The Impact of Odd-Even Policy on Travel Distance and Time in Private Sector

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Abstract: Government of Jakarta has struggled to mitigate the traffic congestion by implementing the odd-even policy. This policy has restricted some roads for vehicles to pass in Jakarta in a certain time and this policy needs to be studied further for its impact on distance and time, especially for private companies. The research was conducted in private sectors which its warehouse located in Tangerang and its customers spread in Jakarta, Bogor, Depok, Tangerang and Bekasi. The study focuses on 49 routes that every route had some customers' location. The sequence for every route was determined if had a shortest distance and/or fastest time with the help of optimoroute software. Then, every route was processed by Google Maps both in normal condition and odd-even policy's condition in order to get the distance and travel time. The results indicated that around 44.89% of routes have further distance and 16.55% have longer time, these results mean costlier for private companies since odd-even policy has been implemented. The study also compared two alternatives between maintaining current condition and switching to rent a vehicle with third party logistics, the result indicated that maintaining current condition alternative was still beneficial than switching to rent a vehicle alternative.

Keywords: Odd-even policy; impact; optimoroute; google maps

I. INTRODUCTION

Congestion in developing countries such as Indonesia is associated with limited road infrastructure and lack of traffic management resources. There are many causes of traffic congestion such as subsequent increase in private vehicle ownership [1], the state of the roads and driving habits, insufficient information available on traffic condition, and institutional problems [2], wrong parking, disobedience to traffic rules (human factors) [3].

Table 1 showed us that number of motor vehicle has been increasing around five percent every year for all types: passenger car, bus, truck, and motorcycle [4], apart from year 2020. During the year 2020, the increment of motor vehicle was around two percent, this was because of pandemic era. This increment made road more congested, because the average increment of road length was relatively near zero percent in Jakarta and Banten. Congestion can cause unpredictable journey times, stress, or anger (psychological discomfort), wasting fuel, tiredness, being late for appointment [5]. Congestion could be eased by prohibiting a portion of the existing fleet of vehicle from circulating without infringing on the right to buy vehicles.

There were some steps that Indonesian government has already implemented, such as three-in-one policy which was revoked in 2016 because of car jockey practices [6], U-turn reduction, increasing number of public transportation such as busway, and odd-even policy which allows odd number plate pass the roads on odd date and even number plate pass the road on even date, specifically 4-wheeled vehicles [7].

Table 1. *Number of motor vehicle 2018 to 2022 [8]*

Province	Motorvehicle	2018	2019	2020	2021	2022
Jakarta	Passenger car	3,082,616	3,310,426	3,365,467	3,544,491	3,766,059
	Bus	33,419	34,905	35,226	36,339	37,180
	Truck	631,156	669,724	679,708	713,059	748,395
	Motorcycle	15,037,359	15,868,191	16,141,380	16,711,638	17,304,447
	Total	18,786,568	19,885,265	20,223,801	21,007,548	21,858,103
Banten	Passenger car	209,212	227,547	232,939	247,020	264,447
	Bus	3,254	3,466	3,519	3,573	3,615
	Truck	70,098	75,374	76,905	82,260	87,934
	Motorcycle	1,991,810	2,161,809	2,234,539	2,371,748	2,514,383
	Total	2,274,374	2,468,196	2,547,902	2,704,601	2,870,379
Indonesia (country)	**Passenger car**	14,838,106	15,600,108	15,803,933	16,413,522	17,175,632
	Bus	223,011	231,717	233,406	237,829	241,215
	Truck	4,804,178	5,029,305	5,090,625	5,299,603	5,528,669
	Motorcycle	106,836,985	112,950,332	115,188,762	120,045,878	125,267,349
	Total	126,702,280	133,811,462	136,316,726	141,996,832	148,212,865

Government of Jakarta, capital city of Indonesia has implemented the odd-even policy in 2019 to mitigate congestion, air pollution that caused by road traffic [9], and density of road [10]. From the perspective of private sector, this policy restricted the shipment activities, because the vehicle could not be operated from Monday to Friday on a certain time, 06 to 10 WIB and 16 to 21 WIB, except for vehicle with sticker of disability, ambulance, fire fighter vehicle, public transportation with yellow plate, motorcycle, electric vehicle, fuel truck, vehicles of high ranking state officials, etc., therefore there was an interruption for shipping the customer's order and an organization had to deal with it. There were some solutions to deal with this time restriction. The first one was dealing with current condition by using existing vehicle. If the vehicle plate number was different with date, then the route must be changed in order to avoid the restricted roads which the distance of route and time needed may be longer. Longer time may cause driver work overtime. In this case, we had to calculate the variance between cost that incurred during and outside odd-even operating hours, and the lowest cost will be chosen. The second one, the organization would replace all private vehicles with public vehicles that have yellow plate number, in other words, the organization had to rent vehicles to third party logistics. In this option, there would be a rental cost per month that organization had to pay. The third one was to buy additional vehicles with even or odd number of plate. Consequently, there would be idler vehicles and the organization did not plan to expand its business now because the average capacity of vehicle used was around 70%. Therefore,

the third option was not being considered. Things to note, the organization did not consider buying the new vehicle, because private organizations could not determine the odd or even number of vehicle plate. The first and the second solution would be studied further in this research.

The aim of this research was to study the impact of odd-even policy implementation on distance, time and cost that incurred in private sector. The study of travel distance and time would be taken from warehouse as a starting point that was located in Tangerang to its customers that located in Jakarta, Bogor, Depok, Tangerang, Bekasi (Jabodetabek) by using OptimoRoute software and Google Maps.

II. MATERIALS AND METHODS

1. DISTANCE AND TIME VARIANCE

Google Maps as an online map service was used to calculate the distance of route for both car and public transport [11]. There were two conditions that we had to know:

a. The distance and time needed during odd even operating hours which vehicle can only go through on the restricted roads.
b. The distance and time needed that out of odd even operating hours which vehicle can go through on all roads or called unrestricted roads.

The distance variance between these two conditions were converted to cost. The formulae are similar to seen at Ruth et al [12].

$$Fuel\ cost = Fuel\ price \times distance\ variance \times consumption\ rate \quad (1)$$

where:

Consumption rate = Litre per kilometre

Distance variance = Kilometre

Price of fuel = EUR 0.41 per litre (subsidized solar), this was the price as of September 1st, 2023.

The distance of route followed the concept of travelling salesman problem (TSP) which the goal is to find the shortest distance by visiting all cities (locations of customers) and returning to the starting point [13], and the starting point will be the same with the ending point, in other words, the vehicle started from warehouse, shipping goods to customer's destinations and returned to warehouse again. The distance was not symmetric (asymmetric) because the route followed the real distance from Google maps.

The time variance between these two conditions were also converted to cost that we called labor cost.

$$Labor\ cost = Labor\ rate \times time\ variance \quad (2)$$

where:

Labor rate = EUR per hour, which minimum wage in Tangerang, Banten was EUR 274.6 per month.

Time variance = hour(s)

$$Total\ cost = Fuel\ cost + Labor\ cost \quad (3)$$

Other factors that may influence time variance are parking, pedestrian crossing, turn like U-turn, all of these are common conditions [14] in Jakarta.

2. ECONOMIC ANALYSIS: RENT VS DO NOTHING

In this research, the organization had two alternatives, one was rent a yellow plate vehicle from third party logistics (3PL) company and another one was do nothing. Do nothing alternative means, the organization has to avoid odd-even roads and may get a longer distance or/and longer time when shipping goods to customers. The factors that may contribute to a longer distance and time could be a slower speed in a narrower road, further road, traffic congestion, and unfamiliar knowledge of driver. These two alternatives would be compared, and the organization would choose the lowest cost. **Fig. 1** shows the framework of research.
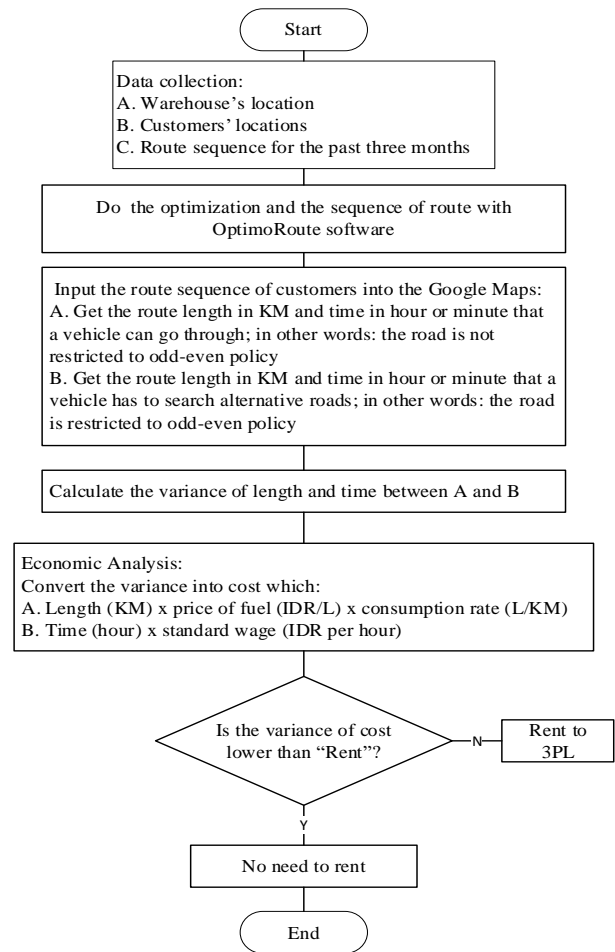

Figure 1. *Framework of Research*

3. DATA AND ASSUMPTION FOR THIS RESEARCH

There were some data needed for optimoroute software, and this data must be prepared:

a. Customer and warehouse's location, a detail address. The objective was to get accurate location, so this accurate location would produce accurate distance.

b. Location name, in this section, one can choose customer's shop or customer name.

c. Number of drivers who would deliver the products to customer's location, this helped route planner get a group of locations of customers that had to be delivered for one vehicle.

Some data were needed for further analysis:

a. Monthly wage of driver
b. Current price of fuel
c. Toll road cost that passed when delivery
d. Current rental cost

There were some calculations in this research that based on these assumptions:

a. Average working hours per day is 8 hours and there are 5 working days per week.

b. The amount of working hours per month = 52 weeks per year x 40 working hours per week: 12 months = 173 hours.

c. The wage rate per hour = EUR 1.59

These assumptions based on Labor Laws, Undang–Undang Ketenagakerjaan nomor 13 tahun 2003.

The starting point was from warehouse and the route was ended in warehouse. Before using the Google Maps, the sequence of customer's locations in one route was determined by the software OptimoRoute.

4. OptimoRoute SOFTWARE

OptimoRoute is regarded as one of the suitable software for solving vehicle routing problem and mobile workforce that has following advantages: high ease of use, the clarity with which solutions are shown, both graphically and analytically, through the use of colours and the sense of the streets, and the high amount of data from the different routes illustrated in the solutions (**Fig. 2**). OptimoRoute is a routing optimization software, created in 2012 in the United States, used by multiple companies from different business sectors around the world [15, 16].
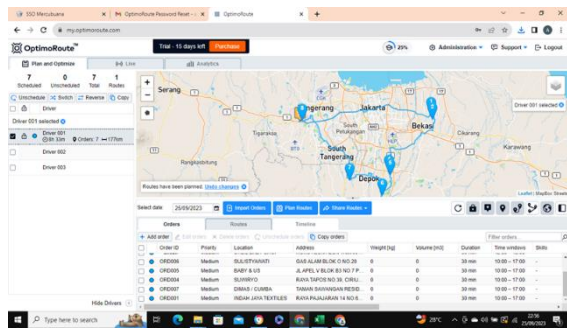

Figure 2. Planning & Optimizing Routes by optimoroute software

III. DATA ANALYSIS AND RESULTS

The shipment data for this research was collected for three months from July to September 2023, working days, Monday to Friday started from 08:30 to 17:30. The average routes were 49 per months and available during observation, all routes started from warehouse, Jatiuwung, Tangerang and at the end, returned to warehouse, Tangerang. Here are the customer's data: 8 in Tangerang, 61 in Jakarta, included expedition, 5 in Depok, 4 in Bekasi, and 1 in Bogor. This following **Table 2** showed us that there were two effects emerged when odd-even policy was implemented, further distance and longer travel time. Further distance means the odd-even policy has made a driver search and pass through unrestricted roads, further distance also means more fuel was consumed. Longer time means the odd-even policy has made a driver pass through unrestricted roads, but the velocity could not exceed 40 KM per hour. Longer time means there was an additional time for driver to work.

Table 2. *The impact of odd-even policy on distance and time*

	Routes	Value
Further distance	22	137.5 KM
Longer time	8	5h 7m 0s

Fig. 3 was the example when odd-even policy implemented then further distance happened, even only a little bit.
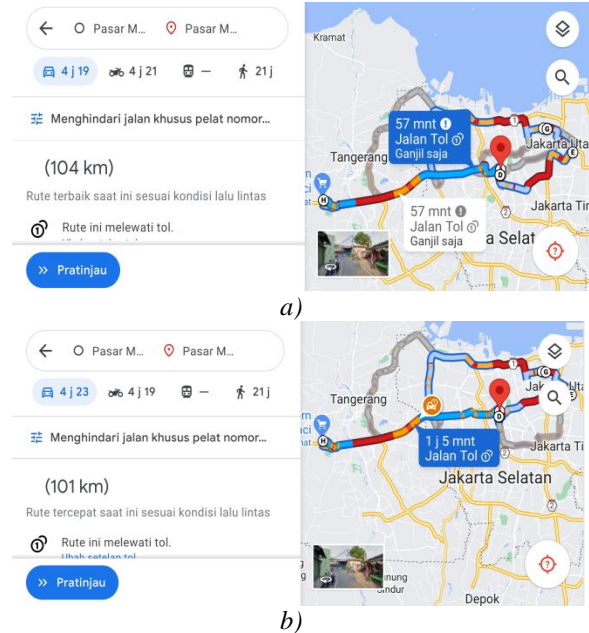

a)

b)

Figure 3. *The odd-even a) policy implemented b) policy not implemented*

1. Routes – Further distance

The impact of odd-even policy could make the route further because some roads were restricted by odd-even policy, then driver had to look for and took another road. From 49 routes per month, there were 22 routes (44.89%) had further distance, the total was 137.5 Kilometre. Average Kilometre per Litre was 5.8, and fuel price was EUR 0.41 per little. The fuel was solar that subsidized by government, then the cost incurred per month that caused by odd-even policy:

$$\frac{137.5\ KM}{5.8\ KM/L} \times EUR\ \frac{0.41}{L} = EUR\ 9.71/month$$

2. Routes – Longer time

The impact of odd-even policy also made the travel time longer. Longer time was caused by narrower road so that a driver could not drive a vehicle more than 40 KM per hour and driver had to look for the unrestricted roads at the time. Other factor was further distance. From 49 routes, there were 8 routes (16.33%) had longer time, the total were 5 hours 7 minutes, then it would cost:

5.12 hours x EUR 1.59 per hour = EUR 8.14 per month

Then, total cost incurred per month by the odd-even policy = *EUR (9.71 + 8.14) = EUR 17.85 per month*

3. Comparison between Rent vs Current Condition

It was important to compare the total cost between current condition and rent a vehicle.

Table 3. Cost comparison

	Average cost (EUR) per month
Current condition:	
- Cost incurred by *odd-even policy*	17.85
- Fuel cost 600 Litre	244.30
- Wage of driver	274.60
- Holiday allow. + overtime	35.90
- Toll road cost	5.98
- Maintenance cost	29.90
- Administrative cost	11.98
- Insurance cost	20.97
Total cost	**631.77**
Rent a vehicle with 3PL	**1,197.60**

Table 3 indicated that cost for current condition was still cheaper than rent a vehicle, so that the private companies does not need to switch to vehicle rental and drop the current vehicles. The organization could save about EUR 565.83 per month.

In this study, it is obvious that, the odd-even policy implementation in Jakarta city had not a big impact on distance and time when delivered finished goods from Tangerang to its customers in Jabodetabek, the reasons were:

- There were customers' locations that could be delivered by taking the toll road and were not restricted by odd-even policy: North Jakarta such as Sunter, Kelapa Gading, Ancol; Tapos, Depok; Tangerang areas; Bogor.
- Delivered at outside of odd-even hour limits, from 10 to 16.

4. Discussion and Future Research

In this study, there was still some aspects that a researcher can do in the future. Government of Jakarta has planned to implement Electronic Road Pricing (ERP). ERP was viewed as a tool to restrict motor vehicle by electronic system at certain roads and certain time. From this, one can further compare some options: do nothing versus ERP. One can also do the research about the factor that influence most on driving time, whether length of road, route, parking, pedestrian crossing, or may be turn like U-turn.

IV. CONCLUSIONS

The odd-even policy had an impact on travel distance and time. There were around 44.89% of routes that had further distance and around 16.33% had longer time. The total cost at current condition, do nothing on odd-even policy saved EUR 565.83 than rent a vehicle at 3PL, it was still beneficial for the company to maintain current condition than to switch to rent a vehicle from third party logistics (3PL). In the future, one can do research about benefit and limitations of Electronic Road Pricing (ERP).

AUTHOR'S CONTRIBUTIONS

A. Chandra: Conceptualization, Literature review, Data collection and Experiments, Analysis, Writing and Review.

DISCLOSURE STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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