Correlation of 3 dimensional visibility value to rental price among retail unit in shopping centers

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Abstract. Conventional buying behavior has gradually changed to online shopping because of technological development. It encourages developers to develop a new shopping experience. Shopping center creates a good experience to leave a delightful impression of the shopping center for their visitors. To create a good shopping experience, we need to consider the visibility factor to provide comfort for the visitors. Shops and products that are visible can help the visitors find what they are looking for and enrich their shopping activities. This research aims to find the correlation between the 3D visibility value of shop front and rental price in the shopping center through shopping experience. The experiment conducted in this research used a different method to measure visibility compared to previous studies. The visibility value is measured in a three-dimensional way by using the volume value of the storefront area. We used an explanatory research design with a quantitative analysis method of 150 units of stores based on permanent storefront and data availability. The results showed that visibility value in estimating rental price retail units in a shopping center is significant. The finding of this research can be useful for shopping center managers to estimate the rental rate for retail units and for architects to consider the visibility factor when designing shopping center.

1. Introduction

Improvements in technology have driven the development of online businesses and change shopping patterns from conventional shopping to online shopping. They encourage shopping center developers to innovate and change concepts such as shopping centers as entertainment venues to spend free time [1]. Besides changing the concept, innovation also includes creating a shopping experience that is not provided by online businesses. A good shopping experience needs to be supported by the visibility factor that can provide enjoyment and comfort for the visitors of the shopping center. The visitors will easily recognize and find stores and products that they can see, thus making shopping more enjoyable [2].

Visibility is one of the factors that can determine the rental price of a retail unit [3]. However, previous research in measuring the contribution of the visibility value to the rental price is inaccurate due to the lack of quantitative data. Visibility assessments are only associated with personal assessments [4], storefront width [3], and interactions between the subjects and the objects [5]. Only Romadhon's research has quantified the measurement of visibility values, but he only measured the visible area of the storefront. In fact, the appearance of an object seen by the observer is determined by the height and...
width of the object [6] and by the depth that makes the visibility of an object look three dimensional. Quantification of the visibility value is important considering the role it plays in determining the rental price. The quantified visibility value can show the correlation between the visibility value and the rental price.

This research aims to find the correlation between the visibility value of 3-dimensional of shop front to the rental price in a shopping center, as seen in figure 1. There are two questions from this aim; (1) what is the correlation between the 3-dimensional visibility of the shopfront to the rental price and (2) how to measure the visibility value in three dimensions.

![Figure 1. Theoretical Framework](image)

Previous research in creating shopping experiences was influenced by factors such as atmosphere [6, 7, 8, 9, 10, 11, 12, 13], variations of products and tenants [9, 13, 14, 15, 16], and layout [14]. The experience provided by the store atmosphere is one of the strategies that can be used by developers as an attraction or added value for shopping centers [17].

The main concern of previous research in creating a shopping experience through the atmosphere is the effort to slow down the movement of the visitors. It can be done by providing music with a slow tempo that can also increase the fun, concentration, and enjoyment while shopping. Slower movements make the shops and the products more visible and easier to be found, thus raising the potential to buy more products [18]. Besides music, pleasant aromas can affect emotions and the amount of time spent in a shop [15]. As the visitors explore the store, it can make existing products more visible. In addition to aroma, soft light can reduce the level of stimulation which has an impact on slowing the movement of the visitors that can influence the amount of time they spend [19], and have the potential to explore the store. The lighting in the shopping experience important to attract their attention so that shops and products are more visible to visitors.

Another important factor in creating shopping experiences mentioned in previous researchers is presenting shopping enjoyment through a variety of products and tenants [15]. Product variations and tenants refer to the service choices [20]. Shopping centers that offer a variety of tenants and products can provide a lot of different service choices that can affect rental prices [16] and attract visitors. Shopping centers that offer a variety of products either within one store or between different stores can encourage visitors to spend a longer time [14]. With this in mind, a shopping center needs a good layout to facilitate visitors in finding what they are looking for. Therefore, variations in tenants and products have a close relation to visibility because it can motivate visitors to browse through the variations and it can influence the amount of time they spend in the shopping center [14].

Even though visibility is important, only a few studies have discussed how it can affect the shopping experience. The layout has a role related to visibility because it displays something that has been created...
[21]. The layout can be defined as a space to set the product to be displayed and as a stimulus to attract visitors who encourage them to make impulsive purchases [22]. A good layout also has a positive effect because it creates a more pleasurable feeling that encourage the visitors to stay longer in their [14]. The enjoyment that visitors feel is the effect of visibility that makes it easy for visitors to find stores and products. We need to consider the visibility factor when creating a shopping experience. It is important to make sure that existing stores and products are visible to visitors and make easier for them to find the stores or products. It makes shopping more enjoyable [2].

Conceptually, previous studies have a weakness when discussing visibility because they only assessed it through personal assessments and just looking at the storefront in two dimensions, namely only by its width [3, 4]. In fact, visibility is three-dimensional because of the interaction between objects and subjects as the observers [5]. In assessing visibility, it requires subjective judgment from an observer and an objective view of something the observer sees. Ordway, et al. (1988) established subjective visibility assessments by identifying visibility through shopping center groups based on determinants such as location, building position, building height, main barriers, and architectural features. Each determinant then are grouped into six assessment index [4]. Index 1 has the worst visibility, while index 6 has the best visibility. Making a visibility index produces a category such as the worst and the best category.

Chau, et al. conducted an objective visibility assessment related to the visibility of the store’s face. A wider storefront provides more space for the visitors to get more information. But then again, the concept of visibility in this studies is only assessed in two dimensions. The only study that has applied the concept of three-dimensional of visibility was carried out by Romadhon.

Joko and Gamal explained that visibility as concept is not only about the object that subject could see but also how subject see the object [23]. The object is the store’s visible area that can be seen by the visitors while the subject is the number of visitors who can see the shopfront [5]. Previous research in looking at object visibility was seen as a point [5]. A point cannot be compared to a store because the store has width, height, and depth of space which makes the object three-dimensional. The visibility of an object in three dimensions relies on the height and width of the object which will produce vertical and horizontal angles [6]. The 88° angle is the comfort limit of someone in seeing visual information horizontally, while the 85.2° angle is the comfort limit of a person in viewing visual information vertically [24]. Therefore, if we want to use visibility to determine the rental price, quantitative measurement is needed to give the right results.

Research on the measurement of visibility value only measures the shopfront and the sea view area of the apartment unit. When considering the interactions between subjects as observers and objects, Romadhon applies the concept of visibility in three dimensions. But, when measuring the visibility value he did in two dimensions that is measuring the visible area. The measurement of the visibility of an object is not only influenced by the width of the object but also the height of the object [6]. The height of the object makes it possible to measure the appearance value based on the vertical area. Romadhon explained the measurement of visibility was calculated through two variables, namely the visible area variable (object) and the number of visitors who can see the storefront (subject). Area describe the size of the store area visible to visitors. Visitor traffic illustrates how many visitors can interact with the store.

Yu, et al. measured the effect of sea views on the selling price of apartment units. Seaview measurement variables are divided into two that is seaview and viewshed variables [25]. There are several steps to measure them. The first stage is creating a digital elevation model (DEM) that contains information about the land and the building heights. Modeling aims to be able to measure the effect of sea view visibility. The second stage is converting DEM into a grid format for analyzing visibility using the ArcView application which requires six parameters for visibility calculation. The final step is creating a viewshed index based on the results of the analysis that shows the value of visibility.

Retail unit rent or sale prices can be influenced by several variables. Physical building, location, and attraction are some of the categories that can determine the rental price or selling price of a retail unit. Physical building factor is related to the conditions of a shopping center such as area, age, and visibility
of buildings [26, 3, 27, 5]. Location is related to the placement or position and floor level [26, 3, 28, 27, 5]. Attraction is related to how shopping centers can attract many visitors through anchors, store images, brand groups, and the types of offered products [26, 27, 5, 29].

2. The Data and Method
We used an explanatory research design with an analytical approach to calculate the visibility value of 150 store units that have a permanent shop front. This research used store units that were in retail type shopping centers and not in wholesale type shopping centers. Retail type shopping centers provide a variety of facilities such as shopping facilities and recreational facilities to spend some free time. The diverse activities make the shopping experience more relevant because it gives an impression on the visitors and encourages them to explore the shopping center.

Rental prices in wholesale type shopping centers rental price vary because store units are usually privately owned and they can sell to other interested parties. On the contrary, retail type shopping centers are managed directly by a management team that acts as the owner of the unit. In this case, the shopping center management has control in determining the rent price of each store.

To make the calculation of visibility value more accurate, we only used one shopping center. We selected stores that have permanent shop fronts and not a temporary store, shops in the food court area, and anchor shops.

2.1 The Data
As have been discussed, previous research only sees the 2-dimensional aspect of the visible area when calculating the visibility value [5]. In this study, the measurement of visibility value is measured in three dimensions by taking the volume of the visible area and the number of visitors who could see it into consideration. In addition to the visibility value, the variable data needed for this calculation is the rental price (RP), unit area (A), floor level (FL), store distance (SD), store image (I), brand group (G), rental term (RT), and watch and gold (WG) which were mentioned in Romadhon's research.

2.2 Measurement of Visibility Value
Three-dimensional visibility value measurement is influenced by the volume of the visible area and the number of visitors who can see the storefront. These factors are important because visibility is an interaction between an object represented by the store’s face and a subject represented by the number of visitors [5] as seen in equation 1.

\[ VV = VA \times VT \]  

\( VV \) = Visibility Value (m³/visitor)  
\( VA \) = Volume of Visible Area (m³)  
\( VT \) = Number of Visitor (visitor)

Volume of visible area (VA) value is a space where visitors can see the storefront. Number of visitor (VT) is the potential amount of visitor traffic that can see the storefront. Therefore, the visibility value (VV) is the space of the storefront area that has a number of visitors who can see the storefront.

2.3 Measurement of Volume of Visible Area
There are three stages to measure visibility volume. The first stage begins by collecting data such as floor plans, elevation, and section to make a comprehensive 3D models of the selected shopping center. The second step is measuring the visible area horizontally and vertically at each shop unit chosen for the calculation. Measurement of the horizontal visible area is done by drawing a line from the left and right ends of the store face by 2°. Measurement of the vertical-looking area is done by drawing lines at
the top and bottom of the store face by 4.8°. The third stage is to determine the space based on the measurements of visible areas that have been made.

2.4 Measurement of Number of Visitors
In previous research, the visitor's traffic calculation was done at 5 points. The first point is located in front of the store, the second point is located across the store, the third point is located near the elevator, the fourth point is located in the escalator area, and the fifth point is located at the main entrance. After the data is collected, the traffic measurement is calculated by normalizing the amount that exists in order to see the ratio of traffic at the point of collection compared to the traffic of the whole a shopping center building, as seen in equation 2. However, in this research the measurement of visitor traffic normalization aims to see the comparison of the amount of traffic at one particular time compared with the amount of traffic in the entire shopping center building, with the formula as seen in equation 3.

\[ NT = \frac{VT_{spot \times Date \times Time}}{VT_{27 \times Date \times Time}} \]  
\[ NT = VT_{spot \times Time} \times \frac{VT_{Entrance \times Time}^z}{VT_{Entrance \times Time}^y} \]  

\[ NT = Normalized \ Traffic \ (visitor) \]  
\[ VT = Visitor \ Traffic \ (visitor) \]

2.5 Variable Correlation
After obtaining the variable data, we processed it by conducting a correlation test between independent variables and control with the dependent variable. The independent variable consists of the visibility value (VV), volume of visible area (VA), and number of visitors (VT). The control variable consists of unit area (A), floor level (FL), store distance (SD), store image (I), brand group (G), rental term (RT), and watch and gold (WG). The dependent variable is the rental price (RP). Table 1 explains the description of each variable and the correlation.

| Variable                  | Description                                           | Correlation |
|---------------------------|-------------------------------------------------------|-------------|
| Rental price (RP)         | Monthly rental price per square meter (m²)            | +           |
| Visibility Value (VV)*    | The number of visitors who can interact with the front area of the store | +           |
| Volume of Visible Area (VA)| The derivative variable of VV, the volume of visible area of the storefront |             |
| Number of Visitor (VT)    | The derivative variable of VV, the number of visitors who can see the storefront |             |
| Unit Area (A)             | Lease area (m²)                                       | +           |
| Floor Level (FL)          | Floor location of unit retail                         | -           |
| Store Distance (SD)       | Distance of the unit retail from the entrance         | -           |
| Store Image (I)           | Image of unit retail                                  | +           |
Correlation analysis can explain the level of relationship of each independent variable and the control of the dependent variable. The level of relationships generated through correlation analysis is divided into 3 categories namely positive, negative, and unrelated.

3. Result and Discussion
Correlation analysis shows and measures the strength of the relationship through the correlation coefficient. The correlation coefficient ranges from -1 to 1. The closer the coefficients to -1 or 1, the relationship between the stronger the independent variable and the control of the dependent variable are. Meanwhile, if the coefficient is closer to 0, the variables have a weaker relationship. The negative (-) and the positive (+) signs of the coefficient indicate the direction of the relationship between the independent variable and the control variable over the dependent variable. The negative sign (-) indicates the opposite direction of the relationship. If there is an increase in the independent variable or control, it will reduce the value of the dependent variable. Likewise, the positive relationship (+) indicates the direction of the directional relationship, meaning that any increase in the independent variable or control variable will increase the value of the dependent variable.

| Brand Group (G) | Brand group of unit retail (local, national, International) | + |
| Rental Term (RT) | Rental term of unit retail (month or year) | - |
| Watch and Gold (WG) | Product sold in the unit retail (watch and gold or not at all) | + |

The correlation between variables will be obtained after the correlation analysis is finished. From Table 2, we can see that the variables that have a positive relationship with rental prices at shopping centers are the visibility value (VV), volume of visible area (VA) and number of visitor (VT), store image (I), brand group (G), and watch and gold (WG). Meanwhile, unit area (A), floor level (FL), rental term (RT) and store distance (SD) have a negative relationship. Table 2 also shows that the number of visitor traffic has the strongest unidirectional relationship to rental prices. The volume of visible area doesn’t show a strong relationship to rental prices either. The rental term has the strongest opposite relationship to the rental price. In addition to correlation analysis, the relationship of each independent variable and control over the dependent variable can be demonstrated through tabulation and graphs, which can be found below.
The results show that visibility value has a positive correlation with rental prices. It is still in accordance with the previous theories that stated visibility is related to the interactions between objects and subjects and it can increase rental prices [5]. Table 3 shows that higher interaction between the visitor and the storefront will increase the rental price. For example, a store unit that has a visibility value of 0 to 1 million have rental prices between Rp 10,000 to Rp 400,000. Whereas, shop units with a visibility value of 2 to 3 million have rental prices range from Rp. 200,000 to Rp. 400,000. In addition to the tabulation, the positive influence of the visibility value can also be seen through the graph between the value of visibility to the rental price which has a positive direction as shown in Figure 2.

**Tabel 3. Tabulation of Visibility Value to Rental price**

| Visibility Value (m³/visitor) | 100K* - 100K | 200K - 200K | 300K - 300K | 400K - 400K | 500K |
|-----------------------------|--------------|-------------|-------------|-------------|------|
| 0-1M*                       | 7            | 5           | 52          | 13          |      |
| 1M-2M                       | 1            | 7           | 33          | 7           | 1    |
| 2M-3M                       | 9            |             | 7           |             |      |
| 3M-4M                       | 1            | 1           | 5           |             |      |
| 4M-5M                       | 1            |             |             |             |      |

*K= Thousand, M= Million

**Figure 2. Correlation Graphic of Visibility Value to Rental price**

**Tabel 4. Tabulation of Volume of Visible Area, Number of Visitor Traffic, Store Image, Brand Group and Watch and Gold to Rental price**

| Store Image                  | 10K* - 100K | 100K - 200K | 200K - 300K | 300K - 400K | 400K - 500K |
|------------------------------|-------------|-------------|-------------|-------------|-------------|
| Product Local                | 9           | 10          | 70          | 25          | 1           |
| Product National             |             |             |             |             |             |
| Number of Visitor Traffic (visitors) | 1   | 10         | 11          | 10          | 1           |
| 0-200                        | 2           |             | 3           |             |             |
| 200-400                      | 1           | 10          | 18          | 1           |             |
| 600-800                      | 1           |             |             |             |             |
| Volume of Visible Area (m³)  | 0-2K*       | 13          | 4           |             |             |
| 2K-4K                        | 5           | 8           | 43          | 9           |             |
| 4K-6K                        | 3           | 4           | 33          | 14          | 1           |
| 6K-8K                        | 1           |             | 4           | 5           |             |
| 8K-10K                       |             | 3           |             |             |             |
Table 4 shows that the volume of visible area, number of visitor traffic, store image, group brand, and watch and jewelry groups experienced an increase in the number of store units as these five factors increased with rental prices. Increasing the number of units of each factor can also be seen in the graph.

|                  | Product International          | 5 | 6 |
|------------------|--------------------------------|---|---|
| Non-Group Brand  | 9                              | 12| 94| 30| 1 |
| Group Brand      | 2                              | 2 |   |   |   |
| Watch and Gold   | 9                              | 12| 81| 23| 1 |
| Watch and Gold   | 15                             | 9 |   |   |   |

*K= Thousand

Figure 3. Correlation Graphic of Volume of Visible Area, Number of Visitor Traffic, Store Image, Brand Group and Watch and Gold to Rental price

Volume of the visible area has a positive correlation to rental prices as shown in Figure 3. This is consistent with the previous theory which states that more extensive the store’s face, the more information it can provide, thus increasing the rental price [3]. Storefront not only relies on the visibility of a horizontal area but also requires the visibility of a vertical area. This is because the visibility of an object is also determined by the width and height of the object [6].

The positive correlation provided by number of visitor traffic on rental prices can triggered by provin a greater spece for storefront visibility. A greater the space of the storefront visibility will increase the interaction with visitors. A greater number of visitors who can interact with the storefront, will also increase the closeness of the relationship to the rental price. It can be seen in Figure 3.

The image of the store has a positive correlation to rental prices as shown in Figure 3. This situation is in accordance with the previous theory that stated that the store’s image can provide a positive relationship or can increase rental prices [29]. Brand with higher image usually target the middle class up to the upper class. This sense of prestige can provide a unique experience and satisfaction to the visitors, especially if they buy a product or service with that particular brand.

Brand group has a positive correlation to rental prices as shown in Figure 3. It becomes more apparent if the retail unit represent a well-known brand. A more well-known brand can increase the rental price higher than an unknown brand [5]. The higher rental rates are also caused by retail units’ location and accessibility.
Watches and gold can increase rental prices because of the income they bring. Even though they only sell in a small quantity compared to other tenants, the income of watch and gold is bigger [5]. Therefore the rental price given to the watch and jewelry tenants are higher as shown in figure 3.

| Rental Price       | 10K* - 100K | 100K - 200K | 200K - 300K | 300K - 400K | 400K - 500K |
|--------------------|-------------|-------------|-------------|-------------|-------------|
| Unit Area (m²)     |             |             |             |             |             |
| 0-60               | 2           | 10          | 61          | 22          | 1           |
| 60-120             | 4           | 1           | 19          | 8           |             |
| 120-180            | 1           | 6           |             |             |             |
| 180-240            | 1           | 1           | 6           |             |             |
| 240-300            | 1           | 4           | 1           |             |             |
| Floor Level        |             |             |             |             |             |
| LG                 | 1           |             |             |             | 11          |
| UG                 | 3           | 1           | 8           | 19          |             |
| 1                  | 1           |             | 12          | 12          |             |
| 2                  | 2           |             | 23          | 1           |             |
| 3                  | 2           |             | 20          | 1           |             |
| 4                  | 2           | 3           | 2           |             |             |
| 5                  |             |             |             |             | 19          |
| 6                  |             |             |             | 6           | 1           |
| 0-50               | 2           |             | 12          | 9           |             |
| Store Distance (m) |             |             |             |             |             |
| 50-100             | 3           | 2           | 37          | 23          |             |
| 100-150            | 4           | 3           | 27          | 1           |             |
| 150-200            | 7           | 19          |             |             |             |
| 200-250            |             |             |             |             |             |
| Rental Term        |             |             |             |             |             |
| Year               | 9           | 94          | 32          | 1           |
| Month              | 9           | 3           | 2           |             | 1           |

*K= Thousand

In contrast to the previous factors, unit area, floor level, store distance, and rental term have negative correlations to rental prices. The decrease in rental prices can be seen from the distribution that the higher the level the lower the number of store units, as shown in table 5.

Figure 4. Correlation Graphic of Unit Area, Floor Level, Store Distance and Rental Term to Rental price
The area of the unit has a decrease in the number of store units as the area of rent is increased and has a negative correlation, as shown in figure 4. This is different from the previous theory that suggested that the area of the unit has a positive relationship with rental prices \([26, 27]\). The difference between theory and existing conditions is due to the growing trend of monthly rental term in shopping centers. The monthly rental term offered by the manager of the shopping center drives the tenants to rent a smaller unit area to minimize losses. The smaller the area rented, the higher the rental price per m² will increase.

The floor level has a negative correlation to the rental price as shown in Figure 4. The higher the floor level the unit is located, the lower the rental price is. The reduced rental price can be caused by the decrease in visibility when viewed from the ground floor. This is consistent with the theory that stated that shop units on the ground floor will be more expensive than the one on the levels above and belows \([28]\). The decrease in rental prices can also be caused by the limited accessibility.

Figure 4 shows a negative correlation between the store distance from the entrance and the rental price. A negative correlation can be seen from the decrease in the number of units as the store goes further from the entrance. Strokes that are far from the entrance means they are also far from the crowd \([5]\). Additionally, the distance of the store from the entrance can be related to the floor level as well. Stores that are one level above and below the ground floor, have a bigger distance to the main door, therefore putting them at disadvantage compared to the store which is close to the entrance or on the ground floor.

The rental term has a negative correlation to the rental price as shown in Figure 4. The rental term is important in this research because it can give discounted rental rates. The monthly rental term usually gives a benefit to the tenants like freeing them of paying the service charge fee. It what makes rental rates for the monthly term cheaper compared to the annual term \([5]\).

4. Conclusion
In order to create a good shopping experience, we need to take the visibility factor into consideration because it can make products and stores easier to be recognized and found by visitors. Visibility is not only related to how an object can be seen or how a subject can see the object. It is also, the interaction between the objects and the subjects \([5]\). The object is represented by the volume of the visible area while the subject is represented by the number of visitor traffic who can see the storefront. Interaction that occurs is how a shopping center visitor can see and know about information provided by tenants that they put in the storefronts. We found that, the visibility has a positive correlation with the rental price as seen in table 2. The positive correlation shows that the higher visibility value of a store unit, the higher the rental price that is offered to the tenants. The method used in measuring the value of visibility is the multiplication between volume of visible area and number of visitor traffic that can see the storefront, as seen in equation 1. Besides the visibility value, other factors that have a positive correlation to rental prices are (1) volume of visible area, (2) number of visitor traffic, (3) store image, (4) brand groups and (5) watch and gold. Other factors such as the (1) unit area, (2) floor level, (3) store distance and (4) the rental term have negative correlations with the rental price.

The positive correlation between the visibility value and the rental price can be relevant for shopping center managers and architects. When the shopping center manager determines the rental price, it can involve the visibility value as a factor in raising the rental price. Whereas for architects can take advantage of the visibility factor when designing shopping centers, so as to produce a design that can maximize the visibility of each unit in front of the store.

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