the surroundings of the building and protect the outer walls. Tropical roof adaptations include shading, reflection and insulation. (Nugroho, 2019)

The local climate of the research location is Depok, West Java, Indonesia. Throughout the year, temperatures usually vary from 22°C to 33°C and rarely below 20°C or above 34°C. The following is a general overview of the climate in Depok City in 1 year, showing the temperature, humidity and precipitation for each month. originating from https://id.weatherspark.com/

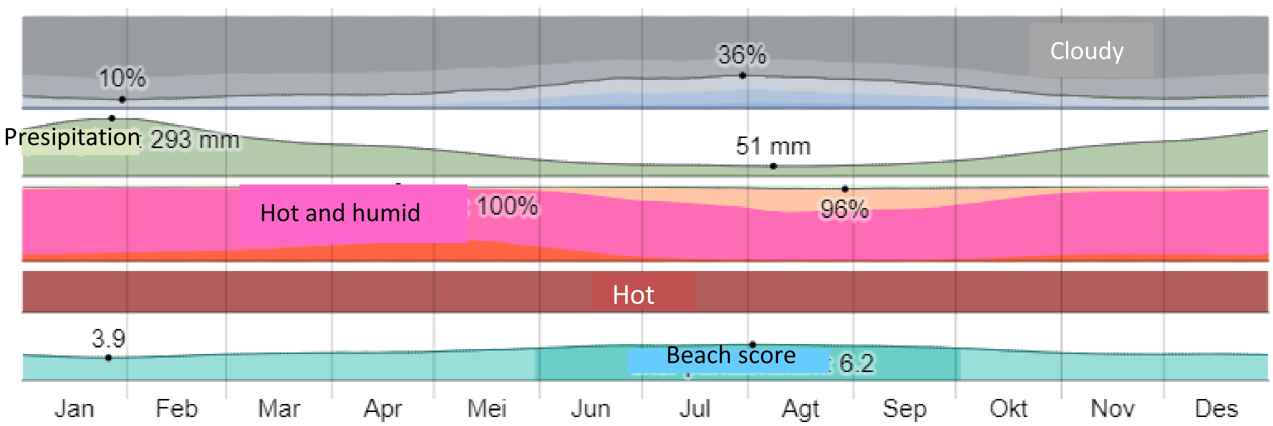


Figure 2. Climate image in Depok City, West Java, Indonesia

Source: https://id.weatherspark.com/

The hot temperatures lasted for 2.5 months, from 19 August to 3 November, with average daily high temperatures above 32°C. The hottest month of the year in Depok City is October, with an average low of 32°C and high of 23°C. The cold temperatures lasted for 1.9 months, from December 30 to February 25, with average daily highs below 30°C. The coldest month of the year in Depok City is January, with an average low of 23°C and high of 30°C. Highest (red line) and coldest (blue line) daily average temperatures, with 25th to 75th and 10th to 90th percentile bands. The thin dotted line is the average perceived temperature.

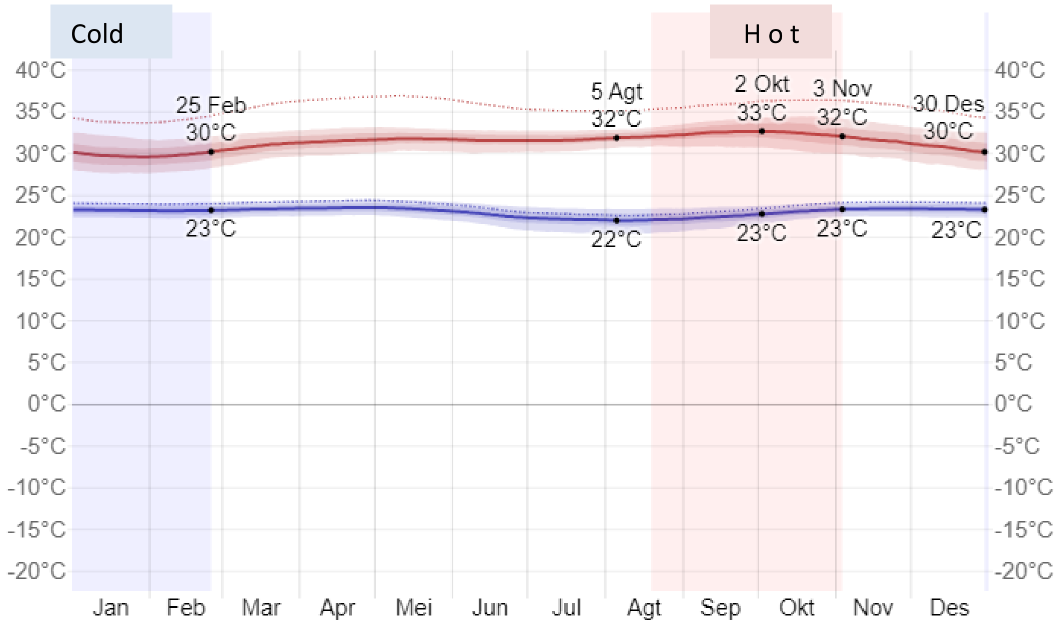


Figure 3. Image of the average temperature of Depok City, West Java, Indonesia

Source: https://id.weatherspark.com/

A wet day is a day with at least 1 millimeter of liquid precipitation or liquid equivalent. The chance of wet days in Depok City varies greatly throughout the year. The rainy season lasts 6.5 months, from October 23 to May 6, with more than a 46% chance of a day being a rainy day. The month with the wettest days in Depok City is January, with an average rainfall of 22.0 days with at least 1 millimeter. The dry season lasts 5.5 months, from May 6 to October 23. The month with the fewest wet days in Depok City is August, with an average of 6.0 days with at least 1 millimeter of rain.

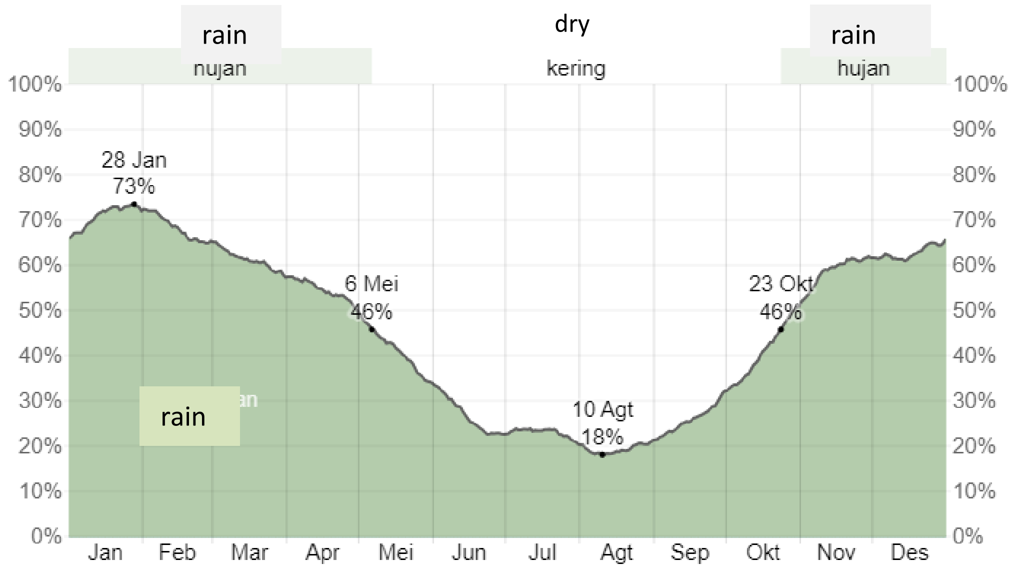


Figure 4. Precipitation in Depok City, West Java, Indonesia

Source: https://id.weatherspark.com/

Passive Design in Buildings

Buildings in humid tropical climates require designs with light and open construction. According to Lippsmeier (1994), light construction can be demonstrated with light traditional materials such as wood, tree trunk fronds, and so on. Modern materials can also be used and adapted to the local climate. In humid tropical climates, temperatures are generally low throughout the night, so the role of direct sunlight is very important for buildings. Nugroho (2018) explains that there are five characteristics of Indonesian tropical house traditions, namely:

1. Accuracy in choosing the position of the house on the site
2. Alignment of the building envelope in response to climatic conditions through the use of porous elements
3. Integration of spaces that shade each other
4. Togetherness of place and use of natural materials as time changes
5. Simplicity of knowledge in adapting to the environment.

Nugroho further explained that the location and position of the house has further consequences related to the influence of the orbit of the sun and wind. This will affect the design of the roof, window openings, building shading and other elements that protect the building against direct solar radiation. There are several terms for space that respond to the tropical climate, namely transitional space, insulated space and residential space. Transition space is a transition space from outside to inside the building. Insulation space, used to retain heat, especially at the top of the building. while residential space is space in a building. If conditions are hot, the transition room can be used for shade, so that the inside of the building becomes less hot. In residential areas, this transitional space can take the form of a terrace equipped with a canopy. (Nugroho, 2018).

According to Talarosha, Passive Design techniques are techniques for designing buildings without converting solar energy into electricity, but with efforts to bypass the building design. Several important variables in implementing passive design include: thermal comfort limits, sun orientation, air circulation, use of sun curtains, natural ventilation, building materials, building roofs, and vegetation. Meanwhile, according to Santoso, the ideal orientation for areas with a tropical climate is to maintain a long building axis from East to West. Do not orient the building from the long side towards North South. (Weni, 2020). Weni also explained that as a passive design, the slope of the roof angle in tropical climates is greater than 30 degrees, the roof is usually in the shape of Jurai, Saddle, Shield, Limasan, etc. The roof must have eaves to ward off rainwater, the typical roof eaves are from 70 cm to 90 cm.

In connection with environmental issues and global warming, it is known that energy savings can be realized through active design and passive design. Today's architecture can choose or combine these two design approaches in buildings. Meanwhile, traditional houses use passive designs, to answer climate problems. Active design is the design of architectural works with the latest technology aimed at efficient energy use. An example is the use of solar panels to utilize solar thermal energy. Meanwhile, passive design is an architectural design that minimizes energy in a way apply architectural designs that respond to local climate and land conditions, while still maximizing the comfort of building users. Passive design emphasizes the physical design of the building such as the facade design, the direction the building faces, the location and size of windows, the building ventilation system, and the layout of the space. (Anonymous, 2022)

It was further explained that there are four aspects of passive design to create an energy efficient home, namely:

1. Building Orientation. The orientation of the building or the direction the building faces plays an important role in the intensity of light and solar heat entering the house. Houses with a north and south orientation have less solar heat intensity compared to houses with an east and west orientation.
2. Canopy and shading. Shading techniques are used to regulate the angle of incidence of light and solar heat entering the room. For example, by placing a canopy over opening areas such as windows and doors, the intensity of the sun's heat entering the house can be reduced, so that the house can still get enough sunlight, but not too much. In this way the use of lights during the day can be reduced.
3. Natural Air Ventilation. Passive design ensures that buildings utilize natural air ventilation, by providing openings for air circulation. By applying the principle of cross ventilation to the house, the house feels cool without the need to use air conditioning.
4. Space Configuration. For example, by designing the inner courtyard of the house, lighting and air circulation in each room can be accommodated well. The inner courtyard can also

have a positive impact on the aesthetics of the house and the view from inside the house becomes more attractive. (Anonymous, 2022)

Discussion

Data collection in this study used a questionnaire, to determine occupants' perceptions of passive design. The questionnaire questions begin with 5 general questions in the form of short-open-answer questions. The core questions are 18 questions with a Likert scale of 1—6. Respondents consisted of 35 people, who were residents of simple houses in Depok, West Java, Indonesia. The gender of the respondents was 3 men and 32 women. The age range for filling out the questionnaire was 31—50 years with the largest distribution being 45—50 years with 15 respondents.

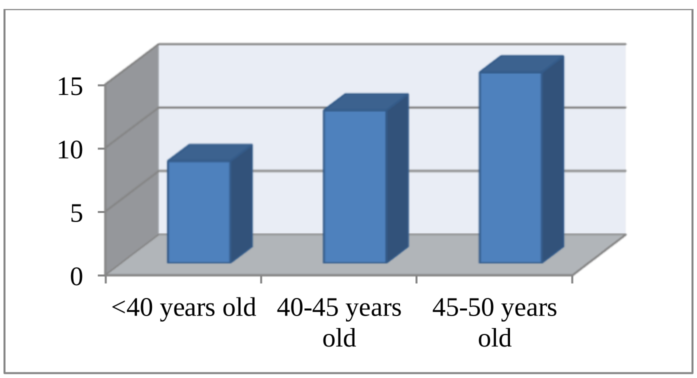


Figure 5. Respondent age range diagram

Respondents are residents of simple houses, with the original building area of the house being 36—45 m^2. Meanwhile, the minimum area of residential land occupied is 72 m^2 and the maximum is 140 m^2. A residence with a land area >100m^2 is a residence located on a hook. The original land area is in the range of 72—84 m^3. In the development of the occupancy process, the area of the house has increased. The minimum percentage of building area to land is 40%, namely with additional space at the back. Meanwhile, the majority was in the range of 40—59%, namely 14 respondents.

Table 2. Percentage of building area to residential land

Percentage of building area to residential land	Amount
80—100%	11
60—79%	6
40—59%	14
<40%	4

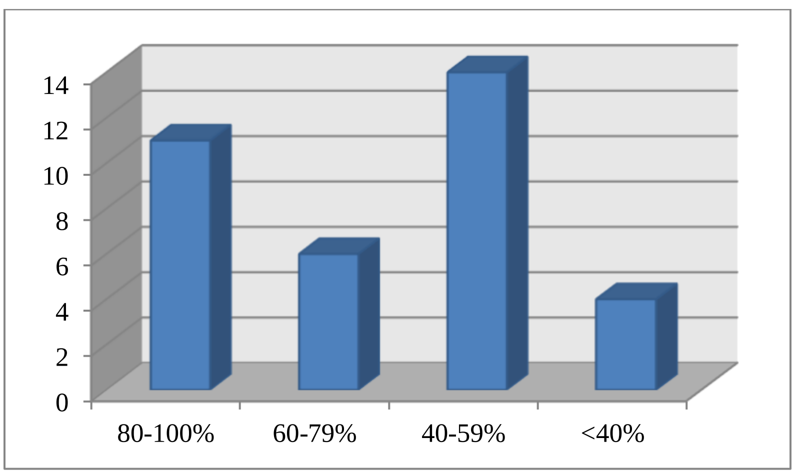


Figure 6. Percentage diagram of building area to residential land

Based on the answers from 35 respondents, it was found that 40% of the respondents' residences faced north, 29% of the respondents' residences faced east, 17% of the respondents' residences faced South, and 14% of the respondents' residences faced west. The direction the house faces is related to the building's response to the sun's path, where in general houses facing east and west will receive direct solar heat, while north and south will receive indirect solar heat.

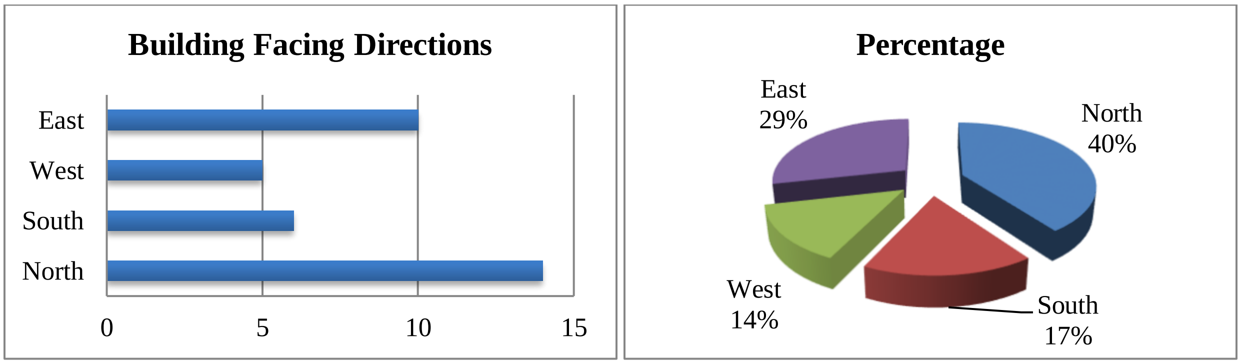


Figure 7. Diagram and percentage of building facing directions based on wind direction

The research respondents were residents of simple houses with initial types 36 and 45. So the original condition of the residence had 2—3 rooms, 1 living room, 1 family room-kitchen and bathroom. Based on the questionnaire, it was found that the majority of respondents' residences consisted of 5 rooms consisting of 2 bedrooms, 1 living room, 1 kitchen, 1 bathroom, which is in accordance with the original conditions of type 36 and type 45 houses.

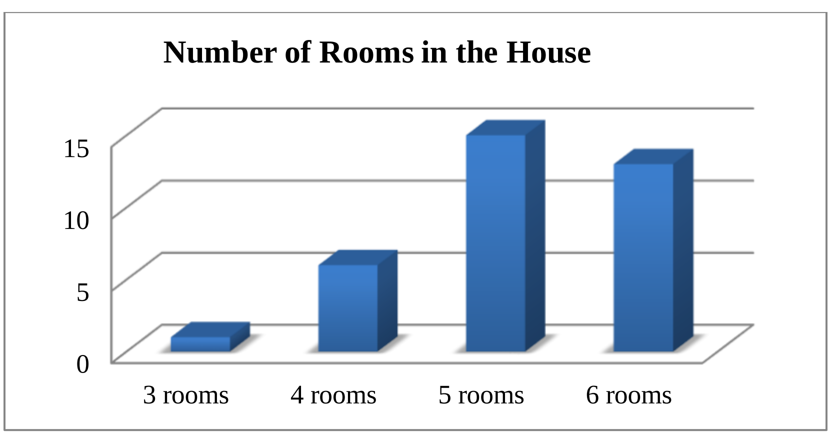
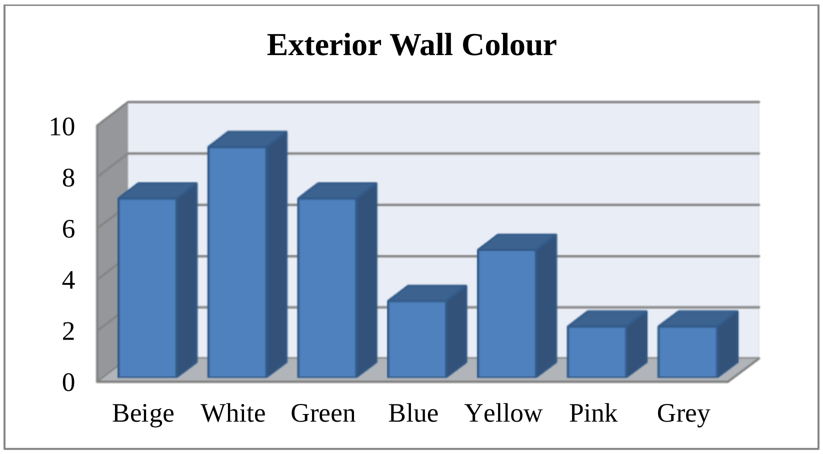


Figure 8. Diagram of the number of rooms in the house

Based on the questionnaire, it was found that 9 houses had white exterior walls, 7 houses each had cream and green exterior walls. Five houses have yellow outer walls. Three houses with blue exterior walls. Each of the two houses has pink and grey exterior walls.



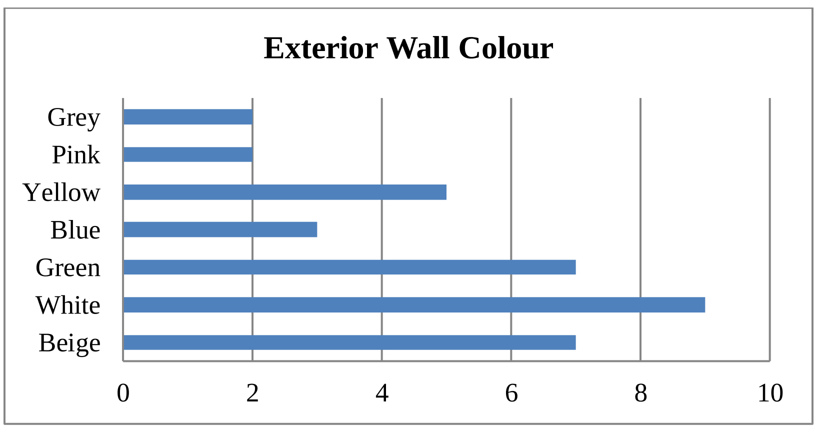


Figure 9. Colour diagram of building exterior walls

Passive design is translated into 4 variables, namely building orientation, canopy and shading, natural air ventilation and space configuration. The results of the questionnaire for 35 respondents obtained results as in the table below.

Table 3. Table of mean and standard deviation

No	Variable	Code	Mean	Standard Deviation
1	Building Orientation	P1	4.66	1.69
		P2	5.17	1.25
		P3	5.26	0.97
		P4	5.34	0.89
		P5	5.17	1.11
2	Canopy and Shading	P6	5.83	0.38
		P7	5.60	0.69
		P8	5.37	0.99
		P9	5.31	1.24
		P10	5.69	0.67
3	Natural Air Ventilation	P11	5.63	0.76
		P12	5.37	0.99
		P13	5.74	0.50
		P14	5.43	0.90
4	Space Configuration Building Orientation	P15	5.54	0.73
		P16	5.43	0.84
		P17	5.43	1.07
		P18	5.40	0.90
			5.40 (X)	0.92 (Y)

The questionnaire questions were made based on these 4 things, then a survey was conducted on the respondents, namely thirty-five residents of simple houses in Depok, West Java.

Respondents' answers then produce a distribution showing the residents' tendency towards passive design in their buildings/residences.

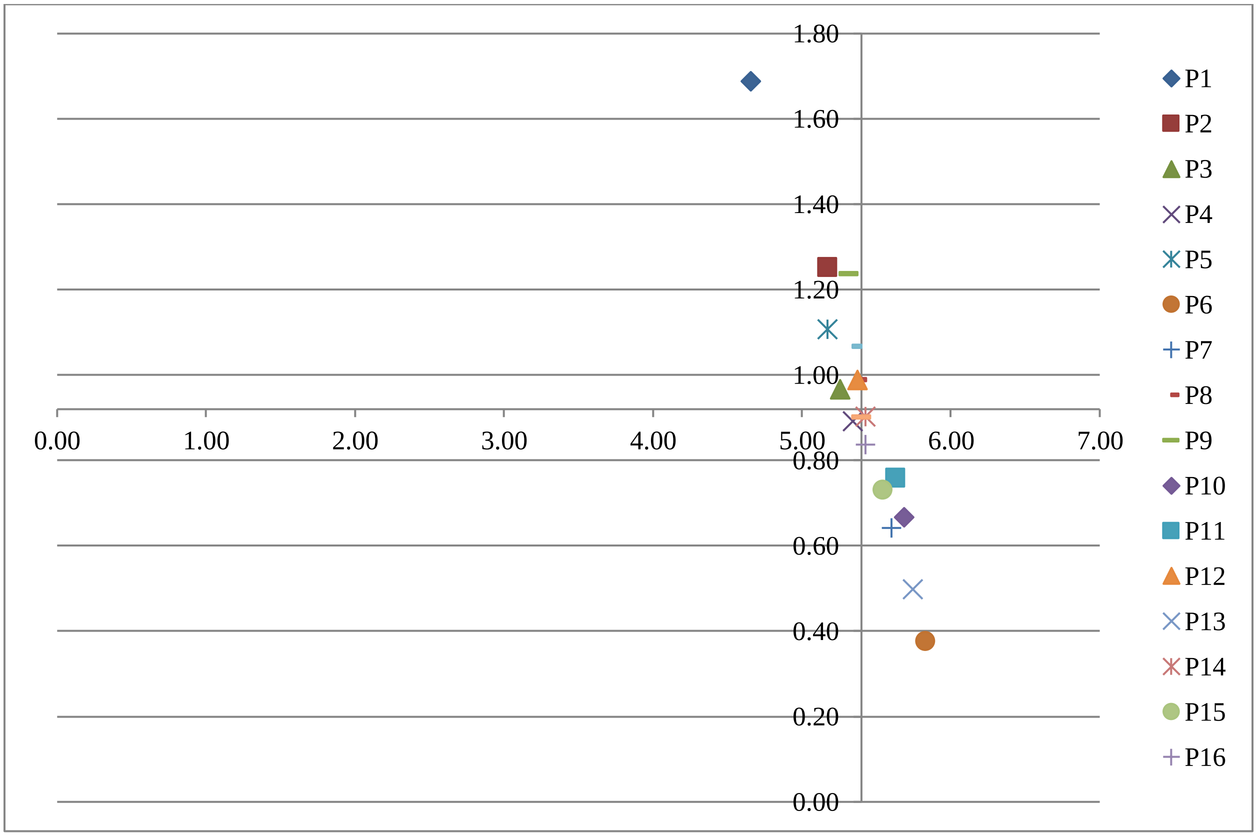


Figure 10. Distribution of Questionnaire Answers (Analysis, 2023)

Based on this distribution, it is known that respondents agree with the existence of passive designs in residences that can respond to climate change. This answer is proven by the positions P6, P7, P10, P11, P13, P15, P16 and P18 which are in quadrant IV (bottom right). Quadrant IV means that the average respondent's answer is very high with a low standard deviation (variety of answers). Therefore, it can be concluded that the codes in quadrant IV are indicators that are agreed upon by respondents. These indicators are displayed with the codes P6, P7, P10, P11, P13, P15, P16 and P18. The description of the code is shown in Table 4.

Table 4. Respondents' tendency towards passive design in residences

No	Code	Indicator
1	P6	Canopies can reduce solar heat entering the house
2	P7	Canopies can create shadow areas (areas that are not hot but not dark) in the house
3	P10	Doors and windows are good for letting light into the house so that during the day there is no need to turn on the lights in rooms with windows
4	P11	The house design makes good use of natural air throughout the day
5	P13	Doors, windows, rosters and other openings can circulate air well
6	P15	The existence of a yard can respond well to climate change
7	P16	The yard in front can reduce the heat from the sun entering the house well
8	P18	The yard is used for parking and is paved (cement, paving, etc.)

Source: Personal analysis (2023)

Codes P6, P7, P11 and P15 indicate passive design in simple houses to respond to climate change. Then codes P10, P13, P16 and P18 indicate passive design supporting building elements. Based on this analysis, it is known that respondents agree that passive design can respond to climate change in simple houses in humid tropical areas.

The results of descriptive statistical analysis P6 and P7 relate to residents' tendency that the canopy in front of the house can be used to reduce heat entering the house and create shadow areas. This is in accordance with Nugroho's opinion that shading sunlight through roof design can control the amount of radiation entering the space, reduce cooling loads, increase thermal comfort and the quality of natural lighting in the space. (Nugroho, 2019). Residents' perception of the existence of a canopy in front of the house is able to respond to local climate changes, because the canopy can reduce heat and create a shadow area. Apart from that, the area covered by a canopy can also be a transition space to reduce the heat temperature before entering the building. This perception tendency is related to the condition of simple houses, where the original designs of simple houses types 36 and 45 have open spaces at the front and back. In the majority of developments, the back room is closed because it is used for house extensions, while the front remains open. Simple houses type 36 and type 45 do not have open space on either side.

Statistical analysis P10, P11 and P13 relate to passive design tendencies related to natural cooling. This natural cooling is related to the direction of the wind and sun, so the placement of the openings will be an optimal passive design if placed in the right place. Apart from that, in tropical areas the design of openings is more varied, not only windows, grilles, rosters, but can also be in the form of porous walls. Openings on the east and west sides are openings that must be protected because on that side the heat is higher in that direction. Although in general every window should be protected or shaded on the outside of the wall. This opening is also related to cross ventilation which can circulate air crosswise in the room.

The tendency for respondents' answers to be related to pages can be seen in the analysis results in P15, P16 and P18. Respondents agreed that the yard around their house could be used to lower the temperature and respond to the microclimate. Apart from that, this yard can reduce heat, even though part of the yard is used for parking (paved) in the form of a carport. This tendency is also related to the conditions around the respondent's residence, which is in Depok, West Java, where there is still protection in the form of shady trees around the residence.

Conclusions

1. This research concluded that residents tend towards passive design to respond to climate change in simple houses in Depok City, West Java, Indonesia. Passive design in simple houses is applied with: (1) A canopy located at the front of a simple house, which is proven to reduce heat entering the house and create a shadow area. So the area under the canopy can become a transition space, to cool the temperature before entering the house; (2) Apart from the orientation of the building towards the sun, the direction of the wind is also an important factor. The placement and size of openings in a simple house can support natural lighting and ventilation. Openings can be doors, windows, grilles, rosters, blinds and other elements; (3) Landscaping or open space around the house can support microclimate changes. Having open space at the front and back of the house can reduce heat.
2. The results showing that the canopy can reduce heat entering the house and create shading areas are consistent with passive design principles. A well-designed canopy can reduce direct exposure to sunlight on the walls and windows of the house, thereby reducing the heat absorbed by the building. The shading effect is also important because it can reduce the temperature of the ground surface around the house, thereby helping to cool the surrounding environment.
3. The use of courtyards to respond to climate change, especially in reducing heat, shows good awareness of the potential of outdoor open space in influencing thermal comfort. A yard that functions as a green zone can absorb heat, provide a cooler environment and allow natural air circulation. This is an effective strategy to reduce heat absorbed by the ground surface and surrounding buildings.

4. Doors and windows designed to facilitate smooth air flow are an important aspect of passive design. Smooth air flow helps reduce heat accumulation in the room and increases fresh air circulation. This also contributes to cross ventilation, which can help remove moisture and reduce the risk of condensation inside the home.
5. Respondents have a good understanding of the principles of passive design and adaptation strategies to climate change in the context of simple houses. This can be a good basis for designing a house that is energy efficient and comfortable for its residents. Through understanding and implementing design strategies such as optimal canopies, courtyards, doors and windows, simple houses can become more efficient in reducing cooling loads and increasing comfort for their occupants.

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