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The Impact of Online Transportation Services on Indonesian Urban Non-Working Trip Volume and Distribution Pattern: A Case Study in Bandung City

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Abstract— The development of digital technology has made it much easier for most people to access online communication through smartphones. Such a phenomenon has encouraged operators to develop an online transportation service system, which has also been growing in Indonesian urban areas. The urban community accepts the new alternative of the application-based transportation system since it offers a much more efficient way to reach transportation services. Moreover, the online transportation system also offers a much wider range of destination locations. It is believed that the creation of an application-based transportation service system will affect metropolitan areas' social and economic conditions and how urban communities' travel. The development of this application-based transportation service would change the configuration of urban non-working trip distribution patterns, which should be understood as inputs for the urban transport development plan. This research aims to understand the impact of online transportation services on non-working trip distribution patterns in Indonesian urban areas, with Bandung City as the case study. The method used in this research is statistical descriptive, using respondents' responses to map the influenced trip generation and distribution patterns. The results show that online transportation has enabled the community to travel more easily and reach wider areas. Such changes have formed a new travel pattern that extends the destination locations to a wider peri-urban area. In the future, the government should anticipate urban fringe area land use growth, changing the region into more "urbanized-built-up" areas.

Keywords— Online transportation; non-working trip; trip distribution pattern.

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I. INTRODUCTION

Digital technology has brought a fast-growing development of online application-based public transport services in Indonesia's urban areas since 2011. In recent years, online transportation has been overgrown in many cities worldwide [1], [2]. Previous research proves online transportation replaces private and public transportation [3]. Online transportation offers some service advantages compared to the conventional system, such as real-time access for the driver and customer to track each other location accurately, customer access to get information about the driver and the vehicle identity, and high flexibility for the customer to get immediate service from any origin to any destination, so they could easily decide to go to any other places [4]. Online transportation is a demand-based service connecting passengers with vehicle owners (drivers) in real time using cellular technology [5]. Online transportation service providers such as Gojek, Grab, and Uber have the largest market share in tight competition. Gojek has become the most used online motorcycle.

The Indonesian online transportation development began with the emergence of Gojek in 2010 and was followed by its wide application in 2015. Uber, a US-based online transportation service provider, arrived in Indonesia in 2014. Grab, a Malaysian company, arrived in Indonesia in 2016 and followed Uber. These three online transportation providers compete with each other in Indonesia through their innovative service features and increasing the range of services in Indonesian cities.

The visitors of Gojek, Grab, and Uber applications on Android cellphones in December 2017 were 15.73 million people, or around 29.6% of all mobile application users in Indonesia. This shows that around 1 out of 4 internet users in Indonesia use at least one of those three online transportation applications. The data also shows the high number of online application users in Indonesia. Around March 2018, Uber

sold its Southeast Asian business to Grab with a share swap system. Since then, there have been two major providers of online transportation platforms in Indonesia, i.e., Grab and Gojek.

The national online transportation development that started in Jakarta's capital has impacted the development of public transportation online in Bandung City. In the middle of 2010, the online transportation company expanded its services area to the Jabodetabek (Jakarta-Bogor-Depok-Bekasi) area, followed by its expansion to Bandung City. Gojek started its service in Bandung on April 13, 2015, and brought along its leading service, i.e., online service using a motorcycle. Grab was the last to arrive in Bandung in November 2015 with online taxi services like Uber. The expansion of Grab in Bandung continued in 2017 with the arrival of a motorcycle-based shuttle service, Grab Bike, to compete with Gojek.

In 2018, after Uber decided to terminate their business in Southeast Asia, Gojek and Grab led the market for online transportation services in Bandung. Both have a similar type of service, i.e., motor-cycle-based shuttle service (online Ojek), car-based vehicle rental service (online taxi), and food delivery service. Both applications also compete against each other to seize the market of users in Bandung who want to get another type of service other than passenger transportation. Gojek, for example, has a pick-up car rental service for carrying goods with point-to-point service. Gojek also has a digital wallet named Go-Pay, which is integrated with the Gojek application to deposit money and pay for the Gojek service. On the other hand, Grab expanded their service by developing a multifunction application (super-app), which offers various car rental services and entertainment in one touch. In Bandung City, Grab also offers an electric *scooter* rental service that can be used to move around the city[6].

The competition between Grab and Gojek in Bandung has positively impacted the economy of Bandung City. The Demography Institute, Faculty of Economy and Business, University of Indonesia, showed in 2018 that Gojek contributed around Rp 21 trillion to the economy of the City of Bandung. The contribution included Go-Ride IDR. 537 billion, Go Car IDR. 111 billion, Go Food IDR. 1.5 trillion and Go Life IDR. 46 billion [7]. On the other hand, research by the Center for Strategic and International Studies (CSIS) and Tenggara Strategic showed that Grab contributed to IDR. 10.1 trillion to the economy of Bandung City. This figure is equal to 20.65% of Grab's contribution to Indonesia's economy. The portion of the contribution includes GrabBike with IDR. 4.59 trillion and GrabFood with a contribution of IDR. 3.76 trillion. GrabBike and GrabCar also contributed to job creation in Bandung City.

Before establishing a partnership with Grab, 38% of the GrabBike partners and 39% of GrabCar partners had no source of income at all [8]. Even though this online transportation technology has a significant positive effect on the economy of Bandung City, this service cannot operate freely in the entire region of the City of Bandung due to its contradictory existence with traditional transport services such as traditional motorcycle service (Ojek) and traditional taxis. For example, drivers of online transportation are prohibited from carrying passengers from the eastern part of Bandung, the northern part of Bandung, and the area of Husein Sastranegara Airport. [9] who researched mapping the potency of conflict between conventional Ojek and online Ojek in Arcamanik District, eastern Bandung, discovered that online Ojek service in the conventional Ojek service area has triggered a serious conflict between the two sides. Conventional *Ojek* drivers worry that the existence of online transportation will reduce their income [10].

While many other studies focus on the impact of the development of online public transportation services on the socio-economic life of the urban community [11], [12], and [13], this research aims to contribute novelty to the discussion regarding its specific impact on urban trip volume, distance, and spatial reconfiguration, particularly on non-working trips such as shopping, visiting relatives, gathering with friends, visiting sports and leisure areas, etc. It is important to find out whether the non-working trip volume has changed (constant, increased, or decreased) and whether its spatial distribution has reconfigured. If they have, it will certainly require transport plan adjustment to maintain the required level of service, e.g., adjusting non-online public transport operation system and road network development, as well as traffic management, central business district land use adjustment, peri-urban development strategy reformulation, etc.

The reason for focusing on the non-working trip is that, while the working trip has a relatively fixed character since they are bound to a fixed origin-destination location and time, the non-working trip would have a more flexible location and timely response to service change in terms of people's decision to travel and to expand their trip destinations. The non-working trips include family visits, social gatherings, shopping, leisure trips, etc. By taking Bandung City as the case study, this research aims to understand the impact of online transportation service development on the volume and pattern of non-working trip distribution in an urban area.

A. Travel Behavior

The theory of travel behavior is fundamental for this research as the basis for understanding trip pattern change due to online transportation service development. Today's activities in various sectors heavily depend on IT applications, including major transportation services. From a spatial transportation perspective, the development of online transportation would most probably affect the volume and trip pattern in urban areas. This research focuses on the effect of online transportation on travel behavior, which could manifest in the form of substitution and may be complementary to other modes and induce trips [5], [13], [14], [15], [16], [17], [18]. The modified travelers' trips would finally change the trip volume and distribution pattern. Meanwhile, most previous studies only focused on ride-sourcing's substitution and complementary implications19] since they potentially impact congestion mitigation [20].

Travel behavior patterns are remarkably diverse in a pluralistic society like Indonesia. Trip categories can be based on the types of activities at the destination. Trip destinations were divided into six categories: trips to workplaces, trips to schools or campuses, trips to stores, excursions to recreational and social activities, destinations accompanying trips, and other trips [21]. Mandatory travel must be taken to work, school, or campus. Other journeys are designated as optional or voluntary and occur less frequently than required trips [22]. Trips can be conducted during peak or non-peak periods,

according to the trip time. Most trips during peak periods are mandatory, whereas most visits between peak periods are bureaucratic, and most trips during non-peak periods are returned home trips.

Individual travel behavior can be influenced by a variety of factors, including structural factors (e.g., transportation operations, infrastructure, etc.), demographic factors (e.g., age, income, education, etc.), travel-related factors (e.g., travel purpose, travel cost, travel distance, etc.), and psychosocial factors (e.g., individual attitudes, perceptions, etc.) [23]. On the other hand, online transportation will cause changes in the social environment, which will most likely lead to changes in travel behavior and individual mobility patterns. Many studies have discussed the relationship between travel and mode choice. Some have confirmed the existence of complex relationships in travel behavior, e.g., the number of transits on public transport. Another factor in the choice of modes for complex trips is the pattern of location [24]. This shifting transport-communication technology may influence travel decisions, which would consider additional concerns such as reliability and personal safety in addition to traditional factors established in prior studies.

Transportation mode choice and the reason for travel have been the subject of several studies. The results of the study found that gender, individual age, and employment status play an important role in trip chaining [25]. According to this research, women, older persons, and employees link more trip segments. Employment-related variables, household structure variables, accessibility, geographical variables, and mobility-related variables have all been found to influence trip frequency [25].

Most of the research focuses on worker travel, but in reality, the urban form also has an impact on non-working travel behavior. Other studies have shown that the non-employed population makes a significant contribution to the total urban traffic; this is because non-workers have a flexible schedule of activities compared to workers, so they have more opportunities to travel [25]. This interesting finding reflects an exciting implication of the growing IT application in public transportation services on traffic volume and spatial distribution, which needs further exploration. The main strands of research in this area have included ride-hail ing's interaction with public transport systems [26] and individuals' mode substitution behaviors in the presence of ride-hailing [12], [14], and [1].

II. Material and Method

This research uses the descriptive statistics method to analyze the data and map the trip's spatial reconfiguration resulting from online transportation services. The presentation of data in descriptive statistics uses tables, graphs, pie charts, mode calculations, medians, average percentile calculations (central tendencies), data distribution with average and standard deviation calculations, and percentage calculations. Descriptive statistics can also be used to find relationships between variables through correlation analysis. The analysis is carried out by making predictions through regression analysis and making comparisons by comparing average and population sample data.

This research uses a descriptive statistical method to compare the trip volume and distribution before and after the era of online transportation in the study area. Questionnaires are distributed through a home interview survey (HIS) to gain the primary data. The target houses were selected randomly for each zone and received positive responses from a total of 167 respondents. The questionnaire was constructed based on the literature regarding ride-sourcing [14], travel behavior [27], mode choice [28], and service performance [29]. A household interview survey was conducted in October 2019. The number of respondents collected during the data collection activity spread out in municipalities in the study area. The feedback is useful for answering the question of whether the online transport service has increased the total trip volume and has also stimulated a spatial reconfiguration of trip distribution patterns. In addition, another piece of data needed to develop a trip generation model in this research is secondary data in the form of a map of Sub-Region IV and the population in the region.

A. Study Area

The study area has an area of 21.01 km2. It is located in Bagian Wilayah Kota/BWK (City Sub Area) IV of Bandung City, which consists of four districts, i.e., Regol District, Lengkong District, Batununggal District, and Kiaracondong District. This location was selected since it has the largest residential area and also has the highest traffic growth. Therefore, this selected study area is considered to best represent the typical characteristics of the trip generation zone of Bandung City. The study area is shown in Fig.1.

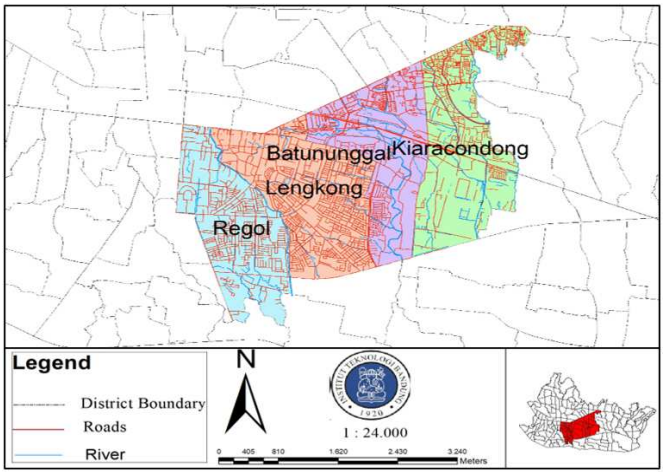

Fig. 1 Study Area.

B. Sampling Method

Samples of the respondents in this study are Bandung residents, aged 18 years or older. The sampling technique uses a random purposive sampling approach so that the respondent's selection can be more precise. The results of the survey are used to estimate the response pattern of the community (population). The sample calculation uses the Slovin method because it is assumed that the total population is known. The Bandung City Transportation Agency states that the highest traffic in Bandung City is generated from the four districts: Regol District, Lengkong District, Kiaracondong District, and Batununggal District. For these

four districts, the total volume of trip generation in 2018 was 214.129 pcu/day, and trip attraction was 213.472 pcu/day.

C. Data

The distribution of the characteristics of the respondents to the research variables was obtained by conducting a descriptive statistics analysis using SPSS. Descriptive statistics use continuous and interval variables. The amount of data observed in each variable is 167, with a 93% trust level. The standard deviation results show that the data is quite varied. Descriptive statistics are explained in Table 1.

TABLE I
DESCRIPTIVE STATISTICS

Variables	Min	Max	Mean	Std.Dev
Gender				
Men	0	1	0.437	0.497
Women	0	1	0.562	0.497
Occupations				
Students	0	1	0.329	0.471
Civil Servant/Private/State-Owned Enterprises	0	1	0.143	0.351
Freelance	0	1	0.407	0.492
Unemployed	0	1	0.119	0.325
Income				
< 1 milion IDR	0	1	0.305	0.461
1 – 1,5 milion IDR	0	1	0.179	0.385
1,5 – 2 milion IDR	0	1	0.095	0.295
2 – 2,5 milion IDR	0	1	0.107	0.311
>2,5 milion IDR	0	1	0.311	0.464
Vehicle Ownership				
Car	0	1	0.113	0.318
Motorcycle	0	1	0.658	0.475
Bicycle	0	1	0.047	0.214
Not own a vehicle	0	1	0.179	0.385
Travel Destinations				
Working	0	1	0.718	0.451
Non-Working (Shopping)	0	1	0.281	0.451

The respondents are residents of the study area whose ages are 18 years old or older, with non-working activities (such as family visits, social gatherings, shopping, leisure trips, etc.) using online transportation. The survey was conducted from October 14 to November 1, 2019, with 167 respondents. Given that women dominate online transportation users, most respondents are female. Women have more diverse travel patterns than men[30]. The proportion of females using online transportation is 56%, whereas the proportion of males is 43%. This is because fewer women use private vehicles. From the respondent's age point of view, 35% of online transport users are those whose age ranges between 20 and 30 years old. It is the dominant figure compared to other age ranges. This figure is logically based on the fact that the age range of 20 - 30 years belongs to the most productive group that makes plenty of trips. They are also the group that adapts more easily and quickly to technological development and online transportation. Based on occupation, the most dominant respondents are students, who comprise 32% of the population.

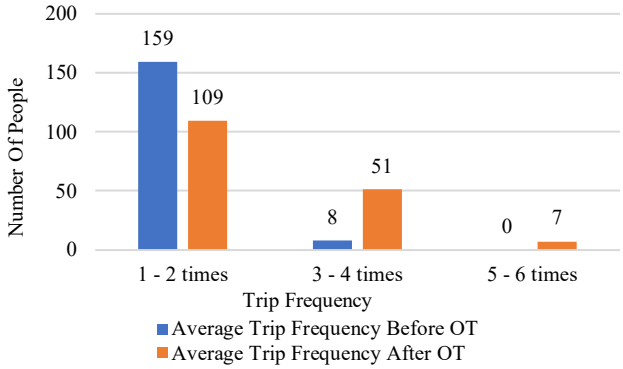

Fig. 2 The Percentage Non-Working Trip Frequency in Bandung City.

III. RESULT DISCUSSION

A. The Impact of Online Transportation on Trip Frequency

The development of online transportation (OT) shows the impact on the number of non-working trips. Fig.2 shows that the number of people conducting 1-2 daily trips is declining after online transport (OT) service operates, i.e., from 159 to 109. However, the number is still dominant compared to other groups of trip frequency. Interestingly, the 3–4 trips per day have increased from 8 to 51 people, while the 5–6 trips have increased from 0 to 7 people. These results show that access to online transportation services has enabled the community to travel more easily, thus making them travel more frequently. Online transportation facilitates people's travel because it can efficiently avoid increased travel costs and parking difficulties [20].

B. The Impact of Online Transportation on Trip Volume

The existence of online transportation also has an impact on trip volume. To estimate the impact of online transportation on the total non-working trips in Bandung City, the "after OT" total non-working trips are calculated from the number of trips divided by the sample size and multiplied by the population size.

TABLE II
THE BEFORE-AFTER OT NON-WORKING TRIP VOLUME

	Non-Working Trips Volume (trips/day)		
District	Before OT	After OT	% Increase
Kiaracondong	2,873	4,162	45 %
Batununggal	2,035	3,704	82 %
Regol	2,111	3,790	80 %
Lengkong	2,723	3,906	43 %
Average Trip Volume	2,435	3,891	60 %

Table II shows that the highest trip increase occurs in Batununggal District, i.e., 82% (increased from 2,035 to 3,704 trips/day). On average, the trips in the study area increased from 2,435 to 3,891 trips per day. The results of the analysis support previous research. In 2015–2018, when the mobility of people and goods used a lot of online-based transportation services, this impacted the increasing movement of vehicles on the highway [31]. When comparing the number of trips and the population, Table III shows an increase in the number of trips by 2%.

TABLE III
NUMBER OF TRIPS AND POPULATION

		Before Online Transportation	After Online Transportation
Estimated Population (people)		268.893	268.893
Total (trip/day	Trip	9741	15562
% Trip		4%	6%

C. *The Impact of Online Transportation on Non-Working Trip Distance*

Online transportation affected the average volume of daily non-working trips and their average trip distance. Fig.3 shows that after the online transport service was in operation, the number of people's non-working trips as far as 1-2 km has declined from 96 to 58. Meanwhile, the number of people traveling as far as 3–4 km has increased from 33 to 39, and so has the number of people traveling 5–6 km, which has increased from 23 to 30 people. Interestingly, the number of people traveling more than 7 km has increased from 15 to 40. These results show that the development of online transportation encourages the community to travel farther away, up to peri-urban areas, such as the neighboring Bandung Regency. This is because online transportation services enable people to travel longer distances to their destination locations than before. The era of online transportation has increased the community's average travel distance from 2 km to 4 km.

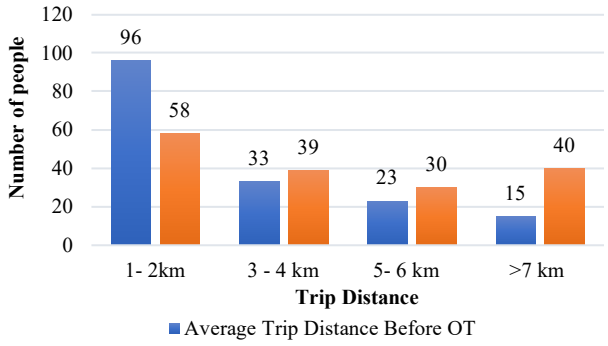

Fig. 3 The Percentage of Non-Working Trip Distance in Bandung City.

D. *The Impact of Online Transportation on Non-Working Trips Distribution Pattern*

This section describes the impact of online transportation on non-work trip distribution patterns.

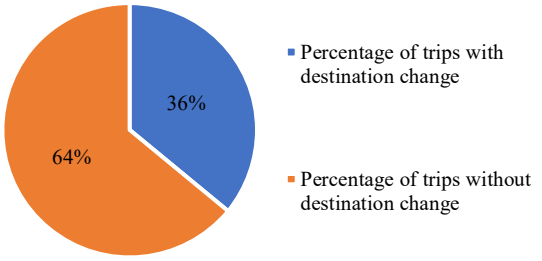

Fig. 4 Destination Changes Stimulated by Online Transportation.

Fig. 4 shows online transportation development has also stimulated non-working trip distribution patterns. The analysis of the "before and after" destination locations shows that as many as 36% of the trip destination locations have changed, while 64% have not. The number of travelers who have changed their trip destination locations is estimated to be 96,608 people, while those who have not changed their destination locations are 172,284 people.

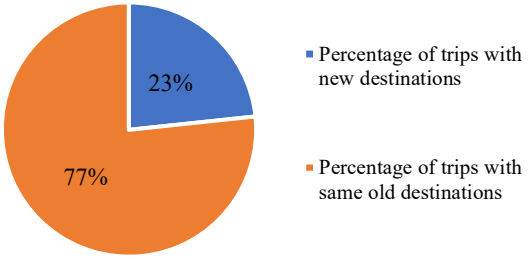

Fig. 5 Percentage of the Changed Destination

Fig.5 shows that online transport has also stimulated people to visit new destinations they never did before. The survey result shows that 23% of the respondents decided to conduct a trip to some new location or destination, whereas 77% of them did not. There are 25 new destination locations identified; most located in the Bandung peri-urban area. This research estimates that, after the online transport service was in operation, as many as 62,795 people visited new destinations daily.

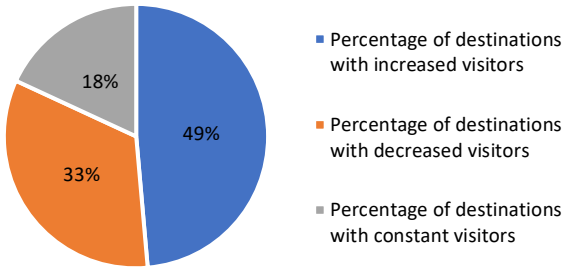

Fig. 6 Percentage of Location by Visitor Number Changes

Fig. 6 shows that 49% of the destinations experienced increasing visitors. Meanwhile, destinations with declining visitors are 33%, and those with constant visitor numbers are 18%. Interestingly, this research identifies that most destinations that more people visit after an online transport service operates are located farther away from the study area. This result confirms the previous result that online transport has stimulated people to the extent of their travel distance [32].

Fig.7 shows that, before the online transportation era, most of the people's movement originated from the Kiaracondong District toward the most visited destination, Kiaracondong Market, with some trips. Regarding travel distance, the longest trip from the Kiaracondong District is to the Setiabudhi Area. Before the availability of online transportation, people used to commute to the city center or nearby locations. However, the availability of online transportation has made it easier for people to travel to all locations. This condition shows that the easier it is to get

transportation services, the faster and easier the citizens move from one location to another location.

Meanwhile, Fig. 8 shows that, by the time online transportation is in operation, this research identifies some new locations of destinations that people have rarely visited before. Those new locations of destinations are located in some districts within Bandung City's neighboring regencies (Bandung Regency, West Bandung Regency, Sumedang Regency, and Subang Regency), i.e., Cibaduyut District, Bojongsoang District, Soreang District, Padalarang District, Cikole District, Ujungberung District, Lembang District, etc.

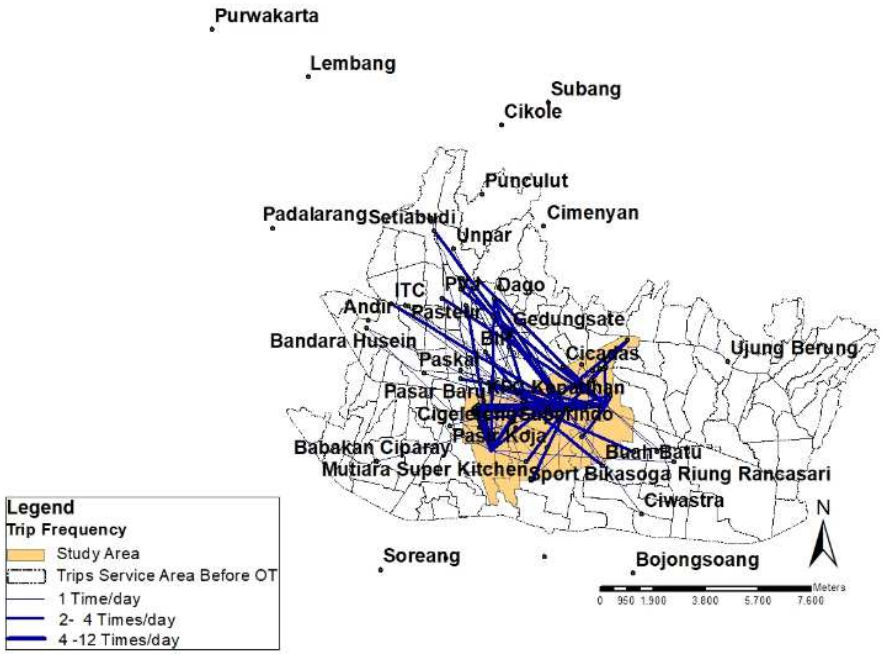

Fig 7. Non-Working Trip Distribution before Online Transportation.

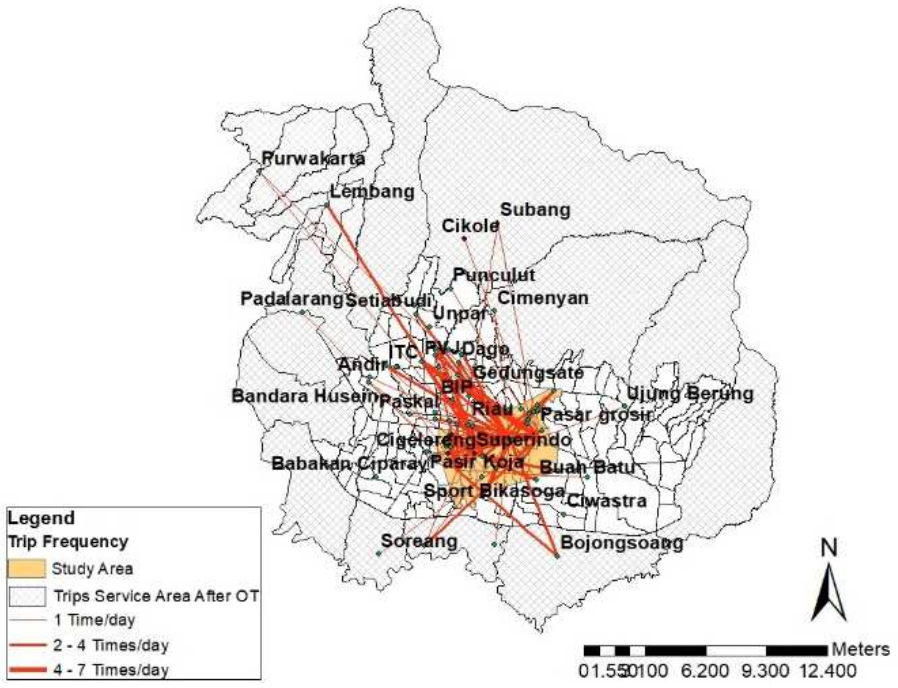

Fig. 8 Non-Working Trip Distribution after Online Transportation.

However, the most frequent trip remains to the destination spot of Paris van Java Shopping Mall, which is located in Sukajadi District. This is supported by research [33]; the data show that the level of road service in the "before online transportation service period" (2013-2015) the level of road level of service was in stable condition, whereas in the "after online transportation service period" (2016- afterward), the road level of service has increased. This finding shows that online transportation has stimulated a higher level of people's mobility in urban areas [34].

The results of this study prove that the increasing online transportation services significantly stimulate today's greater

people mobility. Such services allow people to order online transportation services anywhere, anytime, quickly, and in real time. Technological advances make online transportation applications easy to use and help people fulfil their daily needs 35] .

E. The Impact of the Findings

The overall findings show that the development of online transportation services has stimulated more frequent trips, higher trip volume, increased trip distance, and changing trip patterns across Bandung City and its surrounding area. These findings are substantial input for land use and transportation policy adjustment. As for non-working trips, particularly, the impact of increased frequency means that society is generally becoming more socially mobile. People are making more non-working trips, such as shopping, visiting relatives, gathering with friends, visiting sports and leisure areas, etc. Such findings are well aligned with existing research on ride-hailing in the academic literature, which states that ride-hailing impacts leisure and health trips [36]. The logistic model shows that leisure and health trips are 3.808% and 9.908 %, respectively, which is higher than work trips at 0.924% and not significant [36]. Research in Tehran states that ride-hailing is a significant mode for day-to-day travel [11]. People from all social backgrounds use ride-hailing, as it is the most versatile and flexible mode of transportation in the metropolitan area [11]. The development of appropriate public facilities should follow this to respond to the increasing demand for social activities.

Online transportation can improve vehicle utilization efficiency, it does not necessarily reduce the car trip volume in urban traffic [37]. A survey of Philadelphia [38] found that more than a quarter of respondents used online transportation as a substitute for public transportation on their last trip. Some studies also suggest that substituting public transportation for ride-hailing transportation is an important cause of increased traffic congestion [39]. The increased trip volume, as well as trip distance, would certainly demand transportation infrastructure adjustments. They would require Bandung transportation supply capacity improvement as well as new road network development in the urban periphery, where longer trips would currently reach.

Meanwhile, the changing trip pattern implies urban spatial policy adjustments. To respond to the wider urban area that online transportation-based trips could reach, the government should anticipate urban fringe area land use growth, which would change the region into more "urbanized-built-up" areas. The government's role as a regulator is limited to issuing rules, conducting certification, and supervising the implementation of transportation that meets standards [40]. A more intensive environmental impact assessment should follow this. In the future, it may also be done using queuing theory, which is one of the methods for dealing with traffic growth [41]. However, this online transportation impact would potentially stimulate positive urban economic development by creating new economic opportunities stimulated by increasing people's mobility. Under these conditions, there will be equity in diverse places.

IV. CONCLUSION

This research contributes to the discussion regarding the development of online transportation services by expanding our understanding of the impact of such services on urban trip spatial reconfiguration. The findings enable us to map the "before-after OT service" trip frequency, distance, and spatial configuration, which are found to be significantly changed. The analysis confirms that the development of online transportation (OT) in Bandung City has enabled the community to travel more easily and longer. Based on the analysis of non-working trip frequency, this research found that the trip volume increased significantly after the online public transportation service was in operation.

Meanwhile, this research found that the availability of online transportation services also enables the community to reach longer distances from the trip destination location than before. The growing online public transportation service has brought several new destination locations outside the "before" locations, such as the districts of Cibaduyut, Bojongsoang, Soreang, Padalarang, Purwakarta, Cikole, Subang, Ujung Berung, and Lembang.

These findings confirm the implications of the growing online public transportation service on non-working trip volume, travel distance, and spatial distribution in Bandung City, as typical Indonesian urban areas. In a practical sense, these research conclusions are useful for further transport system adjustment to maintain a good level of service. The transportation system adjustment includes non-online public transportation service system adjustment, road network development, traffic management adjustment, central business district land use adjustment, peri-urban development strategy reformulation, etc.

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