Transportation mode choice of workers in Cikupa Village, Cikupa Sub-district, Tangerang Regency, Banten Province

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Abstract. In carrying out a travel plan, people will have to consider a lot of things such as distance and their financial abilities as well as various other considerations so that they are able to pick the most suitable transportation mode to reach their destination. This includes making a trip to one’s workplace. This research was conducted in Cikupa Sub-district, which is a sub-district with the highest number of workers in Tangerang Regency, as well as an industrial central area surrounded by regular and irregular settlements with differences in settlement quality, derived from settlement patterns, accessibility, and existing facilities, resulting in differences in the choice of transportation modes for work. This study aimed to analyze the transportation mode choice by workers in Cikupa Village and the variables that influence it. The variables studied were the travel-based characteristics including travel costs, travel time, and distance traveled. Variables were processed and analyzed with spatial analysis methods supported by statistical methods of chi-square and contingency coefficient. The results showed that the majority of workers in Cikupa Sub-district use private vehicles, mainly motorcycle. The results of the statistical test indicated that the only variables that greatly influenced the choice of transportation modes are travel costs and travel time.

1. Introduction
Transportation is one of the things that play a big role in supporting human life. In choosing a transportation mode, someone certainly needs several considerations, such as distance and human capabilities in financial terms. However, although humans consider distance, time, and costs in spatial movements, their spatial behavior is also affected by several other conditions [1].

Transportation is one of the integral aspects of everyday human life. There are 3 categories of urban transportation based on the type of operation and use, namely private, for hire, and public [2]. In the choice of transportation mode, one certainly needs several considerations, such as distance and human capabilities in financial terms can be taken into consideration in choosing a mode of transportation. Even though humans consider distance, time, and costs in spatial movements, their spatial behavior is also affected by several other conditions of space activity and awareness, economic conditions and individual life cycles, mobility levels, and unique perceptions of wants or desires, and needs or needs [1].

The choice of mode of transportation certainly cannot be separated from the characteristics of the trip carried out. Cost is one of the most important considerations in choosing transportation modes. Because each mode has its own cost/performance profile, modes competition depends on the distance traveled,
the number of items to be moved and the value of the goods. Distance is still one of the basic determinants of capital use for passenger transportation. However, for the same distance, cost, speed, and comfort can be a significant factor behind the selection of modes [3].

Each individual will have a different travel behavior according to their background or socio-economic characteristics [4]. Socio-economic factors including gender, employment status and income, nationality, age, education level, type of house, family condition, length of stay in the current place of residence, and number of children [5]. In this study, socio-economic factors are limited to age, sex, income, and ownership of private vehicles.

When discussing travel distance, the farther the distance that will be traveled, people will tend to choose public transportation modes. Travel time also includes waiting time in nodal interchange, walking time to nodal interchange, etc. Meanwhile, travel costs also include the costs of public transport fares, fuel costs, etc. such as the cost of using the toll road. Transportation costs will be considered especially if someone wants to effectively travel with minimum expenditure [6].

Someone chooses the most appropriate route for each trip according to the purpose of the trip, so that the travel time is short with the lowest travel costs. Selection of the best route often directs travelers into intermodalism. Rodrigue et al. defined intermodal transportation as the movement of passengers or goods from one mode of transportation to another, usually occurring in terminals specifically designed for that purpose [3]. It is not uncommon for a person change modes of transportation in one trip according to the purpose and efficiency of the trip. In transportation system, the term transportation node is known as a place where someone changes modes of transportation which are often called intermodal terminals or hubs, defined as the place that’s used to change transportation modes so that the continuity of movement of humans and goods will go well [6].

Tangerang Regency is a regency with the largest population in Banten Province with a density of 3,736 people/km2 in 2017 [7]. This research was conducted in Cikupa Sub-district which is the second most populous sub-district in Tangerang Regency with working age population (15-65 years) reaching 208,654 people, the largest number of companies in Tangerang, which is 1,419 companies, and the highest number of workers reaching 195,257 people or around 93.57% of the working age population.

Cikupa Sub-district itself is an industrial central area surrounded by settlements which are divided into two, namely regular settlements (housing) and irregular settlements. Data collection for this research was conducted in Cikupa Village. Cikupa Village is one of the villages in Cikupa District which is a suburban area where the largest regular settlement area in Cikupa District (Perumahan CitraRaya) is located in that has very different facilities and infrastructure that are very different from the irregular settlement areas, showing the living quality gaps in the region. In carrying out work activities, people would have to make a movement towards the workplace by using their chosen mode of transportation.

2. Research Method
The area studied was Cikupa Sub-district, Tangerang Regency, Banten. Data collection was carried out in Cikupa Village. The research method used is a research method with a spatial approach. The research was conducted in three stages, namely pre-survey, survey, and post-survey. In this study, the Y variable is the transportation mode used for work. While the variable X used consists of travel characteristics (cost, time, distance).

The types of data used are primary and secondary data. Because the exact population of the study is unknown, the determination of the number of samples was determined using a non-probability quota sampling method. The respondent sample was categorized based on the type of settlement, namely the Regular Settlement Class I (RSC I), Regular Settlement Class II (RSC II), and Irregular Settlement.
RSCI consists of clusters in Perumahan CitraRaya with house type of >36, RSC II includes clusters with house type of ≤36. The criteria of the respondents in the study were workers residing in Cikupa Village who had worked full time (not part time) and are of working age (15-65 years). Each sample group has a quota of 20 respondents. The research sample was taken accidentally (accidental/convenience), according to the quota. Data collection is done door-to-door by filling out the questionnaire. The primary data needed can be seen in Table 1. Secondary data obtained from literature study activities carried out in the pre-survey stage as well as during the study. Secondary data needed for this study can be seen in Table 2.

### Table 1. Primary Data

| No | Variable               | Data                                      | Source          |
|----|------------------------|-------------------------------------------|-----------------|
| 1  | Transportation Mode    | The transportation mode used by          | Field Survey    |
|    |                        | respondents to work                       |                 |
| 2  | Travel Characteristics | Travel Costs                              |                 |
|    |                        | Travel Time                               |                 |
|    |                        | Travel Distance                           |                 |

*Source: Data Processing, 2019*

### Table 2. Secondary Data

| No | Data                  | Source                                         | Year |
|----|-----------------------|------------------------------------------------|------|
| 1  | Administrative Region | Peta Rupa Bumi Skala 25k, BIG                  | 2014 |
| 2  | Landuse               | Peta Penggunaan Lahan Skala 25k, BIG           | 2014 |
| 3  | Road Network          | Peta Transportasi Skala 25k, BIG               | 2014 |
| 4  | Perumahan CitraRaya   | Digitized from Google Earth                   | 2018 |

*Source: Data Processing, 2019*

### Table 3. Classification of Survey Results

| Variable               | Factor                  | Class        | Criterias               |
|------------------------|-------------------------|--------------|-------------------------|
| Travel Costs (Rp/month)| Low                     | < 1.000.000.00|                         |
|                        | Medium                  | 1.000.000.00-1.999.999.00 |            |
|                        | High                    | ≥ 2.000.000.00|                         |
|                        | Short                   | 1 - 44       |                         |
| Travel Time (Minutes)  | Medium                  | 45 - 89      |                         |
|                        | Long                    | ≥ 90         |                         |
|                        | Near                    | 1 - 44       |                         |
| Travel Distance (Km)   | Medium                  | 45 - 89      |                         |
|                        | Far                     | ≥ 90         |                         |

*Source: Data Processing, 2019*

Data processing is then carried out by making a map of the research area, then tabulating the results of the survey data, and then the data is classified into a few classes. The classification and categorization of data based on data distribution can be seen in Table 3.

The method of data analysis used in this study is descriptive spatial analysis with map overlays, supported by statistical analysis methods of chi-square and contingency coefficient. Chi-square statistical analysis is a method for analyzing the correlation between nominal variables. This method is used to test the hypothesis that there is a significant relationship between x and y variables [8,9]. Both of these methods are used to answer the research questions, "How is the choice of transportation modes used by workers based on the characteristics of travel in Cikupa Village?"
Table 4. X and Y Research Variables

| No. | Variable Type | Variable               |
|-----|---------------|------------------------|
| 1   | X             | Travel Characteristics |
| 2   | Y             | Transportation Mode     |

Source: Data Processing, 2019

3. Results and Discussion

3.1. Results

3.1.1 Transportation Mode Choice by Workers. The use of transportation modes in this study can be classified into several types of modes of use, namely P1 (Private Car), P2 (Private Motorcycle), U or Public Transportation (bus, KRL, etc.), PA or Paratransit (commercial ojek, on-line ojek, taxi, bajaj, etc.), P-U or Private Vehicles (cars/motorbikes) → Public, P-U-U or Private → Public → Public, and PA-U or Paratransit → Public. Most of the workers choose to use P2 to work, which amounted to 41.67% of the total respondents, followed by car (P1) of 33.33%. This shows that more than 70% of workers choose to use private vehicles to get to their workplaces. For the modes that are rarely used by workers is Type U or public vehicles only and Type P-U, that is by using private vehicles then changing to public vehicles with a percentage of 3.33% of the total respondents.

Figure 1. Map and percentage chart of transportation mode usage

Source: Data Processing, 2019

3.1.2 Travel Characteristics. Travel characteristics are factors that are related to and influence a person's trip. In this study, the factors included in travel characteristics are travel costs and travel time which are included in the characteristics of the transportation mode, as well as the distance traveled which is a characteristic of movement. The most dominant costs of travel is of Class Low (63.33%). The most rarely found travel costs are those included in the High Class. The most expensive cost spent by workers to work is Rp. 4,000,000.00, while the lowest cost is Rp 50,000.

The majority of workers reach the workplace in less than 45 minutes, which is around 51.67%. While workers who spend more than 90 minutes on the trip were the least encountered, which was 21.67%. Most of workers in Cikupa have a workplace location under a radius of 15 km from their residence. This can be seen from the percentage, which is equal to 43.33% of the sample of workers, followed by a distance of over 30 km with a percentage of 38.33%. Finally, the rarely encountered range of distance from residence to workplace is the distance of 15-29 km, which is only 18.33% of the total sample.

3.2. Discussion

Selection of Transportation Modes Based on Travel Characteristics

To facilitate analysis and discussion, the travel destinations are divided into two, namely Banten Province and DKI Jakarta Province. Banten Province covers Tangerang Regency, Tangerang City,
South Tangerang City, and Serang City. Based on the results of the data, DKI Jakarta Province covers West Jakarta, Central Jakarta, South Jakarta and North Jakarta.

3.2.1 Travel Costs. Most workers in Cikupa Village spend relatively low travel costs, while high travel costs are the most difficult to find. Workers who spend low and medium costs use varied modes of transportation. Workers with low travel costs usually use a motorbike. While for workers with medium and high travel costs, they usually use a car to reach their work place.

Workers with high travel costs are not as diverse as the others. This is because the cost of using private vehicles is greater, especially cars. For example, for fuel costs, toll roads, parking lots, and so on. It can be concluded that workers who use private vehicles, especially motorcycles, will pay less, or if reversed, usually workers with higher costs usually use cars. For workers who are included in the medium and high cost classes who work in the Banten area, they generally use cars. This shows that the higher the cost of travel, a person will tend to use the car. For workers with Jakarta as their travel destination, the dominant mode of transportation is P1 (car), only then followed by motorbike users.

From Figure 2, it can be seen that for low travel costs to Jakarta, motorbikes and cars are widely used. Another case with the cost of middle-class travel is dominated by P-U-U and PA-U. This is because for the two types of mode usage, there are fees for public transportation tickets and paratransit that must be paid which are still relatively affordable. For high-cost classes, it is dominated by the use of cars which are certainly not as affordable as other modes.

It can also be assumed that workers who use the largest travel costs also have high income. As according to Diaz's research, people with higher incomes tend to not pay too much attention to the difference in travel costs in choosing transportation modes. Someone with lower income usually tends to choose the most effective mode of transportation, which is the cheapest. [10] This encourages someone with a higher income to prefer private vehicles because costs are something that is not considered an obstacle. Apart from that, for the use of other modes of transportation such as those that can be seen on the map, none was in the class of high travel costs. For public vehicle users only (U), they usually have low and medium costs. Users of paratransit vehicles only (PA) usually incur low travel costs. P-U mode users usually have low and medium travel costs. While for P-U-U tends to have low costs.
Based on the results of the chi-square calculation, it is known that the significance number of the relationship between travel costs and transportation modes is less than 0.05, which is equal to 0.039, which means that $H_0$ is rejected. Thus, it can be concluded that there is a relationship between the cost of travel and the mode of transportation used. The results of the contingency coefficient calculation show the value of the relationship between travel costs and transportation modes is 0.517 which is closer to 1, indicating that the relationship between the two is getting tighter.

3.2.2 Travel Time. It is known that most workers in Cikupa Village only need a short time to reach their work place. Workers who have to spend a lot of time on trips are much less. For workers with short and long travel times, most of them use private vehicles to go to work, only a few use public transportation, paratransit, or other types. For workers with short and long travel times, motorbikes dominate more. For workers with medium travel times differ from others, where they usually use cars. Workers with relatively short travel time in Banten as a whole mostly use motorbikes. Another case with trips in Banten that takes a medium amount of time are usually surpassed by a car. While for trips to the workplace in Banten which is classified as long there is only 1 trip, and the trip is done by motorcycle.

A different case with workers who work in the Jakarta area. There are only medium and long travel times. Regarding location, the Jakarta area is far enough so that it certainly takes more time to reach the destination. Broadly speaking, most workers heading to Jakarta use cars to leave for work, which are then followed by motorbike users. For workers in Jakarta with medium travel time, the majority use cars, while for long travel time, the majority use motorbikes.

To reach a destination, someone will definitely choose the most effective modes and routes. For trips with a short time, it can be concluded that motorbike is more effective because motor can use various alternative roads to reach the destination. However, apart from that, motorbikes can also hamper travel because they cannot pass through several routes such as highways which in many cases can help shorten travel time. Therefore, there were also respondents with long travel times who turned out to be motorbike mode users. The use of cars can shorten the time with the use of toll roads as shortcuts, especially for the Jakarta area.

Users of other modes of transportation are very diverse. For users of public transportation and P-U, they tend to spend short and long travel times. It is different with PA transportation mode users who tend to have short travel times. Unlike the others, workers who use the P-U-U and PA-U modes of transportation tend to have medium travel times.

![Figure 3. Map of Transportation Mode Choice Based on Travel Time](image-url)
Based on the results of the chi-square calculation, it is known that the significance number of the relationship between travel time and transportation mode is less than 0.05, which is equal to 0.031, which means that $H_0$ is rejected. Thus, it can be concluded that there is a relationship between travel time and the mode of transportation used. The results of the contingency coefficient calculation show the value of the relationship between travel time and transportation mode of 0.523.

3.2.3 Travel Distant. In Cikupa Village, it turns out that more workers have workplaces that are either near or far, compared to medium distances. For workers with close (near) work distance, they tend to use a motorbike. Conversely, for longer distances, namely medium and far distance classes usually use a car. For near travel distances in Banten, the use of motorbike is dominating. Meanwhile for medium distances the use of the mode is more varied with the use of cars more dominating. After cars, PA and P-U-U are more widely used. For long distances, though not much, it can be seen that there are P1 and P2 users.

For workers in Jakarta, of course they have to travel further. Therefore, there are only two classes, namely short and long distance. There was only one worker with near travel distance, while the remaining sample of workers is included in the distance class. For workers with close distances using the PA-U. Workers with long distances vary greatly which are then dominated by P1 users or cars. After the car, the motorbike is often chosen as the mode to get to work in Jakarta.

![Figure 4. Map of Transportation Mode Choice Based on Travel Distance](image)

From the map above, it can be seen that there is a pattern in the choice of transportation modes for workers in Cikupa Village. The farther a person has to go to reach his workplace, they will tend to use a car. Conversely, the closer the location of a person’s workplace, will tend to use a motorbike. It is inversely proportional to the theory by Tamin which says that the farther the distance that will be traveled, people will tend to choose the mode of public transportation. [6]

Naess stated that people in suburban areas tend to use private vehicles. [11] The argument turned out to be in accordance with the discussion above based on data obtained during the survey. Cikupa Village is included in the suburbs and part of the capital’s supporting city. Many workers have to use vehicles to reach farther places, sometimes there are also locations that cannot be accessed by public transportation, encouraging high use of private vehicles. Burian et al. stated that transport service plays a great role in people’s travel behaviour. People who do not have public transportation options to reach their
destination in decent time and conditions tend to seek for individual transport options. This is surely in contrast to metropolitan areas which often have destinations that are not far away, they can be reached without using motorized vehicles, and also the transportation network system is much better than in the suburban area. [12]

For the use of other transportation modes, type U mode users tend to travel medium and long distances. PA type mode users usually do medium distance trips. It is different with P-U mode users who tend to travel near and far. For P-U-U it usually takes long distances, while for PA-U there are three samples of workers, each of which has close (near), medium, and far distances.

Analysis of chi-square calculation was carried out based on number of significance. It is known that the significance number of the relationship between travel time and transportation mode is greater than 0.05, which is equal to 0.072, which means that H0 is accepted. Thus, it can be concluded that there is no relationship between travel time and the mode of transportation used. The results of the contingency coefficient calculation show the value of the relationship between travel time and transportation mode is 0.498 which indicates that the relationship between the two is not tight.

The results of the correlation analysis show that travel characteristics have a strong influence on the choice of transportation modes, seeing two of the variables included in the trip characteristics have a low significance value, and the C value is closer to number 1. However, it is slightly different from the results of research by Wibowo and Chalermpong who concluded that time, cost, and distance had a significant influence on the use of mass transportation modes [13]. In this study conducted in Cikupa Village, it was known that only travel time and costs affected the choice of modes included in the travel characteristics.

4. Conclusion
The choice of mode is more determined by the cost of travel and travel time which is also supported by the results of statistical tests. Workers tend to choose transportation modes that can speed up time on the road and be the most economical. Workers in Cikupa Village tend to choose motorbikes because of the lower cost of travel, compared to the use of cars with high travel costs. This is because the cost of using private vehicles is greater, especially cars. For example, for fuel costs, toll roads, parking lots, and so on. Workers with short and long travel times mostly use motorbikes, while workers with moderate travel time usually use cars since motorbike can use various alternative roads to reach the destination. However, motorcycles can also hamper travel because they cannot pass through several routes such as highways which can also help shorten travel time. The farther the distance, workers tend to use cars. Conversely, the closer the workplace, tend to use a motorbike.

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