



THE VARIETY OF FURNITURE ARRANGEMENT INSIDE APARTMENT UNIT AROUND JABODETABEK AREA TO IMPROVE COP_c

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ABSTRACT

An exploration of wall split air conditioning (AC) unit working in some apartments around Jabodetabek is conveyed based on the variety of furniture layout. The type of furniture arrangement of the apartments is exclusively developed to investigate their influence to the cooling coefficient of performance (COP_c). The study was focused on the establishment of the flow pattern uniqueness depend of the furniture arrangement. Using computational fluid dynamics tool, several variables were exploited such as apartment location and furniture layout. It is obtained specific air flow pattern since every single room within operated wall split AC unit which is control the COP_c degrees. There are five furniture layout designs for every city therefore it is obtained twenty-five different airflow patterns which is influence the performance of AC unit. It is concluded the best furniture arrangement for all city where it could be operated within the lowest energy consumption of air conditioning. The effort to reduce the electricity energy consumption of air conditioning operation in the building industry is in line to the Indonesia government policy. The selection of furniture arrangement which is the best COP_c is the one method to realise the energy saving program. Besides the number of Indonesia apartment building is very excessive particularly in the big metropolises such as in Jabodetabek (Jakarta, Bogor, Depok, Tangerang and Bekasi) area.

Keywords: furniture arrangement, split air conditioning, apartment unit, Jabodetabek area, cooling coefficient of performance.

INTRODUCTION

Air conditioning unit (AC) is turn on to improve the thermal comfort in the several rooms. There are enormously of split AC in the infomercial besides window types, where in this examination it will be used the wall split types due to this kind is very often to be usage by the developer or resident. This manuscript recommend us the contemplation to decide on furniture layout in the apartment unit is correlated to the value of air conditioning performance.

The forthright working of whichever refrigerating system when used for cooling is expressed in terms of the cooling coefficient of performance, COP_c [1].

$$COP_c = \frac{\text{useful refrigerating effect}}{\text{net energy input}} \quad (1)$$

COP_c is a dimensionless amount, expressible by way of a vivid numeral. For AC unit, it is chosen the high-level COP_c means it has high serviceable refrigerating perform or/and small power input. The beneficial refrigerating outcome is depending on the dissimilarity between the temperatures of room previously the AC unit works and following it works. Hence the surveillance of the temperature discrepancy is supreme in the COP_c analyse. There is plenty of technique how to improve COP_c in practically besides academically. The very commonly used methods embrace subcooling of the

refrigerant where Wankhede used evaporative condenser to get the better COP of air conditioning [2].

Stratification air temperature also ventilation efficacy are some considerable uniqueness of displacement ventilation in line with Hu, Chen and Glicksman [3]. They contrast the energy intake of some U.S. buildings with displacement ventilation method. King *et al.* [4] accomplished that the accurate persistence of stratification air conditioning technique for the building where the indoor air quality escalates can present various advantage. In the case study, 1.138.195 kilowatt per annum electrical power operation could be saved, 50.55% of the operation budget estimates with the common system.

Iskandriawan [5] improve the disparity amongst displacement then mixed system in investigate of temperature and velocity gradient in the specific room. It is accomplished that cassette AC type is the best compare to the wall, ceiling suspended, floor standard and floor suspended concerning to their COP_c, unfortunately people still prefer wall type due to economical cause and the simplicity of installation [6].

Bojic, Yik, Lo, Gao, Lee also Hua [7, 8 and 9] concentrate to observe carefully the performing of the air conditioning in the domestic usage. The floor based air conditioning method (FAC) are worked to displace ceiling based technique (CAC) for energy saving. Sorts of split wall, ceiling suspended, and cassette could be classified in CAC group near with floor suspended into FAC, where the floor standard in anywhere amongst them. Gao and Lee verify the variety of COP for the 4 (four) situation,



where the first and second methods represent scenarios by the two degrees of deflection at finished level 0.6 m; and at level 1.1 m for third and fourth scenarios.

Hill, Edwards and Levermore research the proportional energy necessity of supermarket retail floors simulated similarly through and minus the cooling consequence of refrigeration cabinets encompassed in the simulation [10].

The objective of this investigation is to search the establishing of distinctive airflow depend on the furniture arrangement inside the apartment room is accompanying to the convective heat transfer comprehension established on the computational fluid dynamics approach. The styles of furniture arrangement which is realised in this study are 5 (five) design for each town. The outcome of this investigation is supposed could provide the extensive expedition to acquire the considerable augmentation to recuperate the diminishing of energy utilisation in the air conditioning practice.

METHOD

This study is supported by the simulation of CFD; Fluent within constructs use of the kinds of the furniture arrangement will be used. The CFD simulation is set up with the design of furniture planning of apartment unit room developed from the current principle. The position of wall split AC unit is not replaced for every layout in the apartment room. There are some viscous flow methods in the Fluent that are laminar and κ - ϵ turbulent where κ - ϵ turbulent flow consists of standard, realizable or RNG. Before we do the simulation, it is employed the trial of air ventilation system for determining which of the simulation flow is closed to the direct measurement of temperature in the experimentation. Figure-1 shows us the temperature relationship amongst them. It is distinct that

the standard κ - ϵ flow viscous method was closed to the experiment room temperature measurement. Furthermore it is used it in the CFD simulation process.

The phases of vocation are as follows:

1. The deepening of apartment room unit in Jabodetabek area in inspection: Season City, Jakarta; Sentul, Bogor; Margonda, Depok; Silkwood, Tangerang; and Mutiara, Bekasi.
2. Creating of AutoCad drawings based on the apartment business plan as well as the measurement of detail apartment unit dimension.
3. Making of GAMBIT 3D model and meshing based on AutoCad drawings. Transfer 3D model to fluent software. System boundary condition and the simulation/iteration of Fluent.
4. Measurement of temperature and velocity air of the simulation result. Making graphic and analyse of the measurement result based on the simulation result.
5. Cooling coefficient of performance (COP_e) computation of each 5 (five) furniture arrangement using in 5 (five) apartment unit location.

In the role of the illuminating, *Season City* apartment, Jakarta is selected. It can be find out 5 (five) alternatives of furniture arrangement completed with the airflow pattern (Figure-2).

Within truthful supervision of airflow pattern for each furniture layout for every apartment unit, it could be seen the effectiveness of airflow to decrease the room temperature in every section of room. The cooling coefficient of performance is calculated based on the measurement of temperature randomly inside the room before and after the refrigeration within the certain electricity energy consumption is operated.

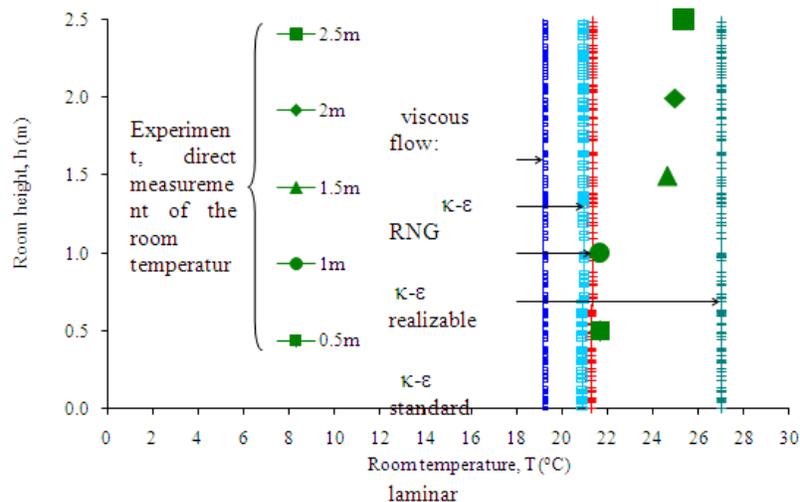


Figure-1. Comparison of room temperature amongst direct measurement and fluent simulation through the different viscous flow.

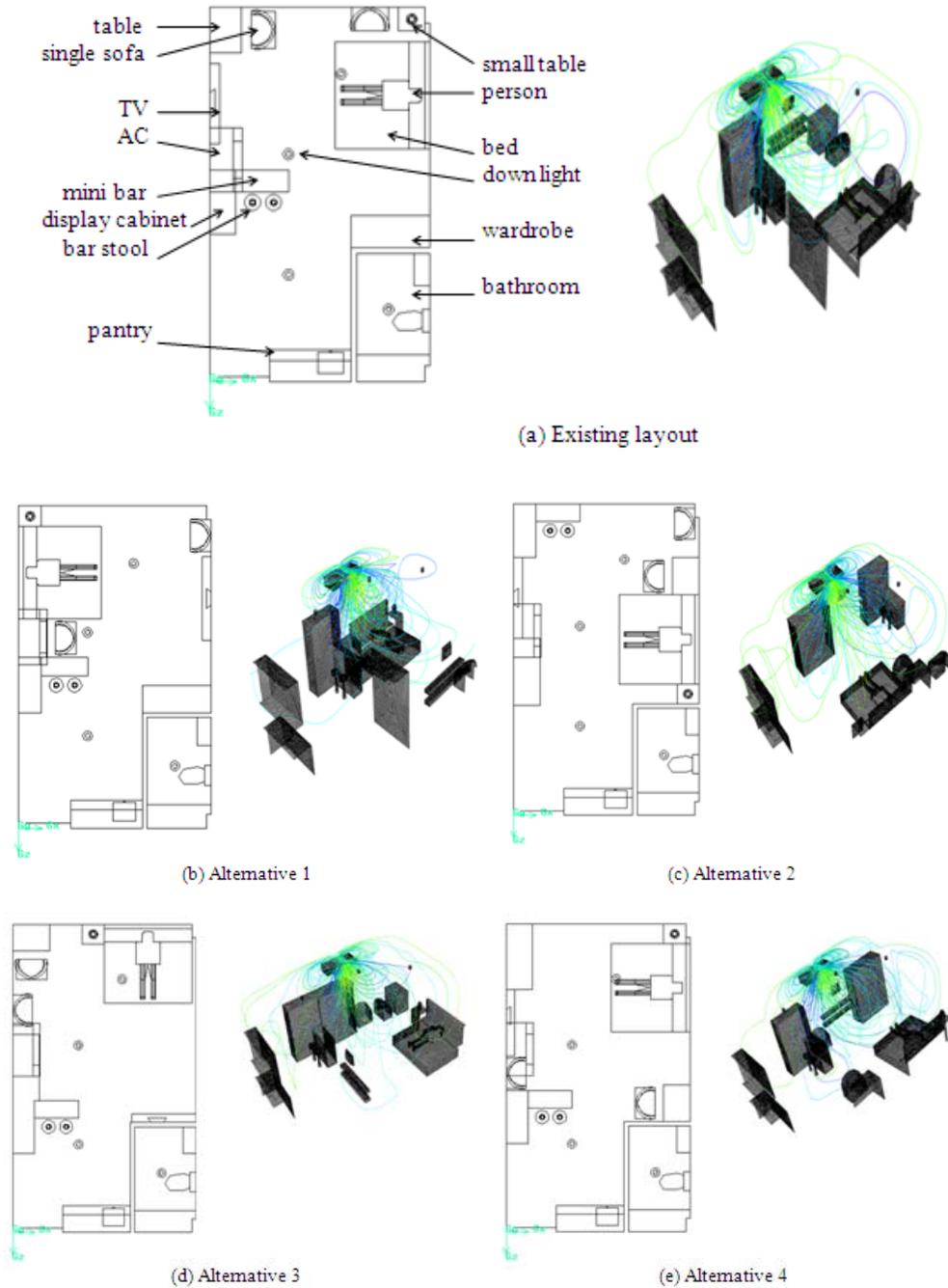


Figure-2. 5 (five) alternatives of furniture arrangement accomplished with the airflow pattern inside the room in Season City apartment, Jakarta.

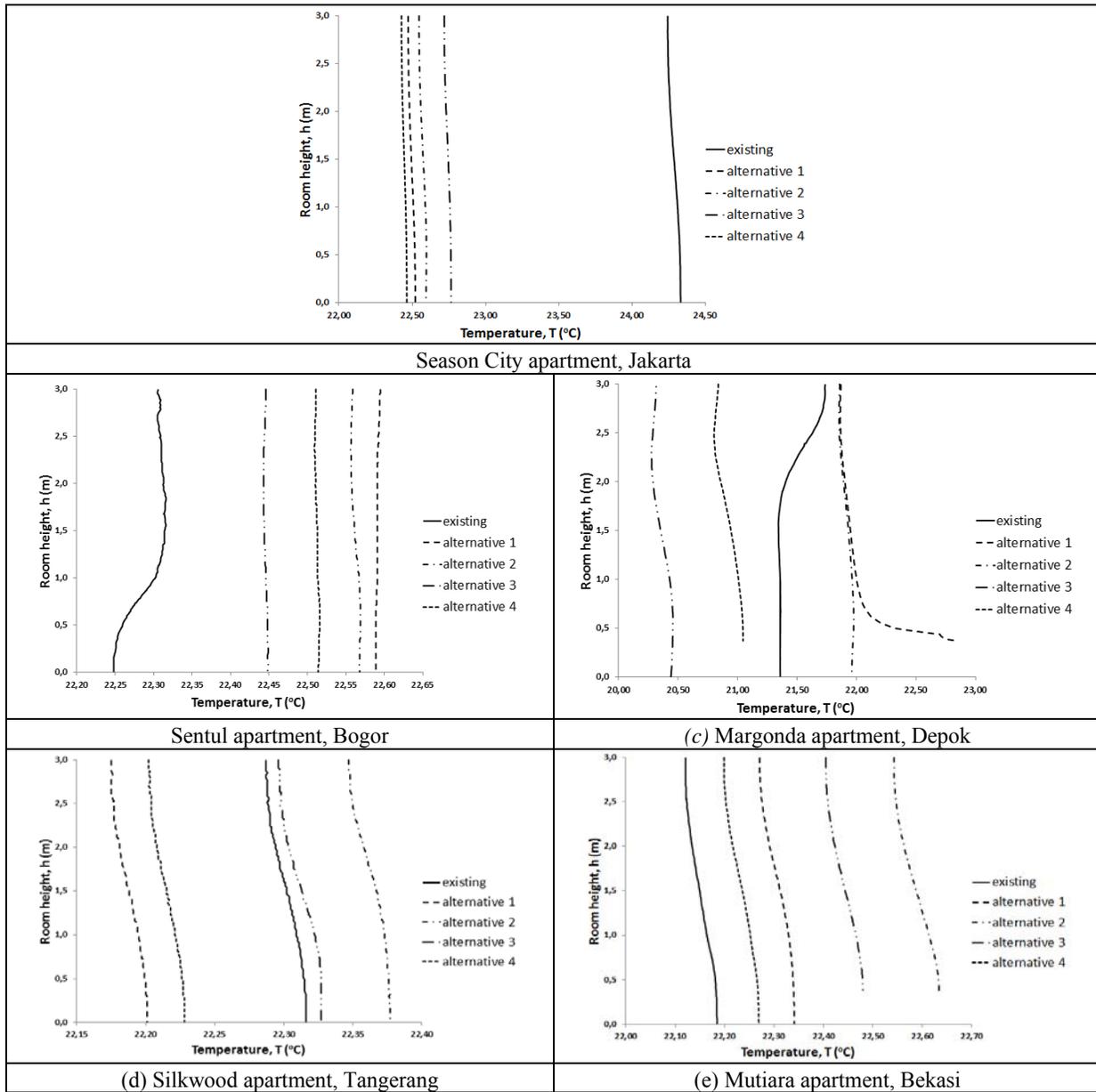


Figure-3. Gradient temperature within 5 (five) alternatives of furniture arrangement for apartment in Jabodetabek area.

Table-1. COP_c ranking of 5 (five) alternatives furniture arrangement for apartment in Jabodetabek area.

No.	Apartment	Existing layout	Alternatives			
			1	2	3	4
1	Season City, Jakarta	3.84 (5)	5.07 (2)	5.02 (3)	4.90 (4)	5.31 (1)
2	Sentul, Bogor	5.18 (1)	4.98 (5)	5.00 (4)	5.08 (2)	5.04 (3)
3	Margonda, Depok	5.76 (3)	5.39 (5)	5.43 (4)	6.48 (1)	6.11 (2)
4	Silkwood, Tangerang	5.18 (3)	5.26 (1)	5.14 (5)	5.17 (4)	5.24 (2)
5	Mutiara, Bekasi	5.28 (1)	5.17 (3)	4.99 (5)	5.09 (4)	5.22 (2)



RESULT AND DISCUSSIONS

The airflow pattern is identifiable for each condition of the supply air position derived from the variation of furniture arrangement is used in each apartment room unit. Temperature data retrieval is implemented in around the centre area of the room as we can see at Figure-3. Frequently the room temperature is uniform vertically.

In general, there are only 2 (two) groups of room cooling in Season City apartment, Jakarta: effective (alternatives 1, 2, 3 and 4) or ineffective (existing layout). Gradient temperature in alternatives 1, 2, 3 and 4, $T_{1,2,3 \text{ and } 4}$ is around 22.50 °C, where the existing layout temperature, T_e is about 24.30 °C. Why it is happened? Since the position of one of furniture system namely minibar is very close to the AC unit so it blocks the cool air flow. As we know that the measurement of room temperature is around of the room midpoint. We should be carefully to prevent the setting similar to the existing layout.

At Sentul apartment, Bogor the existing layout is outstanding compare to the other alternatives. A valuable experience is obtained for our furniture layout designer. They decide to dismantle the divider consequently the room temperature rise in alternatives 1, 2, 3 and 4. As we know that it splits bedroom and living room. It is understood why did the room temperature of alternative 3 was lowest (T_3 is nearly 20.50 °C) in Margonda apartment, Depok. At the front of AC unit was vacant, free of furniture so the airflow could wander without obstruction. Distinction circumstance were happen inside the alternatives 1 and 2 ($T_{1 \text{ and } 2}$ is roughly 22 °C). Indeed at alternative 1, the room temperature increase, T_1 is almost 23°C at the room height, $h=0.5\text{m}$.

Again inside Silkwood apartment, Tangerang, because of the television table block the cool airflow cause the alternative 2 is very serious where T_2 is about 22.37 °C vertically. Alternative 1 is excellent (T_1 is below 22.20 °C) followed by the alternative 4 where T_4 is lower than 22.23 °C. Finally at Mutiara apartment, Bekasi, the existing layout is selected due to it has minimum barrier. Room temperatur existing, T_e is below 22.19 °C. The position of bed is upsetting therefore the room temperature are high in the alternative 2 and 3 where T_3 is around 22.44 °C and T_2 is about 22.58 °C vertically.

Cooling Coefficient of Performance (COP_c)

Based on the quantifying of room temperature furthermore will be acquired the cooling coefficient of performance (COP_c). Table 1 shows us the COP_c ranking for every furniture layout alternatives and apartment location. The COP_c results are straight comparable with the scores of room temperature agree with the equation 1. It is well-defined that the analysis of furniture arrangement will control the grade of COP_c. The placement of bed, partition, wardrobe, television, AC and the other goods

inside the apartment room will establish the efficacy of air conditioning system.

CONCLUSIONS

There are several methods how to increase the coefficient of performance which finally reduce the operational cost of air conditioning unit. Possibly there are two groups of approach in this matter: 1. Improvement of AC unit performance (included how to select the type of AC unit) and 2. Take advantage of environment where AC unit will be operated. This examination is correlated to the last. To be truthful, there is another sensitivity to exploit COP_c by means of furniture layout. Interior designer and architect make serious effort in order to the occupant feel comfort do some activities inside the apartment room.

Nevertheless, the effort to reduce operational cost of air conditioning system within maximize COP_c by means of furniture layout is in line to the electrical energy saving program of the government.

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