Toll road development impact on tourism sector: macro and micro analyses

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Abstract. This study investigates the effects of toll road development on tourism growth in the traversed area, using a case study in the Jakarta and Bandung region – the largest urban area in Indonesia. In doing so, firstly, we carried out a statistical analysis on the data of economic indicators and regional tourism travel trends. Lastly, we estimated an ordinal logit model on leisure trip frequency via a toll road based on a household survey among 1,188 respondents who live in the proximity of toll gates. Our analysis showed that there is a correlation between the development of toll roads and the increased tourism activities in the area traversed by the toll roads. This finding is supported by the estimation results of the ordinal logit model that the closer the residential location of a respondent to a toll gate, the respondent would be more frequent to travel via a toll road. Despite the benefit that comes with toll roads, this study also highlights that its development should address its equity implications, which is the distribution of benefits across different segments of income.

1. Introduction

In certain developing countries, such as Malaysia, Thailand, and Indonesia, as part of the scenario for returning foreign funds for road building, toll roads are typically built on tracts that are arterial roads or critical corridors. Toll road procurement is intended to ensure sustainable national growth and balance. Even in developed countries and urban cities, such as London (England) and Stockholm (Sweden), toll roads are used to control drivers’ travel behaviours so that congestion can be minimized. Regardless of their growth priorities, the construction of toll roads can have direct or indirect effects on national and neighbourhood growth.

The overall effect of constructing new toll roads is related to improvements in travel time, distance travelled, and the cost of transportation. In the end, this can affect the travel behaviour of a person, for example, by modifying the route, travel mode, or travel frequently. Toll road building can indirectly affect improvements in the medium and long term, such as shopping, driving, working, or even residence [1]. Studies in Indonesia suggest that the presence of toll roads in the region traversed by toll roads has increased economic efficiency [2, 8].

Construction of the toll road is intended to foster local development and fairness in civic welfare. In fact, however, not all regions have benefited from the presence of toll roads in the tourism sector, for example, Bandung Regency. One of Bandung Regency’s challenges is the poor average tourist length of stay at Bandung Regency. In fact, if viewed on the basis of potential for tourism, Bandung Regency has many leading tourism destinations. BPS data in 2018 revealed that, with 867 thousand international
tourists and 5.5 million domestic tourists, the number of foreign and domestic tourist arrivals in Bandung Regency was the largest in West Java province. However, the latest trend shows that most visitors to Bandung Regency are thought to tend to stay at Bandung City Hotels. The situation is believed that Bandung Regency has not been a major tourism destination compared to Bandung City at this time.

Therefore, this study investigates the impact of the introduction of the toll road on the development of the tourism sector in terms of national and global economic indicators, as well as individual domestic tourism travel patterns. In order to find any empirical evidences of the toll road benefits, for the first analysis, we focus on the Cipularang and Soroja toll roads since both toll road developments are expected to have a significant role, not only to reduce travel time in Bandung Metropolitan Area (BMA)\(^1\), but also to simulate regional economic development.

The rest of the paper is structured as follows. Section 2 describes some background for this study, including a review of tourist movements and the impact of road infrastructure development. Section 3 and 4 explain the case study in detail. Section 5 provides the methodology and data employed in this study. Section 6 and 7 present the results and discussion of the analysis. Finally, section 8 contains concluding remarks and suggestions for further research.

2. Literature Review

2.1 Tourist Movements

One of the tourism geography aspects is to study tourism activities and spatial patterns concerning the surrounding physical and environment. It focuses on explaining the spatial patterns of tourism activities at different scales, such as global, national, regional, and local [3]. Thus, the movement of tourists is a spatial change in the location of tourist activities. In tourism, tourists’ flow shows that there are areas that have advantages and disadvantages in tourism resources. The movement of tourists is influenced by one’s interests to fulfill their needs. The mobility of tourists can be affected by several factors. Following are three factors that influence the flow of tourists [3]:

- Human push factors: travel arrangements, tourist motivation, priority visits, travel experiences.
- Physical pull factors: geomorphological conditions of attractions.
- Time factors: length of stay in the tourist destination, length of trip, and length of visit to a tourist attraction.

Moreover, the following are factors that influence the movement of tourists [4]:

- Tourist characteristics example social (age, marital status), economy (income, education), and behavior (motivation, visiting experience).
- Knowledge about the location of tourist destinations.
- Trip description: distance, length of stay at a tourist destination, time and cost, and travel agency.
- The advantages of tourist destinations: the type and nature of tourist attractions, accessibility, an image of tourism.

In the tourists’ movement, tourists do not only move from a place of origin to a tourist attraction but also move to visit other attractions, two or three, even more, tourist objects. It induces the movement of tourists is often not only to visit one tourist attraction. The availability of adequate infrastructure causes the existence of tourist movements.

Paths and trails traversed by tourists strongly influence the tourism movement pattern [5]. The tourists’ travelled way in making a tour will form a pattern of movement, so there is a direct route, a short traverse pattern, a long traverse pattern, and a return pattern to the origin/loop.

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\(^1\) This metropolitan area has the third largest population of any Indonesian metropolitan areas and is located close to Jakarta Metropolitan Areas (the largest Indonesian metropolitan area). Often being referred as the Greater Bandung, this area covers Bandung City, Cimahi City, Bandung Regency, West Bandung Regency, and several districts in Sumedang Regency.
There are several types of tourist movements, namely: a single pattern, multiple patterns, and complex pattern. Single pattern movement type is a single point, while multiple pattern types are subdivided into three types, namely site, stopover, and chaining loop. The complex pattern movement is further divided into two types, the destination region loop and complex neighborhood [3].

Single pattern movement is a movement that only visits one tourist destination point without visiting another destination point and returning to its original place using the same route. Meanwhile, multiple pattern movement is a movement that visits more than one tourist destination points.

Multiple pattern movements consist of a base site, stopover, and chaining loop. They have some differences in terms of the tourist movement in visiting the leading destination. In base site movement, tourists start the journey from the place of origin and visit the object’s leading destination and then continue to visit other attractions or secondary destinations.

In stopover movement type, tourists visit other attractions whilst moving and continuing to visit the leading destination at the end of the movement. Chaining loop movement is a movement with a rotating pattern such as a ring that connects two or more points of tourist attractions, or in other words, tourists who travel with this type of chaining loop movement visit the object’s leading destination before proceeding to the secondary destination.

2.2 Toll Road Development in Indonesia

Referring to Government Regulation of the Republic of Indonesia No. 15/2005 [6], toll roads are public roads as a part of the road network system and as a national road for which users are required to pay tolls. The toll road’s implementation aims to create equitable development, balance in regional development, and increase economic sector growth. The implementation of the toll road, which consists of regulation, guidance, operation, and supervision, is the government’s authority.

The first toll roads in Indonesia was the Jagorawi Toll Road connecting Jakarta, Bogor, and Cianjur which was only 59 kilometres and built in 1978. Then, the length of the toll road increased to 553 kilometres in 2007, where PT. Jasa Marga operated 418 kilometres, and other private parties operated the remaining length of the toll road. By July 10, 2020, 1,820 kilometres of toll roads have been constructed throughout Indonesia, not only in Java but also in Sumatra and Kalimantan.

The toll road development that began in 1975 was carried out by the government. Although carried out by the government, the funds for toll road development came from the government budget and foreign loans. The funding was handed over to PT. Jasa Marga (Persero) Tbk as equity participation. Then, the government assigned PT Jasa Marga to carry out toll road development funded by the government budget. Since 1987, the private sector began to be involved in toll road investment as a toll road operator after a Concession Agreement with PT. Jasa Marga was established. Acceleration efforts in toll road development were stopped or delayed due to the monetary crisis in 1997. However, it was restarted in 1998 with the issuance of Presidential Decree No. 7/1998 on Public-Private Partnership in Infrastructure Provision by the government. In 2005, the Toll Road Regulatory Agency was established to replace PT. Jasa Marga as the regulator of toll roads in Indonesia. In the future, funding for toll road development will use three approaches, namely financing that comes entirely from the private sector, investment using a public-private partnership (PPP) program, and development financing from the government and the private sector, which finances the operation-financing.

2.3 Impact of Road Infrastructure Development on Economic/Tourism Sector Development

In identifying the impact of increasing transportation infrastructure growth, especially road infrastructure, we need to consider the spatial dimension. The benefits of the infrastructure will spread throughout the region, not only give benefits to the investment area. The impact of road infrastructure development, including the economic sector, simultaneously influences the movement and land use changes.

Ardiyono, Parenrengi, and Faturachman [8] analysed toll road impacts on accessibility, trades, and investments in short term using the case of Cipali toll road in West Java, Indonesia and concluded that the toll road increased accessibility in the surrounding area, indicated by smoother traffic and faster
travel times. Besides, it also created positive externalities to non-toll roads that are now less congested with 45 minutes less travel time. Access to the toll gate is one of the contributing factors that affect sales growth; they found an increase in cargo volume carried along the area.

Furthermore, Alonso, Mills, and Muth [10, 11, 12] argue that improvements in transportation infrastructure, especially road infrastructure, can cause suburbanization. This theory assumes that employment happens at a central location, and the rental rate of land adjusts as a function of distance from the centre to compensate for different travel times. Thus, road infrastructure results in an outward shift in the provision of available land for certain travel times in the part of the city. It causes the rental rate of land to fall in all metropolitan areas, reducing population density through price effects throughout the metropolitan area. New highways also allow firms to move to the suburbs. It is because urban employment decentralization was more rapid than residential decentralization between 1950 and 1990. In addition to chasing suburban workers, companies may move because the highway can free manufacturing companies from shipping through ports or centres railroad cities or because highways allow the local agglomeration economy to operate at longer distances [13]. According to Firman [9], a highway that connects two metropolitan areas can form a mega-urban region, which is characterized by a mixture of rural and urban activities and the blurred rural differences in the Jakarta-Bandung Region (JBR). It can lead to the development of socio-economic activities that are likely to cause the problem of uncontrolled land conversion caused by many violations of land use plans by local governments and the private sector, caused by political interests and motives.

The development of toll roads or highways in a country can be also used as an indicator to determine the growth of a country’s economic sector. The toll road industry can also be used to prove a country’s readiness to face the fast-paced and easy times in carrying out every activity [14]. The development of toll roads by the government and business entities has the objective of improving the region’s economy through which the toll road is carried out, among others, by increasing inter-regional connectivity, shortening travel time, and launching movements as to reduce logistics costs. However, the areas that are traversed by the toll road do not experience the same economic development [15]. Some local governments and community are concerned about the existence of toll road development. For example, some local governments and community in the Pantura line that is crossed by the toll road feel worried that the economy in the region is threatened, so that vehicle users are no longer traverse the business and tourism sectors because they prefer to take the toll road [16]. Therefore, local government and community need preparation in facing the various impacts of toll road development. Developers or investors who carry out toll road development are expected to pay attention to entrepreneurs who open businesses along the road that are affected by the toll road’s existence, for example by giving priority to food stalls entrepreneurs affected by toll road development to occupy rest areas built around fatigue points without applying compensation fees. The compensation fees are burdensome, so it is expected that the development of the toll road can be an alternative in expanding employment if it is well-managed [14]. Therefore, we need indicators that can be useful to determine the impact of toll road development.

3. Toll Roads in the Jakarta – Bandung Corridor

The study area of this research is Purbaleunyi toll road connecting Bandung and Jakarta. This toll road passes through Karawang Regency, Purwakarta Regency, West Bandung Regency, Cimahi District, Bandung District, and Bandung Regency. This toll road is a southwards continuation of Jakarta City-Cikampek Toll. The boundary between the two toll roads is Dawuan Interchange, at kilometre 66. The Jakarta-Cikampek Toll Road is also connected to the Jakarta Inner Ring Road and Jakarta Outer Ring Road (JORR), in addition to being connected and integrated with the Purbaleunyi Toll Road. The Jakarta-Bandung toll road is also called the Cipularang toll road.
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Figure 1. Map of the Jakarta - Bandung Toll Road.

The toll of Jakarta-Cikampek has a length of 83 kilometres, while Padalarang-Cileunyi toll road has been 58.5 kilometres. The Cipularang toll road began operating 64.4 km in 2005, making the Cipularang toll road one of the longest connecting sections between Jakarta and Bandung. The 123-kilometre long Cipularang toll road brings Jakarta-Bandung closer and integrated.

The Cipularang Toll Road has 27 traffic intersections, 16 crossing bridges, and 18 toll gates, and four lanes for two directions and ten interchanges (27 interchanges). The toll road, which is operated by the branch of Jakarta-Cikampek, will become the densest portion of the Trans Java toll road network. The toll gate that links to the Cipularang Toll is shown in the following table.

Table 1. Toll Gate on the Jakarta-Bandung Connecting Toll *

| Kilometres (KM) | Toll gates  | Location         | Destination                              |
|----------------|-------------|------------------|------------------------------------------|
| M 67           | SS Dawuan   | Kabupaten Karawang | Tol Jakarta – Cikampek                    |
| KM 76          | Sadang      | Kabupaten Purwakarta | Sadang, Subang, Purwakarta               |
| KM 84          | Jatiluhur   | Kabupaten Purwakarta | Jatiluhur, Ciganea, Purwakarta           |
| KM 116         | Cikamunining| Kabupaten Bandung | Cikamunining, Cikalong Wetan, Purwakarta |
| KM 121         | SS Padalarang| Kabupaten Bandung | Padalarang, Cianjur, Cikalongwetan       |
|                |             | Barat             |                                          |

* https://www.jasamarga.com.
Figure 2. Jakarta – Cikampek Toll Road Section. 
https://www.jasamarga.com.

Figure 3. Purwakarta - Bandung - Cileunyi Toll Road Section.
The Cikampek-Padalarang segment is a panoramic toll road that provides a stunning view. The Cikampek-Padalarang toll road that crosses hills and ravines have a high reputation for tourism. In this toll road, there are several new rest areas that also offer views as its attraction. At Jakarta-Cikampek and Cipularang Toll Roads, there are ATMs, gas stations, hotels, mosques, or small mosques. Compared with other toll roads, this toll road segment has more new rest areas. The Cipularang Toll Road rest area is located at KM 72, KM 88, and KM 97.

![Rest Area at Cipularang Toll Road](image1)

**Figure 4.** Rest Area at Cipularang Toll Road.

One of the newly completed road development projects in the Bandung Metropolitan Area is the Soreang–Pasir Koja Toll Road (The Soroja Toll Road). This 10.57 km long toll road connects Bandung Regency to Bandung City and has a strategic function in supporting economic activity in the Bandung Metropolitan Area (BMA). On the north side, the Purbaleunyi toll road is connected to the Soroja toll road (see Figure 1).

![Soroja Toll Road](image2)

**Figure 5.** Soroja Toll Road
4. Development of the Tourism Sector in the Study Area

Tourism destinations in West Java are very diverse, including nature tourism, cultural tourism, and artificial tourism. They have unique features that improve the competitiveness of West Java tourism items. The tourism attractions scattered around Bandung City, both in the North Bandung area (including Taman Hutan Raya Ir. H. Juanda, Lembang and Mount Tangkuban Parahu) and South Bandung (including Ciwalini, Cimanggu, Pate). This region also has national/international cultural attractions such as the Geological Museum, Asian-African Conference Museum, Saung Angklung Mang Udjo, and undeveloped properties (historic buildings and Cimahi military complex).

The geographic benefits of Bandung’s industrial and educational areas act as the base of economic development in West Java. The construction of the flyover in Pasupati (Pasteur Surapati) and the Cipularang (Gikampek-Purwakarta-Padalarang) toll road improves not only the accessibility of the population but also the traffic of visitors and tourists, particularly tourists coming from Jakarta. Before heading to Bandung, tourists from Jakarta can also firstly visit several tourist objects in Bekasi City, Bekasi Regency, Karawang Regency, Purwakarta Regency, or Cimahi City. The distribution of tourism attractions in the Jakarta – Bandung area can be seen below.

The numbers of tourists in West Java fluctuate all the time. Figure 6 shows visitors in Bandung are higher than in the surrounding cities. The highest number of visitors in Bandung was 8,411,064 visitors in 2019. The rate of tourist development in Bandung City is 4.3 percent. However, the number of tourists in Jakarta is higher than in Bandung. In 2019, the number of tourists in Jakarta was 32,982,472 visitors.

![Figure 6. Map of Tourism Objects in the Study Area](image-url)
Cimahi City has the lowest number of visitors, i.e. only 1,705 in 2015, which may be caused by a smaller area than the surrounding cities.

![Figure 7. Number of Tourists in the Study Area.](image)

5. Methods and Data

To identify the impact of toll road development on the economic growth of the tourism sector in the area around the toll road sector; this research used aggregate data of the number of tourists and gross domestic, regional product of trading, hotels, and restaurants – as a proxy to indicate tourism growth in six municipalities. We defined this as the macro analysis, consisting of association and inferential analyses with quantitative approach. For the dependent variable, this study used GDRP data. Meanwhile, to determine the independent variables, this study used the 3A approach (attractors, amenities, and accessibility). 3A approach is an attribute in assessing a tourism destination [17], carried out by estimating the ordinal logit model of trip frequency for leisure trips via a toll road using a household survey data consisting of 1,188 respondents. More details related to the household survey data are explained in the following section.

5.1 Household Survey Data

This study used a household survey conducted in October – November 2017. The survey collected data of 1,188 respondents who previously had leisure trip via the Cipularang toll road to travel between areas in the Jakarta – Bandung region and the respondents who lived in a 5-km buffer from the Cipularang toll road. The respondents were collected through a door-to-door survey using computer-aided personal interview (CAPI) technology, with the help of a tablet. The respondents were all workers with paid jobs within the productive age (15-64) and, at the time of the survey, not working from home. Details on the survey are explained in Andani [7]. Data on the respondents’ travel characteristics via the toll road, as well as their socio-economic, housing, and neighbourhood characteristics, were also considered in the analysis. Table 2 shows the descriptive statistics of the data used in the ordinal model.

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2 Distributed over five municipalities, which are Bandung City, Bandung Regency, West Bandung Regency, Cimahi City, and Purwakarta Regency
Table 2. Descriptive Statistics

| No. | Variables                                      | Notation parameters | N  | Minimum | Maximum | Mean   | Std. Deviation |
|-----|-----------------------------------------------|---------------------|----|---------|---------|--------|----------------|
| 1.  | Total cost in trip via Cipularang (IDR)       | $\beta_{\text{cost}}$ | 1188 | 4,000.0 | 800,000.0 | 138,784.0 | 125,726.2      |
| 2.  | Total travel time in trip via Cipularang (min)| $\beta_{\text{time}}$ | 1188 | 10.0    | 450.0   | 111.0  | 72.8           |
| 3.  | Transport mode used in trip via Cipularang toll road |                     | 1188 | 1.0    | 4.0     | 2.6    | 1.4            |
|     | a. Private car                                | $\beta_{\text{car_user}}$ | 511  |         |         | 43.0%  |                |
|     | b. Taxi                                       | $\beta_{\text{taxi_user}}$ | 25   |         |         | 2.1%   |                |
|     | c. Shuttle service                            | $\beta_{\text{shuttle_user}}$ | 107  |         |         | 9.0%   |                |
|     | d. Bus                                        | $\beta_{\text{bus_user}}$ | 545  |         |         | 45.9%  |                |
| 4.  | Frequency of trip via Cipularang toll road    | $\beta_{\text{freq_user}}$ | 1188 | 1.0    | 6.0     | 3.8    | 1.7            |
|     | a. Less than once per year                    |                     | 195  |         |         | 16.4%  |                |
|     | b. 1-5 times per year                         |                     | 204  |         |         | 17.2%  |                |
|     | c. 6-11 times per year                        |                     | 73   |         |         | 6.1%   |                |
|     | d. 1 - 3 times per month                      |                     | 67   |         |         | 5.6%   |                |
|     | e. 1 - 3 times per week                       |                     | 534  |         |         | 44.9%  |                |
|     | f. 4 of more times per week                   |                     | 115  |         |         | 9.7%   |                |
| 5.  | Distance to toll gate in km                   | $\beta_{\text{distance}}$ | 1188 | 0.6    | 14.3    | 5.3    | 3.5            |
| 6.  | Municipality                                  |                     | 1188 | 1.0    | 4.0     | 2.3    | 1.3            |
|     | a. Purwakarta                                 | $\beta_{\text{purwakarta}}$ | 501  |         |         | 42.2%  |                |
|     | b. Cimahi                                     | $\beta_{\text{cimahi}}$ | 208  |         |         | 17.5%  |                |
|     | c. Kota bandung                               | $\beta_{\text{bandung}}$ | 123  |         |         | 10.4%  |                |
|     | d. Kab. Bandung barat                         | $\beta_{\text{westbandung}}$ | 356  |         |         | 30.0%  |                |
| 7.  | Age                                          | $\beta_{\text{age}}$ | 1188 | 18.0   | 72.0    | 36.9   | 11.9           |
| 8.  | Working status                                |                     | 1188 | 1.0    | 5.0     | 2.6    | 1.5            |
|     | a. Own account worker                         |                     | 550  |         |         | 46.3%  |                |
|     | b. Employer assisted by temporary workers/unpaid worker | $\beta_{\text{entrepreneur}}$ | 17   |         |         | 1.4%   |                |
|     | c. Employer assisted by permanent workers     |                     | 80   |         |         | 6.7%   |                |
|     | d. Employee                                   | $\beta_{\text{employee}}$ | 490  |         |         | 41.2%  |                |
|     | e. Freelance                                  | $\beta_{\text{freelance}}$ | 51   |         |         | 4.3%   |                |
| 9.  | Gender (1=male)                               | $\beta_{\text{male}}$ | 1188 | 0.0    | 1.0     | 0.5    | 0.5            |
| 10. | Number of household member                   | $\beta_{\text{housemember}}$ | 1188 | 1.0    | 11.0    | 3.4    | 1.3            |
| 11. | Number of working days                       | $\beta_{\text{workdays}}$ | 1188 | 0.0    | 7.0     | 6.0    | 0.8            |
| 12. | Working hours                                 | $\beta_{\text{workhours}}$ | 1188 | 1.0    | 5.0     | 2.2    | 0.5            |
| 13. | Income per month (in million IDR)            | $\beta_{\text{income}}$ | 1188 | 1.3    | 10.0    | 4.4    | 2.7            |
5.2 **Ordinal Logit Model Specifications**

The ordinal logit model is a member of the family of the ordinal model, along with ordinal probit. It is obtained on the basis that the error term $\varepsilon$ used a logistic distribution rather than a standard normal. Let $y^*_n$ be the utility that an individual $n$ facing ordinal decision associates to alternative $i$. The ordinal logit model is based on a latent regression as follows:

$$y^*_n = \beta X_n + \varepsilon_n$$

(Eq. 1)

where $y$ is the unobserved dependent variable, consists of the usual systematic and random components; $X_n$ is a vector of explanatory variables, $\beta$ is a vector of coefficients, and $\varepsilon$ is a logistic distributed error term, meaning that the cumulative distribution of $\varepsilon$ is $F(\varepsilon) = \frac{\exp(\varepsilon)}{1+\exp(\varepsilon)}$. It is assumed that discrete and ordinal observations $y_n = (0, 1, \ldots, i, \ldots, l)$ are produced to the following mechanism:

$$\begin{align*}
y_n = 0 & \text{ if } y^*_n < \mu_0, \\
y_n = 1 & \text{ if } \mu_0 < y^*_n \leq \mu_1, \\
y_n = i & \text{ if } \mu_{i-1} < y^*_n \leq \mu_i, \\
y_n = l & \text{ if } y^*_n > \mu_l
\end{align*}$$

(Eq. 2)

Where $\mu$s are threshold parameters estimated together with the vector of coefficients. The thresholds depend on the problem to be solved. In this study, the trip frequency had a six-point numerical scale. Thus, the model assumed the following specifications for the utility $y_n$ of the $n$-th respondent choosing the alternative, $i$ is explained below:

$$\begin{align*}
y_n = 1 & \text{ if } y^*_n < \mu_0, \quad \text{then the trip was conducted less than once per year} \\
y_n = 2 & \text{ if } \mu_0 < y^*_n \leq \mu_1, \quad \text{then the trip was conducted 1-5 times per year} \\
y_n = 3 & \text{ if } \mu_1 < y^*_n \leq \mu_2, \quad \text{then the trip was conducted 6-11 times per year} \\
y_n = 4 & \text{ if } \mu_2 < y^*_n \leq \mu_3, \quad \text{then the trip was conducted 1-3 times per month} \\
y_n = 5 & \text{ if } \mu_3 < y^*_n \leq \mu_4, \quad \text{then the trip was conducted 1-3 times per week} \\
y_n = 6 & \text{ if } y^*_n > \mu_4, \quad \text{then the trip was conducted 4 of more times per week}
\end{align*}$$

(Eq. 3)

It means an individual $n$ would not travel if the utility $y_n$ is lower than the stated threshold $\mu_0$. Likewise, if the utility $y_n$ is between $\mu_0$ and $\mu_1$, the individual makes 1-5 times per year, and so on. The probability of observing $y_n$ taking the value of $i$ can be described as follows:

$$P_{ni} = \text{Prob} (\varepsilon_n \mu_{i-1} - \beta X_n) - \text{Prob} (\varepsilon_n \mu_i - \beta X_n)$$

(Eq. 4)

$$P_{ni} = \frac{e^{\varepsilon_n \mu_{i-1} - \beta X_n}}{1 + e^{\varepsilon_n \mu_{i-1} - \beta X_n}} - \frac{e^{\varepsilon_n \mu_i - \beta X_n}}{1 + e^{\varepsilon_n \mu_i - \beta X_n}}$$

(Eq. 5)

Ordinal logit structure can be optimized using current techniques for standard logit estimation with maximum likelihood, but it is viewed as a binary logit. The model portrays the choice as the outcome of a series of binary decisions. Hence, it is not based on global utility maximizations of values. Since one alternative reflects many values, the choice is whether “take one more trip” or accept the existing value instead rather than select between alternatives. Once the first local maximum is reached, the maximization ends.
6. The Impact of Toll Road Developments on the Tourism Sector of the Bandung Metropolitan Area

Some studies have proven empirically that there is a strong correlation between road construction and economic development of the region (The availability of road infrastructure will impact the region’s economy by guaranteeing the connectedness between regions in linking the centres of activities and supporting the distribution of goods and services).

One of the toll road constructions that has a significant impact on the growth of the Bandung Metropolitan Area (BMA) is the construction of the Cipularang Toll Road. Operating since 2005, this toll road increases the accessibility of cities and regencies in the BMA with the capital city, Jakarta. Before the Cipularang Toll Road operates, the alternative connection between Bandung and Jakarta was the highway with a slightly twisted route through Purwakarta Regency or by train. The Cipularang toll road has cut the travel time between Jakarta-Bandung from 4-5 hours to 1.5-2 hours. The increased accessibility between Jakarta and Bandung has an impact on the tourism sector of the BMA, in which there are many tourist attractions located in some cities and regencies in this region. This is evidenced by the trend of the increasing number of tourist arrivals in Metropolitan Bandung Raya, both to the tourist attractions and to hotel accommodation located in the BMA as shown in the chart below.

Furthermore, the number of tourist visits to the attraction tends to be much higher than tourist visits to the accommodation or hotel. This is due to the possibility of the occurrence of double counting on the tourist objects, considering that the trip chaining often occurs, in which visitors might visit several tourist attractions in their vacation. Since the number of tourists in this attraction is calculated based on the sold ticket, there is a possibility of double counting. However, this number is enough to represent how attractive the tourism sector is in generating traffic in the BMA. Other data that can reflect the growth of tourism is seen from the traveller’s visit to the accommodation. Having a similar trend to the number of visitors to tourist attractions, the number of tourists visiting the accommodation in the BMA continue to increase annually.

Figure 8. The trend of Visitors/Tourists in the Bandung Metropolitan Area (Jawa Barat in Figure 2006 – 2010).

To further review whether the increase of tourist visits is significant towards the tourism sector in Metropolitan Bandung Raya, one of the indicators that can indicates the growth of the tourism sector in the region is the value of Gross Domestic Regional Product (GDRP) of trading, hotels, and restaurants.
Tourism activities will generate revenue in the accommodation sector to stay in the tourists and increase the revenue from the restaurant sector. To identify if there is any significant development in the value of GDRP of trading, hotels, and restaurants in the BMA between before and after the construction of the Cipularang Toll Road, the value of GDRP of trading, hotel, and restaurant was presented in a time series chart from 2000 to the year 2010. With the cutting point of the development of the Cipularang Toll Road in 2005, the GDRP development pattern between before and after the construction and operation of the toll road can be identified. Identifying the effect of this new route’s growth on the old Jakarta-Bandung route, the value of GDRP of Purwakarta Regency was also included.

The trend of the 2000 to 2010 data indicates that there was a significant increase in the value of trading, hotels, and restaurants in several districts/cities in the BMA, especially from 2005 to the year 2006. Bandung City was in the first order with the fastest growth. It was undeniable that the city of Bandung has a wide range of tourist attractions that became the attraction factor in the tourism sector. Besides the city of Bandung, other districts in Metropolitan Bandung Raya also experienced growth but not so significant. The same case was experienced by Purwakarta Regency, the growth tended to only follow the normal growth.

Bandung Regency and West Bandung Regency also showed a fairly high trend of improvement, although not as significant as the growth of Bandung City. In this analysis, Bandung District was analysed into one unit since West Bandung Regency is a new district of regional expansion from Bandung Regency in 2007. Thus, the analysis of the development of its GDRP cannot be done separately because until the Cipularang Toll Road operated in 2005, the value of GDRP of West Bandung Regency is not available. It is analysed separated, will be less relevant in describing the comparison of its GDRP between before with the construction of the Cipularang Toll Road.

In the case of Cimahi, although its position in the chart is in the bottom sequence, but if it is seen further, the developments of GDRP of commerce, hotels, and restaurants of Cimahi after the construction of the Cipularang Toll Road increase more than half the value of GDRP before the construction of the Cipularang Toll Road. The average value of GDRP Cimahi City in 2000 – 2004 was 816,21 billion rupiahs and its average in 2006 – 2010 increased to 1.180 billion rupiahs.

![Figure 9. GDRP of Commerce, hotels, and restaurants in Bandung Metropolitan Area and Purwakarta Regency](image)

Figure 9. GDRP of Commerce, hotels, and restaurants in Bandung Metropolitan Area and Purwakarta Regency
To test whether there is a significant difference between the growth of the GDRP of trading, hotels, and restaurants in the Regencies and cities in the BMA between before and after the development of the Cipularang Toll Road, a paired t-test was applied. The hypotheses built in the test are as follows:

$H_0: \mu_D = 0$, There is no difference in the average growth of GDRP of commerce, hotels, and restaurants in cities and regencies in the BMA between before with after the construction of the Cipularang Toll Road.

$H_1: \mu_D \neq 0$, There is a difference in the average growth of GDRP of the commerce, hotels, and restaurants in cities and regencies in the BMA between before with after the construction of the Cipularang Toll Road.

Table 3. Paired t-Test Result of the comparison of growth of GDRP of the commerce, hotels, and restaurants, between before and after the development of Cipularang Toll Road

| Paired Samples Test | Paired Differences | Std. Deviation | Std. Error Mean | Lower | Upper | t  | df  | Sig. (2-tailed) |
|---------------------|--------------------|----------------|-----------------|-------|-------|----|-----|----------------|
| Mean                | Deviation          |                |                 |       |       |    |     |                 |
| Pair 1 Before_Toll_Road - After_Toll_Road | -3,14250 | 1,68686 | 0,84343 | -5,82667 | -0,45833 | -3,726 | 3 | 0,034 |

The test result shows a counted t value of -3,726 for two-sided testing with the value of $\alpha$ 0.05%. Meanwhile, the t value gained from the t table for $\alpha$ 5% on two-sided testing is ± 3.18. Since the counting T value falls on the critical area, then $H_0$ is declined and $H_1$ is accepted. It means that there is a difference in the average growth of GDRP of the commerce, hotels, and restaurants of cities and regencies in the BMA between before and after the construction of the Cipularang Toll Road. To provide an overview of the position of GDRP ‘s growth differences in trade, hotels, and city restaurants and regencies in the BMA between before and after the construction of the Cipularang Toll Road, the growth data were compared in Figure 10.

The growth of GDRP of trading, hotels, and restaurants in all cities and regencies in the BMA experienced positive growth, with the highest growth was experienced by the Bandung City, then followed by Cimahi, Bandung Regency and West Bandung Regency and Sumedang Regency. However, despite having a significant growth of GDRP across the years, Purwakarta Regency experienced a negative trend of growth after the construction of the Cipularang Toll Road.

To investigate if the improvement of the GDRP of trading, hotels, and restaurants in the BMA correlates with the increasing number of tourist visits to the tourism attractions, the Pearson test correlation was applied, with the result are provided in Table 4.
Figure 10. GDRP of commerce, hotels, and restaurants in Bandung Metropolitan Area and Purwakarta Regency

Table 4. Paired t-Test Result of the comparison of growth of GDRP of the commerce, hotels, and restaurants, between before and after the development of Cipularang Toll Road

| City and Regency            | Before The Cipularang Toll Road Construction | After The Cipularang Toll Road Construction |
|-----------------------------|---------------------------------------------|-------------------------------------------|
| Bandung City                | 7.05                                        | 12.02                                     |
| Cimahi City                 | 4.23                                        | 8.41                                      |
| Bandung Regency and West Bandung Regency | 5.42                                        | 7.04                                      |
| Sumedang Regency            | 3.93                                        | 5.73                                      |
| Purwakarta Regency          | 4.43                                        | 4.03                                      |

By using data after the development of the Cipularang Toll Road from 2005 to 2009, it is identified that there is a significant correlation between GDRP of commerce, hotels, and restaurants with the number of tourist in the Bandung Metropolitan Area with the value of Pearson correlation is close to 1 (0.949). This indicates a very strong correlation between the increasing number of tourists visiting the BMA and the increase of GDRP of commerce, hotels, and restaurants. Even though we cannot interpret that the GDRP enhancement was caused by an increase in the number of tourists, it needs further analysis of the factors that affect the GDRP because it is possible that the increasing GDRP of the trading, hotels, and restaurants is also influenced by other variables such as the number visitors to the BMA for work or business purposes. However, it is sufficing to say that there was a very strong correlation between the increase of tourist visited the Bandung Metropolitan Area with the increase of GDRP of the commerce, hotels, and restaurants which might be an indication that the higher the number of tourists, the higher the value of GDRP of commerce, hotels, and restaurants in the BMA.
Another toll road recently developed in the BMA is the Soroja Toll Road. Operated since December 2017, this toll road has a strategic function to connect Bandung City and Bandung Regency. High potential tourism objects in both areas are expected to increase the potential movement of tourists in the form of trip chaining between these areas. To identify the impact of the development of this road, the time-series analysis was carried out to analyse the value of the GDRP of accommodation and consumption between before with the development of Soroja toll road. The results of the analysis showed considerable growth before and after the construction of the Soroja Toll Road. From 2013 to 2017, the average growth in the GDRP of accommodation and consumption of Bandung Regency was 6.19% per year. After the construction of the road toll Soroja, the average growth increased to 7.14% per year.

The data above provides an overview of how toll road development could improve regional tourism development. Figure 10 shows that the Cipularang and the Soroja Toll Road development have increased the GDRP of accommodation and consumption, which is a key indicator of the growth of the tourism sector. Therefore, it can be concluded that the analysis results of these two case studies are in line with the previous studies that there is a strong correlation between road construction and economic development of a region.

7. Estimating Frequency of Leisure Trips via the Cipularang toll road

In order to produce a model with best-fitted parameters, variables in Table 1 were added and estimated one-by-one into the model. Thus, any correlated variables can be hindered, which potentially could change the vector and the values of the parameters significantly. This iteration stopped once all variables have been tested, and stability was reached.

Table 4 presents the estimation result of the ordinal mixed logit model, using Python Biogeme version 2.6a [18]. The model estimated 15 parameters, consisting of not only trip-related variables, such as travel time, travel costs, travel modes, and distance to the nearest toll gate, but also socio-economic parameters, such as age, income, and gender. Most of the estimated parameters were found to be highly significant to affect the frequency to travel via the Cipularang toll road for leisure at the 95% confidence level. The explanatory power of the model is also rather high, given the value of the rho-square-bar (0.89). The value of σ represents the threshold of each interval of the trip category. We fixed the value μ2 as a reference. The difference between μ2 and μ3 is quite small (0.28). This indicates that the utility value of the respondents is very low (close to zero) when they chose to travel 11 times per year or less via the Cipularang toll road for leisure trips. As expected, the higher the values of the threshold, the higher the frequency to travel via the toll road for leisure trips.
The cost and time parameters were assumed to be randomly distributed to capture unobserved taste variation in cost and time across respondents, with a log-normal specification to ensure a negative coefficient for all observations [19]. The mean and standard deviation of the underlying normal parameter across the entire observations were estimated.

Furthermore, the parameter of distance to the nearest toll gate was found to be negatively significant to influence the trip frequency. It signifies that the closer the respondents reside to the toll gate, the more they are likely to travel via the toll road. Car users also tend to travel via the toll road frequently than bus users. Moreover, we found that females, younger respondents, and high-income earners were more likely to travel via the toll road frequently for leisure trips. This result is in line with Andani [7], who previously stated that high-income people are willing to pay higher land taxes to live closer to the toll road to capture travel time benefits.

Surprisingly, respondents in Bandung Municipality were less likely to travel via the Cipularang toll road for leisure trips, compared to their counterparts. This can be explained by the fact that Bandung residents preferred to travel to the northern or southern part of Bandung. Thus, they would not use the Cipularang toll road.

### Table 5. Model Estimation Results

| Parameter                   | Estimated coef. | Robust Std err | Robust t-test |
|-----------------------------|-----------------|----------------|---------------|
| Threshold parameters        |                 |                |               |
| $\mu_2$                     | -0.02           | 0.06           | -0.36         |
| $\mu_3$                     | 0.26            | 0.07           | 3.66          |
| $\mu_4$                     | 0.50            | 0.07           | 6.79          |
| $\mu_5$                     | 3.08            | 0.12           | 25.10         |
| Trip characteristics       |                 |                |               |
| $\beta_{\text{cost}}$       | -26.90          | 0.36           | -74.99        |
| $\beta_{\text{cost_std}}$   | -0.70           | 0.10           | -7.25         |
| $\beta_{\text{time}}$       | -29.50          | 2.31           | -12.77        |
| $\beta_{\text{time_std}}$   | -3.47           | 0.67           | -5.23         |
| $\beta_{\text{distance}}$   | -0.04           | 0.01           | -2.84         |
| $\beta_{\text{car_user}}$   | 1.10            | 0.16           | 6.89          |
| $\beta_{\text{bus_user}}$   | 0.62            | 0.16           | 3.90          |
| Socio-economic-geographic characteristics |               |                |               |
| $\beta_{\text{age}}$       | -0.01           | 0.00           | -2.14         |
| $\beta_{\text{income}}$    | 0.09            | 0.02           | 4.86          |
| $\beta_{\text{male}}$      | -0.63           | 0.11           | -5.68         |
| $\beta_{\text{bandung}}$   | -0.44           | 0.15           | -3.05         |

The goodness of fit:
- The number of estimated parameters: 15
- Final log-likelihood: -1749.87
- Rho-square-bar: 0.894
- Sample size: 1188

### 8. Conclusions

This paper provides an insight about how toll road developments affect tourism activities in the traversed area through macro and microanalyses, using a case study in the Jakarta and Bandung region. The macro analysis was conducted using aggregate data of the number of tourists and gross domestic, regional product of trading, hotels, and restaurants – as a proxy to indicate tourism activities’ growth in six
municipalities. A microanalysis was carried out by estimating the ordinal logit model of trip frequency for leisure trips via a toll road using a household survey data consisting of 1,188 respondents. Our analysis firstly showed that there was a considerable growth of GDRP of commerce, hotels, and restaurants in the study area after the constructions of Cipularang and Soroja Toll Roads. The GDRP of commerce, hotels, and restaurants is further found to positively correlated with the number of tourists. These results indicate that there might be a correlation between the development of toll roads and the increase of tourism activities in the area traversed by the toll roads.

These findings were also supported by the estimation results of the ordinal logit model. The model uncovered that the closer the residential location of a respondent to a toll gate, the more frequent it would be to travel via a toll road. Car users were also found to travel more frequently than bus users—similarly, the higher the income, the more frequent the trip. We further found that respondents resided in Bandung were less likely to travel via the Cipularang toll road for leisure trips, given the fact that the locations of tourism attractions are distributed in the southern and northern areas of Bandung.

The findings of this research highlight potential implications that transport policy should tackle its equity implications. Furthermore, it was found that the higher the income (similarly for car users), the more frequent they are to travel via the toll road. This result suggests that those with higher incomes benefit more significantly from the toll road than those with lower incomes.

Several directions are available for further study. Firstly, the macro analysis can be improved by incorporating data on the average length of stay in hotels as another indicator. Secondly, regarding the methodology, this study showed that both micro and macro analyses used different type of data, where macro analysis used longitudinal data (to compare the conditions before and after the toll road construction) and micro analysis used cross-sectional data. In order to provide a stronger evidence regarding to the toll road development impacts, both analyses should employ the same type of data. Thirdly, to assess the impact of newly built toll roads, such as Soroja Toll Road, more respondents located in Bandung Regency should be collected. Finally, this study can be strengthened by investigating how the distribution, the amenity, and the accessibility of tourism activities affect the demand for leisure trip in this region.

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