Revealed preference survey indicators of public transport use in various continent

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Abstract. Public transportation is a solution to congestion throughout the world. Many researchers have revealed public transport usage indicators with the revealed preference method. From the 38 studies around the world, the researchers revealed that there were 46 indicators that influenced the use of public transport. This paper reveals indicators that significantly affect travelers to use public transport throughout the world. The sequence of indicators that are very influential in the use of public transport are travel time, rates, convenience, reliability and safety. So this paper is expected to facilitate other researchers to choose and establish indicators of public transport use in another country or continent.

1. Introduction
Jakarta has a population of 10.27 million (BPS, 2017). Every day there are 19 million trips affected by travelers from Bogor, Depok, Tangerang and Bekasi (dephub.go.id, 29 September 2016). In addition to private vehicles, the DKI Jakarta Provincial Government provides modes of public transportation such as KRL (electric train), TransJakarta, taxis and paratransit. KRL and TransJakarta are the main public transportation in Jakarta.

The number of KRL passengers in 2016 reached 280,588,767, while the number of Transjakarta passengers in the same year was 123,706,856 (BPS, 2017). So that KRL / day passengers reach 768,736 passengers and Transjakarta passenger / day numbers are 338,992 passengers. If the total number of KRL and TransJakarta passengers reaches 1,107,728 passengers / day. This means that the KRL and TransJakarta market share is only 5.83% compared to other transportation modes.

Tiwari (2006) states that if a city with a population of more than 5 million people, ideally the public transport market share is 44%, taxis and other public transportation (taxis and public transportation are not motorized) 5%, walking 29%, 4% cars, 10% motorbikes and 7% bikes. Therefore, the number of KRL and TransJakarta passengers still needs to be increased. So that the main public transport share mode can approach 44%.

The purpose of this paper is to find out indicators that can influence travelers to use public transport throughout the world. The results of research and publications that will be reviewed are those using the revealed preference method. From the results of preliminary studies conducted throughout the world, the results of this paper will be applied as a basis for determining indicators for research in Jakarta. This is in accordance with what is desired by the research team to determine the indicators that influence the use of public transport that already exists in Jakarta, namely KRL and TransJakarta. The contribution of
this paper is to make it easier for other researchers to determine significant indicators so that travelers use public transportation in other countries.

2. Methods
There are 2 writing methods in this paper, i.e: 1. Learn and understand all literature study and 2. Collecting papers from 5 continents related to the RP survey indicator that triggers the transition of private vehicle users to public transportation on 5 continents (the Continents of Africa, Europe, America, Australia & New Zealand, and Asia). From the literature we get some theories about the factors of modal choice derived from Khisty & Lall (2006), Litman (2017), while the literature study on Revealed Preferences we get from Lancaster (1966), Samuelson (1996), Louviere (1983) and Hainmuller (2013). 35 papers were collected (from Africa 1 paper, from Europe 9 papers, from America 4 papers, from Australia & New Zealand 4 papers, and from Asia 17 papers). The 35 papers successfully collected from 5 continents. In fact, there were 46 indicators related to the transfer of private vehicle users to public transportation through RP surveys. From the 46 indicators that have been obtained.

3. Result and Discussions

3.1 Study of Literature
To estimate how a trip and transportation mode will be chosen, there are factors that influence the choice of transportation modes made by the community. The three major categories considered in the selection of transportation modes are as follows (Khisty & Lall, 2006: 189):

1. Characteristics of traveling (e.g. Income, family, number of cars available, family size and settlement density)
2. Travel characteristics (e.g. Travel distance and departure time)
3. Transportation system characteristics (travel time and additional time)

According to Litman (2017: 11-12), the factors that tend to influence transportation demand are the following demographics, economic activity, transportation choices, geography & land use patterns, demand management strategies, prices (monetary costs).

Table 1. Factors Affecting Transportation Demand

| Demography                          | Commercial Activity          | Mode Choice     | Land Use     | Demand Management | Price                           |
|-------------------------------------|------------------------------|-----------------|--------------|-------------------|---------------------------------|
| Number of people (residents, workers/visitors) | Number of jobs               | Walking         | Density      | Land Use Priority | Price & Fuel Tax                |
| Occupation                          | Business Activity            | Cycling         | Mix-Use      | Price Reformation | Cost & Vehicle Tax              |
| Wealth / income                     | Tourist activity             | Public Transportation | Walkability | Parking Management | Road Pricing                   |
| Age                                 | Goods Transportation         | Ridesharing     | Connectivity | User Information | Parking Fare                   |
| Life Style                          | Car                          | Transit         | Road Design  | Promotion Campaign| Vehicle Insurance              |
| Hobby                               | Taxi                         | Telework        |                           | Public Transportation Fare     |

Source: Litman (2017:12)

In the transportation preference survey, there are two methods of approach. The first approach is
Revealed Preference (RP) and the second approach is Stated Preference (SP). The RP method analyzes people’s choices based on existing reports using statistical techniques identified by factors that influence electability.

The RP method approach was introduced by Lancaster (1966). This approach has the view that consumers in buying products not only because of the usefulness of the product, but because of the characteristics or attributes provided by the product. This RP method was developed by Samuelson (1996). The basic assumptions of RP are:

1. Rationality, namely consumers is rational. That is, the number of items that are a lot more preferable than items that are few.
2. Consistent, meaning that as usual, if the consumer has determined that A is preferred over B, then he will never say that B is preferred over A.
3. Transitive principle, meaning that if the consumer states that A is preferred over B, and B is preferred to C, then he will also declare that A is preferred over C.
4. RP axioms. Consumers will certainly set aside a certain amount of money for their expenses. This amount is the budget that can be used. The combination of goods X and Y that are actually purchased on the market is a preference for a combination of other combinations of X and Y. This combination purchased will give the highest satisfaction for him.

The RP and SP methods have been widely used in the study of travel behavior to produce empirical models for predicting travel choices, as well as for predicting tariff plans and travel attribute values (Louviere, 1983). Survey trials in recent years are evidence of widespread belief among scholars who argue that stated preference can be useful for understanding real-world behavior (Hainmuller, 2013).

3.2 Findings of RP Indicators on Various Continents

There were 46 indicators found to choose public transportation in various continents. These indicators include:

| Traveler Characteristics | Travel Characteristics | Transportation System Characteristics |
|-------------------------|------------------------|---------------------------------------|
| Sex                     | Travel Distance        | Public Transportation Availability   |
| Age                     | Time Departure         | Punctuality                           |
| Occupation              | Time Arrival           | Operating Time                        |
| Education               | Bus Stop Distance      | Time Travel                           |
| Income                  | Route Characteristic   | Waiting Time                          |
| Needs                   | Frequency of public transportation using | Public Transportation Fare |
| Number of working family members | Car Fuel Cost        | Easy to gets a ticket                 |
| House location          | Car Registration Cost  | Get a seat                            |
| Destination Location    | Parking Fee            | Density                               |
| Travel Type             | Park Facility          | Transit Number                        |
|                         |                        |                                       |
There are 46 indicators of findings that are able to influence traveler to choose public transportation, there are 5 main indicators, namely the travel time of public transportation, public transportation fare, reliability, convenience and safety.

In writing this paper, the discussion will be divided according to the location of the country grouped again by continent. The results of the previous RP research have been collected from 5 continents, namely Africa, Europe, America, Australia & New Zealand and Asia.

a. RP indicators in Africa
Birago (2014) explained in Accra (Ghana) there was an increase in the use of private vehicles, micro buses and mini buses and had an impact on congestion and pollution. Therefore, it is very important to transfer private vehicle users to large buses managed by Metro Mass Transit Limited (MMT). But after 10 years, mini buses (trotro) are still the most preferred mode of travel in Accra, while MMT has the least share of modes among public transport modes. Because the mini bus is able to provide travel time services, reliability and comfort that are considered better than the large MMT buses. However, on the other hand, large MMT buses are considered to be able to provide travelers with more affordable rates.

b. RP Indicators in Europe
There are 5 main RP indicators have an impact on travelers choosing public transport in Europe are travel time, reliability, comfort, tariffs and safety. Each of the travel times, reliability, comfort and rates were expressed by 6 researchers. While the safety indicators were expressed by 3 researchers. Following is a list of research findings in Europe are involving 9 researchers with 5 main indicators.

### Table 3. Main RP Indicators in Europe

| Authors            | Travel Time | Reliability | Convenience | Safety | Fare |
|--------------------|-------------|-------------|-------------|--------|------|
| Paulley (2006)     | √           | √           | √           |        | √    |
| Filipovic (2009)   | √           |             | √           |        |      |
| Souche (2010)      | √           |             |             | √      |      |
| Cirillo (2011)     | √           | √           |             |        |      |
| Eboli (2012)       |             | √           |             | √      | √    |
| Fearnley (2013)    |             |             |             |        |      |
| Vij (2013)         | √           |             |             |        |      |
| Bordagaray (2014)  | √           | √           |             |        |      |
| Roman (2014)       | √           |             |             |        |      |

Source: 9 Previous Studies
c. RP Indicators in America

There are 5 main RP indicators that have an impact on travelers choosing public transport in America as well as in Europe i.e., travel time, reliability, convenience, fare, and security. Travel time and public transport fares are very important indicators according to 4 researchers. Convenience indicators are very important indicators according to 3 researchers. While indicators of reliability and safety are very important indicators according to 2 and 1 researchers. The following is a list of research findings in America involve 4 researchers with 5 main indicators.

| Authors          | Travel Time | Reliability | Convenience | Safety | Fare     |
|------------------|-------------|-------------|-------------|--------|----------|
| Ponnuswamy (1995)| ✔           | ✔           | ✔           |        | ✔        |
| Alpizar (2001)   | ✔           | ✔           |             |        | ✔        |
| Kumar (2008)     | ✔           | ✔           | ✔           | ✔      | ✔        |
| Batarce (2015)   | ✔           |             | ✔           | ✔      | ✔        |

*Source: 4 Previous Studies*

From Table 4 and Figure 2 above, it appears that travel time indicators and fares are very much considered by travelers in America compared to indicators of comfort, reliability and safety for choosing public transportation.
d. RP Indicators in Australia and New Zealand

There are 3 main RP indicators have an impact on travelers choosing public transportation in Australia and New Zealand, i.e., travel time, convenience, and public transport fares. Travel time is a very important indicator according to 4 researchers. Convenience indicators are very important indicators according to 2 researchers. While the indicators of public transport rates are only 1 researcher. However, reliability and safety are not important indicators in the continent of Australia and New Zealand. Following is a list of research findings in Australia and New Zealand involving 4 researchers with 3 main RP indicators.

Table 5. 3 Main RP Indicators in Australia and New Zealand

| Authors            | Travel Time | Convenience | Fare |
|--------------------|-------------|-------------|------|
| Kilsby (2003)      | ✓           | ✓           |      |
| Muley (2009)       | ✓           |             |      |
| Hensher (2012)     | ✓           |             |      |
| Islam (2015)       | ✓           | ✓           | ✓    |

Source: 4 Previous Studies

Figure 3. Main RP Indicators in Australia and New Zealand

Source: 4 Previous Studies

From Table 5 and Figure 3 above, it appears that the travel time indicators and fares are very much considered by travelers in Australia and New Zealand compared to indicators of convenience in choosing public transportation.

e. RP Indicators in Asia

There are 5 main RP indicators have an impact on travelers choosing public transportation in Asia, i.e., fares, travel time, convenience, reliability and safety of public transport. Public transport fares are a very important indicator according to 13 researchers. Travel time indicators are the second most important indicator according to 12 researchers. While the convenience indicator is the third most important indicator according to 11 researchers. Reliability and safety indicators are the fourth most important indicator according to 7 researchers. The following is a list of research findings in Asia involving 17 researchers with 5 main RP indicators.

Table 6. 5 Main RP Indicators in Asia

| Authors    | Travel Time | Reliability | Convenience | Safety | Fare |
|------------|-------------|-------------|-------------|--------|------|
| Hu (2006)  | ✓           |             | ✓           |        | ✓    |
| Sheikh (2006) | ✓       | ✓           | ✓           | ✓      |      |
| Irawan (2007) |         |             |             | ✓      |      |
| Nurdeen (2007) | ✓        |             |             |        |      |
From Table 6 and Figure 4 above, it appears that the indicator of public transport fares is the most dominant indicator of traveler to use public transportation. Then followed by travel time, safety and reliability.

4. Conclusions
From 38 results of studies that have been studied from 5 continents, it turns out that only the 5 most dominant indicators are public transportation travel time, travel fares using public transportation, public transport reliability, public transportation convenience and public transport safety. Travel time is an indicator that most influences travelers to use public transportation. This was revealed by 27 researchers. Then successive public transport fares (24 researchers), convenience indicators (22 researchers), reliability indicators (15 researchers) and safety indicators (10 researchers). When looking at the results of these studies, there is still much to be done to improve the performance of public transport on various continents. This is very important to do to reduce the level of congestion in various countries and support the transportation system in a sustainable manner.
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