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Evaluation of space comfort based on occupant satisfaction in west Jatinegara flats residential units

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ABSTRACT

The Special Capital Region (DKI) of Jakarta is an area that experiences population growth every year, which raises the number of housing-related needs and reduces the amount of available vacant land for housing. In order to get around the lack of land for housing, a plan for flats—like the West Jatinegara Flats—must be implemented. The spaces in an apartment that are designed by an architect are required to produce a design that takes into account the comfort factor of the space for the occupants or users in addition to aesthetics. Residents feel comfortable if they are at a thermal temperature of between 22.8 ℃-25.8 ℃ with humidity of 70%. The study, "Evaluation of Space Comfort based on Occupant Satisfaction in West Jatinegara Flats Residential Units," attempts to ascertain whether or not improving strategies are required to raise space comfort based on occupant satisfaction and whether or not an appropriate level of space comfort is achieved. This study employs the quantitative method, which entails gathering primary and secondary data and conducting interviews with at least 10% of the resident population selected at random. This study's results indicate that improvement strategies are required to improve room comfort. These strategies include organizing each room to make it cozier and more compact, considering the type of opening material, the opening area ratio, and the materials used for the glass and frame to prevent breakage and damage to the windows and handles. Every room in the residential unit needs to have optimal air exchange during strong wind conditions.

Introduction

The Special Capital Region (DKI) of Jakarta is one of the provinces in Indonesia whose population continues to increase every year (Ulinata 2021; Wulandari and Pasaribu 2023). So, with the increase in population, the demand for housing in the Special Capital Region (DKI) of Jakarta will also increase (Susilowati 2016). This has resulted in an increasingly limited amount of vacant land available in the Special Capital Region (DKI) of Jakarta (Jaya and Antara 2014). Therefore, a solution is needed to optimize empty land which is increasingly limited, namely by providing vertical housing such as flats so that residents can obtain comfortable and decent housing (Hendaryono 2010; Pramudito, Praptantya, and Nasir 2019; Sanjaya and Tobing 2019). A flat is a multi-storey building that functions as a residence that has elements of individual or joint ownership (Rubiati 2023). A flat consists of several rooms including a multi-purpose room and a residential unit measuring around 18 m^2-54 m^2 which contains a bedroom,

drying room, kitchen and bathroom (Adisurya 2016).

Space is an object consisting of length, width and height consisting of points, lines and planes, if in an architectural context it can be described in the form of floors, walls and roofs (Paryoko, Rachmawati, and Soemardiono 2015). The spaces in an apartment are generally designed by an architect and the architect is obliged to produce a design that not only considers aesthetic or beauty factors but also considers comfort factors for the occupants or users (Suwandi and Nur'aini 2021). Comfort is a feeling of comfort that arises from physical and psychological comfort that comes from a person's assessment of their environment (Mandau 2017). Activities can be carried out well so that optimal work productivity is obtained if comfort is created (Budiono et al. 2023). Activity can also be interpreted as one of the residents' activities that cannot be avoided so that a space can accommodate activities that create comfort (Котлер 2008). Therefore, space comfort is needed so that residents can feel comfortable in their activities.

Space comfort comes from thermal comfort which is one part of activity comfort so that if activity increases optimally in a space that is designed and built if the thermal comfort is appropriate (Sugini 2014). Thermal comfort can be defined as the level of satisfaction experienced by a person when consciously or unconsciously accepting the thermal conditions they experience (Tondobala n.d.; Antaryama, Ekasiwi, and Erwindi 2022).

Indonesian people feel comfortable if they are in a temperature range of 22.8℃ - 25.8℃ with humidity of 70% (Ramawangsa 2021). Specifically, the capital city (DKI) Jakarta is located close to the equator and has a humid tropical external climate (Tomasowa 2013). Humidity throughout the year is also quite high, namely around 80% to 90%, December to January also has very high rainfall conditions and under certain conditions the temperature in the Special Capital Region (DKI) Jakarta also experiences a temperature range where some people feel uncomfortable. Comfortable (Wati and Fatkhuroyan 2017). This causes several problems for the Indonesian people, especially the Special Capital Region (DKI) Jakarta because it will result in decreased productivity caused by temperature conditions that make it uncomfortable, such as very cold or very hot (Aldrian, Karmini, and Budiman 2011). So, research is needed to be able to evaluate room comfort based on occupant satisfaction through a survey or interview and filling out a questionnaire in an apartment residential unit.

The research entitled evaluation of space comfort based on occupant satisfaction in West Jatinegara flats residential units aims to carry out an evaluation to determine whether spatial comfort based on occupant satisfaction in West Jatinegara flats residential units is appropriate or not and whether improvement strategies are needed to increase space comfort based on Satisfaction the occupant. The results of this research will be a consideration in the design and construction of subsequent flats so that architects, practitioners, developers and other parties who contribute to the design and construction stages of flats then consider space comfort factors based on occupant satisfaction so that later residents will feel comfortable when carrying out activities in the residential unit. the flat.

Method

Before the research was conducted, the researcher took an approach first by reviewing several national and international journal articles from three (3) similar studies. This study is needed so that it can be known what methods previous researchers will use and use. From the results of this study, research methods that are most suitable for this research can be selected or determined.

The first research was entitled Post-Occupancy Evaluation of Pudai Rental Flats in Kendari City which was carried out in 2016 by Achmad Sepryadi, Ir. Agam Marsoyo, M.Sc., Ph.D., Dr. Ir. Budi Kamulyan, M. Eng who described the results of the evaluation of retirement of Pudai flats in Lapulu sub-district, Kendari City using quantitative and qualitative deductive research methods (Sepryadi, Marsoyo, and Kamulyan 2016). The second research is entitled Post Occupancy Evaluation (POE) in Flat Buildings in Banten Province (Case Study "Construction of MBR Flats in Banten Province) which describes the results of occupant satisfaction (Andiyan, Rachmat, and Kadir 2021). This research uses quantitative methods. The third research is entitled Thermal Comfort in Flats in West Jakarta by Susanto, Sigit Wijaksono, Albertus Galih Prawata which describes how to create thermal comfort in flats in West Jakarta using quantitative methods (Susanto, Wijaksono,

and Prawata, n.d.). This research uses several approaches derived from three studies that have been carried out by a number of researchers, where there are several titles and backgrounds to the problems in this research.

Based on these three studies, it can be seen that the appropriate methodology to be used in the research entitled Evaluation of Space Comfort Based on Occupant Satisfaction in Residential Units of West Jatinegara Flats is quantitative deductive with a post-occupancy evaluation research approach method which focuses on the thermal conditions of the room and occupant activities. at the Jatinegara Barat flats.

The process of collecting and processing research data was carried out in the following steps: (1) field observation, (2) literature study, and (3) comparison. Field observations were carried out using two methods, namely field measurements (physical measurements of residential units and room thermal measurements) and occupant interviews; a literature study was carried out by reviewing literature related to research such as room comfort studies which focus on thermal comfort and activity space, theories regarding housing, standards related to comfort in residences, and high-rise buildings; and comparison is carried out by comparing the results of field observations and literature studies to obtain final comfort evaluation results.

Physical measurements of West Jatinegara flats residential units with the aim of describing existing conditions were carried out using a measuring tool that has a measuring limit of 10 meters and a laser meter with the measured area being 2 (two) bedroom areas along with doors, windows and the clear height of the room (ceramic -ceiling), and 1 (one) common room area including the main door, the drying room area door, and the clear height of the room (tile-ceiling). Existing physical measurements in the analysis are used as basic data to determine the comfort of occupant activities.

Figure 1. Measuring tools, measuring area (plan), measuring area (piece)

Room thermal measurements are divided into three data, namely temperature, wind speed and humidity. Measurements were carried out at the highest radiation points, namely 2 hours after sunrise (08.00-10.00), mid-day (11.00-13.00), and 2 hours before sunset (15.00-17.00). The tools used in room thermal measurements are a 3 in 1 environment meter (vane anemometer, thermometer and hygrometer) and a hot wire anemometer. Vane anemometers are used to measure wind speed in areas outside the residential unit, while hot wire anemometers are used to measure air movement in areas inside the residential unit. The room thermal measurements in the analysis are used as basic data to determine the body comfort of the occupants.

Figure 2. Environment Meter and Hot Wire Anemometer

The thermal measurement points are located in the bedroom area (two rooms), the common room including the kitchen (1 room), and the drying room area. In the bedroom area, the measurement points are at the window sill area, the living room area of the bedroom, and the bedroom doorway area; in the common room and kitchen area, the measurement points are in the main doorway area, the middle area of the common room, and the drying room doorway area; and the measurement points for the drying room area are located at the threshold area of the drying room fence and the middle area of the drying room. The measuring point for the indoor area is at an elevation of + 1.2 meters starting from the ceramic area.

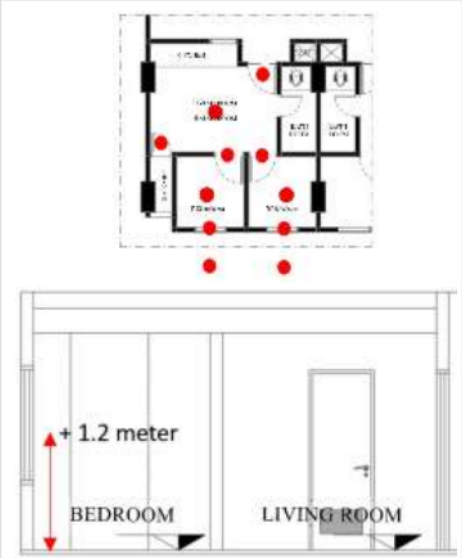

Figure 3. Position of measuring point (plan) and height position of measuring point (section

In addition to physical measurements of residential units and room thermals. Field observations were also carried out using the interview method to determine occupant satisfaction with the size of the supporting space and thermal conditions. Specific questions in the interview concerning thermal comfort and occupant activities are as follows:

1. What activities do you carry out in the apartment residential unit?
2. Is the size of the residential unit able to accommodate all the activities of the apartment residents?
3. What are the wind conditions in the flat?
4. Are the temperature conditions in the apartment building comfortable for the residents?
5. Are the air humidity conditions in the apartment building comfortable for the residents?
6. Do you feel comfortable living in an apartment?

Respondents who took part in the interview were residents of the residential unit used as the unit of measurement. The number of respondents was 12 people in tower A and 12 people in tower B. Apart from that, other respondents came from the technical management unit of Jatinegara Barat flats. The final results of the interview are entered into the Google Form platform to find out the final results in the form of a percentage diagram.

Result and discussion

Interviews and measurements were carried out in 36 residential apartment units, 18 units in each apartment tower. On average, residents have lived in an apartment unit for 6 years, with a percentage of 78% (30 respondents) of residents feeling comfortable and 22% (8 respondents) feeling uncomfortable living in an apartment. Based on interviews with the 36 units, with an area of 30 m^2, 20-unit residents felt that it was sufficient, 7 felt that it was not enough and 8 felt that it was not enough. From the results of interviews and thermal measurements in towers A and B, it can be concluded that:

1. Wind conditions in flat residential

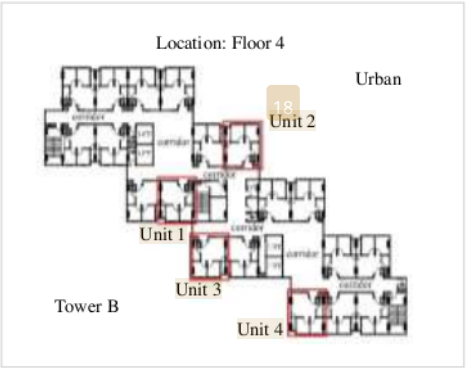

Figure 4. Plan of the 4th floor in Tower A where a temperature, humanity and wind speed measurement survey was carried out

units are inadequate. In the worst conditions, heavy rain and wind can cause the service area door to make a loud noise and the window handle often breaks.
2. The temperature conditions inside the apartment are inadequate. In the worst conditions, summer, causes high temperatures so that the help of a fan that is continuously turned on is needed.
3. The humidity conditions in the apartment are inadequate. High air humidity occurs after rain, which causes residents to feel hot in the unit.

These inadequate conditions also affect the physical condition of the residential unit. From the results of the interview, data on existing residential facilities was obtained as follows:

Tower A
1. 7 residential units with windows still functioning properly and window handles not damaged
2. 7 residential units with 1 broken window latch
3. 4 residential units with 2 broken window latches
4. *Tampya*s which causes rainwater to enter residential units in the worst conditions during heavy rain can flood the bathroom area.

Tower B
1. 9 residential units with windows still functioning properly and window handles not damaged
2. 2 residential units with 1 broken window latch
3. 7 residential units with 2 broken window latches
4. There was a leak in the ceiling area during heavy rain and the window edge area caused by the window installation not being tight enough
5. *Tampyas* which causes rainwater to enter residential units in the worst conditions when it rains.

The residential units where temperature, humidity and wind speed measurement surveys were carried out were units on the 4th, 10th and 15th floors. On the 4th floor, temperature, humidity and wind speed measurement surveys were carried out on units marked with red boxes as seen in the image below.

In unit 1, a temperature, humidity and wind speed measurement survey was carried out in 2 periods, namely in March and September, where in March it was carried out from morning to evening with normal wind speed so that the windows in both bedrooms could be opened optimally. The results of temperature measurements from morning to evening were above normal. The humidity measurement results are still in the normal/ideal category.

Table 1. Survey results for temperature, humidity and wind speed measurements in unit 1 floor 4

Unit 1								
Time and weather		Temperature (°C)				Humidity (%)		
03	09	03		09		03		09
07.17 Bright	07.42 Bright	31.6		30.8		65.6		64.5
11.11 Cloudy	11.11 Strong winds	30.8		32.3		62.9		57.3
15.32 After the rain	15.29 Bright	30.5		32.4		63.1		50.9
Unit 1								
Time and weather		Wind velocity (m/s)						
		Outside building		Window sill			Room	
03	09	03	09	03	09	Rg	03	09
07.17 Bright	07.42 Bright	1.42	0.73	0.91	0.42	R1	0.32	0.23
						R2	0.36	0.30
						R3	0.57	0.26
11.11 Cloudy	11.11 Strong winds	2.53	3.36	0.77	0.42	R1	0.53	0.40
						R2	0.47	0.32
						R3	0.24	0.27
15.32 After the rain	15.29 Bright	1.26	3.81	0.67	0.47	R1	0.28	0.65
						R2	0.22	0.41
						R3	0.37	0.34

Unit 1		
Time and weather		Note
03	09	
07.17 Bright	07.42 Bright	The windows of both rooms can be opened maximally
11.1 Cloudy	11.11 Strong winds	The windows of both rooms can be opened maximally
15.32 After the rain	15.29 Bright	The windows of both rooms can be opened maximally

In unit 2, a temperature, humidity and wind speed measurement survey was carried out in 2 periods, namely in March and September, which was carried out in the morning until the evening with normal wind speed and the windows were in good condition or functioning and nothing was damaged. The results of temperature measurements from morning to evening were above normal. The results of humidity measurements in March started to feel damp but in September it became normal/ideal again.

Table 2. Survey results for temperature, humidity and wind speed measurements in unit 2 on the 10th floor

Unit 2							
Time and weather		Temperature (°C)			Humidity (%)		
03	09	03	09		03	09	
07.28 Bright	07.50 Bright	31.9	30.6		70.6	64.5	
11.35 Light rain	11.16 Strong winds	30.9	32.3		63.2	58.5	
15.69 After the rain	15.35 Bright	30.7	32.3		63.3	52.8	
Unit 2							
Time and weather		Wind velocity (%)					
03	09	Outside building		Window sill		Room	
		03	09	03	09	Rg	03	09
07.28 Bright	07.50 Bright	1.47	1.80	-	0.46	R1	0.11	0.11
						R2	0.08	-
						R3	0.12	0.11
11.35 Light rain	11.16 Strong winds	2.61	3.86	-	0.60	R1	0.12	0.11
						R2	0.11	0.27
						R3	0.24	0.12
15.69 After the rain	15.35 Bright	1.28	2.04	-	0.37	R1	0.08	0.12
						R2	0.09	0.24
						R3	0.21	0.13
Unit 2							
Time and weather		Note					
03	09						
07.28 Bright	07.50 Bright	Window is broken					
11.35 Light rain	11.16 Strong winds	Window is broken					
15.69 After the rain	15.35 Bright	Window is broken					

The temperature, humidity and wind speed measurement survey continued on the 10th floor of tower A, in the unit marked with a red box as in the picture below (figure 5):

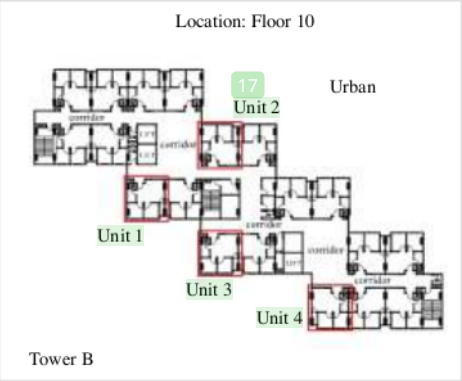

Figure 5. Plan of floor 10 in Tower A where a temperature, humidity and wind speed measurement survey was carried out

In unit 1, a temperature, humidity and wind speed measurement survey was carried out

In 2 periods, namely March and September, where in September it was carried out from morning to evening with higher wind speeds than in March, causing parts of the bedroom windows to be damaged. The results of temperature measurements from morning to evening were above normal. The results of humidity measurements in March started to feel damp but in September it became normal/ideal again.

The temperature, humidity and wind speed measurement survey continued on the 10th floor of tower A, in the unit marked with a red box as in the picture below:

In unit 1, a temperature, humidity and wind speed measurement survey was carried out in 2 periods, namely in March and September, where in September it was carried out in the morning until the evening with higher wind speeds than in March, causing part of the bedroom window to be damaged. damaged. The results of temperature measurements from morning to evening were above normal. The results of humidity measurements in March started to feel damp but in September it became normal/ideal again.

Table 3. Survey results for temperature, humidity and wind speed measurements in unit 1, 10th floor

Unit 1								
Time and weather		Temperature (°C)				Humadity (%)		
03	09	03		09		03	09	
08.25 Bright	08.23 Bright	30.8		31.1		68.4	64.7	
12.20 Windy rain	11.51 Strong winds	31.5		32.3		66.7	57.1	
16.55 Windy rain	16.22 Bright	30.8		32.6		66.5	51.5	
Unit 1								
Time and weather		Wind velocity (m/s)						
03	09	Outside building		Window sill		Room		
		03	09	03	09	Rg	03	09
08.25 Bright	08.23 Bright	1.98	1.57	0.75	0.36	R1	0.16	0.17
						R2	0.18	0.21
						R3	0.16	0.23
12.20 Windy rain	11.51 Strong winds	5.91	3.72	-	0.65	R1	0.12	0.11
						R2	0.13	0.53
						R3	0.37	0.21
16.55 Windy rain	16.22 Bright	6.67	3.72	-	0.84	R1	0.17	0.31
						R2	0.21	0.77
						R3	0.37	0.33
Unit 1								
Time and weather		Note						
03	09							

08.25 Bright	08.23 Bright	Room R1 window is broken
12.20 Windy rain	11.51 Strong winds	Room R1 window is broken
16.55 Windy rain	16.22 Bright	Room R1 window is broken

In unit 2, a temperature, humidity and wind speed measurement survey was carried out in 2 periods, namely in March and September, which was carried out in the morning until the evening with normal wind speed and the windows were in good condition or functioning and nothing was damaged. The results of temperature measurements from morning to evening were above normal. The results of humidity measurements in March started to feel damp but in September it became normal/ideal again.

Table 4. Survey results for temperature, humidity and wind speed measurements in unit 2 on the 10th floor

Unit 2								
Time and weather		Temperature (°C)				Humadity (%)		
03	09	03	09			03	09	
08.40 Bright	08.27 Bright	31.1	31.2			69	65.3	
12.35 Strong winds	11.58 Strong winds	31.2	31.9			68.7	58.4	
17.09 Windy rain	16.28 Bright	31.1	32.6			67.5	54.7	
Unit 2								
Time and weather		Wind velocity (m/s)						
03	09	Outside building		Window sill		Rg	Room	
		03	09	03	09		03	09
08.40 Bright	08.27 Bright	2.43	2.21	0.31	0.28	R1	0.15	0.21
						R2	0.11	0.23
						R3	0.22	0.20
12.35 Strong winds	11.58 Strong winds	5.62	3.92	-	0.47	R1	0.20	0.27
						R2	0.31	0.31
						R3	0.39	0.30
17.09 Windy rain	16.28 Bright	6.76	3.87	-	3.87	R1	0.18	0.08
						R2	0.22	0.14
						R3	0.27	0.11
Unit 2								
Time and weather		Note						
03	09							
08.40 Bright	08.27 Bright	Room R1 window is broken						
12.35 Strong winds	11.58 Strong winds	Room R1 window is broken						
17.09 Windy rain	16.28 Bright	Room R1 window is broken						

The temperature, humidity and wind speed measurement survey was then continued again on the 15th floor of tower A, in the unit marked with a red box as in the picture below (figure 6):

In unit 1, a temperature, humidity and wind speed measurement survey was carried out in 2 periods, namely in March and September, where in September it was carried out in the morning

until the evening with normal wind speed and the windows were in good condition or functioning and nothing was damaged. The results of temperature measurements from morning to evening were above normal. The results of humidity measurements in March started to feel damp but in September it became normal/ideal again.

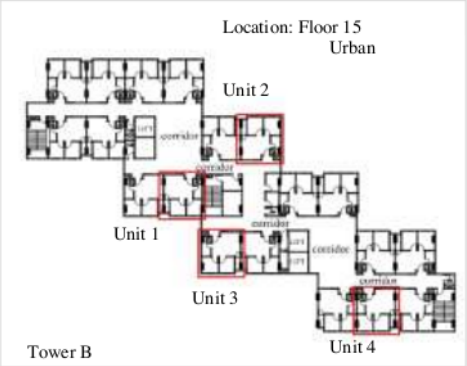

Figure 6. Plan of floor 15 in Tower A where a temperature, humidity and wind speed measurement survey was carried out

Table 5. Survey results for temperature, Humidity and wind speed measurements in unit 1, 15th Floor

Unit 1								
Time and weather		Temperature (°C)				Humidity (%)		
03	09	03		09		03	09	
09.25 Bright	08.50 Bright	30.7		31.7		70.9	62.3	
08.50 Bright	12.31 Strong winds	30.5		32.0		71.3	61.6	
17.47 Windy rain	17.02 Bright	30.5		32.6		70.8	49.4	
Unit 1								
Time and weather		Wind velocity (m/s)						
03	09	Outside building		Window sill		Room		
		03	09	03	09	Rg	03	09
09.25 Bright	08.50 Bright	3.24	2.52	0.46	0.28	R1	0.11	0.08
						R2	0.13	0.11
						R3	0.21	0.15
08.50 Bright	12.31 Strong winds	6.82	3.48	0.27	0.43	R1	0.09	0.20
						R2	0.11	0.23
						R3	0.18	0.31
17.47 Windy rain	17.02 Bright	7.21	6.39	-	0.90	R1	0.12	0.48
						R2	0.14	0.44
						R3	0.31	0.27
Unit 1								
Time and weather		Note						
09.25 Bright	08.50 Bright	The window works						
08.50 Bright	12.31 Strong winds	The window works						
17.47 Windy rain	17.02 Bright	The window works						

In unit 2, a temperature, humidity and wind speed measurement survey was carried out in 2 periods, namely in March and September, where in September it was carried out in the morning until the evening with normal wind speed and the windows were in good condition or functioning and nothing was damaged. The results of temperature measurements from morning to evening were above normal. The results of humidity measurements in March felt a bit damp

in the morning, but in the afternoon and evening and in September it became normal/ideal again.

Table 6. Survey results for temperature, humidity and wind speed measurements in unit 2 on the 15th floor

Unit 2								
Time and weather		Temperature (°C)				Humidity (%)		
03	09	03		09		03		09
09.37 Bright	08.57 Bright	30.9		31.1		67		62
13.40 After the rain	12.38 Strong winds	32		32.7		65.5		60.4
17.47 Windy rain	17.15 Bright	31.3		32.6		64.7		49.4
Unit 2								
Time and weather		Wind velocity (m/s)						
03	09	Outside building		Window sill		Room		
		03	09	03	09	Rg	03	09
09.37 Bright	08.57 Bright	3.13	1.44	-	0.24	R1	0.17	0.29
						R2	-	0.18
						R3	0.05	0.21
13.40 After the rain	12.38 Strong winds	6.14	2.69	0.63	0.31	R1	0.42	0.21
						R2	0.23	0.46
						R3	0.44	0.32
17.50 Windy rain	17.15 Bright	7.08	2.69	-	0.39	R1	0.15	0.48
						R2	0.17	0.44
						R3	0.47	0.17
Unit 2								
Time and weather		Note						
09.37 Bright	08.57 Bright	The window works						
13.40 After the rain	12.38 Strong winds	The window works						
17.50 Windy rain	17.15 Bright	The window works						

The temperature, humidity and wind speed measurement survey was then continued on the 4th floor in tower B, in the unit marked with a red box as in the picture below (figure 7):

In unit 1, a temperature, humidity and wind velocity measurement survey was carried out in 2 periods, namely in March and September, where in September it was carried out in the morning until the evening with normal wind velocity so that it could be opened optimally. The temperature measurement results from morning to evening were at normal temperatures. The results of humidity measurements in March felt damp, however, and in September in the morning but in the afternoon to the evening it became normal/ideal again.

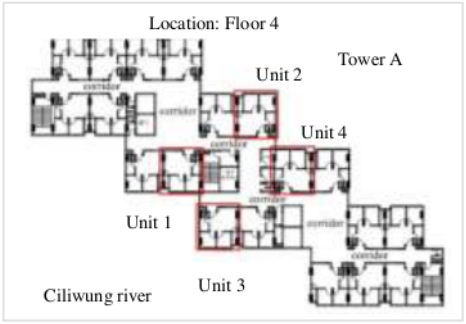

Figure 7. Plan of floor 4 in Tower B where a temperature, humidity and wind speed measurement survey was carried out

Table 7. Survey results for temperature, Humidity and wind velocity measurements in unit 1, Floor 4

Unit 1		
Time and weather	Temperature (°C)	Humidity (%)

03	09	03	09	03	09
07.15 Bright	07.40 Bright	29.4	29.8	66.4	68.2
11.10 Cloudy	12.34 Strong winds	31.2	31.7	67.9	62.4
15.35 After the rain	15.21 Bright	30.8	30.2	71.3	55.7

Unit 1								
Time and weather		Wind velocity (m/s)						
03	09	Outside building		Window sill			Room	
		03	09	03	09	Rg	03	09
07.15 Bright	07.40 Bright	1.52	1.16	0.87	0.8	R1	0.12	0.07
						R2	0.17	0.11
						R3	0.25	0.13
11.10 Cloudy	12.34 Strong winds	2.35	4.31	1.06	0.56	R1	0.36	0.14
						R2	0.47	0.22
						R3	0.52	0.13
15.35 After the rain	15.21 Bright	1.29	2.52	0.71	0.51	R1	0.12	0.17
						R2	0.17	0.21
						R3	0.23	0.08

Unit 1		
Time and weather		Note
07.15 Bright	07.40 Bright	The window can be opened maximally
11.10 Cloudy	12.34 Strong winds	The window can be opened maximally
15.35 After the rain	15.21 Bright	The window can be opened maximally

Then in unit 2 a temperature, humidity and wind velocity measurement survey was carried out again in 2 periods, namely in March and September where in September it was carried out in the morning until the evening with high wind velocity so that the windows became non-functional (could not be opened). The results of temperature measurements from morning to evening were above normal. The results of humidity measurements in March felt damp, however, and in September in the morning but in the afternoon to the evening it became normal/ideal again.

Table 8. Survey results for temperature, Humidity and wind velocity measurements in unit 2, Floor 4

Unit 2					
Time and weather		Temperature (°C)		Humidity (%)	
03	09	03	09	03	09
07.35 Bright	07.45 Bright	29.8	30	67.5	69.2
11.35 Strong winds	11.06 Strong winds	30.9	31.6	67.7	59.5
15.57 Light rain	15.32 Bright	31.1	31.6	73.9	57.5

Unit 2								
Time and weather		Wind velocity (m/s)						
03	09	Outside building		Window sill			Room	
		03	09	03	09	Rg	03	09
07.35 Bright	07.45 Bright	1.47	1.41	0.93	0.75	R1	0.18	0.07
						R2	0.07	0.03

						R3	0.37	0.23
11.35 Strong winds	11.06 Strong winds	4.90	3.07	-	0.88	R1	0.52	0.09
						R2	0.15	0.05
						R3	0.22	0.21
15.57 Light rain	15.32 Bright	1.57	4.78	1.22	0.93	R1	0.12	0.12
						R2	0.08	0.06
						R3	0.23	0.10

Unit 2	
Time and weather	Note
07.35 Bright / 07.45 Bright	Room window R2 is not working
11.35 Strong winds / 11.06 Strong winds	Room window R2 is not working
15.57 Light rain / 15.32 Bright	Room window R2 is not working

The temperature, humidity and wind velocity measurement survey was then continued on the 10th floor in tower B, in the unit marked with a red box as in the picture below (figure 8):

In unit 1, a temperature, humidity and wind velocity measurement survey was carried out in 2 periods, namely in March and September, where in September it was carried out in the morning until the evening with normal wind velocity so that it could be opened optimally. The results of temperature measurements from morning to evening were above normal. The results of humidity measurements in March felt damp, but in September it became normal/ideal again.

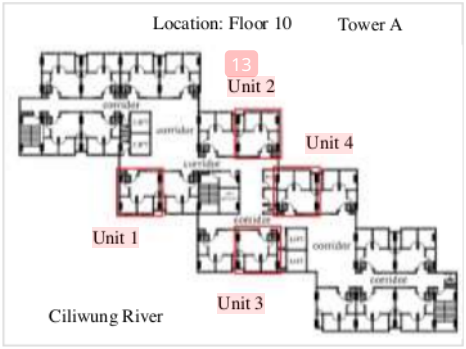

Figure 8. Plan of floor 10 in Tower B where a temperature, humidity and wind speed measurement survey was carried out

Table 9. Survey results for temperature, humidity and wind velocity measurements in unit 1, 10th Floor

Unit 1								
Time and weather		Temperature (°C)		Humidity (%)				
03	09	03	09	03	09			
08.27 Bright	08.05 Bright	30	30.7	66.7	64.9			
12.17 Light rain	11.28 Strong winds	30.4	31.6	66.1	59.2			
16.37 Windy rain	15.50 Bright	30.3	32.1	66.5	56.3			

Unit 1								
Time and weather		Wind velocity (m/s)						
03	09	Outside building		Window sill			Room	
		03	09	03	09	Rg	03	09
08.27 Bright	08.05 Bright	2.11	3.36	0.52	0.45	R1	0.17	0.04
						R2	0.19	0.05
						R3	0.33	0.07
12.17 Light rain	11.28 Strong winds	2.80	6.72	0.76	0.29	R1	0.11	0.12
						R2	0.15	0.14
						R3	0.33	0.25
16.37 Windy rain	15.50 Bright	4.27	5.09	-	0.67	R1	0.15	0.11
						R2	0.19	0.13
						R3	0.37	0.19

Unit 1		
Time and weather		Note
08.27 Bright	08.05 Bright	The window can be opened maximally
12.17 Light rain	11.28 Strong winds	The window can be opened maximally
16.37 Windy rain	15.50 Bright	The window can be opened maximally

Then, in unit 2, a temperature, humidity and wind velocity measurement survey was carried out in 2 periods, namely in March and September, where in September it was carried out in the morning until the evening with high wind velocity, resulting in damaged windows. The results of temperature measurements from morning to evening were above normal. The results of humidity measurements in March felt damp, but in September it became normal/ideal again.

Table 10. Survey results for temperature, humidity and wind velocity measurements in unit 2, 10th Floor

Unit 2								
Time and weather		Temperature (°C)				Humidity (%)		
03	09	03		09		03		09
08.39 Bright	08.12 Bright	30.1		30.7		65.4		65.6
08.12 Bright	11.37 Strong winds	30.4		31.7		66.1		60.9
16.55 Windy rain	15.58 Bright	30.2		32.2		66.3		54.8
Unit 2								
Time and weather		Wind velocity (m/s)						
03	09	Outside building		Window sill		Room		
		03	09	03	09	Rg	03	09
08.39 Bright	08.12 Bright	2.43	2.41	0.71	0.56	R1	0.08	0.07
						R2	0.08	0.06
						R3	0.31	0.07
08.12 Bright	11.37 Strong winds	6.06	4.98	0.82	0.77	R1	0.15	0.12
						R2	0.13	0.07
						R3	0.60	0.24
16.55 Windy rain	15.58 Bright	6.75	12.18	-	2.30	R1	0.17	0.17
						R2	0.16	0.14
						R3	0.34	0.40
Unit 2								
Time and weather		Note						
08.39 Bright	08.12 Bright	Window is broken						
08.12 Bright	11.37 Strong winds	Window is broken						
16.55 Windy rain	15.58 Bright	Window is broken						

The temperature, humidity and wind velocity measurement survey was then continued on the 15th floor in tower B, in the unit marked with a red box as in the picture below (figure 9):

In unit 1, a temperature, humidity and wind velocity measurement survey was carried out in 2 periods, namely in March and September, where in September it was carried out in the morning until the evening with normal wind velocity so that it could be opened optimally. The results of temperature measurements from morning to evening were above normal. The results of humidity measurements in March and September were normal/ideal.

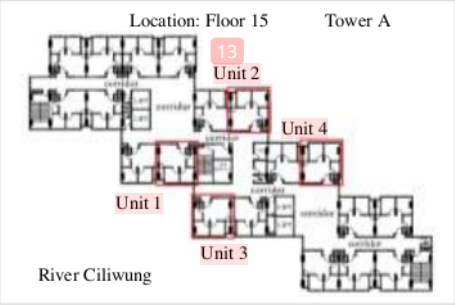

Figure 9. Plan of floor 15 in Tower B where a temperature, humidity and wind speed measurement survey was carried out

Table 11. Survey results for temperature, humidity and wind velocity measurements in unit 1, 15th Floor

Unit 1								
Time and weather		Temperature (°C)				Humidity (%)		
03	09	03		09		03	09	
09.17 Bright	08.35 Bright	31.2		30.9		63	63.6	
13.21 Strong winds	12.00 Strong winds	30.7		32		64.5	59.3	
17.23 Windy rain	16.17 Bright	30.8		31.9		64.3	53.1	
Unit 1								
Time and weather		Wind velocity (m/s)						
03	09	Outside building		Window sill			Room	
		03	09	03	09	Rg	03	09
09.17 Bright	08.35 Bright	3.17	3.11	0.76	0.26	R1	0.12	0.07
						R2	0.15	0.12
						R3	0.45	0.06
13.21 Strong winds	12.00 Strong winds	5.73	5.92	-	0.57	R1	0.21	0.05
						R2	0.22	0.07
						R3	0.47	0.11
17.23 Windy rain	16.17 Bright	5.89	3.49	-	0.55	R1	0.22	0.04
						R2	0.24	0.05
						R3	0.51	0.21
Unit 1								
Time and weather		Note						
09.17 Bright	08.35 Bright	The window can be opened maximally						
13.21 Strong winds	12.00 Strong winds	The window can be opened maximally						
17.23 Windy rain	16.17 Bright	The window can be opened maximally						

In unit 2, a temperature, humidity and wind velocity measurement survey was carried out in 2 periods, namely in March and September, where in September it was carried out in the morning until the evening with normal wind velocity so that it could be opened optimally. The results of temperature measurements from morning to evening were above normal. The results of humidity measurements in March and September were normal/ideal.

Table 12. Survey results for temperature, humidity and wind velocity measurements in unit 2, 15th Floor

Unit 2					
Time and weather		Temperature (°C)		Humidity (%)	
03	09	03	09	03	09
09.26 Bright	08.43 Bright	31.1	31.3	69.5	67.9
13.31 Strong winds	12.08 Strong winds	30.4	31.9	71.6	59
17.34 Windy rain	15.32 Bright	30.3	31.9	70.2	55.9

Unit 2								
Time and weather		Wind velocity (m/s)						
03	09	Outside building		Window sill		Room		
		03	09	03	09	Rg	03	09
09.26 Bright	08.43 Bright	3.33	3.13	0.86	0.23	R1	0.09	0.09
						R2	0.19	0.14
						R3	0.15	0.06
13.31 Strong winds	12.08 Strong winds	6.28	4.62	1.28	0.62	R1	0.15	0.08
						R2	0.19	0.11
						R3	0.52	0.25
17.34 Windy rain	15.32 Bright	7.56	5.94	-	0.64	R1	0.13	0.12
						R2	0.14	0.14
						R3	0.55	0.55

Unit 2		
Time amd weather		Note
09.26 Bright	08.43 Bright	Room window R1 is not working
13.31 Strong winds	12.08 Strong winds	Room window R1 is not working
17.34 Windy rain	15.32 Bright	Room window R1 is not working

Conclusions

The conclusions that can be drawn in this research are as follows: (1) Survey results measuring temperature, humidity and wind velocity were carried out in two periods, namely March and September; (2) Based on the results of temperature measurements in the two periods shown in the table above, the results of measuring the temperature range in each unit on floors 4, 10 and 15 in towers A and B are normal and above normal; (3) Based on the results of the humidity survey in the table above, the room in units 1 and 2 on floors 10 and 15 of tower A felt damp in March, the room in unit 1 on the 4th floor in March was damp and, in unit 2 on the 4th floor, it felt damp in March. March and morning in September. Units 1 and 2 on the 10th floor in March also felt damp; (4) Wind velocity in unit 2 on the 4th floor and units 1 and 2 on the 10th floor of tower A and units 2 10 of tower B, causing the windows to be damaged or even unable to function; (5) Apart from conducting surveys measuring temperature, humidity and wind velocity, researchers also conducted interviews with 36 residents in residential units where there were responses from residents as many as 8 respondents who felt uncomfortable living in flats and with an area of 30 m2 there were 7 residents who felt inadequate and 8 felt not enough; (6) From the results of interviews and thermal measurements, it was found that the worst conditions were rain and strong winds which caused the service area doors to make loud noises and window handles often broke. And if the dry season arrives, it causes high temperatures, so you need the help of a fan that is continuously turned on. The air humidity conditions inside the apartment are inadequate. High air humidity occurs after rain, which causes residents to feel hot in the unit.

Based on the conclusions above, the researcher provides recommendations to increase

room comfort in tower A and B units, as below: (1) Additional space is needed so that every activity can be accommodated so that it feels comfortable. However, current conditions do not allow for additional unit area, so it is necessary to arrange each room so that it is more compact and comfortable; (2) It is necessary to consider the type of opening material, the ratio of the opening area and the glass and frame materials used so that the window is not easily damaged, the handle is not easily broken and does not make a loud sound if there is a strong wind; (3) The air humidity in tower A and B flats is still not good so it does not support thermal comfort inside. Therefore, it is necessary to optimize air exchange in every room in the residential unit.

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Author(s) contribution

Ulinata contributed to the research concepts preparation, methodologies, investigations, data analysis, visualization, articles drafting and revisions.

Sally Septania Napitupulu contribute to the research concepts preparation and literature reviews, data analysis, of article drafts preparation and validation.

Adinda Garda Merah contribute to methodology, supervision, and validation.

Kristoforus Dandy contribute to methodology, supervision, and validation.

Sally Septania Napitupulu (Evaluation of space comfort based on occupant satisfaction in west Jatinegara flats residential units)

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