A study on the quality of natural ventilation in Jakarta traditional market

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Abstract. This study aims to determine the components of natural ventilation needed in traditional markets that have been built in Jakarta. This is an important matter to be processed regarding natural ventilation in the influence of the thermal comfort of market users when doing activities. This study uses quantitative methods to analyze the precedents of traditional markets that have been built in Jakarta. Natural ventilation components that pay attention to building shape, building orientation, size and location of inlets and outlets, vegetation, and average wind speed as a form of optimizing natural ventilation in traditional markets. The steps of this research are as follows: (1) conducting a numerical assessment of each precedent with natural ventilation components as a measure of the quality of traditional markets, (2) conducting a building mass study by simulating it to Autodesk Flow Design software (3) providing design recommendations to improve natural ventilation quality in traditional markets.

Keywords: traditional market, thermal comfort, natural ventilation

1. Introduction
The comfort aspect of architecture has two aspects of comfort that need to be fulfilled, namely psychological and physical comfort. Psychic comfort is personal and qualitative. Meanwhile, physical comfort consists of space comfort, visual comfort, hearing comfort and thermal comfort [1]. According to Karyono, thermal comfort is the most important thing to pay attention to because it affects energy use in buildings and the comfort of users of a building. He said that the theory of thermal comfort states that the feeling of heat or cold that is felt by the human body is a form of response from the sensory sensors on the skin to temperature stimuli that are around it. In conclusion, in order to save energy and increase the quality of comfort, it is necessary to pay attention to and improve thermal comfort in a building [2].

One of the buildings most often used by humans is the Traditional Market. Traditional markets as a place for human activities are very often used by some urban communities to make ends meet. This research was conducted in each traditional market in Jakarta. Pasar Jaya is a regional company owned by the Provincial Government of DKI Jakarta which is engaged in the management of the market area, fostering market traders, contributing to price stability and the smooth distribution of goods and services. Pasar Jaya has managed 152 markets in Jakarta [3]. However, about 30% are in poor condition, either from their physical condition or the number of active kiosks [4].
Therefore, this research was conducted to find out the factors that influence the natural ventilation components as a measure of the convenience of traditional markets in Jakarta. Natural ventilation components that pay attention to building shape, building orientation, size and location of inlets and outlets, vegetation, and average wind speed as a form of optimizing natural ventilation in traditional markets [5].

In conclusion, this study presents an assessment study of traditional markets as a precedent chosen to be investigated for natural components in assessing the comfort level of natural ventilation. So, the results will be known that the highest value will be used as a recommendation for the best ventilation design approach in designing a comfortable traditional market.

2. Methodology

2.1. The method of study

The method used in this research is quantitative analysis of the traditional market precedents. The activities carried out are observing and documenting the traditional markets under study, and calculating the average wind speed to determine the attainment of natural ventilation. The results of the study are in the form of a table on the comparison of the existing traditional market conditions under study to the natural ventilation components so that the best design form can be found.

2.2. The Case Study

The objects chosen for analysis were Pasar Jaya Kelapa Gading (Figure 1a), Pasar Sunter Podomoro (Figure 1b), Pasar Jaya Gondangdia (Figure 1c), Pasar Jaya Manggis (Figure 1d), and Pasar Jaya Mayestik (Figure 1e). All traditional markets studied are located in the Jakarta area and use the concept of natural ventilation in order to save energy in buildings, but the results studied have different benchmark values so that they have an impact on the effect of thermal comfort.

![Figure 1](image_url)

Figure 1. Traditional markets, namely (a) Pasar Jaya Kelapa Gading, (b) Pasar Sunter Podomoro, (c) Pasar Jaya Gondangdia, and (e) Pasar Jaya Mayestik.

3. Result and Discussion

3.1. Analysis and result of traditional markets with the application of natural ventilation

On this stage is to observe the theory of natural ventilation design principles, then analyzed from the surveyed market typology. This activity is to measure the quality of a traditional market with the best natural ventilation concept as an approach at the design stage. Table 1 shows the results of the analysis of several traditional markets by applying natural ventilation that takes into account several aspects, including the typology of buildings, building mass, building orientation, and vegetation:
Building Orientation
The orientation of the building mass influences the natural passage that enters the building by exposing the direction of the building to the source of the wind. In tropical climate areas, the widest part of the building area should have a north-south orientation.

Building Forms
Determining the shape of the building mass greatly influences direct access to air entering and passing through buildings that follow the wind orientation. Each form has advantages and disadvantages that affect natural ventilation. According to the theory, building mass no. IV is the most effective for natural ventilation (Lechner, 2010:10)

Inlet and Outlet Sizes and Location
The inlet opening not only determines velocity, but also determines the air flow pattern in the room. On the other hand, the location of the outlet has little effect on the air velocity and flow pattern. According to the theory, if the opening is smaller, should usually be the inlet because that maximizes the velocity and that has the greatest effect on comfort. However, the best way to have a good flow pattern is to have inlets and outlets the same size (Lechner, 2015).

Vegetation
Trees and bushes can funnel breeze through buildings. By preventing the wind from spilling around the sides of a building, a few tree or bushes can significantly increase natural ventilation.

Table 1. Results of typology analysis of traditional markets with the application of natural ventilation

| Natural Ventilation Component | Pasar Jaya Kelapa Gading | Pasar Sunter Podomoro | Pasar Jaya Gondangdia | Pasar Jaya Manggis | Pasar Jaya Mayestik |
|-----------------------------|--------------------------|----------------------|----------------------|-------------------|-------------------|
| Building Form               | Rectangle                | Rectangle            | T-Shaped             | Square-Compact    | Square-Compact    |
| Building Orientation        | North-South              | North-South          | East-West            | North-west-South East | East-West         |
| Inlet-Outlet Location       |                          |                      |                      |                   |                   |
Section

High and low openings with void
Cross Ventilation

Vegetation

Wind Avg. | ± 0.78 m/s | ± 0.85 m/s | ± 0.70 m/s | ± 0.76 m/s | ± 0.77 m/s
Score | 75% | 90% | 70% | 70% | 60%

Based on the results of the analysis studied, the Sunter Podomoro Market has the highest percentage value compared to other market objects. The design at Sunter Podomoro market has succeeded in achieving wind speeds that are suitable for human comfort, namely between 0.5-1 m/s [6]. The elongated shape of the building leads to the wind source; north-south so that the wind can enter the building maximally, then the placement of the inlet and outlet openings close together and across so as to facilitate air exchange. Furthermore, this building concept uses a stack ventilation system. This system can make it easier to flow hot air vertically so that the lower area in the building has good wind quality. Then the placement of vegetation around the site so that it will affect the movement of the wind so that it can enter the building.

3.2. Building mass simulation research

Based on the results of the analysis studied previously on Table 1, each traditional market has a building mass simulated into the Autodesk Flow Design software in order to determine the wind pattern on the effect of the natural ventilation concept used in each building (Table 2). The results of this study will find out which building form is the best so that it can make a solution as a cool and comfortable traditional market development in the future.
Table 2. Building mass simulation research

| Traditional Market | Illustration | Wind Speed Information |
|--------------------|--------------|------------------------|
| Pasar Jaya Kelapa Gading | ![Illustration](image1) | The wind speed that occurs inside the building is constant, with an average wind speed of ± 0.71 m / s |
| Pasar Sunter Podomoro | ![Illustration](image2) | The wind speed that occurs inside the building is constant, with an average wind speed of ± 0.82 m/s |
| Pasar Jaya Gondangdia | ![Illustration](image3) | The wind speed that occurs inside the building is not so constant, with an average wind speed of ± 0.70 m / s |
The wind speed that occurs inside the building is constant, with an average wind speed of ± 0.72 m/s

| Pasar Jaya | Manggis | The wind speed that occurs inside the building is not so constant, with an average wind speed of ± 0.76 m/s |
|------------|---------|-----------------------------------------------------------------------------------------------------|

3.3. Traditional Market Design Recommendation
Based on the results of the analysis of the 5 market objects examined from the aspect of natural ventilation components, it can be said that:
- Form IV, namely the elongated mass most widely used because it is considered the most effective way to get wind flow.
- The orientation of the building above and the location of the opening facing and parallel to the wind source so that all wind can enter the building.
- The location of the openings and the width of the openings are very influential in the amount of wind entering the building. Good placement of openings close together and across to increase use of the cross-ventilation system,
- Each market has high ceilings with high and low openings in order to accelerate the spread of the wind,
- The use of voids in buildings can make it easier for the wind to enter from the lower floors to spread upwards evenly and can smooth the air up over the building,
- The use of mezzanine floors as openings in the building can help to spread air evenly on each floor,
- Apart from being a wind guide, vegetation can be used as a dust filter, shade and gives a beautiful impression.

4. Concluding Remarks

Traditional markets are public facilities that are often used by people as a space for human activities are very often used by some urban communities to fulfill their needs. Thermal comfort is an important physical aspect to pay attention to for the comfort of building users. Optimization of natural ventilation can help improve human comfort in activities in the market. This research was conducted to measure the quality level of natural ventilation against traditional markets in Jakarta. As a result, there are still markets that do not meet the natural ventilation component. However, Pasar Sunter Podomoro can be used as an example of traditional market design for the application of natural ventilation in buildings. As recommendations, are to use an elongated building shape facing the wind source, provide the location of adjacent and opposite openings, use the concept of void, the mezzanine floor, the concept of the stack-ventilation system, and use of vegetation that surrounds the site.

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