



# **MODE SHIFT PROBABILITY FROM PRIVATE TO PUBLIC TRANSPORTATION (Case Study: Bandung, Indonesia)**

**Master Thesis**

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(Case Study: Bandung, Indonesia)

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*- For my beloved dad, Yusef Ruhanya -*

## PREFACE

Four years of studying urban planning and then delving deeper into the environmental and infrastructure planning on the last additional year, it has made me absolutely convinced of the complexity of the urban planning. This has caught my interest and challenged me to learn more about this subject. When I thought hard of what my thesis should be about, I was reminded of Bandung, the city where I was born. To illustrate its beauty and comfort at that time M.A.W. Brouwer quoted that “*Bandung was created when God was smiling*”. However, nowadays, a contrasting situation occurred can be found. Urban problems, and especially the transportation problems have reduced the comfort of this city. For this reason I chose to focus particularly on the transportation sector.

This study would not be possible without the support from God and from the amazing people in my life. Thus, first of all, I would like to thank God Almighty. Praised be to God, the compassionate and the merciful. I also would like to express my gratitude to my family and my boyfriend who have endlessly supported me with their love and prayer. I also would like to express my deep gratitude to Dr. Tim Busscher, my supervisor who has been patiently guiding me and giving many constructive advices, views and opinions and also to Marije Hamersma MSc, my second reader of my thesis who has given useful advices for my thesis improvement.

In this short space, I also would like to thank Nuffic – Neso that through the Stuned Scholarship Program has provided me with financial support. Many thanks also to PPI Groningen which has become a second home for me during my stay in Groningen. In addition, this study would also not be possible without the participation of the questionnaire respondents. Therefore, I am grateful to all participants and to PT. Surveyor Muda Indonesia that has helped me distributing the questionnaires. Last but not least, I also would like to thank all people who helped me in pursuing my master program, to all my lecturers, my friends, and my colleagues who cannot be mentioned one by one.

Lisna Rahayu

Groningen, August 2015

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## **ABSTRACT**

*Urbanization is an unavoidable phenomenon. Its predicted future increase will have a significant impact on transportation demand. This makes that anticipation through a good transportation planning is required. Bandung is an important city in Indonesia that has a strategic function. In the National Spatial Plan, this city is established as part of the national activity center. Considering this strategic function, the transportation system of Bandung City has an important role to serve the movement that not only within the Bandung City but also widely serves the regional scope of the Bandung Metropolitan Area. However, in the existing condition, the public transportation in Bandung City is still far from adequate nor reliable. This unreliable public transportation as well as a mediocre improvement provided by the government has created a distrust and pushed people to find a self-generated alternative solutions that mostly are by using a private vehicle that generates a bigger congestion.*

*Using the Transport Demand Management Perspective as a standpoint, this research is aimed to model the transportation mode preferences of Bandung City Residents, especially the workers, and combines it with their willingness to use public transportation. This allowed us to further identify alternative strategies to increase the mode shifting probability from private to public transportation. Since the workers are the biggest contributors to traffic in Bandung City, the intervention toward this group is predicted to have a big impact on the improvement of the Bandung City transportation system.*

*Based on the modelling result using logistic regression, it is identified that there are six variables that significantly influence mode shifting probability in Bandung City. These variables are 1). Private vehicle ownership, 2). Driving license ownership, 3). The distance between public transportation and location of work, 4). Perception of current mode efficiency, 5). Perception of current transport cost, and 6). Perception of mode comfort. As an implication, in order to increase the mode shift probability, these variable should be addressed as main priority in the Bandung transportation planning. In addition to these variables, enhancing the workers' willingness to use public transportation through building the public trust should be taken into account as well. Jointly, these variables will be a basis for strategy making to increase the mode shifting probability (from the private to public transportation) of the workers in Bandung City.*

*Key Word: Mode preferences, mode shifting, transport demand management, willingness*

## CHAPTER 1 INTRODUCTION

### 1.1. Background of the Importance of Public Transportation in Bandung City

The city is a center of accumulation of various activities. The high urban activity in the city creates a high demand for transport, especially with the presence of increasing urbanization phenomena. In the case of Indonesia, in 2000 the percentage of the urban population in Indonesia is approximately 85 million or 42% of the total population and it is predicted that by 2020, this number will have increased to 132.5 million or approximately 52% of the total estimated population in Indonesia (Indonesia Agenda 21, 1997 in Pontoh and Kustiwan, 2009). Increasing urbanization is predicted will lead to an increase in transport demand. This means that anticipation of a good transportation planning is fully required.

Bandung City is the capital of West Java province, which is the second most populous province in Indonesia after Jakarta. In 2013, the population of Bandung City is around 2.48 million people with a density of almost 15 thousand people per Km<sup>2</sup> (BPS, 2014). According to the National Spatial Plan, Bandung City is established as part of the National Activity Centre, functioning to serve international, national, and several provinces activity scale (Indonesian Government Regulation No 26/2008). Based on that function, the transportation infrastructure of Bandung City does not only serve the internal movement in Bandung City itself, but also widely serve the regional scope movement in the Bandung Metropolitan Area which includes the Bandung City and several cities and municipalities surround it.

The main public transportation in Bandung City until now is still served by *angkot*, the small four-wheeled vehicle that has been modified and used as public transport. The service area of *angkot* covers 39 trajectories that are served by 5.521 cars. Compared to the other kind of public transportation currently available in this city, for example the public bus, which only covers 7 trajectories and served by only 142 units of bus, it is clear that *angkot* has a big domination towards the public transportation sector in this city.

The existence of *angkot* as a public transport is a dilemma. On the one hand, this mode of public transportation is perceived as a flexible mode since passenger can stop *angkot* anytime and anywhere, without any specific schedule or need to walk to a specific public

transportation stop. On the other hand, unorganized schedule makes *angkot* becomes unreliable in its travel time since it frequently stops. Apart from that *angkot* is often accused of being the cause of congestion (Tamin, 1996). Its flexibility and the absence of specific stops as well as the lack of management becomes a factor that inhibits the traffic flow. Considering the existing road still serves mixed traffic, the slowdown caused by *angkot* often gives an impact to the traffic congestion.

The absence of the adequate public transport system results in the increase of the use of private vehicles as a mode of transportation. According to the data from Bandung City Statistics, from 2009 to 2013, the average annual growth of private passenger car and motorcycle ownership in Bandung City respectively is 7.34 and 7.63 %. The increase use of private vehicles may lead to even more congestion, especially when that growth of vehicle ownership does not balance with the growth of transportation infrastructure.

In order to minimize the congestion problems, according to the theory of travel demand management ideally there should be a modal shift from private vehicle usage to public transportation usage which has bigger occupancy yet use less space (Ferguson, 2000). However, the mode choice highly depends on the trip maker preferences, which are not only influenced by the rational factors, but also by the behavior of the trip maker (Ortuzar, 2011; Abou-Zed et al., 2011; Van Acker et al., 2009; Van der Waerden et al., 2008; Kingham et al., 2001). This means that it is important to identify the mode choice pattern concurrently with the willingness of the trip maker in switching their mode to public transportation to make it more comprehensive.

Based on this background, this thesis will model the mode preferences of Bandung City Residents and combine it with the people's willingness to move out of their current private vehicle and switch it to public transportation. The object of this research will be more focused on the workers. This specialization is based on the argument that workers are the most potent group that generates traffic. Their regular travel pattern as well as their large proportion in Bandung city population structure (approximately 43 % of the total population of Bandung City), makes this group as an important determinant in the transportation of Bandung City. The intervention towards the willingness of the workers to switch their transportation mode into public transportation will give a significant impact towards the transportation of Bandung City in general.

This is a relevant study since the study that correlates the relationship between current mode choice pattern and the willingness of mode switching are still limited (Van der Waerden et al., 2008). This study can be used as a basis for the prediction of the probability of modal shift from private to public transportation and ultimately this study is expected can propose alternatives to increase the mode shift probability from private to public transportation in order to support Bandung City Development.

## **1.2. Objective and Research Questions**

The purpose of this research is to model the modal choice probability of the workers in Bandung City as an effort to further identify the alternative strategies to do to increase the public transportation usage. It is necessary to identify this case, the improvement in the transportation sector will create positive externalities to the other sectors that eventually will lead to the development of Bandung City in general. Moreover, with the important role of the city in the national scope both in the existing and future plan development, the city scale-improvement will give impact to national development as well. Based on this objective, therefore this research is aimed to answer this main formulated research question as follows.

“What is the current modal choice and the willingness behavior of the workers at Bandung City and its implication on the probability and strategies on the modal shift from private to public transportation?”

In an attempt to achieve the research’s goal, this research question is detailed into four sub research questions, which jointly will build basic components to answer the main research question. The formulated sub research questions are highly correlated one each other, the output gained from answering one sub research question will comprehend or even become an input to answer other sub research questions. The sub research questions in this master thesis are as follows:

1. What are the current characteristics of the trip maker/ the workers, the journey and the transport facility in Bandung City?
2. How is the behavior or willingness of the workers in using public transportation?
3. How big is the probability of the transportation mode shifting of the workers from private to public transportation?
4. What are the potential alternative strategies to increase the preferences of public transportation as a main transportation mode in Bandung City?

### 1.3. Scope of the Theory in this Research

The scope of the theory in this research can be classified into three components as follows:

1. The theory of the role of transportation in an urban system, reviewing transportation as a system and issues in urban transport. Then the theory will be more specified to the public transportation theory, ranging from the type, characteristics and its planning. This theory is used as a theoretical basis for understanding issues in the transportation sector. In turn, this theoretical basis will be useful to further analyze the current characteristics of the trip maker/ the workers, the characteristics of the journey and the characteristic of the transport facility to identify whether there are the transportation issues that are currently going on in Bandung City. The main reason to choose this theory is because reviewing the transportation aspect as a system instead of as a closed and self-contained aspect is perceived will give a more comprehensive perspective of public transportation in Bandung City. This theory is considered to be better to explain transportation issues and the problem at a complex urban system.
2. The theory of travel demand management, particularly related to the mode shifting as an attempt to accommodate the movement with more efficient public transit. In favor of the research goal of this thesis, this theory provides a strong argument for mode shifting from private to public transport. The selection of this theory is based on the reason that this theory allows a creative solution for transportation problem, especially the management from the demand side. Current strategies that tend to be practiced in a business as usual pattern are proven to keep making the transportation problem unsolved. Considering that fact, a breakthrough which intervenes transportation from the demand side instead of the supply side needs to be adopted.
3. Theory of the Planned Behavior is used to describe the willingness of the workers in using public transportation. This application of theory is in line with the second research objective to answer the question related to the behavior or willingness aspect. The former studies have indicated that this theory has extensive application in various sectors, including transportation sector, thus the application of this theory to explain the willingness of the workers at Bandung City in using public transportation is considered trustworthy and suitable
4. The theory of modal choice, including the influencing factors to the mode choice decision and the transportation modelling. For the transportation modelling, the theory then will be specified to the discrete choice model. In line with the research questions in this research, this theory will answer the question relates to the mode shifting probability from private

to public transportation and also to answer the question relates to the alternative strategies that must be made to increase this probability. This theory has been widely recognized and proven effective in identifying the modal choice cases, thus it is expected will provide a reliable analysis results.

#### **1.4. Structure of the Thesis**

The structure of this thesis is divided into six chapters. After describing an introduction regarding the background, the research objectives and its relation to the scope of the theory in this chapter, the remaining chapters will dig deeper into the theoretical arguments, the research process and the result of this research.

In **Chapter 2**, the elaboration of the theoretical base in transportation planning, especially the modal split theory will be provided. As an introduction, the explanation about the position of transportation in an urban system will come in advance and then continued with the brief theory about the transportation problem. In order to give a strong basis for the analysis, the theory about mode choice will also be elaborated in this chapter. After that, the explanation will be continued with the explanation about travel demand management.

**Chapter 3** will explain the methodology used in this research. The scope of the methodology will be classified into two sections, including the methodology to collect the data and methodology to analyze the data. So basically chapter one to three will consist of the introduction, theories used, process and procedure in conducting this research.

**Chapter 4** describes the detail existing condition of transportation in Bandung City. The transportation problem, as well as the availability of transportation infrastructure, will be described in detail in this chapter.

Afterward, **Chapter 5** will consist of the analysis result in detail. This chapter is the core section of this master thesis and will describe the answer to the key research question of this thesis research.

Finally, **Chapter 6**, will conclude the overall process, substantive and the research result. In addition, the recommendation to increase mode shift probability from public to private transportation in Bandung City will be provided as well in this chapter

## CHAPTER 2

### THEORETICAL BASE IN THE TRANSPORTATION MODAL CHOICE

Transportation is often defined as a derived demand. Transport is not a goal in itself, but a way to reach other goals (Bouwman and Linden, 2004; Ortuzar and Willumsen, 2011; Tamin, 2000). The demand for travel is not derived from the utility of the trip itself, but originates rather from the need to reach the location where activities take place, such as the residential areas, the workplace and services (Button, 2010 in Van Wee et al, 2013). Those propositions indicate that decision in making transportation action highly depends on the final intention of the trip. In addition, the decision making will also be influenced by the personal consideration. The worker travel behavior will be different to those who only travel for shopping or recreation, and vice versa.

Besides time and route selection, other important aspects that trip makers considered in making the trip is a mode selection aspect (Tamin, 2000). This aspect relates to the consideration in choosing the type of vehicles used in making a trip, whether will use public transportation or private vehicle. If it is decided to use a private vehicle, what kind of vehicle will be chosen then, for example, car, motorcycle, bike and so on. In aggregate, the mode choice of trip makers will influence significantly towards the transport activity in a city. Furthermore, the aspect will also influence to the extent to which the demand of transportation should be organized and to the extent to which the supply of transportation infrastructure should be provided. Based on its big influences, therefore mode choice of trip makers is important to be taken into account in the transportation planning.

Before further explaining the theoretical base in the modal split, the theory of the role of transport in the urban system will be described first. After that, the explanation will be continued with the explanation about transportation problem and issues. This explanation will then be specified to the problem regarding the cause-effect relationship of a car and public transport operation which has become a dilemma all this time. In order to enrich the insight and also as a basis to support analysis, the theory of Transport Demand Management (TDM) will be described after that. Ultimately, to provide a strong theoretical base in approaching the modal split, the theory regarding the modal choice and willingness to switch transportation mode will be explained then.

## **2.1. Positioning Transportation in an Urban System**

### **2.1.1. Transportation as a component of Urban System**

The system is a term which is broadly used in many different aspects. International Council on systems engineering defined system as a construct or collection of different elements that together produce results that are not obtainable by the elements alone. In line with this definition, many transportation experts base their definition of the transportation system to that basic principle. Those definitions basically define transportation system as a combination of elements which interact each other to achieve its purpose in transporting passengers or freight (Cascetta, 2001; Meyer and Miller, 2001; Van Wee et al., 2009). From these definitions, it can be inferred that transportation system has two main characteristics, firstly it consists of subsystems and secondly it has an interdependent pattern among its subsystems.

As a system, transportation system does not work alone or in other words, it is not a closed system. The performance of the transportation system is highly influenced by another system, for example, by the land use system and the telecommunication system. A certain land use pattern often generates the transportation demand and conversely the supply of transportation infrastructure can induce the land use development. So does with the telecommunication system. The telecommunication system will ease the transfer of information and decreased the burden of transportation. To be able to resolve the transportation problem, it requires the understanding of transportation in a broader framework.

Tamin (2000) has tried to put the transportation in a broader context. According to his proposition, in a macro context transportation can be defined as a system which consist of three main subsystems which correlates and influences each other, including the network system, the activity system, and the movement system (Tamin, 2000). Firstly, the network system refers to the whole infrastructure which support the movement of passenger and freight from one point to another point, for example, road and rail infrastructure. Secondly, the activity system can be defined as the activities take place in a certain area which is usually characterized by a particular land use, for example, settlement area, office, and commercial area. Thirdly, the movement system is a real manifestation of the transportation needs which is distributed in the network system. These three subsystems are built in an organizational system which govern the system function. In their correlation within a transportation system, the change in one subsystem will give an impact to the other

subsystems. The correlation between subsystems in a macro transportation system is illustrated in Figure 2.1.

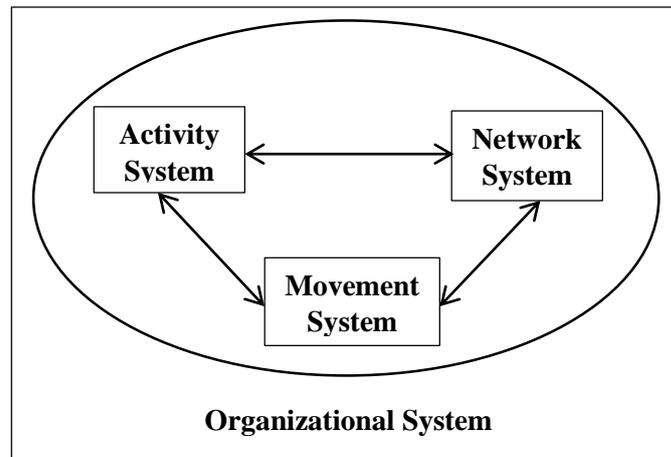


FIGURE 2.1

### MACRO TRANSPORTATION SYSTEM

*Source: Tamin, 2000*

Van Wee et al (2009) perceives the transportation system in a configuration of the land use system. Transportation and land use are positioned as components that influence each other. This definition gives a broader perspective about the correlation between transportation infrastructure and the characteristic of the land use. Change in the transportation sector will give impact to the development of land use and conversely, change in land use will give impact into traffic generation. Some key land-use variables that will give an impact to the travel behavior are density, mixed land use, neighborhood design, distance to public transport connections, and interactions between determinants.

In line with the definition of the transportation system from Tamin (2000) and Van Wee (2009) above, Meyer and Miller (2001) also describe the transportation system in a broad context. They further viewed transportation as a system component which together with another system, for example, drainage system, waste water system and telecommunication infrastructure system that build up an urban system. Comparing to the previous definition of the transportation system from Tamin and Van Wee, this idea of the transportation system from Meyer and Miller gives a more comprehensive insight. The latter definition gives a broader perspective about the configuration of transportation system relates to the other system in building an urban system. Meyer and Miller (2001) provide a well structured

about position of infrastructure system in an urban system by using a hierarchy as shown in Figure 2.2 below.

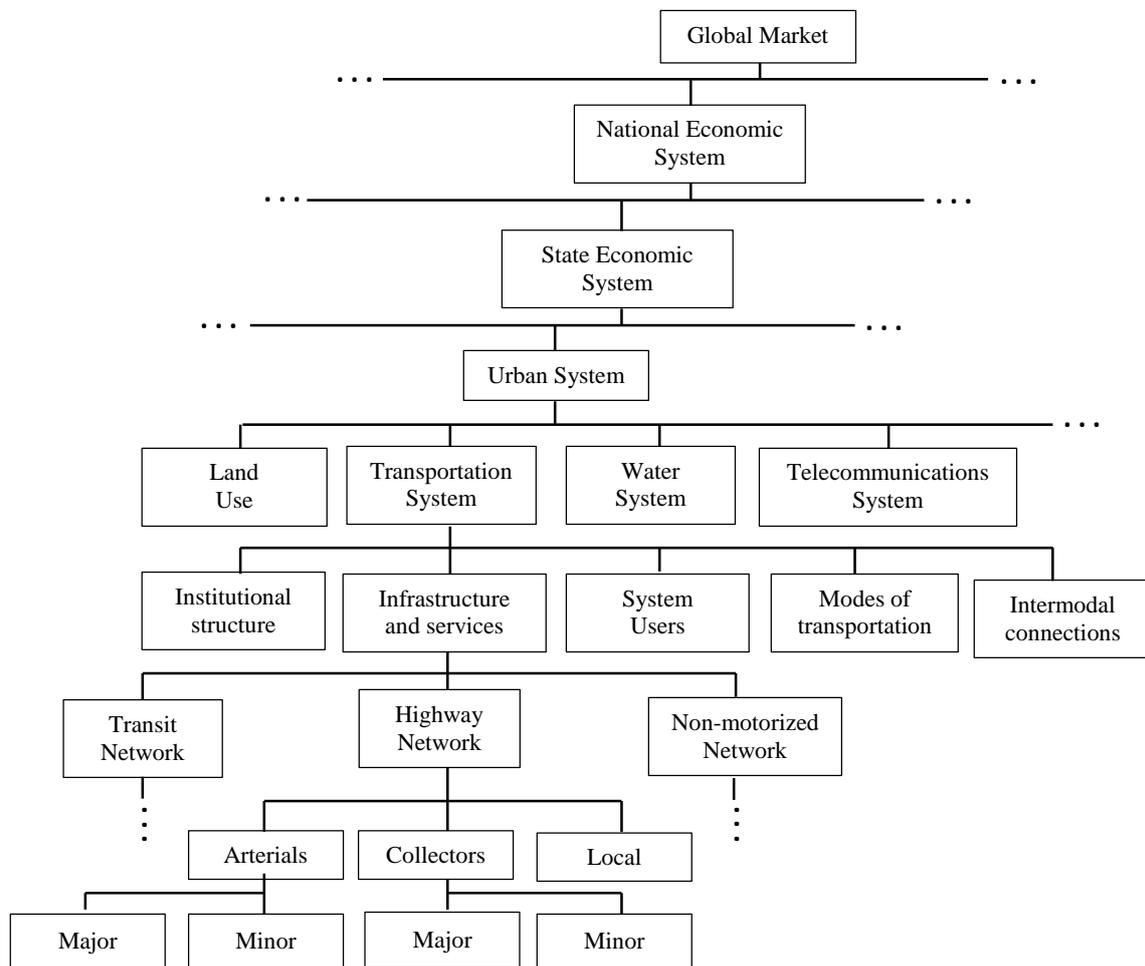


FIGURE 2.2  
 TRANSPORTATION IN A SYSTEM HIERARHY

*Source: Meyer and Miller, 2001*

It the structure above, Meyer and Miller put transportation system in a horizontal and vertical constellation. In the vertical structure, upward the transportation system together with other systems such as land use system, water system and telecommunication system build a bigger system, which is the urban system. Meanwhile downward, this transportation systems is built by smaller subsystems, for example institutional, system user, infrastructure, services et cetera. From this configuration, it can be inferred that transportation system is a multisector and multiscale aspect. As an implication, the approach to solve this complex transportation issue should also be based on the system approach.

### 2.1.2. Transportation Problem

Together with its component, transportation builds a system which affects and is affected by other subsystems. This interplay makes transportation becomes a complex system, therefore it needs to be understood by a system approach. In order to improve transportation sector, several closely correlated aspects which potentially trigger transportation problem such as land use and economic aspect should be taken into account.

According to Thomson (1977), the urban transportation problem can be seen as a seven-sided problems, which every side represents a specific problem (Tolley and Turton, 1995). Those problems include traffic movement, accident, peak – hour crowding on public transport, off – peak inadequacy of public transport, difficulties for pedestrians, environmental impact and parking difficulties. Based on the problems’ definition from Thomson, it appears that transportation problem is not merely about the movement problem, but furthermore transportation problem involves many aspects such as environmental aspect and the time period of activities which it indirectly refers to land use system.

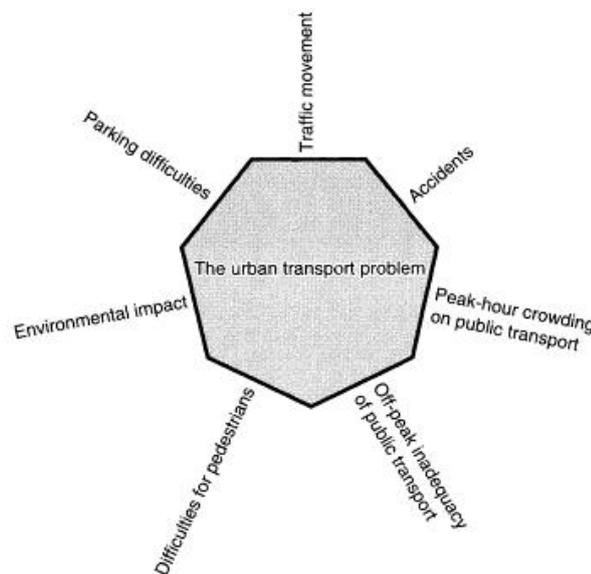


FIGURE 2.3

#### THE SEVEN FACETS OF THE URBAN TRANSPORTATION PROBLEM

*Source: Thomson, 1977 in Tolley and Turton, 1995*

An approach can be applied to define the transportation problem is by comparing the gap between demand and supply of transportation (Goodwin, 1969; Ortuzar and Willumsen, 2011; Tolley and Turton, 1995). Lack of transportation infrastructure supply, as well as

unreliable public transportation, can induce the private vehicle usage. On the other hand, the increase of private vehicle may generate bigger transportation problems. Many experts illustrate the attraction between demand and supply as a circle loop in which its components are continuously interconnected and reinforce themselves.

Even though in their argument Ortuzar and Willumsen (2011) and Goodwin (1969) argues that the increasing use of private vehicle will generate transportation problem, however Tolley and Turton (1995) in their analysis argue that transportation problem is not caused by the kind of vehicle used itself, but it is caused by the economic factor when the price system fails to keep a balance between the demand for transport facilities and the cost of supplying them.

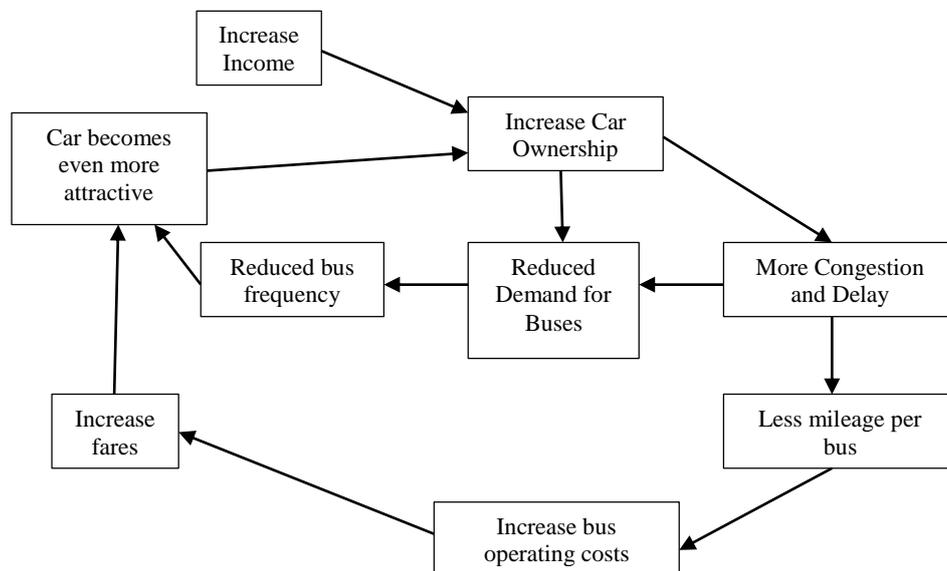


FIGURE 2.4

### CAR AND PUBLIC TRANSPORT VICIOUS CIRCLE

*Source: Ortuzar and Willumsen, 2011*

Ortuzar and Willumsen (2011) assume that the increase in income will trigger people to own private vehicle, moreover, in the condition where the supply of transportation infrastructure and its facilities is unreliable. The increase of private vehicle will reduce demand for public transportation and at the same time it will generate more congestion and travel time delay. On the one hand, this decrease of public transportation performance can be a driving factor to the mode shifting from public transportation to a private vehicle. The unreliability of public transportation makes it less selected than private vehicle and only people who do not have

another alternative option (the captive) who stay using public transportation. On the other hand to maintain its operation, public transport is forced to increase fares as a consequence of increasing operation cost (more gasoline usage due to congestion). This state at one moment might become a factor that attracts transportation users to use a private car and so on the cycle continues to occur and generates worse congestion.

Similar to the idea of Ortuzar and Willumsen (2011), Goodwin (1969) sees the supply and demand relationship in transportation, especially in its relation to public and private vehicle usage, as a vicious circle. However, in his theory Goodwin define the impact congestion (due to the increase of private vehicle usage) in a broader perspective. Not only it will take an impact to reduce of public transportation demand, but also it will take an impact to the environment and locational aspect. The detail picture about the demand and the supply problem in the transportation of Goodwin is displayed in Figure 2.5.

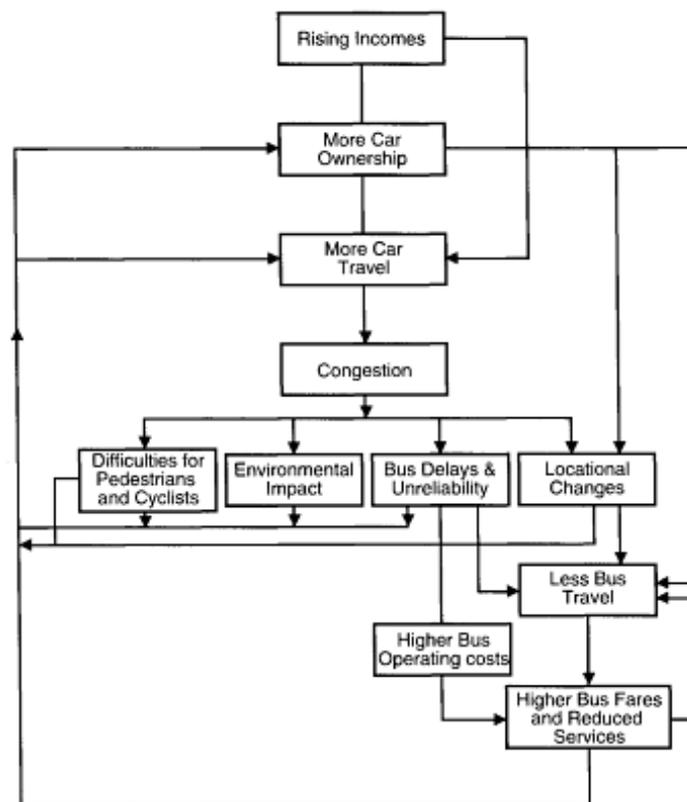


FIGURE 2.5

THE RISE OF THE CAR AND THE FALL OF THE BUS:

VICIOUS CIRCLE IN URBAN TRANSPORT

*Source: Goodwin, 1969 in Tolley and Turton, 1995*

## 2.2. Travel Demand Management

Traffic congestion-related problems have always been associated as an imbalance between the travel demand and the supply of facility and infrastructure which accommodate it. The intervention toward the infrastructure supply such as widen the road or construct a new road are often considered obsolete. The current trend of transport management has been shifted from managing the supply of transportation to managing the demand, which is widely known as the concept of Transportation Demand Management (TDM). Through this concept, the movement was distributed in such a way. Referring to this concept, managing the demand does not mean to decrease the movement, however, it manages the distribution of the traffic so the accumulation of the vehicle on the road can be managed.

TDM is the sets of policies whose its aim objective is to influence the travel behavior (Saleh and Sammer, 2009; Ison and Rye, 2008; Orski, 1998; Tamin, 2000). This demand management can be conducted through increasing people's awareness to foster a voluntary reduction or through a mechanism to restrict private vehicle usage. Actually, Travel Demand Management has a lot of measures in a broad sector covering economic measures (through public transport subsidy, fuel tax, road user charging), land use (through park and ride facilities), information regarding travelers (through car sharing), substitution of communication for travel and administrative measure (Ison and Rye, 2008). Regarding to the mode choice topic, according to the theory of travel demand management, as an effort to minimize the congestion problem, ideally at least there should be a modal shift from private vehicle usage to public transportation usage which has bigger occupancy yet use less space (Ferguson, 2000).

In General, several policies can be performed to implement the concept of Travel Demand Management are as follows (Tamin, 2000):

1. Shifting the time

The traffic movement keeps taking place at the same route and with the same mode. In other words, there is no addition to the road supply nor mode conversion. The interference is merely in time by distributing activity within a certain time, for example by varying the schedule of work hours to distribute the travel to and from work.

2. Shifting the route

This policy is effective to distribute the movement within space. In this policy, the traffic movement takes place at the same time and with the same route. Different to the first

policy, in this policy the management is done through adding the alternative route, so instead of using the same route, the road user has many route alternatives.

### 3. Shifting the mode

In his policy, the traffic movement takes place at the same route and at the same time, but by using a more efficient mode. Decreasing the usage of private vehicle (car and motorcycle) while increasing public transport usage at the same time. The traffic movement is directed to be accommodated by a higher occupancy vehicle but use less space.

### 4. Shifting the Destination

This policy assumes that the traffic movement will remain take place at the same route, at the same time and with the same mode. The difference is in the destination, by arranging land use.

Based on those four strategies above, actually the combination of the strategies are perceived will increase the success probability of the application of the TDM concept.

## 2.3. Mode Choice Theory

### 2.3.1. Influencing Characteristic and Transport Modelling

One consideration used by the traveler in making a trip is the mode preferences; which kind of transportation mode will be used? Whether it will be motorized or non-motorized? Whether it will be public transportation or private vehicle? Whether it will be a four-wheel vehicle or two-wheel vehicle? And so on and so forth. Mode preference is influenced by many factors, ranging from the income of the trip maker, the availability of transportation infrastructure to the social status. According to Ortuzar and Willumsen (2011), mode choice is influenced by three kinds of characteristics, including the characteristics of the trip maker, characteristics of the journey and the characteristics of the transport facility. Ortuzar and Willumsen break down further those three characteristics as follow:

1. Characteristics of trip maker:
  - Car availability and car ownership
  - Possession of driving license
  - Household structure
  - Income
  - Residential density

2. Characteristics of the journey
  - The trip purpose
  - Time of the day
  - Whether the trip is undertaken alone or with others
3. Characteristics of the transportation facility
  - Quantitative factors (components of travel time, components of monetary costs, availability and cost of parking, reliability of travel time and regularity of service)
  - Qualitative factors (comfort and convenience, the demand of the driving task and opportunities to undertake other activities during travel)

To identify the preferences of transportation mode and functional form of its probabilities, transportation modelling, especially modal split and direct demand models can be an alternative. One of the methods can be used is a discrete choice models. This method puts more emphasize to the utility maximization of choice. The assumption used in this model is that the user (trip maker) will tend to maximize their utility. Higher utility indicates that a choice has a greater probability to be selected by a trip maker.

In order to make a mode choice model, at least 4 phase should be passed (Miro, 2005). Those phases, including:

- a. First Phase: Identifying the behavior of trip maker in choosing a transportation mode.
- b. Second Phase: Modelling the utility of trip maker for every kind of mode. Several variables that can be used for example travel time, cost, waiting time and terminal cost (for public transportation)
- c. Third Phase: Modelling the probability of every transportation mode. Many methods can be used to determine the probability of mode choice. Basically, the model can be classified into the aggregate and disaggregate model. This study will give more emphasize to disaggregate model, especially discrete choice model. This type of model is presumed can describe a better real condition since the model is based on the observed choices made by individual travelers or household. In discrete choice models, the utility of every individual  $q$  for mode choice  $j$  can be formulated as the sum up of the measurable systematic representative ( $V_{jq}$ ) and observational errors made by the modeler ( $\epsilon_{jq}$ ). That function can be written in this equation below:

$$U_{jq} = V_{jq} + \epsilon_{jq}$$

(Ortuzar and Willumsen, 2011)

To predict whether a certain type of transportation mode will be selected or not, the value of utility should be converted into a probability value between 0 and 1 by using logit transformation in the binary logistic regression. Different to the model of linear regression which is stated in  $\pi(x) = \beta_0 + \beta_{1x}$ , the model of logistic regression is formulated as follows:

$$\pi(x) = \frac{e^{\beta_0 + \beta_{1x}}}{1 + e^{\beta_0 + \beta_{1x}}}$$

(Hosmer, Lemeshow and Sturdivant, 2013)

In which:

e = the base of natural logarithms ( $e \approx 2.718$ )

$\beta_0$  = the y- intercept

$\beta_1$  = the slope of the regression line

If  $\beta_0 + \beta_{1x}$  in the equation above is expressed in  $g(x)$ , the equation above can be reformulated as follow:

$$g(x) = \ln \left[ \frac{\pi(x)}{1 - \pi(x)} \right] = \beta_0 + \beta_{1x}$$

d. Fourth Phase: determination of proportion of transportation mode

### 2.3.2. Willingness Factor in Mode Switching

The driving factors that influence mode switching are varied and relative to each person. Past research indicates that different motivations scientifically proven might become the cause of someone willing to change their transportation mode. In general, these driving factors can be classified into the willingness triggered by the rational factors that can be measured quantitatively and the willingness triggered by the attitude or behavior that only can be assessed qualitatively.

Back to the theory of modal choice that has been explained at sub 2.3 above, the rational driving factors of people's willingness to switch their transport mode are highly correlated with the characteristics influencing mode choice from Ortuzar and Willumsen. It can be inferred that changes at any characteristics will result in changes at transportation mode. The sample research that went deep into this rational driving factor, for example, a research by Kingham, Dickinson and Copsy about the commuting habits of the worker at the United Kingdom. Based on their analysis result, they found that significant improvement of public

transportation and the shortening distance from residence to public transport stop will increase the willingness of the employee to move to public transport (Kingham et al., 2001). Other research, for example, a research about travel mode switching experiment conducted by Abou-Zed and Akiva in the effect of temporary use of public transportation by giving free ticket toward switching in two locations, Switzerland and MIT (Massachusetts Institute of Technology). Their analysis result indicates that free public transport tickets seem effective to encourage people to move from car to public transport (Abou-Zeid and Akiva, 2012). Take a look back into the mode choice theory from Ortuzar and Willumsen, these driving factors in these two pieces of researches are analogous to the characteristics of transport facility, so that the characteristics choose a mode are assumed mutually affect the willingness of people to switch their transportation mode.

Besides quantifiable factor, some research found that people willingness to switch transportation mode is influenced by behavior and attitude that hard to be measured quantitatively, for example awareness, and satisfaction which relates to the happiness, perception and pride (Abou-Zeid, 2011; Bamberg et al, 2003; Borhan et al, 2014; Klockner and Matthies, 2004). Even though every research reveals different motivational factors, however, a similar theoretical base can be drawn from this research. Theory of Planned Behavior has been widely considered can explain the motivation behind a person's action, including in term of transportation mode choice.

Theory of Planned Behavior was postulated by Icek Ajzen in order to explain human behavior in specific circumstances. According to this theory, every person has an intention in performing their behavior, which is this intention is influenced by three determinant factors, including: a) attitude toward the behavior; b). subjective norms; and c). perceived behavioral control. Attitude toward the behavior is a measurement which indicated to the extent to which a person has a favorable or unfavorable evaluation of the behavior. As the second determinant, subjective norms can be described as person's perception about what other people might think about his/ her future action. This perceived perception eventually will influence someone to perform or not perform a certain behavior. The last determinant, perceived behavioral control describes the insight of people about the ease or difficulty to perform the behavior. This determinant is closely related to the past experience as a predictor for what problems and challenges will probably emerge in the future based on what happened in the past (Ajzen, 1991).

## 2.4. Resume: The Conceptual Framework in This Master Research

As a resume of the theories that has been explained above as well as to give a clearer map about the linkages between theories in an attempt to achieve the goal and objectives of this research, the conceptual framework in this research can be illustrated in figure 2.6 as follows.

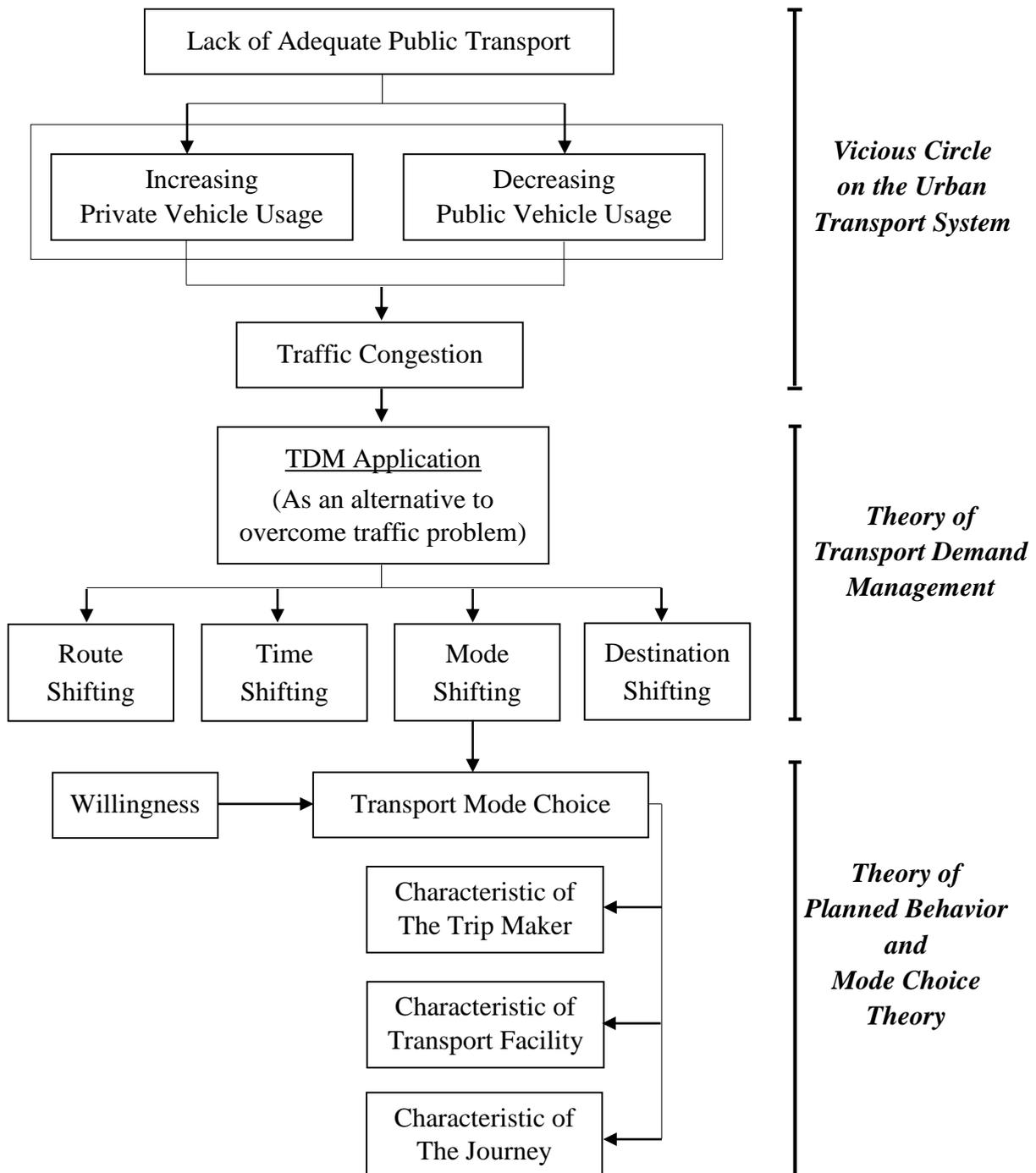


FIGURE 2.6

### THE CONCEPTUAL FRAMEWORK

Source: Analysis Result, 2015

Basically, theories used in this research can be classified into three groups of theories. The first group is the theory about the vicious circle on the urban transport system. Positioning transportation as a system as well as a sub-system of the other bigger system, the urban system, this group of theories explains the transportation problem in a cyclic way. Suppose that in the initial condition the condition of public transportation is still lacking in term of quality and quantity, on the one hand automatically it will force people to search other alternatives prefer a private vehicle which can be more reliable. On the other hand, the mode shifting to a private vehicle will cause a decrease in public transportation usage. For a moment, this individually made solution seem solve the problem faced by the trip maker, however after a certain period of time, this condition can trigger the tragedy of commons where everybody else starts shifting their mode to a private vehicle and the bigger congestion began to take shape then.

To solve this problem, the second group of theories is used. Using the theory of transport demand management as a basis for hypotheses making. This theory provides some breakthrough alternatives from the transportation demand side. In line with the dilemma between the usage of the public and private vehicle in the given condition, the transport demand management strategy will be focused on mode shifting. This theory provides a strong theoretical basis for the selection of mode shifting to overcome transportation problem in Bandung City. In other words, the mode shifting theme in this master research is not determined randomly but based on a theory developed earlier.

In line with this mode shifting strategy proposed by the theory of transport demand management, and as a core part to answer research goal about the mode shifting probability, the third group of theories is applied. This group of theories is related to the mode choice theory to identify the probability of mode shifting of the workers at Bandung City from private to public transportation. Some characteristics, including the trip maker characteristic, the transport facility, and the journey characteristic will be described first and be used as a basis for mode choice modelling. To give a comprehensive analysis, the willingness of the workers to shift their mode will also be included in the analysis.

## CHAPTER 3

### METHODOLOGY

#### 3.1. Methodology to Collect Data

The methodology to collect data in this research can be classified into primary data survey and secondary data survey:

##### 1. Primary Data Survey

The primary data survey is conducted directly from the study area in order to collect these data below:

- a. The Physical characteristic of *angkot* as a main public transportation in Bandung City. The scope of data which is collected in this survey is the physical appearance of *angkot*, the pattern of picking up and dropping off passengers, and the payment method.
- b. Characteristic of Bandung City Residents regarding mode choice aspect, which includes characteristic of the trip maker (car/ motorcycle ownership, driving license ownership, income, and household structure), characteristic of the journey (trip purpose, the way to make a trip) and characteristic of transport facility (mode preference, travel time, travel cost, parking cost, comfort, safety). This data is collected by spreading questionnaires.

The population in this research will be all workers in Bandung City. The selection of the work purpose trip instead of other categories (for example trip generated by students or housewife), is based on two reasons. Firstly, trip generated by the workers is relatively regular and give big influence towards daily traffic. Moreover, with a big proportion of workers at Bandung City with the percentage of 43 % of the total of Bandung City population, this transport generated by the workers contributes significantly towards the current transportation issues and problems. As a consequence, the intervention to this determinant factor will be potential to give big impact towards the improvement of transportation condition at Bandung City. Secondly, different to the trip generated by students, in making their trip to work, the workers have a greater freedom in determining the type of vehicle. The workers have their own income and can decide to have or have not a private vehicle as well as preferring a certain mode to support their work trip.

Based on the latest data, the number of workers in Bandung City is 1.078.080 people. Since the size of the population is more than 500.000 and can be classified as a big population, the formulation used to determine the sample size in this research is as follows:

$$n = \frac{z^2 \cdot [p(1 - p)]}{E^2}$$

(Eriyanto, 2007)

In which:

Z = Level of confidence (z = 1.65 for level of confidence 90 %, z = 1.96 for level of confidence 95 %, Z = 2.58 for level of confidence 99%)

p (1-p) = Variance of the population

E = Sampling error

With a level of confidence 90 %, sampling error 5 % and assuming that population variance is 50 % (p = 0.5), the total questionnaire spread is as follows:

$$n = \frac{1.65^2 \cdot [0.5(1 - 0.5)]}{0,05^2}$$
$$n = 272$$

In this research, the determination of the sample is done through the combination between the online questionnaire and the manually distributed questionnaire. Since not all of Bandung residents have had an access to the internet, the questionnaire cannot be fulfilled merely by the online questionnaire. From 86 respondents collected through this online survey, only 72 questionnaires or approximately 26 % of the total questionnaires that are valid and can be used further for the analysis. Meanwhile the rest 74 % or 200 questionnaires are fulfilled with the manually distributed questionnaire. Since the list of the population in this research is not available, so the determination of sample is done by using the combination of Stratified Random Sampling and incidental method

for manually distributed questionnaires that have been used for 200 questionnaires. Through stratified random sampling, the taken final sample or the secondary sample unit is taken proportionally to the number of workers at the primary sampling units. So even though the samples are taken incidentally, however, the stratified selection allows samples to be more evenly distributed and represent the entire population

The primary sampling unit used in this case study is the Sub Service Area, a development area division that has been established in Bandung City Spatial Plan 2011 - 2031. Meanwhile the secondary sampling unit or the final sample unit is the individual workers who live within the Sub Service Areas. The selection of Sub Service Areas as the primary sampling unit is based on the argument that the distribution of questionnaires within these areas will increase the probability of people at all areas of Bandung to be chosen as a sample. So the results are expected will more able to describe Bandung as a whole.

The detail distribution of questionnaire for the manually distributed questionnaire is presented in Table 3.1 below.

TABLE 3.1  
 SAMPLE DISTRIBUTION

Sub Service Areas	Number of Worker	Percentage	Number of Sample
Setrasari	186,657	17	35
Sadang Serang	180,819	17	34
Kopo Kencana	245,748	23	46
Maleer	185,066	17	34
Arcamanik	80,561	7	15
Ujungberung	87,963	8	16
Kordon	61,567	6	11
Derwati	49,699	5	9
<b>Total</b>	<b>1,078,080</b>	<b>100</b>	<b>200</b>

Source: Analysis Result, 2015

The survey to spread the manually distributed questionnaire is conducted from 30 June to 4 July 2015 by using the services from a questionnaire distributor company in Indonesia, namely *Surveyor Muda Indonesia (SMI)*. The questionnaire was distributed by using a household survey mechanism, in which the questionnaire is spread based on the domicile of the workers. Instead of choosing the office complex, the domicile-based survey is preferred on the

grounds to avoid the accumulation of the questionnaire at only one point as well as to avoid the uniformity of the socio-economic characteristic of the respondents. Differ to the office complex area or other work locations which are generally concentrated at city center, the residential area is more widely spread and perceived will better reflect the socio-economic characteristic of the city.

Considering to increase the probability for the workers to be in their house by the time the survey take place, the logic is that weekend (Friday, Saturday, Sunday) is chosen to be a priority time to spread the questionnaire. However, in this case, since the questionnaire distribution time is coincided with the fasting month (Ramadhan) in Indonesia, in which at this month the normal working hour is usually reduced by one hour, the questionnaire distribution in a weekday is feasible, and there is no time constraint in this questionnaire distribution, yet the prediction about the time that the workers have been out of work still become a main consideration, and thereby the questionnaires are distributed in the afternoon to increase the probability to obtain respondents.

## 2. Secondary Data Survey

The secondary data survey is conducted to collect the information about the general condition of Bandung City, for instance city structure, geography, demography, economic condition, transportation infrastructure condition, and transportation policy of Bandung City. The data will be collected through desk study and study literature.

### 3.2. Methodology to Analyze Data

In this study, the author intends to identify the probability of mode shift from private to public transport and identify alternatives to improve current public transportation (*angkot*), so the form of analysis will be used in this study is as follows:

#### 1. Analyzing the characteristic of Bandung Residents regarding mode choice

Several data regarding characteristics of trip maker, the characteristic of the journey and the transportation ownership will be analyzed by using descriptive analysis. Several features to support the analysis, such as a graph, chart and diagram will be included in this analysis.

2. Determination of utility function and the calculation of mode choice probability will be conducted by using discrete choice model and logistic regression. The analysis will be conducted by using SPSS (Statistical Package for Social Science) software.

To test the reliability of the generated model, some tests will be conducted. Those tests comprise the test of the feasibility of a regression model, overall assessment of regression model and Test of Significance of the partial Coefficient Parameters.

3. Identifying alternatives to increase the preference of public transportation as main transportation in Bandung City.
4. To identify its possibility, the intervention will be carried out towards the result of mode choice modelling in point 2. Several scenarios will be set, adjusted to the direction of Bandung city transport policy.

### 3.3. Methodological Framework

As a summary of this chapter, in general, the methodology in this research can be classified into the methodology to collect data and the methodology to analyze data. To collect the supporting data for this research, primary and secondary data survey is conducted. The primary data survey is applied to look for data or information which could only be obtained directly from the field, for example, the information about the physical feature and the operation pattern of *angkot*. Meanwhile, the secondary data survey is applied to obtain secondary data which have been available, whether in Bandung City database which is published annually or in its previous planning documents. This secondary data survey is also useful in finding the theories and literature to support the research.

The methodology to analyze the data can be differentiated into two categories, the methodology to analyze the willingness and methodology to analyze characteristics influencing mode choice. For the data regarding the willingness to move to public transportation, the analysis is conducted by using descriptive analysis. Meanwhile, for the data regarding the characteristics that influence mode choice, the analysis is done through the combination between the descriptive analysis and the discrete choice model by using binary logistic regression. The methodological framework of this research is represented by Figure 3.1 as follows:

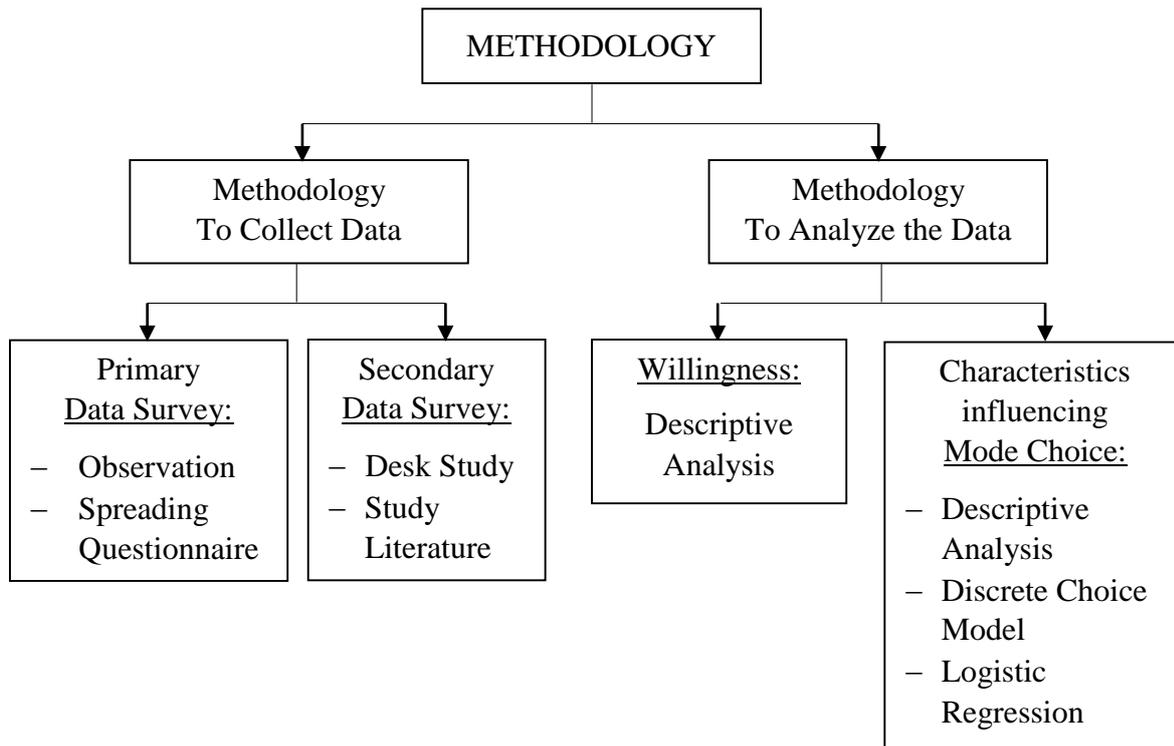


FIGURE 3.1  
THE METHODOLOGICAL FRAMEWORK  
*Source: Analysis Result, 2015*

## **CHAPTER 4**

### **OVERVIEW OF THE STUDY AREA**

#### **(BANDUNG AND ITS PUBLIC TRANSPORTATION SYSTEM)**

Bandung is one of the cities that play an important role in Indonesian Economy. Its function as the capital of West Java Province and supported by strategic geographical location that situated close to the capital of Indonesia, Jakarta, has made Bandung grows as a reliable economic center in Indonesia. Based on its current economic condition along with its potential future development, the National Spatial Plan of Indonesia established Bandung as part of the National Activity Center, whose function is to serve the provincial, national and international scale activities in Indonesia. Besides due to its strategic role in the national economy, Bandung is also established as a National Strategic Area.

As a stepping-stone before further explaining the analysis result, the argument about the importance of this study to be carried out at Bandung City will be presented in this chapter. Apart from that, to give a clear description about the condition of public transportation at Bandung city, description about current condition of the infrastructure as well as its future development plan will also be provided in this chapter.

#### **4.1. Brief Overview of Bandung City**

Administratively, this city covers 167.31 Km<sup>2</sup> that is divided into 30 districts and 151 sub-districts. In 2013, the population of Bandung is approximately 2.4 million people with the ratio between men and women are nearly equal. In the last five years, the trend of population growth of Bandung has continued to grow. Based on this trend, it is predicted that in the future this population is going to keep increasing. Moreover, with its fast economic growth, which has an average of over 8 % every year in the last five years, which will become a city attraction and potentially generates a bigger in-migration.

Based on its age structure, the population pyramid of Bandung is dominated by young dependents with age below 15 years old. The population in the age range between 10 to 14 years old is the largest number, with a percentage of man and women respectively are 10 % and 9 %. Population pyramid of Bandung indicates a low death rate and low birth rate. It is proven by the high percentage of the population aged over 64 years and the low percentage of

the population in the age range between 0 to 10 years old. Almost 71 % of Bandung population are productive age people that potentially active economically. This high population cluster has implication on the need for job creation. In relation to the transportation sector, this also has implication to the need for the provision of transportation infrastructure facilities that capable to accommodate the movement of this population group in carrying out their daily activities.

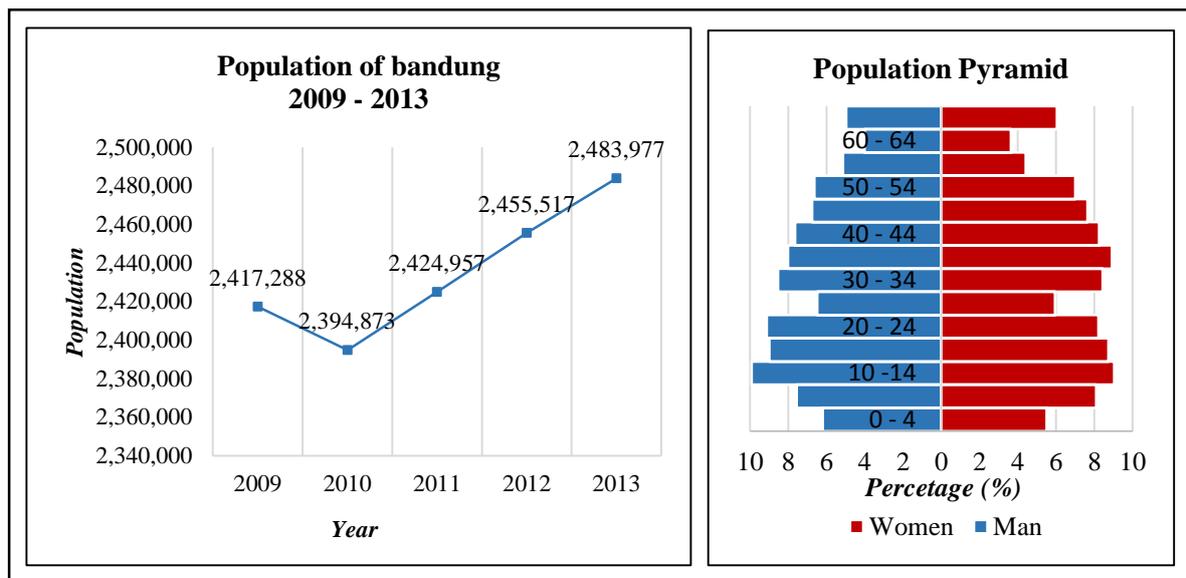


FIGURE 4.1

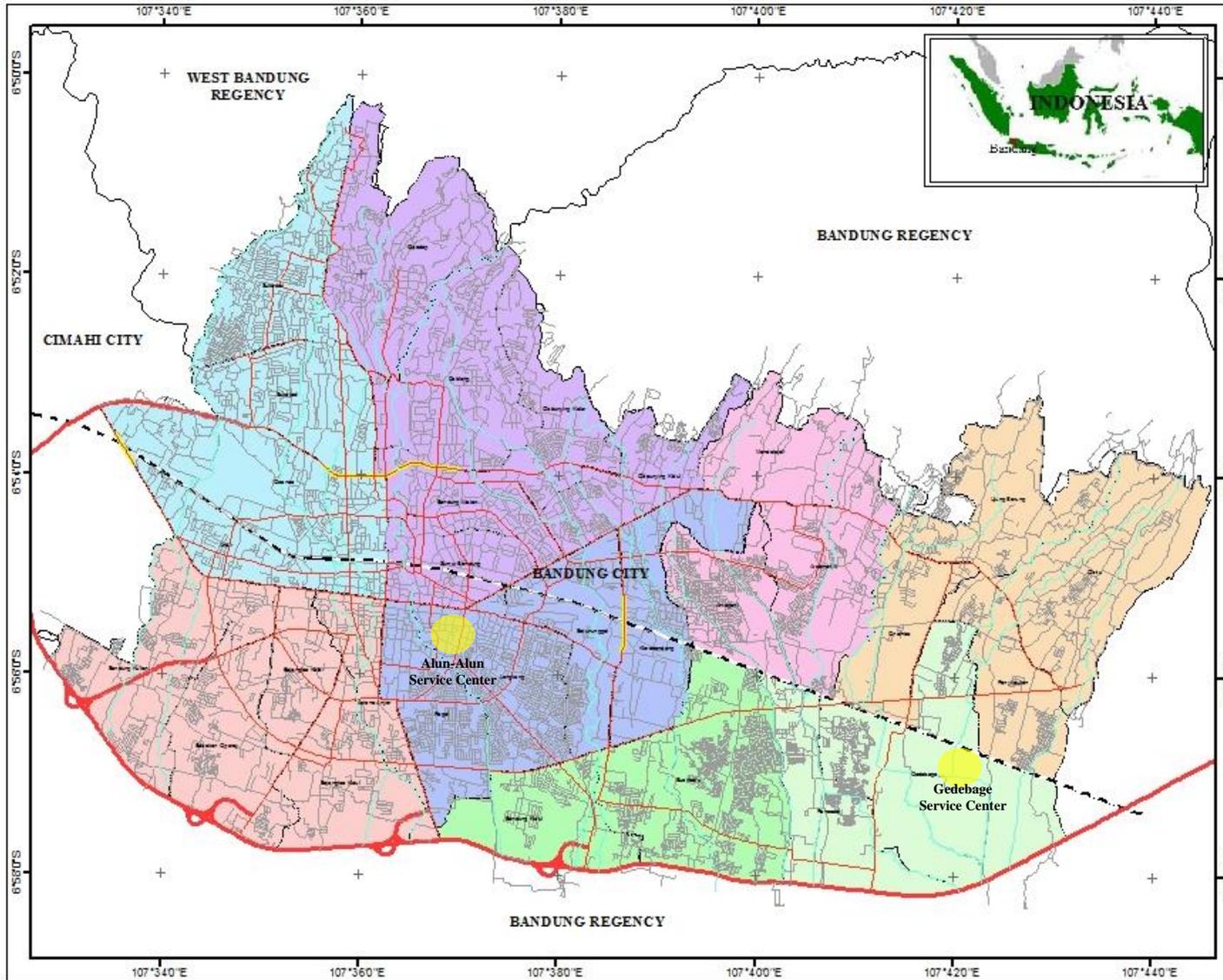
#### BANDUNG POPULATION

Source: Analysis Result, 2015

In the employment sector, 43 % of Bandung City population are the workers. Classified by the work field type, the trade is an employment sector with the largest number of employees. The growth of this sector cannot be separated from the presence of creative industries which thrives in this City. In line with this employment size, measured by gross domestic product indicator, the trade sector gives the biggest contribution to the total gross domestic product. In 2013, the total GDP of Bandung based on the constant market price of 2000 is Rp 40.89 trillion and the share of trade sector toward this total GDP is approximately 42.62 %.

To support Bandung development in the future, the provision of infrastructure and facilities are fully required. One of the important infrastructure and facilities to support a city system is a transportation infrastructure and facilities. This transportation facilities and infrastructure usually will follow the city spatial structure. In Bandung spatial planning, transportation

facilities and infrastructure are arranged as part of the spatial structure plan. According to Bandung City Spatial Plan 2011 – 2031, in order to balance the development of the western and the eastern area of the city, two center points are established, the Alun-Alun Service Center and Gedebage Service Center. The function of these two service centers is as the first tier of the Bandung spatial structure that provide the city-scale infrastructure and facility and together they serve the eight Sub-Service Centers. These Sub-Service Center comprises Bojonagara, Cibeunying, Tegallega, Karees, Arcamanik, Ujungberung, Kordon and Gedebage Sub Service Center, which all of them have a function as the second tier in Bandung spatial structure. The spatial structure of Bandung which has double centers in its first tier implicates on the facilities and infrastructure provision, including the transportation facility and infrastructure. Moreover, with the current potential and its development in the future.



**MASTER THESIS**  
Probability of Mode Shift  
From Private to Public Transportation

**Legend**

- River
- Primary Artery Road
- Secondary Artery Road
- Primary Collector Road
- Secondary Collector Road
- Overpass
- Local Road
- Toll Road
- Rail Way
- District Boundary
- City/ Municipality Boundary

**Sub Service Area (SSA):**

- Arcamanik SSA
- Derwati SSA
- Kopo Kencana SSA
- Kordon SSA
- Maleer SSA
- Sadang Serang SSA
- Setrasari SSA
- Ujung Berung SSA



**CASE STUDY LOCATION**



## 4.2. Bandung, a City with the Competitive Edge

Basically, there are two arguments in choosing Bandung as a case study location. The first reason is based on the consideration of its potential future development. As has been mentioned before, in the national context, Bandung City has been established as a National Activity Center and as a National Strategic Area. To support that plan development, transportation facilities and infrastructure, including public transportation should be reliable and capable to serve the movements in Bandung City.

The second argument to prefer Bandung instead of other cities in Indonesia is because Bandung has a competitive edge. Since the colonial era, Bandung has been a tourist destination for domestic and international tourist. The layout of the city at several parts, coupled with its mild climate makes Bandung often associated as Paris Van Java (Aritenang, 2015). In the existing condition, Bandung still becomes one of the tourism destination in Indonesia. In line with this tourism sector, Bandung has often been a venue for the international event. One of the international big events is the Asian-African Conference in 1955 and its commemoration at 2005 and 2015.

In the current condition, Bandung grows as a metropolitan city which has a competitive edge compared to the other cities. This competitiveness of Bandung is directly supported by its fast growing of the creative home industry sector. This fast growth has made Bandung as an emerging creative city. Supported by the British Council, currently Bandung becomes a pilot project for the creative city in South East Asia (Aritenang, 2015; Cohen, 2014; Wiryono et al., 2014). The creative industry sector has become a tourist attraction, not only for the domestic tourist, but also for the international tourist. In the last five years, more than 150.000 international tourists come to Bandung annually. Much more than this international tourist number, the domestic tourist who visits Bandung on average nineteen times bigger than the number of international tourists every year.

This tourism sector had a major impact on the following four sectors: a). Trade b). Transportation and Communication c). Finance, Rental and Service Company and d). Services. As an implication, those activities require a reliable transportation system, including public transportation to support them. Together in a synergy, transportation system and the other urban system will reinforce each other. The better the transportation system, the bigger the contribution given to the development of the city.

### 4.3. Public Transportation System

Public transportation sector determines the mobility of people in a city. Its provision is absolutely necessary, given the economic capacity of the people is not homogeneous. Some people afford to buy a vehicle, meanwhile some other people not. The people who fully rely on public transportation to support their daily mobility is called “*the captive*”, this group of people was forced to use public transportation because they have no other choice.

The provision of public transportation is not merely about to ensure that everybody, regardless of their income, can move to and from the location where he works, but it is also about an effort to organize the traffic. In line with the theory of Travel Demand Management, which states that the public transportation with a bigger capacity can move people from one place to another place by using a less space than private vehicles. The high occupant rate is the key factor which makes public transportation ahead.

As a general picture of the study area, in this part the current condition of public transportation at Bandung will be described. As a benchmarking for the alternative strategies that should be taken to improve the public transportation condition in this city, some future plan of public transportation that has been established in Bandung Spatial Plan will be explained then.

#### 4.3.1. Current Condition of Public Transportation

Similar to the public transportation in other metropolitan cities, public transportation in Bandung City can be divided into two categories, land transportation and air transportation. For the land transportation, it can be further classified into a road/highway-based land transportation and railway-based land transportation. In this chapter, the explanation will be limited to only the road/highway-based land transportation, especially which serve the internal movement in Bandung City.

In the current situation, the internal movement in Bandung city is served with two kinds of public transportation, comprises public bus, which is already widely known in many countries and by *angkot*. The thing that makes public transportation in Bandung different from it in the other part of the world is the presence of *angkot*. Basically, *angkot* is a minivan whose function is converted into public transportation. In a full condition, *angkot* can load 14 passengers and 1 driver. However, usually there is an extra seat for two persons which is

placed behind the door. From the safety point of view, this extra seat is far from meeting the safety standard. In fact, the condition with filled extra seat indicates over capacity that eventually can harm the passengers themselves. As an illustration, presented below are some features of *angkot* in Bandung City.



FIGURE 4.3

#### ANGKOT FEATURES

*Source: Observation Result, 2015*

The picture in the upper left shows an external feature of *angkot*. Its external color indicates the trajectory or route of *angkot*, the cars within the same route will have similar color. In addition to the route explanation board attached to the front and back of the body of *angkot* passenger usually will also recognize *angkot* by its color. The picture on the right side shows the internal feature of *angkot*. Passengers will sit side by side in rows without any barriers. In a full condition, it sometimes provokes the pickpocket to carry out their crime operation. Differ to the two pictures before, the third picture on the lower left shows the operation of *angkot* in the traffic system. *angkot* does not have a specific route, in its operation *angkot* move in the same road space with the private vehicles. Since *angkot* often stop to drop off and pick up passengers, this operation pattern of *angkot* in the mixed traffic often lead to the traffic congestion.

The pattern of picking up and dropping off passengers of *angkot* is still not well organized. If there is a passenger who want to get off, or otherwise if there is a potential passenger who wants to take *angkot*, the driver will stop immediately at the place desired by the passengers. No specific public transportation stops nor rules about how long *angkot* can stop at the roadside. This pattern which in turn often leads to traffic problems. For the payment method, the passengers usually pay by cash directly to the driver. The tariff rate is adjusted to the distance they take. However, since passenger mileage is not measured precisely, the price that

was determined by the driver is usually the estimated price. The different driver may charge different cost, thus the passengers are potentially harmed by this uncertain tariff system.

Compare to the public bus, the service area of *angkot* that has been established by Mayor's Decree No. 551/Kep.055-Huk/2008 is much wider than the public bus route. In 2013, there is more than five thousand vehicle unit of *angkot* in Bandung City which is distributed at 39 routes. Every route has different distance and number of the vehicle unit. Some of the routes have longer mileage and more vehicle unit than other routes. This unbalances distribution of *angkot* at every route currently become an issue. The unequal distribution of *angkot* causes inefficiencies in its operation. For the route with few vehicles of *angkot*, it cannot fulfill the demand of transportation, meanwhile conversely for the route with plentiful vehicles of *angkot*, low occupancy most likely to occur. The detail *angkot* routes can be seen at Appendix 1 of this document.

In its operation *angkot* is individually owned and usually gathered in the small cooperatives. Each small cooperatives usually take care of one route and together they are a member of a bigger cooperative, namely Kobanter. At the end, Kobanter will report its activity to the Department of Transportation which has a legal authority to regulate transport activities. The absence of a strict management result in the absence of a minimum operating standards. To meet the revenue target, sometimes the driver ignores the safety and comfort factor of the passengers, for example by dropping off and picking up passenger anywhere with neglecting the safety aspect, waiting long for the potential passenger by paying no attention to the passengers who have been waiting long in the *angkot*, and transporting passengers by exceeding the capacity limit.

The second type of public transportation which serve the internal movement within Bandung City is a public bus. This public bus is managed by DAMRI, a stated owned company under the management of the Department of Transportation. Compared to *angkot*, the number of public buses in Bandung City is much less. In 2013, there are only 185 buses which serve 10 main routes. Some feature and detail number of public buses in Bandung City managed by DAMRI are presented respectively in Figure 4.4. The detail total number of public buses can be seen at Appendix 1 of this document.



FIGURE 4.4  
PUBLIC BUS FEATURES

Source: Internet Search Result, 2015

Similar to the operation of *angkot*, public bus also does not have a specific line. Even though, these public buses are managed within the coordination of DAMRI, but in its operation, informal sector like busker and informal trader often operates in the buses.

#### 4.3.2. The Future Plan of Bandung Public Transportation

The development plans of Bandung City transportation were listed in several official spatial plans, ranging from national to local level. In the national context, the transportation of Bandung is directed to support its future plan as part of the National Activity Center and National Strategic Area. Based on this establishment, all transportation regulations in the lower level (provincial and city level) are required to follow these directives.

At the provincial level, Bandung is established as a capital of West Java Province. In line with the directives of the National Spatial Plan, in the West Java Province Spatial Plan 2009 - 2029, Bandung public transportation is directed to achieve an integrated transport in order to support major activity centers. According to this development plan, public transportation in Bandung City is directed to be developed in the form of an urban mass transportation system. So, according to this plan, the operation of public transportation by using *angkot* is no longer appropriate. As a consequence, if refer to this plan, existing *angkot* should have started being converted into another kind of mass transportation.

Although the plan says so, in practice it can trigger conflict moreover with the current broad service area of *angkot*. Conversion of *angkot* into public transportation that have a bigger capacity will have an impact to the decrease of employment in the public transportation

sector. Since in the existing condition, *angkot* operation has been very dominant, therefore many people will probably lose their job, especially *angkot* driver if this policy is fully implemented.

The tendency to replaced *angkot* with mass transit is not only indicated in the Provincial Spatial Plan. The Bandung City Spatial Plan has a similar regulation in managing public transportation. Making integrated public transportation, renewing the mode as well as increasing the capacity of public transport are main policies will be implemented in Bandung City within the period of 2011 up to 2031. In detail, there are around 12 policies regarding public transportation improvement in Bandung City. These detail policies are as follows:

- a. Application of an integrated transport system;
- b. Optimization of an integrated transport system;
- c. Optimization of tariff policy;
- d. Provision of public transport facilities and infrastructure integrator modes (bus line) with the path:
  - Corridor 1 : Cibiru-Soekarno Hatta - Elang;
  - Corridor 2 : Antapani- Laswi- Lingkar Selatan;
  - Corridor 3 : Ujung Berung-Surapati- Dr. Djunjunan;
  - Corridor 4 : Cibeureum-Cicaheum;
  - Corridor 5 : Buah Batu-Kebon Kawung;
  - Corridor 6 : Banjaran-Gedebage-Kebon Kawung;
  - Corridor 7 : Padalarang-Elang-Kebon Kawung;
  - Corridor 8 : Soreang-Kopo-Leuwipanjang-Kebon Kawung;
  - Corridor 9 : Cibaduyut-Tegallega-Kebon Kawung;
  - Corridor 10: Ledeng-Gegerkalong-Kebon Kawung; dan
  - Corridor 11: Caringin-Pasirkaliki-Sarijadi.
- e. Mode rejuvenation and increasing the capacity of public transport;
- f. The application of function -worthy public transportation vehicles with exhaust emission test;
- g. Regulating and controlling paratransit (*ojek*, rickshaw and wagon);
- h. Increasing the operational performance of public transportation by adjusting the number of taxi cabs operating in accordance with the requirements and carrying capacity of facilities and infrastructure;

- i. Policing and increasing stops function;
- j. Controlling the movement of AKAP (Inter City Transport Province) and AKDP (City Transport In the Province);
- k. Improving the institutional system of the transport sector; and
- l. Increasing private participation in the development of public transport.

Based on the regulations above, the public bus seems to become a development priority. The tendency to follow regulation in the developed countries with encouraging public transportation in the form of the public bus seems more attractive for decision makers than developing the current main public transportation (*angkot*) into something more advance. On the one hand, public bus development will increase the capacity of the vehicle which at the same time use less road space so it is perceived more efficient. But on the other hand, this kind of public transportation might also not fully appropriate to be implemented in Bandung. The street structure of Bandung is dominated by a grid structure with many junctions and narrow streets in some area. The distance between junctions is often short, thus the operation of *angkot* seems more effective to alter the movement in such kind of street structure. Bus rapid transit is rather unsuitable for the conditions of Bandung that have many narrow streets, unless otherwise there is an agreement to widen the street into a six –lane road (Bandung Spatial Plan 2011 – 2031).

The direction to develop mass public transit in Bandung City, whether at national, provincial or city spatial plan is also influenced by the decree of the director general of land transportation which has classified Bandung City into a Metropolitan City. The basic determination of this classification is based on the population number. Following this regulation, Bandung which has a population more than one thousand inhabitants is classified as a metropolitan and as a requirement, its public transportation should be served by a mass rapid transit. However, since there is no any research yet that identify the suitability of public transportation type to be implemented at Bandung, thus the judgment about the importance of current *angkot* is determined directly by the user perception. The analysis about these people's preference of the transportation mode as well as the opinion about the current public transportation will be explained in the next chapter.

## **CHAPTER 5**

### **ANALYSIS OF THE MODE SHIFT PROBABILITY**

#### **FROM PRIVATE TO PUBLIC TRANSPORTATION IN BANDUNG CITY**

This chapter will describe the analysis result of this research and answer the research questions that has been formulated before in Chapter 1. This chapter consists of three parts, comprising the characteristics influencing transportation mode choice, the willingness of the working people to use public transportation, and the analysis about the mode shifting probability.

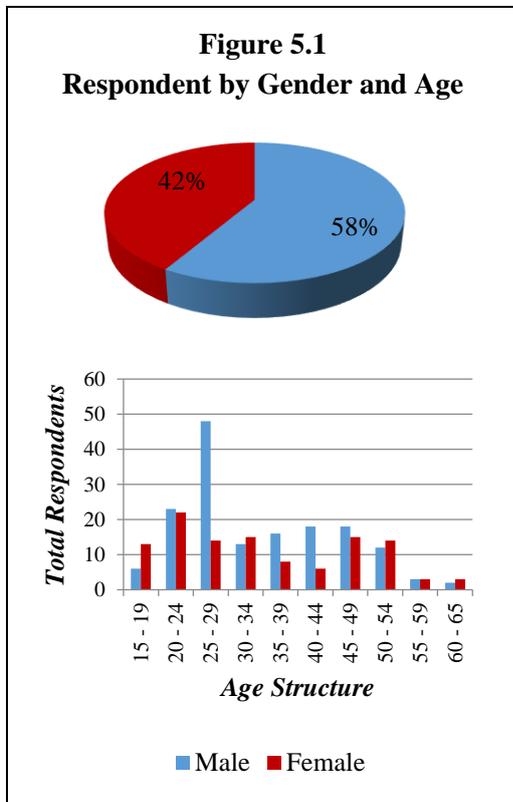
#### **5.1. Characteristics Influencing Mode Choice in Bandung City**

Before further analyzing the mode shift probability, the characteristic of working people of Bandung City will be described first in this section. Identifying these characteristics will give an overview about the real condition of social economics, the working trip behavior and the availability of the existing provided facility and infrastructure, in which all of these characteristics will jointly help in explaining transport mode preferences of working people at Bandung City. Taking all Bandung people at the productive age structure that actively work as a population, this research take 272 people out of it as a sample. Through the sampling method, this quantity of sample taken will be able to represent the characteristics of the entire working people of Bandung City. In line with the mode choice theory from Tamin (2000), Ortuzar and Willumsen (2011), some variables used in this research comprises characteristics influencing mode choice, inter alia characteristic of the trip maker, characteristic of the journey and characteristic of the transport facility. The detail findings on those characteristics are as follows.

##### **5.1.1. The Social-Economic Characteristic of the Working People in Bandung City**

To give a comprehensive picture about the social and economic characteristics of the working people at Bandung City, some variables are selected. Based on that selection, some variables that are used to describe this social-economic condition are gender, age structure, education, job and monthly income. Some characteristic regarding the marital status, family structure, private vehicle ownership and driving license ownership are also included in this analysis. This inclusion is based on the arguments that these characteristics are potential to influence the transport mode preferences. The bigger the family structure, the bigger potency

to have a private vehicle and practicing vehicle sharing. So does the private vehicle ownership and the driving license ownership, people who have a private vehicle or driving license tends to use a private vehicle than those who do not have whether a private vehicle or driving license.



From the total respondent taken as a sample, it can be identified that the composition of respondent's gender is almost equal. The percentage of male and female respondents, respectively are 58 % and 42 %. Compared to the latest official data of Bandung City in general (data 2013) that has been published by the Bandung Statistic Agency, there is a difference in the proportion between male and female workers. In 2013, the total male and female workers respectively, are 66 % and 34 %. Meanwhile, the data obtained from the questionnaire distribution shows the increase of the female workers in these last two years. Since the recent official data from the Statistic Agency is not available at this time,

Source: Analysis Result, 2015

thereby there is no definitive justification yet about this increase, however, the most possible reason behind this increase is because the women empowerment in Bandung City has been getting higher in the last two years, in which women have the same chance as men to enter the work field.

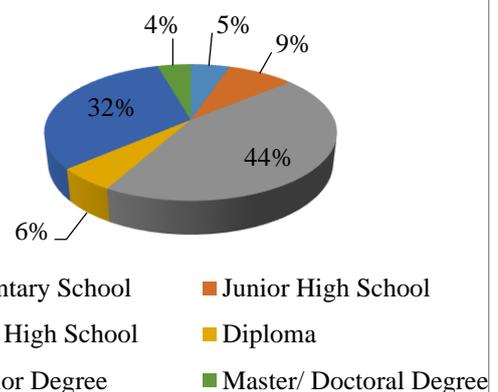
Reviewed by its age structure, there is an increase in the number of respondents along with the increasing of the age range. The increasing number of respondents can be identified significantly from the age range of 15 – 19 years old up to the age range of 25 – 29 years old. This number is getting constant and going back to decrease at the age range of 50 – 54 years old and so on. From the correlation graphic between the number of respondents and the age structure above, it can be seen that the number of respondents obtained within the range of 25 – 29 years old is the highest compared to the other ranges. The possible explanation for this situation is because this age range is probably the most productive age range, in which each person within this age range, especially man definitely is a labor force. Different to the age

range of 15 – 19 which its population is likely dominated by the student instead of the labor force or the population by the age 50 years onwards that are likely dominated by the pension people, people in the range 25 – 29 is potential to work.

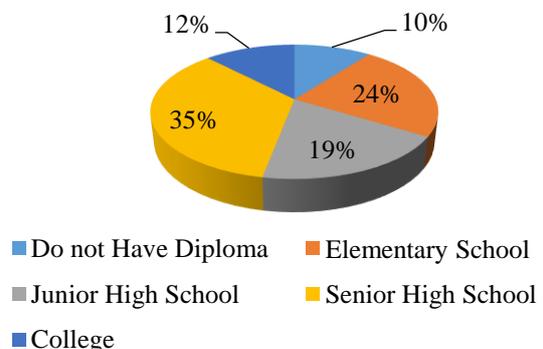
Compared to Bandung City population in general, the population pyramid in Figure 4.1 shows that Bandung City Population is characterized by an expansive structure which are dominated by the productive age people. Contrast to the age structure graphic in Figure 5.1, in the Bandung Population pyramid in general, it can be seen that the percentage of people within the age range 25 -29 is not higher than the percentage of people in other productive age ranges (except for 55 -59). Since the respondents in this research only represent the workers, this finding imply that in the field survey, people within this age range who actively works is easier to find. It means that almost people in this range have actively worked, and thereby this age range can be categorized as the most productive among other age ranges.

In terms of education, 44.12 % of workers have an education level of senior high school. This is the largest proportion among another number of workers in other education levels. The proportion of workers with a bachelor degree is in the second position with a percentage of 31.99 % and only 4.41 % of workers that have a master or doctoral degree. Meanwhile the rest is varied between elementary school, junior high school and diploma with their percentage respectively, are 5.15 %, 8.82 %, and 5.51 %. The pattern of this education level of the workers is nearly similar to the education level structure of Bandung People in general. Regardless whether having work or not, in general the largest education level possessed by Bandung population based on the latest data (2013) is the senior high school level, with

**Figure 5.2**  
**Education Level of Workers in 2015**



**Figure 5.3**  
**Education Level of Bandung Population in General in 2013**



Source: Analysis Result, 2015; BPS, 2013

the percentage of 34.85 %. Meanwhile, for the education level higher than the senior high school level, even though the questionnaire result indicates a high percentage, however, in general the percentage of Bandung population who has a higher education level than senior high school is only 12.19 %. This means that the group of people with bachelor or other higher degrees has big possibility to entry field work.

In 2015, Bandung City Government established the regional minimum wage as Rp 2.300.000,-. Refer to this setting and in relation to the correlation between current income and education of the respondent, the identification shows that the respondents with level of education of elementary school and junior high school mostly have income below the regional minimum wage. Whilst for the other education levels, the majority of respondents have income above the regional minimum wage. This income gap should get a concern, considering there are still a lot of people who have income under the regional minimum wage. The detail picture about the correlation between income and educational level of working people at Bandung City is presented in Figure 5.4 below.

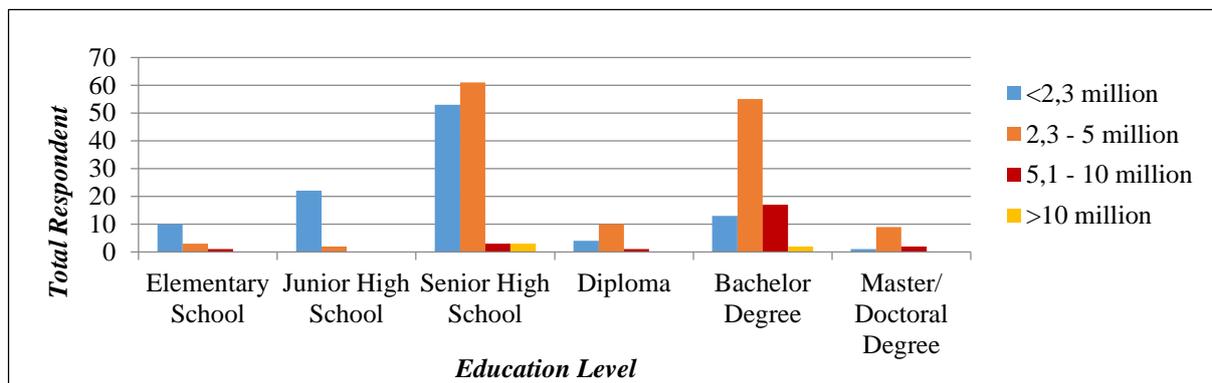


FIGURE 5.4  
 CORRELATION BETWEEN INCOME (RUPIAH) AND EDUCATIONAL LEVEL

Source: Analysis Result, 2015

Another social-economic characteristics that determine transport mode preferences are the private vehicle ownership and the driving license ownership. The possession of these two factors tends to provide a chance for working people to use a private vehicle. Currently, almost 82 % of the working people taken as respondents in this research possess a private vehicle, and only 18 % of them who do not have a private vehicle. The trend that happens in Bandung and in other many big cities in Indonesia shows that there is a high increasing of motorcycle ownership. The cheap and affordable price is the main reason for many people to prefer using a motorcycle instead of a public transportation. The data derived from the

questionnaire proved that in the current condition almost all of the working people in Bandung City have a motorcycle. Of the total respondents who have a private vehicle, approximately 69 % of them have a motorcycle, 5 % have private car and 26 % have both car and motorcycle. To further analyze whether there is a relationship between the possession of the motorcycle and the income of the respondents, a crosstab analysis toward these variables are applied. Based on the cross tabulation obtained, almost more than fifty percent of the respondents within all the income ranges have a motorcycle. The interesting finding from the Bandung City case is that the percentage of motorcycle possessed by working people with income lower than Rp 2.3 million (the regional minimum wage) is bigger than the percentage of motorcycle possessed by working people with income more than 10 million. This finding indicates that the motorcycle has become an affordable transportation mode, which can be possessed by all of the economic income.

The high private vehicle ownership in Bandung City is reinforced by the fact that the number of ownerships that are registered at the vehicle registrar of Bandung City Police Agency has increased every year. The trend from 2009 to 2013 shows the significant increase of vehicle ownership in Bandung City, especially for motorcycle with average growth per year is approximately 7.63 %.

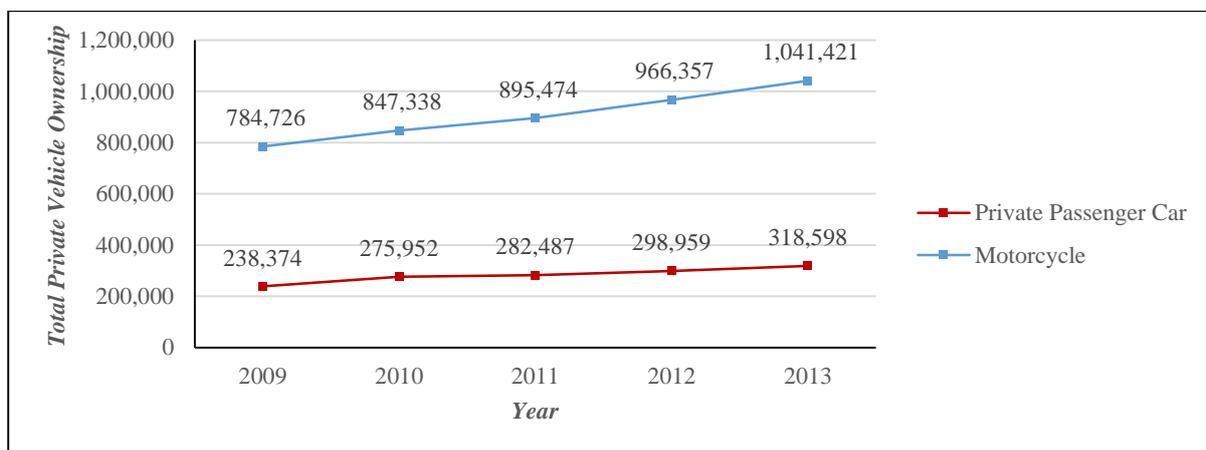


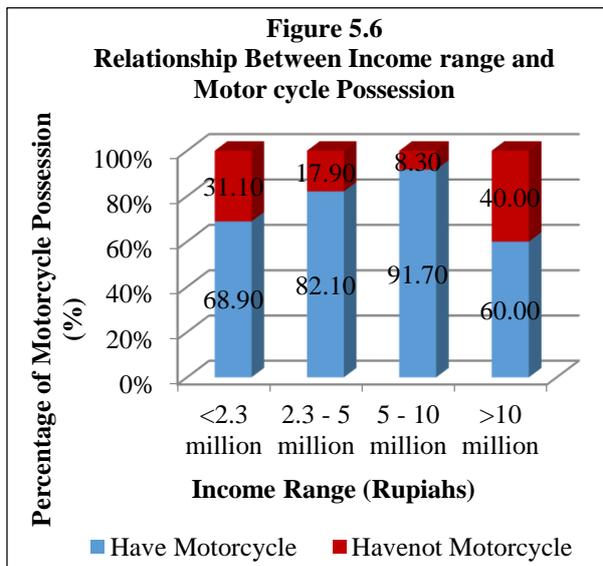
FIGURE 5.5

#### PRIVATE VEHICLE OWNERSHIP IN BANDUNG CITY 2009 – 2013

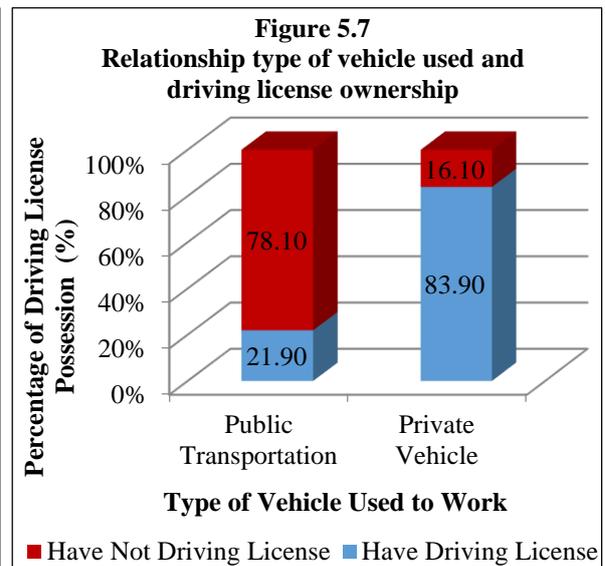
*Source: BPS, 2010; BPS, 2011; BPS, 2012; BPS, 2013; BPS, 2014*

Besides the private vehicle ownership aspect, another factor that directly influences the tendencies to use a private vehicle is the driving license ownership aspect. The possession of

the driving license determines the ability of someone to drive a private vehicle to work. By classifying the respondents into the public and private vehicle users, then comparing both classes in term of the driving license possession, it can be inferred that the majority of public transportation users do not have a driving license. Of the total of workers who use public transportation to work, only approximately 21.90 % that currently have a driving license. Contrast to this condition, for the private vehicle users, almost 83.90 % have a driving license already, and there are about 16.10 % that illegally drive a private vehicle to work without having the driving license.



Source: Analysis Result, 2015

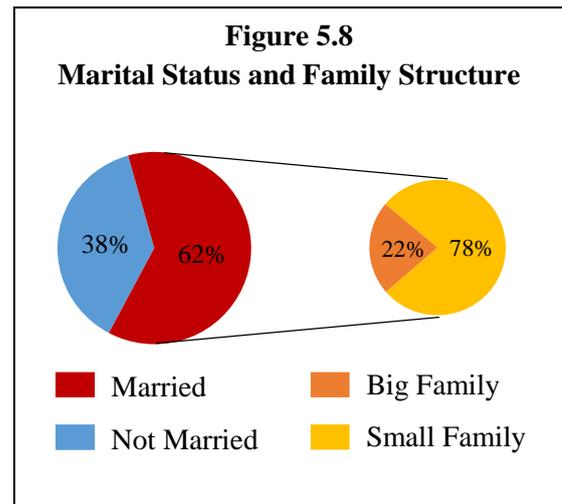


Source: Analysis Result, 2015

Besides of the variables above, as has been explained earlier, the transport mode preference is also suspected will be influenced by other socioeconomic factors like the marital status and the family structure. Even though there are no scientific facts about that, however, I have a view that it is necessary to consider to see the connection between them. This relation will be further explained in section 5.3, thus in this section, suffice it to only explain its characteristics.

From the total of 272 respondents, the proportion of respondents is dominated by married people. 62 % of them are identified married, whilst 38 % the rest are not married. This trend of working people in Bandung shows a similar pattern to the typical of Indonesian people in general who married after entering a certain age. In relation to the family structure, from those respondents who are married, 78 % of them have a small family structure with the family member not more than four persons.

Meanwhile, the other 22 % respondents have a big family structure with the family member more than four people. The tendency of this family structure pattern can indicate many things. The first indication is because many respondents are a relatively young couple. This is in line with the analysis of the age structure that has been explained which shows that the amount of respondents within 25 – 29 years old is the biggest compared another age range.



*Source: Analysis Result, 2015*

These young couples most likely still have a smaller family structure, but however, there is a possibility for this family structure to grow bigger in the next period. The second indication is that it can also be caused by the high awareness of the respondents. Giving more emphasis to the quality of children instead of the quantity may also become a factor which determines this small family structure domination.

### 5.1.2. Characteristic of the Transport Facility

The second characteristic influencing mode choice is the characteristic of the transport facility. This characteristic provides an overview about people's preferences in choosing a certain mode to support their working trip as well as the considerations behind it. These considerations can be constructed by a variety of reasons, depends on the individual. Nevertheless, some literature indicate that transport mode choosing is positively related to the availability of network and alternative modes.

Based on the data obtained from the questionnaires, 73 % of the working people in Bandung prefer to use a private vehicle for their trip to work, and only 27 % who rely on a public transportation. On the one hand, this big private vehicle usage indicates that this mode is considered more attractive than the public transportation. On the other hand, this proportion shows that current public transportation is still less reliable to support the movement of workers in the city. This condition is in line with the theories regarding vicious circle in the urban system that has been described at chapter 2. Lack of adequate public transportation has pushed the workers to look for other alternatives by using private vehicle to support their daily transport activity. Even though there are many other alternatives that influence

someone's decision to prefer private car (for example income, prestige, and personal reason), however, the bad public transportation condition will make private vehicle seems more attractive and increase its probability to be selected.

Looking a little deeper into the kind of private vehicle used to support their working trip, the data shows that 82.91 % private vehicle user tends to prefer motorcycle for their transportation mode. 16.58 % prefer to use a private car and the 0.5 % prefer to use paratransit (*ojek*<sup>1</sup>). The motorcycle becomes a dominant mode in supporting workers to commute from and to their office. This identified pattern gives a hint that addressing policies toward the motorcycle control will give a significant effect to the transportation condition overall. The detailed graphic about the current mode preferences of working people at Bandung is presented in Figure 5.9 below.

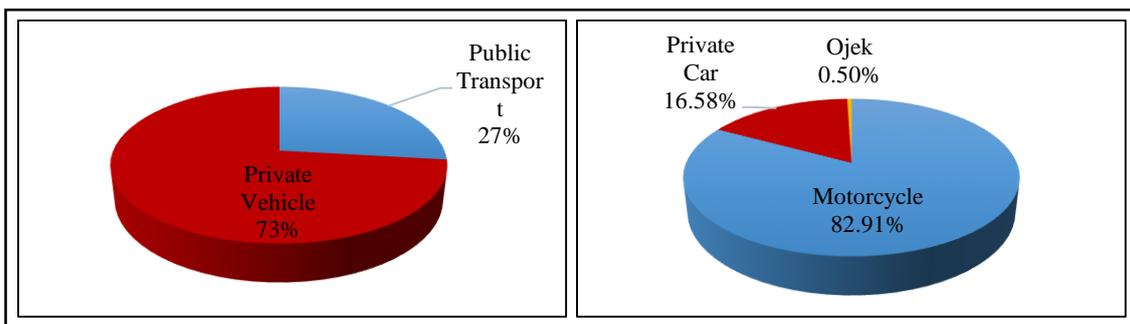


FIGURE 5.9

#### MODE PREFERENCES OF WORKING PEOPLE IN BANDUNG CITY

*Source: Analysis Result, 2015*

There are many factors stimulating the working people to prefer motorcycle instead of other transportation modes. The main reason is because its reliable speed, its small and compact size enables the motorcycle to go faster. This advantage of the motorcycle is getting to increase when the situation is faced with a mixed traffic condition with a high probability of traffic congestion. The fast speed and the reliability to avoid traffic jam are positively correlated and become a reason of respectively 38.79 % and 12.73 % of motorcycle user to prefer motorcycle than another mode choice.

<sup>1</sup> Transport services which using motorcycle as a transport mode and usually it is individually owned. There is no a certain rule to manage and operate it. In addition, the organization of this paratransit is informal in general.

Another factor which makes the motorcycle more preferably is because of its affordable price. From the total of 165 respondents who use motorcycle for the purpose of work, 35.15 % stated that the transportation cost they should spend when using a motorcycle is cheaper than using the other modes. Apart from that, this mode is also rated flexible or practical by its users since not like using public transportation, by using motorcycle people need not to walk or taking another paratransit to the public transportation stops first. Apart from that motorcycle driver can pass through whichever route which is considered shortest and the best route to get the workplace on time. Different to the trip for leisure or recreation purpose, working trip is tightly bound to a time frame. People should get to work on time to pursue productivity, as a consequence, they tend to use the transportation mode that is considered the most effective and efficient. In line with this argument, from the total motorcycle identified, approximately 20.61 % of them perceived that motorcycle is an efficient and effective mode to support their working trip.

From this analysis, it can be inferred that the election of a motorcycle is more based on the reasons of low price and higher speed. In this case, comfort and safety factor become a neglected priority. For the short term, it makes the motorcycle as a profitable transportation mode. However, for the long term, taking the safety and pollution exposure into account, the motorcycle usage can generate externalities cost that maybe do not influence the transportation cost directly but in the form of rising cost of health care. In contrast to the case of motorcycle usage, the users of a private car give a high concern toward the comfort and safety factor. Of the total respondents who using private car for their working trip, 48.48 % prefer to use private cars because it is comfortable and 21.21 % of them stated that it is also safer to use a private car than using any other transportation mode. Another reason to use the private car is the flexibility factor, the user need not to go to public stops or changing route several times.

For the user who prefer public transportation, the main reason is because the respondents do not have a private vehicle, thus they do not have other alternatives and are forced to use public transportation. Another reason is because of the energy efficiency reason. They argue that by choosing *angkot* they do not need to drive the vehicle by their selves thus it can avoid fatigue. Only 5.48 % of the *angkot* user who stated that using *angkot* due to a comfort factor. Indirectly, this information tells that current public transportation has not been able to

provide a comfort factor. Detail information about the reasons behind transportation mode preferences is presented in Figure 5.10 below.

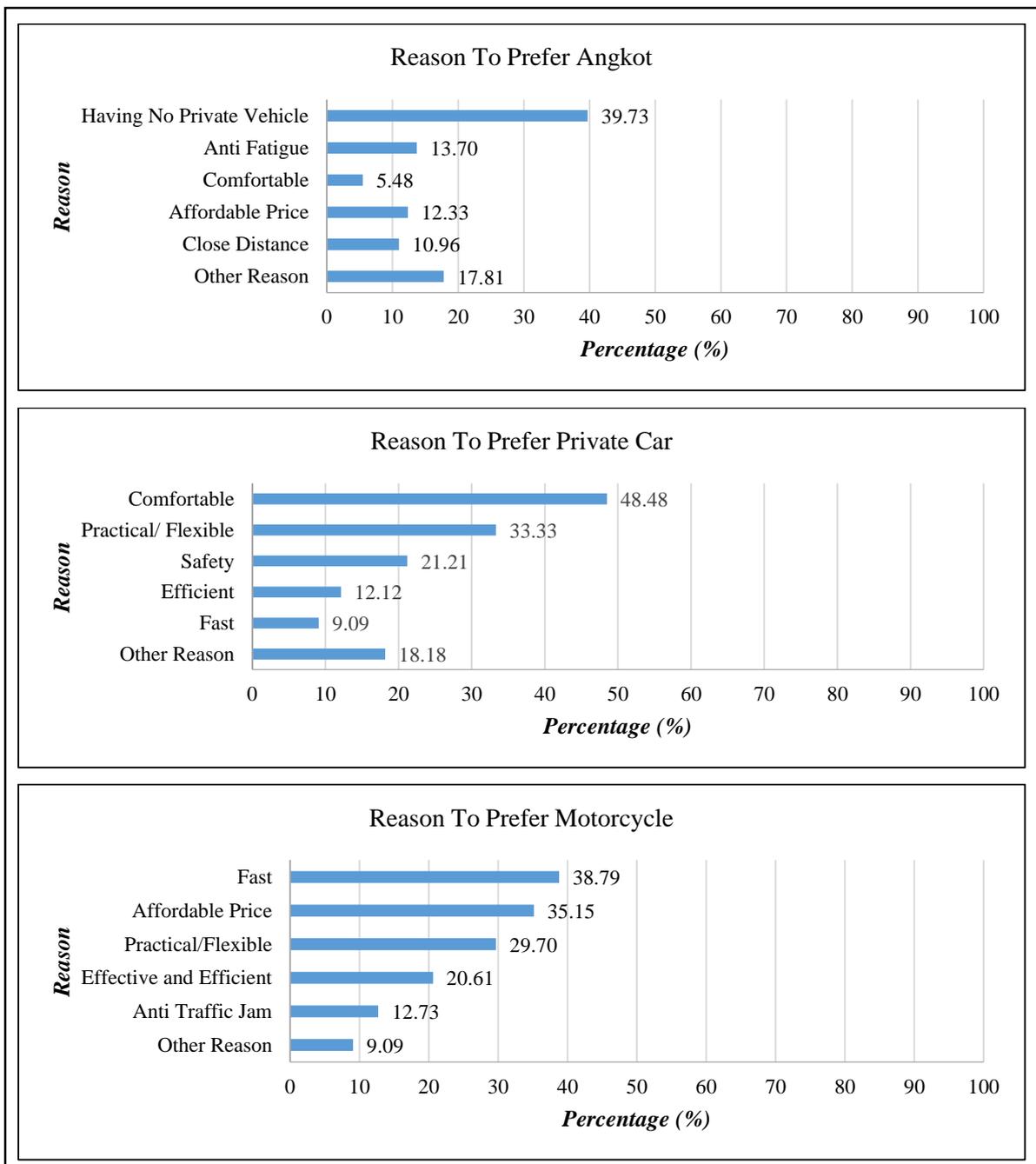


FIGURE 5.10

REASON FOR SELECTING MODES

Source: Analysis Result, 2015

The consideration about mode choice cannot be separated from the cost factor. In order to provide a clear image about the characteristic facility, the cost that respondents should spend to support their working purpose trip is compared between the cost spent by those who use

private and public transportation. The comparison result shows that the transportation cost spent by the private vehicle user is almost double the cost incurred by the public transportation user. Based on the questionnaire data, the transportation cost spent by the public and private vehicle user per week respectively, are Rp 53.000,- and Rp 117.000,- on average. In terms of the transportation cost, it can be inferred that current public transportation is able to provide a cheaper transportation than the private vehicle.

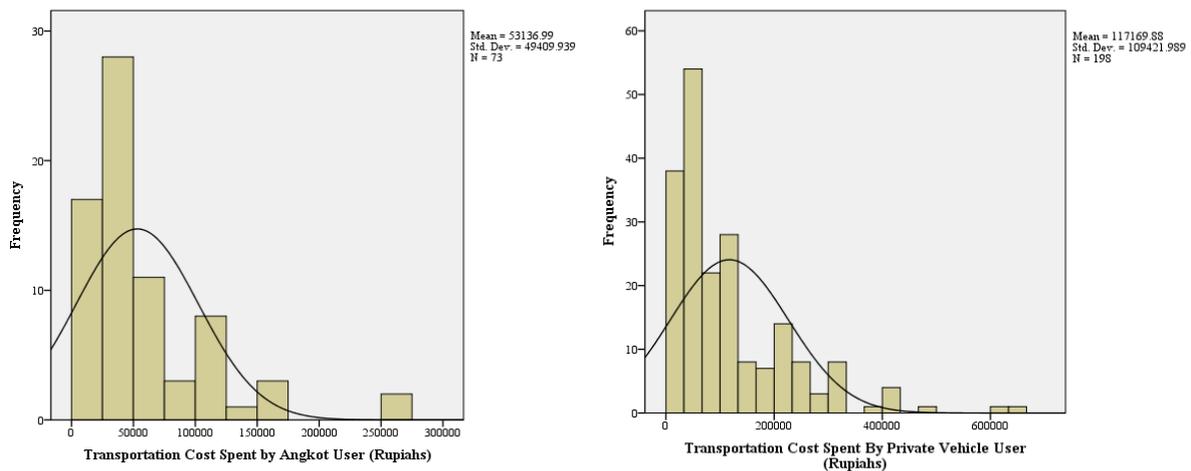


FIGURE 5.11

### COMPARISON OF TRANSPORTATION COST (PER WEEK) SPENT BY PUBLIC AND PRIVATE VEHICLE USER

*Source: Analysis Result, 2015*

In Bandung City, informal paratransit also plays a role in determining the condition of the city transportation system. *Ojek*, the main kind of paratransit which operate in Bandung City are usually can be found in the residential areas or at the location with high activity for example office area. Basically, this paratransit takes part to serve areas which are not passed by public transportation route. In other words, this paratransit has functioned to provide services in the blank spot areas.

In general, the distance between residential areas with the public transport stops and the distance between public stops and the workplace is still within the Average Walking Distance (AWD). The public transportation service area generally includes two AWDs. In Indonesia one AWD is determined approximately 0 – 200 meters. Within this average walking distance, it is possible for the residents to reach public transportation stops by foot. Based on the calculation result, the average distance should be taken from home to public stops by the working people at Bandung City in case they use public transportation is 332

meters. This distance is still within the range of 2 AWDs, and based on this condition it indicates that the current service area of network system of facility and infrastructure has been already feasible to support an effort to increase the mode shifting from private to public transportation.

To find a solution to increase the public transportation usage, especially of the working people, the analysis toward the network connecting residential areas with public transportation stops should also be supported by the analysis of the current network connecting public transportation stops and the workplace. From the questionnaire data, it can be identified that this network is better than the network connecting the residential areas and the public transportation stops. In case the respondent should use public transportation, currently the average distance should be taken by the respondents between the public stops and their work location is approximately 137 meters. This shorter distance is probably caused by the tendency that the offices or workplace are distributed at the strategic location or at the city center with high public transportation services.

The distance respondents given is not the precise distance, but the estimated distance. However, this data is quite important to give an overview about the condition of the current network system. The detail variation of distance between residential areas with the nearest public stop and between the public stops and the work location is presented in Figure 5.12.

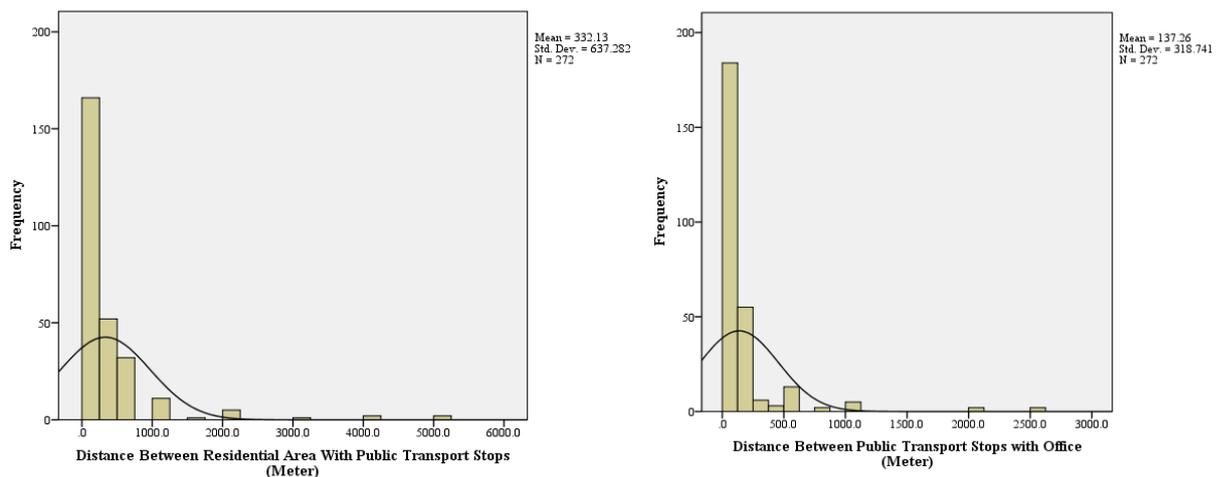


FIGURE 5. 12  
 DISTANCE FROM PUBLIC TRANSPORT STOPS TO RESIDENTIAL AREA  
 AND WORK LOCATION

*Source: Analysis Result, 2015*

### 5.1.3. Characteristic of the Journey

The third characteristic influencing mode preferences is the characteristic of the journey. This characteristic is associated with the way people move, whether they drive along the other family members or driving alone. This information is useful to determine the level of effectiveness of the transport activity. The behavior of car sharing of the respondents indicates a bigger occupancy vehicle in which it means that it is more efficient in using road space. Otherwise, driving the private vehicle alone indicates the low occupancy and inefficient in the road space using. Of all respondents who using a private vehicle as their transport mode, only 23.12 %, which using vehicle together with another family member. This low percentage indicates low efficiency of transport activity.

The car sharing behavior is predicted has a tight correlation with the family structure. The bigger the family structure the bigger the possibility of the people to apply car sharing. To test this premise, the chi-square test toward the variable of family member and car sharing behavior is applied. The variable of family member which at first has interval ratio data scale is converted first into the nominal data. In the form of nominal data, the family structure variable is classified into three categories including: 1). Not married, 2). Small family, with the family member equals or less than 4 peoples, and 3). Big family, with family member more than four peoples. The Analysis is conducted by using an SPSS software with the level of confidence 95 % or  $\alpha = 0.05$ . In this test, two hypotheses below are established:

H<sub>0</sub>: There is no relationship between vehicle sharing behaviors with the family structure.

H<sub>1</sub>: There is a relationship between vehicle sharing behaviors with the family structure.

TABLE 5.1  
 CHI-SQUARE TESTS RESULT

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.958 <sup>a</sup>	2	.001
Likelihood Ratio	16.073	2	.000
Linear-by-Linear Association	10.860	1	.001
N of Valid Cases	199		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.17.

Source: Analysis Result, 2015

Based on the test result, there is obtained a Pearson chi-square significance value of 0.001. Since the significance value is less than 0.05 ( $\alpha$ ), the  $H_0$  is rejected, otherwise  $H_1$  is accepted. Thus the conclusion resulted from this test is that there is a relationship between vehicle sharing behaviors of the working people in Bandung City with the family structure.

## 5.2. Willingness to Use Public Transportation

Mode shifting depends on the willingness of the trip maker and in order to draw up rules that lead to mode changing in the future, it is necessary to also look at the historical trend backward about this people willingness to shift their mode. In this case, a cross tabulation that compare between the type of vehicle that is used five years ago and now may be helpful to explain the trend in the past.

TABLE 5.2  
 THE CROSS TABULATION BETWEEN TYPE OF VEHICLE USED NOW,  
 AND FIVE YEARS AGO

			Type of Vehicle Used Currently				Total
			Angkot	Motorcycle	Other (Bike, Bus, By Foot)	Private Car	
Type of Vehicle Used 5 years ago	Angkot	Count	60	36	0	0	96
		% within used 5 years ago	62.5%	37.5%	0.0%	0.0%	100.0%
		% of Total	22.1%	13.2%	0.0%	0.0%	35.3%
	Motorcycle	Count	8	121	0	10	139
		% within used 5 years ago	5.8%	87.1%	0.0%	7.2%	100.0%
		% of Total	2.9%	44.5%	0.0%	3.7%	51.1%
	Other (Bike, Bus, By Foot)	Count	3	4	1	0	8
		% within used 5 years ago	37.5%	50.0%	12.5%	0.0%	100.0%
		% of Total	1.1%	1.5%	0.4%	0.0%	2.9%
	Private Car	Count	2	4	0	23	29
		% within used 5 years ago	6.9%	13.8%	0.0%	79.3%	100.0%
		% of Total	0.7%	1.5%	0.0%	8.5%	10.7%
Total	Count	73	165	1	33	272	
	% within used 5 years ago	26.8%	60.7%	0.4%	12.1%	100.0%	
	% of Total	26.8%	60.7%	0.4%	12.1%	100.0%	

Source: Analysis Result, 2015

Of the total respondents taken as a sample, only 24.26 % that have shifted their transportation mode in the last five years. From the cross tabulation above, it can be identified that the

biggest percentage of shifting is from *angkot* and private car to motorcycle. 36 of 96 respondents who used to use *angkot* or approximately 37.5 % shifted their mode into the motorcycle. Besides from *angkot*, mode shifting to motorcycle also occurs from the private car and other modes like bus, bike or walking. This shifting trend shows that in the last five years, the motorcycle is the most preferred mode of transportation. As an implication, to shift the transportation mode into public transport, then the public transportation must be made better than motorcycle in some aspects. Two aspects that can be taken into account as a stimulus to increase public transportation usage is the fuel price and improvement in public transportation. Regarding these two aspects, based on the data processing, it can be obtained a result as shown in Figure 5.13 and 5.14.

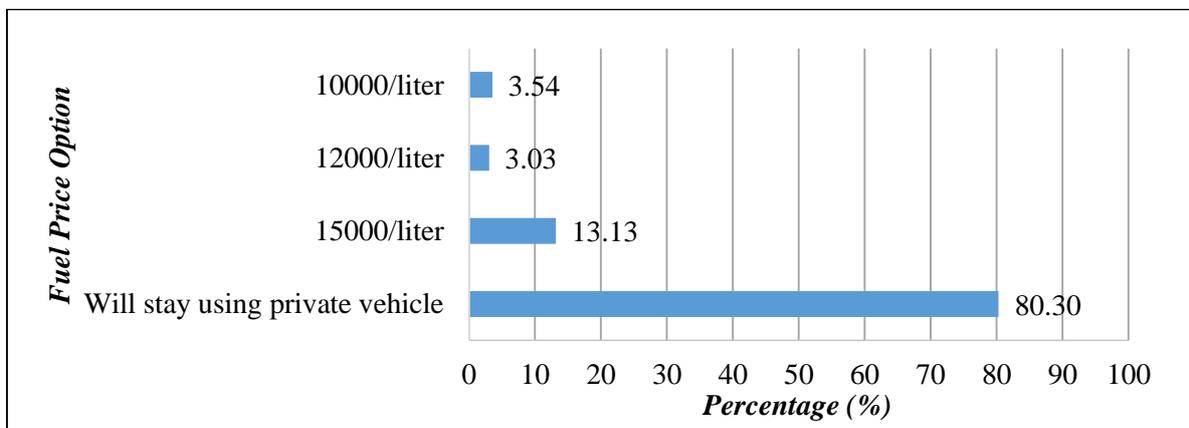


FIGURE 5.13

FUEL PRICE THAT WILL STOP THE WORKING PEOPLE  
 USING A PRIVATE VEHICLE

*Source: Analysis Result, 2015*

A conclusion can be drawn from the graphic above is that fuel price will not significantly influence people willingness to move from private vehicle to public transportation. 80.30 % of respondents stated that they will stay using a private vehicle, whatever the price of fuel will be. This perception is indirectly shaped by the view of respondents in the past and current situation. The increase in the fuel price usually do not only increase the transportation cost of private vehicle usage but also of public transportation usage. Lack of management in the current public transportation operation makes the public transportation cost very sensitive to changes in fuel price. As long as there is no regulation regarding subsidies for public transportation, the increase of this fuel price will not make one mode becomes more advantageous than others.

The distrust toward the public transportation operation has become a stigma in the current working people society. Respondents' opinion about their willingness to shift to public transportation in relation to the public transportation improvements has reinforced the issue. Through an open question asking about the kind of improvements that will stop them using a private vehicle, 42 % of respondents state that no matter how much improvement will be made they will continue using a private vehicle. Nevertheless, the mode shifting regulation still has a probability to succeed as long it is supported by an optimum effort. With varying percentages, some respondents show their willingness to shift their mode if the government makes some improvement, by building a better public transportation stops, providing public transportation with lower price, improving security system and improving the services.

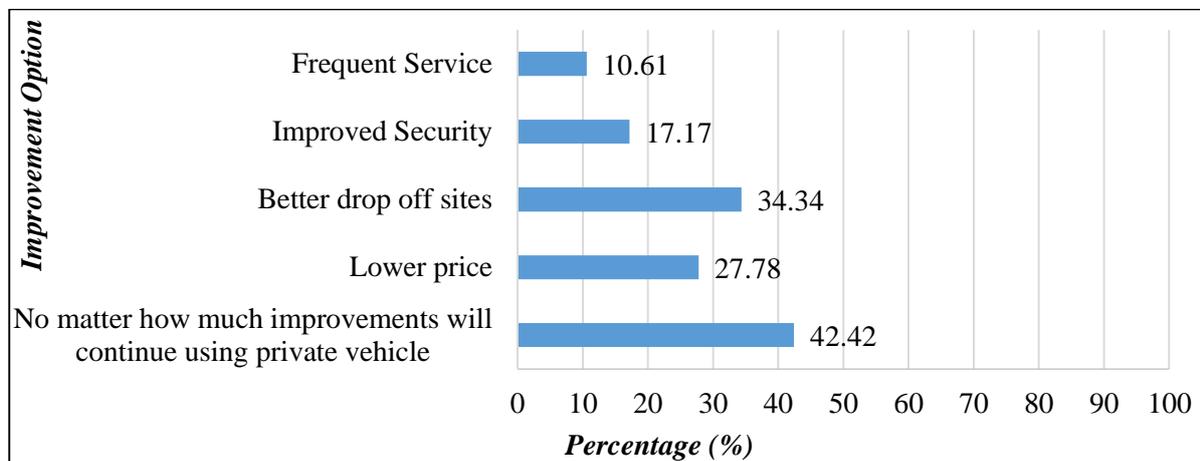


FIGURE 5.14

KIND OF IMPROVEMENT THAT WILL STOP THE WORKING PEOPLE  
 USING A PRIVATE VEHICLE

*Source: Analysis Result, 2015*

Take a look back to the shifting mode trend in the last five years, it gives strong evidence about the phenomenon has occurred. The selection of motorcycle as a dominant trend, apparently, is not unreasonable. Fast, affordable, flexible, effective and efficient are some perception of the motorcycle which leads them to eventually choosing this mode to support their daily transport activities (see Figure 5.10). In line with the theory of Planned Behavior from Ajzen, this behavior of people is not something that just popped out suddenly, but it is something planned. The theory of Planned Behavior proposed that the behavior is shaped by the “*attitude to the behavior*” (consideration regarding the consequence of the behavior), “*subjective norms*” (consideration regarding normative expectations of other people), and

“*perceived behavioral control*” (the possibility of behavior to be done, the extent to which some factors can facilitate or constraint to an action).

The reason such as fast speed, effective and efficient the respondents provided is the examples of the respondents’ “*attitude to the behavior*”. They observe various logical possibilities before deciding to choose a specific mode. Even so, besides these determining factors, there are factors that are difficult to be explained logically. From figure 5.14, it appears that 42 % of private vehicle user prefer to stay using their private vehicle no matter how many improvements will occur in the public transportation sector. In this case, some reason behind that might be classified into “*subjective norm*”, though not absolute since many other factors might also give influence. But certainly the tragedy of common has happened in this case, the action of someone in using motorcycle affect shaping the mind of the other people to do the same.

The motivation in choosing the motorcycle is also influenced by the “*perceived behavioral control*”. It is clearly visible in this case that the mode shifting to use motorcycle has increased in the last five years, in which it is enforced by the factual information about the trend of steep growth of motorcycle ownership from 2009 – 2013 (see Figure 5.5). This increase indicates that there must be some condition that facilitate this ownership and mode shifting, whether it is because the ease of licensing in having a private vehicle, or because the market system that very supportive that still to be investigated further in further research.

### 5.3. Mode Shifting Probability

This section will explain the probability to shift the transportation mode of the working people in Bandung from private to public transportation. To identify the factors that give a big influence towards the probability of transportation mode choice, the logistic regression is performed. Taking into account all the variables in the three characteristics influencing mode choice that has been explained in section 5.1, in this modelling those variables above is separated into a dependent variable and the independent variables. Dependent variable refers to the observed phenomena, the variable that are observed or influenced by the independent variables, meanwhile the independent variable refers to the variables that give influence toward the dependent variable. Independent variables are usually measured and manipulated to identify its relationship with the observed phenomena. Different treatment to independent variable is usually reviewed whether it gives impact to the dependent variable or not.

Since the aim of this modelling is to identify the probability of mode choice, whether public transportation will be chosen or not chosen as a mode of transportation to work, so the respondents' preferences regarding the type of transportation mode (public or private) is set as a dependent variable; the variable will be influenced. Meanwhile, the other variables are set as the independent variables; the variables considered will influence people's decision in selecting a transportation mode.

In this case, 14 variables are selected. This selection is based on the characteristics influencing mode choice from Ortuzar and Willumsen (2011). The 14 variables used in this modelling represent characteristics of the trip maker, characteristics of the journey and characteristics of the transport facility. These variables include: 1). Private vehicle ownership, 2). Driving license ownership, 3). Marital status, 4). The Family member, 5). Transportation cost, 6). The distance between home and office/ location of work, 7). Distance between home with the nearest public transport stop, 8). Distance between public transportation stop with office/ location of work, 9). The availability of paratransit, which connects the residential area with the nearest public transportation stops, 10). The availability of paratransit, which connect public transportation stops with office/ location of work, 11). Perception about mode efficiency, 12). Perception about transportation cost, 13). Perception about mode comfort, and 14). Perception about mode safety.

Different to the linear regression, in the logistic regression the output will be transformed into a binary option in the form of the nominal measurement scale, for example, yes or no, accepted or not accepted, and success or failure. For this analysis, the binary option that are set are "using public transportation" (the code given is 0) and using private vehicle" (the code given is 1). The regression process was performed by using an SPSS software with the level of confidence 95 % ( $\alpha = 0.05$ ).

To measure the validity of the resulted model, some tests toward the output of the binary logistic regression that has been generated by the SPSS will be interpreted. The tests are conducted in two approaches; the overall test and the partial test. The overall test is used to assess whether the resulted model can be used for further analysis. A model can be used if there is at least one independent variable that influence the dependent variable (the mode choice probability), otherwise the model cannot be used. The testing with the SPSS software

has facilitated this test in the form of omnibus tests of Model Coefficients. For this mode choice probability in Bandung City case, the result is presented in the table below.

TABLE 5.3  
 OMNIBUS TESTS OF MODEL COEFFICIENTS

	Chi-square	df	Sig.
Step 1 Step	219.913	14	.000
Block	219.913	14	.000
Model	219.913	14	.000

*Source: Analysis Result, 2015*

To test this result, two hypotheses are established as follows:

H<sub>0</sub>: There is no any independent variable that significantly influences the dependent variable.

H<sub>1</sub>: There is at least one independent variable that significantly influence the dependent variable.

The H<sub>0</sub> will be accepted if the significance of the omnibus tests of the model is bigger than the value of  $\alpha$ , otherwise the H<sub>0</sub> will be rejected. With the confidence level of 95 % ( $\alpha = 0.05$ ), the resulted table above inform that the significance value of the model is 0.000. Actually the value is not zero, but because of the very small value so only zero point zero that is visible in the resulted table. Since this significance value is lower than  $\alpha$ , thus H<sub>0</sub> is rejected and it can be concluded that from the 14 independent variables used, there are at least one of the independent variables that influence the mode choice probability of the workers in Bandung City and it means that the resulted model is feasible and can be used for further analysis.

Similar to the overall test, in the partial test, the significance value is assessed. The difference is that in the partial test, the assessment is applied to the significance of every variable. Based on the logistic regression result, the significance of every independent variable is presented in Table 5.4 below.

TABLE 5.4  
 ESTIMATION OF INDEPENDENT VARIABLES' COEFFICIENT  
 AND PARTIAL HYPOTHESIS TESTING

Variables in the Equation – Independent Variables						
	B	S.E.	Wald	df	Sig.	Exp(B)
Step 1 <sup>a</sup> Private_Vhcl_Ownership	2.514	.780	10.394	1	.001	12.349
Driving_License	1.576	.628	6.310	1	.012	4.838
Marital_Status	.338	.940	.130	1	.719	1.403
Family_Member	.053	.223	.057	1	.811	1.055
Transportation_Cost	.000	.000	2.248	1	.134	1.000
Distance_Res_Office	.053	.044	1.425	1	.233	1.054
Distance_Res_PT_1	.002	.001	2.623	1	.105	1.002
Distance_PT_Office_1	-.002	.001	4.221	1	.040	.998
Paratransit_Availability_Res_PT	.172	.801	.046	1	.830	1.188
Paratransit_Availability_PT_Office	-1.204	1.106	1.185	1	.276	.300
Perception_Mode_Efficiency	.462	.144	10.247	1	.001	1.588
Perception_Transport_Cost	-.349	.146	5.747	1	.017	.705
Perception_Comfort	.616	.172	12.868	1	.000	1.851
Perception_Safety	.049	.161	.091	1	.762	1.050
Constant	-8.107	1.957	17.165	1	.000	.000

a. Variable(s) entered on step 1: Private\_Vhcl\_Ownership, Driving\_License, Marital\_Status, Family\_Member, Transportation\_Cost, Distance\_Res\_Office, Distance\_Res\_PT\_1, Distance\_PT\_Office\_1, Paratransit\_Availability\_Res\_PT, Paratransit\_Availability\_PT\_Office, Perception\_Mode\_Efficiency, Perception\_Transport\_Cost, Perception\_Comfort, Perception\_Safety.

Source: Analysis Result, 2015

The significance value in the sixth column indicates the significance of the influence of the independent variable towards the transportation mode choice. If the significance value is smaller than  $\alpha$  value (0.05), it means that the independent variable significantly influence the mode choice probability. Conversely, if the significance value is bigger than  $\alpha$  value, it means that the independent variable does not significantly influence the mode choice probability. Basically, all independent variables will give an influence toward the mode choice and the significance value generated from the regression process merely indicates how strong or how significant their influence towards mode choice probability.

From the table above, there are six independent variables with the significance value less than 0.05. Those variables are private vehicle ownership (significance value = 0.001), driving

license ownership (significance value = 0.012), distance from public transport to the location of work (significance value = 0.040), perception of current mode efficiency (significance value = 0,001), perception of current transport cost (significance value = 0.017), and perception of mode comfort (significance value = 0.000).

This result gives a quite important information about what action should be performed to increase or decrease the probability of working people to choose public transportation. Since the interference towards these variables will give a significant effect to the public transportation preferences, thus this result might become a basis for transportation policy making. However, rely solely on this value is not enough, this significance value only give the information about the relationship between the dependent variable with its independent variables, but does not give any further information about how the direction of this relationship is (positively correlated or negatively correlated) or about the precision information on how big the independent variable will influence the dependent variable.

To know more information about the direction of the relationship between the variables, the value of B in the second column of the table above should be interpreted. The positive sign of this value indicates that the independent variables will give a positive influence towards the dependent variable, in this case, the dependent variable is a transportation mode choice. Otherwise, if the B value has a negative sign, it means that the independent variables will give a negative influence toward the dependent variable.

Besides showing the direction of the relationship among the dependent and independent variables, this value of B also indicates the coefficient value of every independent variable. Based on these coefficients, a regression equation model can be generated. In the last row of the resulted table above, it can be seen that besides the coefficient value of 14 independent variables, the logistic regression process also produces a constant. The function of this constant is to explain the influence of other variables that might have an effect on the mode choice, but are not included in this modelling process. Configured in an equation, the logistic regression model for the mode choice probability of the working people in Bandung City can be written for as follow:

$$\ln \frac{P(x)}{1-P(x)} = 2.514X_1 + 1.576X_2 + 0.338X_3 + 0.053X_4 + 0.000X_5 + 0.053X_6 + 0.002X_7 - 0.002X_8 \\ + 0.172X_9 - 1.204X_{10} + 0.462X_{11} - 0.349X_{12} + 0.616X_{13} + 0.049X_{14} - 8.107$$

In which:

X<sub>1</sub> = Private vehicle ownership

X<sub>2</sub> = Driving license ownership

X<sub>3</sub> = Marital status

X<sub>4</sub> = Family member

X<sub>5</sub> = Transportation cost

X<sub>6</sub> = Distance between home and office/ location of work

X<sub>7</sub> = Distance between home with the nearest public transportation stop

X<sub>8</sub> = Distance between public transportation stop with office/ location of work

X<sub>9</sub> = the availability of paratransit connecting home with the nearest public transport stops

X<sub>10</sub> = the availability of paratransit connecting public transport stops with the office

X<sub>11</sub> = Perception about mode efficiency

X<sub>12</sub> = Perception about transportation cost

X<sub>13</sub> = Perception about mode comfort

X<sub>14</sub> = Perception about mode safety

The outcome of the logistic regression equation model above is in the form of log of odd. To identify how big the influences of the changes of independent variable towards the probability of the mode choice, the log of odd should be converted into the odd form. In order to do that, the value of B should become an exponent of e; the natural logarithms (e = 2.71828). The operation using SPSS usually automatically produces this value. In the table above, this value is represented by the values in the 7<sup>th</sup> column (Exp (B)). This value gives more information compare to the significance value and B value.

From the analysis of the significance value that has been explained before, it is identified that there are six variables that significantly influence the mode choice of working people in Bandung. Thus, for the next analysis, the interpretation of Exp (B) will only be applied to these six variables. The first variable that has a significant influence is a private vehicle ownership. In the logistic regression process, this variable is coded with this value: 0 = have no private vehicle and 1 = have private vehicle. From this table, it is obtained that the odds

for the variable of private vehicle ownership is 12.35, this means that those working people who have not private vehicle have a probability of 12 times bigger to use public transportation than those who have private vehicle if the value of the other variables is assumed the same or do not change. Similar to the determining process of private vehicle ownership, then for driving license ownership, which is coded by 0 = have no driving license and 1 = have driving license, the value of B (4.83) indicates that those who have no driving license have a probability of 4.83 times bigger to use public transportation than those who do not have driving license.

For distance between public stops with office/ location of work, since the data is in the form of interval/ratio scale, there is a slight difference in interpreting it. The odds value of this variable according to table 5.9 is 0.998. This means that the worker whose their distance between public stops to office is longer 1 meter, they has a probability of 0.998 times smaller than the probability of those whose distance between public stops and office shorter 1 meter. If the distance differences is not 1, for example 100 meters, the probability to use public transportation of those whose distance is 100 m longer is  $e^{(100 \times \beta)} = 2.718^{(100 \times (-0.002))} = 0.81$  smaller than those whose distance between public transportation stops with office is shorter by 100 meters.

Another variable that give significant influence toward mode choice is the perception about mode efficiency. This perception is measured by using a Likert Scale in an ordinal measurement scale. Based on the result of the logistic regression, the odd value obtained for this variable is 1.59. This odd value indicates that if current public transportation is improved until it can change respondent's perception about public transportation efficiency to increase one level, the probability of respondents to use public transportation will increase 1.59 times bigger than the probability of using a private vehicle. So does the comfort perception, if the public transportation can be improved until make people perception about the comfort level is increased one level than the current condition, it will increase the probability of the working people to prefer public transportation than private vehicle. Based on the regression result, the odd value for the variable of mode comfort is 1.85. It means that the probability of respondent to use public transportation will increase approximately 1.85 bigger than the probability using a private vehicle if the government can improve the comfort aspect of

public transportation one level better according to the workers perception than the current condition.

Different to the perception of mode efficiency and safety, the perception about transportation cost have a negative relationship with the probability to choose public transportation. The odd value for this perception is 0.70. It means that if the transportation cost gets more expensive one level according to the perception of the working people, the probability they will choose public transportation is only 0.7 times the probability to choose private vehicle. In other words, the increase in transportation cost will increase the probability of people to prefer private vehicle.

In addition to the overall and the partial test, before the model above was decided to be applied in the decision making process, the test toward the goodness of fit should be performed. This test will measure the feasibility and the reliability of the model; explaining to the extent to which that the model is able to explain the data and to the extent to which that the mode choice probability can be determined by the model. To identify this goodness of fit of the model, the value of Hosmer and Lemeshow Test, the Nagelkerke R square and the value of the classification table that are generated by the logistic regression process will be assessed.

The first analysis is the analysis towards the result of the Hosmer and Lemeshow test. This test measures the model fit with the empirical data. In this test, two hypotheses that are formulated are as follows:

H<sub>0</sub>: The resulted model is able to explain the data

H<sub>1</sub>: The resulted model is not able to determine the data

TABLE 5.5  
 HOSMER AND LEMESHOW TEST

Step	Chi-square	df	Sig.
1	12.270	8	.140

Source: Analysis Result, 2015

For the confidence level of 95 %, the H<sub>0</sub> will be accepted if the significance value for the Hosmer and Lemeshow test is bigger than 0.05 ( $\alpha$ ), otherwise the H<sub>0</sub> is rejected and H<sub>1</sub> is

accepted. The Table 5.5 shows that the significance value is 0.140, this value is bigger than 0.05, thus the  $H_0$  is accepted. Since the  $H_0$  is accepted, it means that the obtained model is able to explain the data. In other words the empirical data have been matched with the model, so the model can be used.

The second analysis to test the goodness of fit is the identification toward the value of Nagelkerke R square. Similar to the  $r^2$  in the linear regression, the Nagelkerke R square value will give an information about the percentage of the ability of the independent variables in determining the output. From the output modelling by using the SPSS software, the value of Nagelkerke R square that is obtained for the mode choice probability of workers in Bandung City is 0.806. It means that the independent variables used in this logistic regression process are able to determine 80.06 % the mode choice probability, meanwhile 19.94 % the rest is explained by other variables that probably have not been included in the model.

TABLE 5.6  
 MODEL SUMMARY – NEGELKERKE R SQUARE

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	96.501 <sup>a</sup>	.554	.806

a. Estimation terminated at iteration number 8 because parameter estimates changed by less than .001.

*Source: Analysis Result, 2015*

That big percentage of accuracy of the independent variables in determining the output indicates that the model is good enough to be used. However, this percentage value is not a precision value, but only an approximate value. To get a better understanding of the model, the percentage in the classification table from the logistic regression result should be interpreted as well. This value will give a better information about how able the model can predicts the output correctly.

TABLE 5.7  
 CLASSIFICATION TABLE<sup>a</sup>

Observed			Predicted		
			Type of Vehicle for Work		Percentage Correct
			Public Transportation	Private Vehicle	
Step 1	Type of Vehicle for Work	Public Transportation	65	8	89.0
		Private Vehicle	4	195	98.0
Overall Percentage					95.6

a. The cut value is .500

Source: *Analysis Result, 2015*

From the table 5.7, it can be seen that the overall percentage in the classification table is 95.6. It means that the model is able to predict the output 95.6 % correctly. This percentage indicates that the model is highly accurate in predicting the outcome.

Based on the explanation above, it can be concluded that the obtained model from this logistic regression process is good enough and has high precision in determining the outcome. The model can be used further as a basis for strategy making regarding the mode shifting of the workers in Bandung City from the private to public transportation. In line with these six generated determinant variables in this analysis, the next chapter will provide conclusion and the recommendation about probable strategies might be applied in Bandung City.

## CHAPTER 6

### CONCLUSION AND RECOMMENDATION

#### 6.1. Conclusion

Transportation mode choice is important to be taken into account in the transportation planning. In aggregate this aspect will give a significant influence toward the city system in general. According to the theory of Transport Demand Management, managing the supply by improving the quantity and quality of the infrastructure is somewhat outdated. Instead of managing the supply, the transportation planning should be directed to managing the demand, by coordinating the demand of the movement with a more efficient way, whether through time shifting, route shifting, mode shifting or destination shifting.

Considering the current public transportation condition in Bandung City that is still far from adequate nor reliable, mode shifting aspect become important to be studied in depth in order to support this city development in the future. In line with the theories of the vicious circle of the problem in the urban transport system, this unreliable public transportation (angkot) as well as a mediocre improvement provided by the government has created a distrust and pushed the workers to find alternative solutions that mostly is by using private vehicles, especially motorcycle. On the one hand, this self-generated alternative solution in a short-term can solve the problem faced by the working people. However, on the other hand, this tendency leads to the occurrence of the tragedy of common and generates a bigger transportation problem.

This conceptual about the relationship between public transportation and private vehicle usage is proven whether by the official data in the governmental report or by the finding fact of the field survey. According to the official data that has been published by the Bandung Statistic Agency (BPS Kota Bandung), it is noted that in the last five years the private vehicle ownership in Bandung City, has continually increased. The average annual growth of motorcycle and private car from 2009 – 2013 are respectively 7.63 % and 7.34 %. This high private ownership growth might increase the probability of the workers to use private vehicle to support their daily transport activity. This argumentation is later enforced by the field survey data result. Based on the data generated from the questionnaire distribution result toward 272 workers in Bandung City, obtained the result that 73 % of working people in

Bandung currently prefers to use a private vehicle for their trip to work, in which 82.91 % of this private vehicle user prefers motorcycle as their transportation mode. The main reasons are because this mode is fast, affordable, flexible, effective and efficient to be used.

The most obvious problems that followed from this massive use of private vehicle are traffic jams. Moreover, the infrastructure supply cannot keep pace with this growth of private vehicle use. Regarding this problem, the Transport Demand Management provides a promising solution. As a breakthrough in the transportation management system, this method manages the demand side of transportation instead of adding the transportation infrastructure supply.

Considering that the successful application of this transport demand management will depend on the willingness of the trip user, this research combined the mode choice modelling with the assessment of workers' willingness to use public transportation. This willingness aspect is reviewed from two perspectives, past – current perspective and future perspective. From the past - current perspective, it is identified that the willingness to use public transportation has decreased. Conversely, the motorcycle has been the most preferred mode of transportation by the workers in Bandung City. Meanwhile from the future perspective, people distrust seems to be a constraint, in which 42.42 % of respondent tends to keep using private vehicle no matter how many improvements will occur.

According to the Theory of Planned Behavior, the workers' behavior in deciding transportation mode is not randomly happened, but it is something planned and reasonable. According to this theory, someone's behavior to undertake a certain action is influenced by the "*attitude to the behavior*" (consideration regarding the consequence of the behavior), "*subjective norms*" (consideration regarding normative expectations of other people), and "*perceived behavioral control*" (the possibility of behavior to be done, the extent to which some factors can facilitate or constraint to an action). In the context of Bandung City, reasons of the workers to prefer motorcycle such as fast speed, effective and efficient can be associated with "*attitude to the behavior*". The workers chose motorcycle based on the consideration that it will bring good consequences for supporting their work trip.

Differ to the "*attitude to the behavior*", some reasons that lead to the occurrence of the tragedy of common might be classified as a "*subjective norm*". The action of someone in

using motorcycle will shape the mind of the other people to do the same. Moreover, in the condition which most people use private vehicles, this will create a social pressure for the other people.

In addition, conditions that facilitate the increase in the private vehicle ownership, whether it is because the ease of licensing in having a private vehicle, or because the market system (still need further research to prove it) are associated with the “*perceived behavioral control*”. Jointly, this “*the perceived behavioral control*” with “*the attitude to the behavior*”, and “*the subjective norm*” determine the transportation mode choice of the workers in Bandung City.

Based on the result of modelling using the logistic regression, there are six variables that will potential to influence mode shifting probability of the working people at Bandung City. These six variables are private vehicle ownership, driving license ownership, distance from the public transport stops to the location of work, perception of current mode efficiency, perception of current transport cost, and the perception of mode comfort. The mode choice probability for each variable are as follows:

- The working people who have not private vehicle have a probability of 12 times bigger to use public transportation than those who have private vehicle if the value of the other variables is assumed the same or do not change
- The working people who have no driving license have a probability of 4.83 times bigger to use public transportation than those who do not have driving license.
- The workers who have distance between public stops to office longer by 100 meters has a probability of 0.81 times smaller than the probability of those whose distance is shorter.
- If current public transportation is improved until it can change respondent’s perception about the public transportation efficiency increase one level, the probability of respondents using public transportation will increase 1.59 times bigger than the probability of using a private vehicle.
- The probability of respondent to use public transportation will increase approximately 1.85 bigger than the probability using a private vehicle if the government can improve the comfort aspect of public transportation one level better than the current condition

- If the transportation cost gets more expensive one level according to the perception of the working people, the probability they will choose public transportation is only 0.7 times the probability to choose private vehicle.

Based on the analysis above, thereby several alternatives can be proposed to increase mode shifting probability of the working people in Bandung City are: 1). Restricting private vehicle ownership, 2). Building a control system towards the driving license ownership, 3). Decrease the distance between public transportation and location of work, 4). Developing an efficient public transportation, 5). Developing a reliable yet affordable public transportation, and 6). Developing a convenient public transportation. In addition to these strategies, since the distrust towards the current public transportation system is still quite high, a strategy to improve people distrust will be necessary as well. The detail explanation about these proposed strategies will be explained in the next section.

## **6.2. Recommendation (Alternative Strategy to Increase Public Transportation Usage)**

Basically, all fourteen independent variables included in the logistic regression process are variables that will influence the mode choice probability. This is scientifically proven and becomes a reference in several literature. However, the modelling result of this research shows that comparing to one another, only some of them that will have significant influence toward mode choice probability of the working people in Bandung City. Giving treatment to this significant variables will create a bigger impact and eventually effective in increasing mode shifting probability from private to public transportation at Bandung City. The modelling result might be different from one city to another depends on the socioeconomic characteristic, the availability of transportation facility and depends on the behavior of its resident in making the trip. For the case of Bandung City, from 14 independent variables chosen as the independent variables, there are six variable which are predicted the most influential towards the mode shifting probability of the working people in this city. These six variables are private vehicle ownership, driving license ownership, distance from public transport to the location of work, perception of current mode efficiency, perception of current transport cost, and the perception of mode comfort.

Considering the implication towards the policy and strategy development for transportation planning at Bandung City, the modelling result provide bases for decision making. One thing that needs to be emphasized, basically to build a comprehensive transportation planning all

aspects representing independent variables and other aspects that may have not been included in the modelling should be planned, nevertheless, to achieve goals and target effectively, strategies should be arranged on a base of the priority list. In line with the modelling result in this case study, due to its significance impact thus the six generated determining variables must be priority strategies. Based on this six generated variables, the strategies might be applied at Bandung City to increase the mode shifting probability of the working people from private to public transportation are as follow.

#### 1. Restricting Private Vehicle Ownership

The facts have proven that private vehicle ownership in Bandung City is continuing to rise sharply, from 2012 to 2013, the growth of private car and motorcycle ownership respectively is 6.57 and 6.66 %. In the current condition, almost 82 % of working people in Bandung City have private vehicle to support their work trip. A Moreover, with a low affordable price of a motorcycle, regardless of the income aspect, every working people at every range of income (includes those whose income is lower than the regional minimum wage) are able to have a motorcycle.

The shifting to motorcycle is based on several reasons. Fast and reliable mode to pass traffic jam is one of the main reason behind this decision. Moreover, with the lack of adequate public transportation in the current condition. On the short term, this alternative will solve the traffic jam problem faced by the working people, however, on the long term, this condition will lead to the tragedy of commons where everybody starts using a motorcycle as their individual problem solving and eventually this will accumulate a bigger traffic jam. So instead of solving the problem, this shifting to use motorcycle will create a bigger problem.

As an alternative towards this problem, private vehicle ownership should be restricted. The restriction term in this strategy does not imply that public transportation should be banned, but this term implies that there should be control to the ownership by tightening the ownership permit. To have a private vehicle, people should be a subject to several requirements. High vehicle tax, for example, can be an alternative to make private vehicle becomes a less preferable mode. Another requirement can be taken is by restricting old vehicle that has reached a certain period of time. In the existing condition, there are still no limitation toward this life of the vehicle. Low income people can buy a very cheap

motorcycle in the second hand condition or even more. The tight regulation about the lifetime of a vehicle will give control toward the private vehicle ownership.

## 2. Building a control system towards the Driving License Ownership

Besides private vehicle ownership, driving license ownership is another factor determines the tendencies of the working people to use a private vehicle. Even though in the current situation, there are still some people who persist using a private vehicle despite do not have driving license. Based on the questionnaire data, approximately 16.10 % of current private vehicle user do not have driving license. Nonetheless, assuming that the law enforcement fully supports the traffic operation, control towards driving license ownership is required.

Compared to the private vehicle ownership control, the impact given by the driving license ownership toward mode choice probability is less than the impact given by the control toward private vehicle ownership. Based on the modelling result, those who have private vehicle tends to have 12 times bigger probability than those who do not possess private vehicle. Meanwhile, for the driving license ownership, someone who have driving license tends only to have 5 times bigger probability than those who do not have driving license. Differ to the private vehicle ownership aspect, driving license ownership cannot be limited. Hence the feasible alternative that can be applied for example through a tight control mechanism, for example through establishing criteria standard for passing the examination to obtain driving license and through strict law enforcement, prohibiting those who does not have driving license to drive private vehicle.

## 3. Decrease the distance Between Public Transportation and Location of Work

One of the factors that influence the working people in making decision about their transportation mode is the condition of the network. In a certain situation, maybe the public transportation has been on a good condition, but the distance between the residential areas with the public transportation stops or between public transportation stops with the location of work is out of range of average walking distance. The distance between residential with public transportation stops is equally important with the distance between public transportation with office/ work location, although the modelling result indicates that the distance between public transportation stops to the location of work tends to be more dominant.

To support this strategy, transit oriented development can be applied by pushing the development towards a compact and walkable city system surround the transportation node for example the terminal. This alternative can be applied for long term development, meanwhile for the short term development, the distance between public transportation and work location can be decreased by providing public transportation that have a broader service area reach up to the office area and through the provision of the public transportation stops facilities as well. Basically, this strategy is aimed to configure public transportation facilities and infrastructure to support the activity at every land use.

#### 4. Developing an efficient public transportation

Restriction towards private vehicle ownership will not successful without the improvement in the public transportation system itself. Working people are a population group which highly depends on a time frame. Their movement is limited by the work hour schedule, thus this working group needs a reliable transportation mode to support their activities. The current condition of public transportation in Bandung City still cannot meet the needs of the working people. It is proven by the study result which indicates that this mode is less preferable than the private vehicle usage.

In order to increase the mode shifting probability from private to public transportation, the public transportation should be built into an efficient mode. Efficient means that to achieve their destination to the workplace, the working people can use the mode which can minimize their time, effort and cost. From this definition, thus to build an efficient public transportation, three aspects can be used as the indicators. Firstly, from the speed aspect the public transportation should be reliable to provide rapid movement. Secondly, from the practical aspect, it also should be achievable within two average walking distance. Apart from that, route organization should also be taken into account. In many cases, the working people are reluctant to use public transportation because their trip requires them to switch the route which sometimes it can be time consuming. To enhance public trust toward public transportation, mode switching mechanism and the provision of facilities which accommodated it should be well planned. Thirdly, from the cost aspect, to build an efficient public transportation means that the fare of public transportation should be affordable for people at all income ranges. For this cost aspect, the argument will be further explained in the next strategy.

## 5. Developing a reliable yet affordable public transportation

This strategy is still in line with the previous strategy to build an efficient public transportation. The modelling results indicate that the more affordable the public transportation, the bigger the probability of the working people to choose public transportation. This conclusion is rather contradiction with the current condition in which the public transportation cost somehow has been cheaper than the private vehicle cost. Comparison result shows that the transportation cost spent by the public transportation user is almost half the cost incurred by the private vehicle user. There are two reasons for this contra implication, Firstly, this occurs because the respondent perception about transportation cost is measured in an ordinal measurement scale which has less precision than the interval/ ratio data in which the current real transportation cost measured by. Secondly, the reason behind this contra implication may also be caused by the perception of the working people who still perceive the existing public transportation cost is too expensive compared to the service it provides.

Based on the consideration above, to increase the mode shifting probability from private to public transportation, current public transportation should be developed into an affordable transportation mode yet reliable to support transportation for working purpose. Subsidies for public transportation might be an alternative to create an affordable public transportation. All this time, subsidies regarding transportation sector are spent for fuel subsidies which eventually reach improper target. Subsidized fuel that was originally intended for low income people tends to be used by people at all income ranges. Firmly allocating transportation subsidy to improve public transportation will increase the probability of the working people to shift their mode from private to public transportation.

## 6. Developing a convenient public transportation

The other priority strategy to increase the mode shifting probability is through developing a convenient public transportation. Based on the previous analysis, only 5.48 % of all public transportation users who prefer public transportation due to its comfort reason. This small percentage denotes that in the current condition, public transportation is still far from comfortable. An alternative can be used to improve the convenience aspect of public transportation is through facility improvement.

## 7. Building public trust

This strategy is intended as an effort to increase workers willingness to use public transportation. The six strategy above will not run properly if it is not supported by the public trust. To increase public trust means that the local city government should perform a monitoring and evaluation regularly and provide stakeholder a regular statement about their progress and activities. In this case, communicative planning might become an alternative to increase public trust. Besides improve transparency, communicative planning will also provide a room for all stakeholders to participate and actively take a role in the public transportation of the Bandung City.

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**APPENDIX 1**
**CURRENT TOTAL OF ANGKOT AND PUBLIC BUS IN BANDUNG CITY**
**ROUTE OF ANGKOT BASED ON DISTANCE AND VEHICLE UNIT**

<b>No</b>	<b>Route</b>	<b>Route Distance (Km)</b>	<b>Vehicle Unit</b>
1	Abdul Muis - Cicaheum Via Binong	16.3	355
2	Abdul Muis - Cicaheum Via Aceh	11.55	100
3	Abdul Muis - Dago	9.3	271
4	Abdul Muis - Ledeng	16	245
5	Abdul Muis - Elang	9.75	101
6	Cicaheum - Ledeng	14.25	214
7	Cicaheum - Ciroyom	17	206
8	Cicaheum - Ciwastra - Derwati	17	200
9	Cicaheum - Cibaduyut	16.1	150
10	Stasiun Hall - Dago	10	52
11	Stasiun Hall - Sadang Serang	11	150
12	Stasiun Hall - Ciumbuleuit Via Eykman	9.8	53
13	Stasiun Hall - Ciumbuleuit Via Cihampelas	8.3	30
14	Stasiun Hall - Gede Bage	21	200
15	Stasiun Hall - Sarijadi	10.2	80
16	Stasiun Hall - Gunung Batu	8.5	53
17	Margahayu Raya - Ledeng	19.8	125
18	Dago - Riung Bandung	20.6	201
19	Pasar Induk Caringin - Dago	19.85	140
20	Panghegar Permai - Dipati Ukur - Dago	19.35	155
21	Ciroyom - Sarijadi Via Sukajadi	11.75	88
22	Ciroyom - Sarijadi Via Setrasari	10.75	31
23	Ciroyom - Bumi Asri	8.35	115
24	Ciroyom - Cikudapateuh	12.9	140
25	Sederhaa - Cipagalo	16.05	276
26	Sederhana - Cijerah	8.9	63
27	Sederhana - Cimindi	9	55
28	Ciwastra - Ujung Berung	13.4	32
29	Cisitu - Tegallega	13.95	82
30	Cijerah - Ciwastra - Derwati	22.3	200
31	Elang - Gede Bage - Ujung Berung	22.45	115
32	Abdul Muis - Mengger	10.55	25
33	Cicadas - Elang	18.05	300
34	Antapani - Ciroyom	13.7	160
35	Cicadas - Cibiru - Panyileukan	13.65	200
36	Bumi Panyileukan - Sekemirung	24.35	125
37	Sadang Serang - Caringin	18.1	200

No	Route	Route Distance (Km)	Vehicle Unit
38	Cibaduyut - Karang Setra	16.6	201
39	Cibogo - Elang	7	32
	<b>Total</b>		<b>5.521</b>

Source: BPS, 2013

#### NUMBER OF PUBLIC BUS MANAGED BY DAMRI ON 2011

NO	Section/ Route	Unit Number	Distance (Km)
<b>ECONOMY CLASS</b>			
1	Cicaheum - Cibeureum	10	13.5
2	Leuwipanjang - Ledeng	10	14
3	Dipatiukur - Leuwipanjang	15	9.5
4	Elang - Jatinangor	15	27
5	Dipatiukur - Jatinangor	5	23
6	Kebon kalapa - Tanjungsari	10	27
7	Leuwipanjang - Cicaheum	10	11.75
8	Kebon kalapa - Cibiru	0	18
9	Alun-Alun - Ciburuy	15	24
<b>NON ECONOMY CLASS</b>			
1	Cicaheum - Cibeureum	10	13.5
2	Leuwipanjang - Ledeng	10	14
3	Elang - Jatinangor Via Tol	15	27
4	Dipatiukur - Jatinangor	15	23
5	Kebon kalapa - Tanjungsari	5	27
6	Leuwipanjang - Cicaheum	10	11.75
7	Kebon kalapa - Cibiru	20	18
8	Kota Baru - Alun-Alun	10	30

Source: DAMRI, 2011 in BPS, 2013

## LOGISTIC REGRESSION RESULT

## Case Processing Summary

Unweighted Cases <sup>a</sup>	N	Percent
Selected Cases		
Included in Analysis	272	100.0
Missing Cases	0	.0
Total	272	100.0
Unselected Cases	0	.0
Total	272	100.0

a. If weight is in effect, see classification table for the total number of cases.

## Dependent Variable Encoding

Original Value	Internal Value
Public Transportation	0
Private Vehicle	1

## Block 0: Beginning Block

 Classification Table<sup>a,b</sup>

Observed			Predicted		
			Type of Vehicle for Work		Percentage Correct
			Public Transportation	Private Vehicle	
Step 0	Type of Vehicle for Work	Public Transportation	0	73	.0
		Private Vehicle	0	199	100.0
Overall Percentage					73.2

a. Constant is included in the model.

b. The cut value is .500

### Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)
Step 0 Constant	1.003	.137	53.712	1	.000	2.726

### Variables not in the Equation<sup>a</sup>

	Score	df	Sig.
Step 0 Variables Private_Vhcl_Ownership	116.710	1	.000
Driving_License	93.264	1	.000
Marital_Status	4.307	1	.038
Family_Member	6.486	1	.011
Transportation_Cost	21.162	1	.000
Distance_Res_Office	7.037	1	.008
Distance_Res_PT_1	4.584	1	.032
Distance_PT_Office_1	2.675	1	.102
Paratransit_Availability_Res_PT	7.422	1	.006
Paratransit_Availability_PT_Office	.129	1	.720
Perception_Mode_Efficiency	97.650	1	.000
Perception_Transport_Cost	7.790	1	.005
Perception_Comfort	75.378	1	.000
Perception_Safety	41.066	1	.000

a. Residual Chi-Squares are not computed because of redundancies.

### Block 1: Method = Enter

#### Omnibus Tests of Model Coefficients

	Chi-square	df	Sig.
Step 1 Step	219.913	14	.000
Block	219.913	14	.000
Model	219.913	14	.000

#### Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	96.501 <sup>a</sup>	.554	.806

a. Estimation terminated at iteration number 8 because parameter estimates changed by less than .001.

### Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	12.270	8	.140

### Contingency Table for Hosmer and Lemeshow Test

		Type of Vehicle for Work = Public Transportation		Type of Vehicle for Work = Private Vehicle		Total
		Observed	Expected	Observed	Expected	
Step 1	1	25	26.667	2	.333	27
	2	25	24.779	2	2.221	27
	3	18	14.717	9	12.283	27
	4	2	4.215	25	22.785	27
	5	2	1.534	25	25.466	27
	6	1	.647	26	26.353	27
	7	0	.325	28	27.675	28
	8	0	.090	27	26.910	27
	9	0	.022	27	26.978	27
	10	0	.003	28	27.997	28

### Classification Table<sup>a</sup>

	Observed	Predicted			
		Type of Vehicle for Work		Percentage Correct	
		Public Transportation	Private Vehicle		
Step 1	Type of Vehicle for Work	Public Transportation	65	8	89.0
		Private Vehicle	4	195	98.0
	Overall Percentage				95.6

a. The cut value is .500

**Variables in the Equation**

	B	S.E.	Wald	df	Sig.	Exp(B)
Step 1 <sup>a</sup> Private_Vhcl_Ownershi p	2.514	.780	10.394	1	.001	12.349
Driving_License	1.576	.628	6.310	1	.012	4.838
Marital_Status	.338	.940	.130	1	.719	1.403
Family_Member	.053	.223	.057	1	.811	1.055
Transportation_Cost	.000	.000	2.248	1	.134	1.000
Distance_Res_Office	.053	.044	1.425	1	.233	1.054
Distance_Res_PT_1	.002	.001	2.623	1	.105	1.002
Distance_PT_Office_1	-.002	.001	4.221	1	.040	.998
Paratransit_Availability _Res_PT	.172	.801	.046	1	.830	1.188
Paratransit_Availability _PT_Office	-1.204	1.106	1.185	1	.276	.300
Perception_Mode_Effic iency	.462	.144	10.247	1	.001	1.588
Perception_Transport_ Cost	-.349	.146	5.747	1	.017	.705
Perception_Comfort	.616	.172	12.868	1	.000	1.851
Perception_Safety	.049	.161	.091	1	.762	1.050
Constant	-8.107	1.957	17.165	1	.000	.000

a. Variable(s) entered on step 1: Private\_Vhcl\_Ownership, Driving\_License, Marital\_Status, Family\_Member, Transportation\_Cost, Distance\_Res\_Office, Distance\_Res\_PT\_1, Distance\_PT\_Office\_1, Paratransit\_Availability\_Res\_PT, Paratransit\_Availability\_PT\_Office, Perception\_Mode\_Efficiency, Perception\_Transport\_Cost, Perception\_Comfort, Perception\_Safety.

Correlation Matrix

		Constant	Private_Vhcl_Ownership	Driving_License	Marital_Status	Family_Member	Transportation_Cost	Distance_Res_Office	Distance_Res_PT_1	Distance_PT_Office_1	Paratransit_Availability_Res_PT	Paratransit_Availability_PT_Office	Perception_Mode_Efficiency	Perception_Transport_Cost	Perception_Comfort	Perception_Safety
Step 1	Constant	1.000	-.326	-.011	-.346	-.314	-.233	-.184	-.239	-.090	-.371	-.276	-.362	-.176	-.034	-.193
	Private_Vhcl_Ownership	-.326	1.000	-.295	.112	.051	-.198	.286	-.115	.116	.061	.114	.032	.012	-.028	-.108
	Driving_License	-.011	-.295	1.000	-.008	-.114	-.117	-.089	.121	-.083	.063	-.114	-.162	-.095	.149	.145
	Marital_Status	-.346	.112	-.008	1.000	.775	.103	.018	-.042	-.063	.161	-.087	-.105	.018	-.040	-.026
	Family_Member	-.314	.051	-.114	.775	1.000	.059	.066	-.103	.028	.073	.005	-.114	-.019	.054	-.141
	Transportation_Cost	-.233	-.198	-.117	.103	.059	1.000	-.214	.280	-.412	.260	-.267	.232	-.006	.136	-.093
	Distance_Res_Office	-.184	.286	-.089	.018	.066	-.214	1.000	-.215	.037	.175	.051	-.157	-.227	.071	.087
	Distance_Res_PT_1	-.239	-.115	.121	-.042	-.103	.280	-.215	1.000	-.372	.259	-.213	.241	-.108	.051	.153
	Distance_PT_Office_1	-.090	.116	-.083	-.063	.028	-.412	.037	-.372	1.000	-.121	.620	-.042	.249	-.228	-.200
	Paratransit_Availability_Res_PT	-.371	.061	.063	.161	.073	.260	.175	.259	-.121	1.000	-.158	-.102	-.017	-.213	.234
	Paratransit_Availability_PT_Office	-.276	.114	-.114	-.087	.005	-.267	.051	-.213	.620	-.158	1.000	-.163	.202	-.099	-.181
	Perception_Mode_Efficiency	-.362	.032	-.162	-.105	-.114	.232	-.157	.241	-.042	-.102	-.163	1.000	.066	-.078	.016
	Perception_Transport_Cost	-.176	.012	-.095	.018	-.019	-.006	-.227	-.108	.249	-.017	.202	.066	1.000	-.499	-.034
	Perception_Comfort	-.034	-.028	.149	-.040	.054	.136	.071	.051	-.228	-.213	-.099	-.078	-.499	1.000	-.427
	Perception_Safety	-.193	-.108	.145	-.026	-.141	-.093	.087	.153	-.200	.234	-.181	.016	-.034	-.427	1.000



## QUESTIONNAIRE FORMAT (IN BAHASA)

## PROBABILITAS PERPINDAHAN MODA TRANSPORTASI DARI KENDARAAN PRIBADI KE KENDARAAN UMUM

(Studi Kasus: Bandung, Indonesia)

Penelitian ini ditujukan untuk mengidentifikasi pemilihan moda transportasi para pekerja di Kota Bandung sebagai upaya menganalisa lebih lanjut mengenai probabilitas dan strategi untuk menstimulasi perpindahan moda transportasi pekerja dari kendaraan pribadi ke kendaraan umum. Dalam rangka mendukung studi tersebut, besar harapan saya Bapak/ Ibu berkenan untuk berpartisipasi dalam penelitian ini dengan mengisi kuesioner berikut sesuai dengan kondisi yang sebenarnya. Atas perhatian Bapak/ Ibu saya ucapkan terimakasih.

Isi dan beri tanda checklist ( ✓ ) pada jawaban yang sesuai

### A. Karakteristik Pelaku Perjalanan

Jenis Kelamin	<input type="checkbox"/> Laki-laki	<input type="checkbox"/> Perempuan
Umur	..... tahun	
Pendidikan	.....	
Pekerjaan	.....	
Penghasilan/bulan	Rp.....	
Apakah anda berkeluarga?	<input type="checkbox"/> Ya	
	Jumlah anggota keluarga: ..... orang	
	Jumlah anggota keluarga bekerja : ..... orang	
Jumlah kendaraan bermotor yang dimiliki	.....unit mobil	
	.....unit sepeda motor	
Apakah anda memiliki SIM?	<input type="checkbox"/> Ya	<input type="checkbox"/> Tidak

## B. Karakteristik Fasilitas Transportasi

1. Beri tanda checklist (  $\checkmark$  ) dan isi tabel dibawah sesuai dengan jenis kendaraan yang anda gunakan untuk bekerja.

$\checkmark$	Jenis Kendaraan untuk Bekerja	Digunakan berapa kali dalam seminggu?	Alasan menggunakan jenis kendaraan tersebut?
...	Angkot	.....	.....
...	Mobil Pribadi	.....	.....
...	Sepeda Motor	.....	.....
...	Lainnya.....	.....	.....

2. Berapa besar *biaya per minggu* yang anda keluarkan untuk kebutuhan transportasi dalam rangka bekerja?

- Bagi pengguna kendaraan umum:  
 Ongkos per minggu = Rp.....
- Bagi pengguna kendaraan pribadi:  
 BBM.....liter = Rp.....  
 Pemeliharaan = Rp.....  
 Parkir per minggu = Rp.....  
 Biaya lainnya:..... = Rp.....

3. Berapakah perkiraan jarak:

Tempat tinggal ke tempat kerja	.... meter
Tempat tinggal ke tempat menyetop angkot	.... meter
Tempat turun dari angkot ke tempat kerja	.... meter

4. Adakah kendaraan yang menghubungkan tempat tinggal anda ke tempat menyetop angkot?

(Misal: becak, ojek)

- Ya ada, jenis kendaraan:.....; Waktu menunggu:..... menit; Biaya: Rp.....
- Tidak ada, lama waktu yang diperlukan untuk berjalan kaki dari tempat tinggal ketempat menyetop angkot: .....menit

5. Adakah kendaraan yang menghubungkan tempat perhentian angkot ke tempat anda bekerja

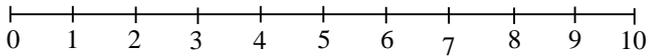
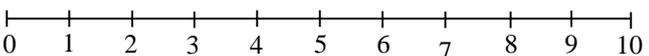
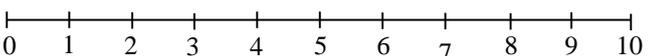
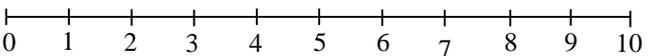
(Misal: becak, ojek)

- Ya ada, jenis kendaraan:.....; Waktu menunggu:..... menit; Biaya: Rp.....
- Tidak ada, lama waktu yang diperlukan untuk berjalan kaki dari tempat perhentian angkot ke tempat kerja: .....menit

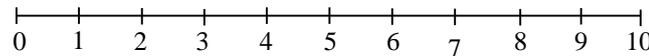
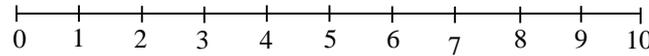
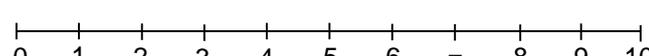
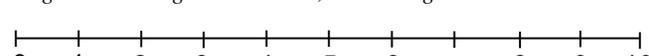
6. **Khusus pengguna kendaraan pribadi**, apa yang menjadi alasan anda tidak menggunakan angkutan umum (Angkot) untuk bekerja?

- |   |   |
|---|---|
| <input type="checkbox"/> Ngetem                                     | <input type="checkbox"/> Tidak aman; rawan copet                  |
| <input type="checkbox"/> Tidak praktis; berganti rute beberapa kali | <input type="checkbox"/> Harus berjalan jauh ke perhentian angkot |
| <input type="checkbox"/> Ongkos lebih mahal                         | <input type="checkbox"/> Lainnya: .....                           |
| <input type="checkbox"/> Tidak nyaman                               |   |

7. **Khusus pengguna kendaraan pribadi**, berikanlah penilaian terhadap beberapa kriteria di bawah. (Lingkari nomor pada garis dikolom sebelah kanan sesuai penilaian yang anda berikan)

Tingkat efisiensi waktu perjalanan dengan kendaraan pribadi	<i>Keterangan: 0 = sangat buruk; 10 = sangat baik</i> 
Biaya perjalanan dengan kendaraan pribadi	<i>Keterangan: 0 = sangat murah; 10 = sangat mahal</i> 
Tingkat kenyamanan berkendara dengan kendaraan pribadi	<i>Keterangan: 0 = sangat tidak nyaman; 10 = sangat nyaman</i> 
Tingkat kewanaman berkendara dengan kendaraan pribadi	<i>Keterangan: 0 = sangat tidak aman; 10 = sangat aman</i> 

8. **Khusus pengguna kendaraan umum**, berikanlah penilaian terhadap beberapa kriteria di bawah. (Lingkari nomor pada garis dikolom sebelah kanan sesuai penilaian yang anda berikan)

Tingkat efisiensi waktu perjalanan Angkot	<i>Keterangan: 0 = sangat buruk; 10 = sangat baik</i> 
Biaya perjalanan Angkot (ongkos)	<i>Keterangan: 0 = sangat murah; 10 = sangat mahal</i> 
Tingkat kenyamanan Angkot	<i>Keterangan: 0 = sangat tidak nyaman; 10 = sangat nyaman</i> 
Tingkat kewanaman Angkot	<i>Keterangan: 0 = sangat tidak aman; 10 = sangat aman</i> 

### C. Karakteristik Perjalanan

1. *Bagi pengguna kendaraan pribadi*, apakah anda berkendara bersama anggota keluarga ketika berangkat/pulang bekerja?  
 Ya  
 Tidak
2. Berdasarkan pertanyaan no.1, Jika ya, berapa jumlah anggota keluarga yang berkendara bersama? Dengan maksud perjalanan anggota keluarga yaitu?  
 Bekerja ..... orang  
 Sekolah ..... orang  
 Belanja ..... orang  
 Rekreasi ..... orang  
 Lainnya..... orang

### D. Pergantian Moda Transportasi dan willingness factor

1. Apa jenis kendaraan yang anda gunakan 5 tahun yang lalu?  
 Kendaraan umum (Angkot)  
 Mobil pribadi  
 Sepeda motor  
 Lainnya: .....
  2. Jika terjadi pergantian jenis kendaraan antara 5 tahun yang lalu dengan saat ini, apa alasan yang mendasari pergantian jenis kendaraan tersebut?  
.....  
.....
  3. *Khusus pengguna kendaraan pribadi*, pada harga BBM berapa anda akan berhenti menggunakan kendaraan pribadi?  
 Rp 10.000,-/Liter  
 Rp 12.000,-/Liter  
 Rp 15.000,-/Liter  
 Saya akan tetap menggunakan kendaraan pribadi berapapun harga BBM
  4. *Khusus pengguna kendaraan pribadi*, perbaikan kendaraan publik seperti apa yang dapat membuat anda berganti moda ke kendaraan umum? .....
- Jumlah armada yang lebih banyak
  - Perbaikan tingkat keamanan
  - Perbaikan infrastruktur
  - Harga yang lebih murah
  - Saya tetap akan menggunakan kendaraan pribadi

## QUESTIONNAIRE FORMAT (IN ENGLISH)

## PROBABILITY OF MODE SHIFT FROM PRIVATE TO PUBLIC TRANSPORTATION

### (Case Study: Bandung City, Indonesia)

The aim of this survey is to identify the transportation mode choice of Bandung City Resident in order to further analyze the probability and efforts should be made in order to stimulate mode shifting from private to public transport. This survey will take 10 minutes to complete, and all participants' responses will remain anonymous. Thank you very much for your time to participate in this survey, we appreciate your kind attention and look forward to receiving your response.

**Please put a tick (✓) in the box next to the answer of your choice or write on the space provided.**

#### A. Characteristic of the Trip Maker

Gender	<input type="checkbox"/> Male	<input type="checkbox"/> Female
Age	..... years old	
Education Level	.....	
Occupation	.....	
Monthly Income	Rp.....	
Married?	<input type="checkbox"/> Yess Family member: ..... people Family member who actively work: ..... people	<input type="checkbox"/> No
How many vehicle do you possess?	.....unit of car .....unit of motorcycle	
Do you have a driving license?	<input type="checkbox"/> Yes	<input type="checkbox"/> No

## B. Characteristic of the Transport Facility

1. Please put a tick (  $\checkmark$  ) fill in this table below according to the type of vehicle that you use to work

$\checkmark$	Type of Vehicle	How many times do you youse this vehicle in a week?	Why do you prefer this transportation mode?
...	Angkot	.....	.....
...	Private car	.....	.....
...	Motorcycle	.....	.....
...	Others.....	.....	.....

2. How much approximately the transportation cost do you spend every week?

- For public transport user:

Fare per week = Rp.....

- For private vehicle user:

Gasoline.....liter = Rp.....

Maintenance = Rp.....

Parking = Rp.....

Others:..... = Rp.....

3. How far is the distance between:

Home to work place	.... meter
Home to public transport stops	.... meter
Public transport stops to work	.... meter

4. Is there a para-transit that connects the residence where you live with the nearest public transportation stops?

(For example: becak, ojek)

Yes, namely:.....; Waiting time:..... minutes; Fare: Rp.....

No, walking time from home to the nearest public transport stop .....minutes

5. Is there a para- transit that connects public transportation stops with your office? (For example: becak, ojek)

Yes, namely:.....; Waiting time:..... minutes; Fare: Rp.....

No, walking time from public transport stop to office: .....minutes

6. **For the private vehicle user**, what is your main reason not using public transport (Angkot) as your transport mode to work?

Long waiting time to depart

Inefficient; should change route several times

More expensive

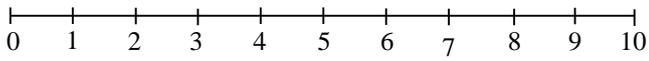
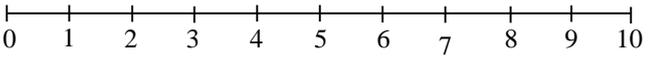
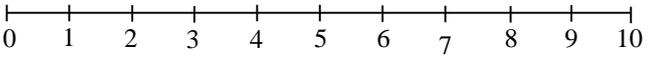
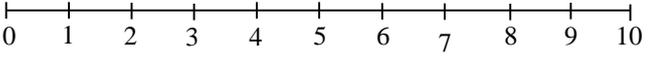
Uncomfortable

Not safe; high-risk pickpocketing

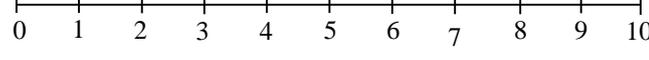
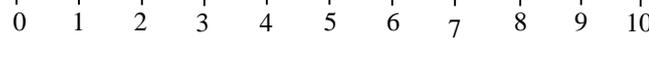
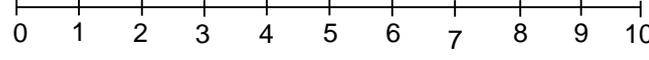
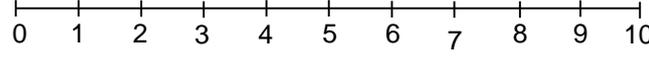
Should walk far to stop the public transport (Angkot)

Others: .....

7. **For the private vehicle user**, please give your score towards these criterias below. (Give circle to the number that in accordance with the assessment you give)

The efficiency level of travel time of using private vehicle	<i>In which: 0 = very bad; 10 = very good</i> 
Travel Cost of using private vehicle	<i>In which: 0 = very cheap; 10 = very expensive</i> 
Comfort level of using private vehicle	<i>In which: 0 = very uncomfortable; 10 = very comfortable</i> 
Safety level of using private vehicle	<i>In which: 0 = very unsafe; 10 = very safe</i> 

8. **For the public vehicle user**, please give your score towards these criterias below. (Give circle to the number that in accordance with the assessment you give)

The efficiency level of travel time of using angkot	<i>In which: 0 = very bad; 10 = very good</i> 
Travel Cost of using angkot	<i>In which: 0 = very cheap; 10 = very expensive</i> 
Comfort level of using angkot	<i>In which: 0 = very uncomfortable; 10 = very comfortable</i> 
Safety level of using angkot	<i>In which: 0 = very unsafe; 10 = very safe</i> 

### C. Characteristic of the Journey

1. **For the private vehicle user**, are you driving along with your other family members (car sharing) in your trip to work?

- Yes  
 No

2. Based on question no 1, if yes, what is the trip purpose of the other family member? How many of them?
- Work ..... people
  - Education ..... people
  - Shopping ..... people
  - Recreation ..... people
  - Other..... people

**D. Mode Switching and the Willingness Factor**

5. What kind of transportation mode did you use five years ago?

- Public transportation (Angkot)
- Private car
- Motorcycle
- Other: .....

6. If there is a change in the types of vehicle between 5 years ago and now, what is the underlying reason for that mode changing?

.....  
 .....

7. *For the private vehicle user only*, what fuel price per liter would stop you using private vehicle to work?

- Rp 10.000,-/Liter
- Rp 12.000,-/Liter
- Rp 15.000,-/Liter
- I will use my car whatever the price of fuel

8. *For the private vehicle only*, what kind of public transport improvements will make you stop using your private vehicle? (Answer can be more than one)

- Frequent services
- Improved security
- Better drop off sites
- Lower price
- No matter how much the improvements, I will continue to use my car



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