1. Introduction

A fundamental aspect of traffic flow analysis is the relationship between vehicle velocity and density, essential for predicting traffic behaviour under various conditions. Traffic congestion is a prevalent issue in many countries, including Indonesia. One significant factor contributing to congestion is the substantial number of vehicles. This increase in vehicle volume, especially on narrower roads, exacerbates traffic congestion. According to the Indonesian Central Bureau of Statistics, in 2020, there were 115,023,039 motorcycles, 15,797,746 cars, 5,083,405 trucks, and 233,261 buses. This vehicle totals 136,137,451 vehicles, reflecting an approximate 4.95% increase from the total in 2019 [1].

In Bandung, especially on Bojongsoang highway, the main congestion factor is caused by the large number of vehicles travelling on the road. The limited and not too-wide road infrastructure also affects the congestion factor on the road. Then, the number of intersections that cause the meeting of traffic flows to be crowded makes it difficult for vehicles to move [2]. However, the main factor is that Bojongsoang Highway has a lot of shops and malls on the side of the road. This makes vehicles sometimes have to cross the road and park on the side of the Bojongsoang highway, making it an obstacle to the problem in this paper.

The characteristic types of traffic flow are generally categorized into three models: the Macroscopic, Microscopic, and Mesoscopic models [3]. The Macroscopic model is a model that views traffic as a continuous fluid flow that will analyze variables such as velocity, density, and traffic flow. Then, the Microscopic model is a model that observes the individual behavior of a vehicle and the interaction between vehicles which focuses more on analyzing acceleration, deceleration, and distance between vehicles. Then, the Mesoscopic model is a model that combines the Macroscopic and Microscopic approaches. (See [4], [5], [6] for more details).

An illustration of traffic jams caused by obstacles from vehicles parked on the side of the road, vehicles crossing the road, and large vehicles can be seen in Fig 1. Fig 1, the red car is an obstacle to vehicles stopped on one side of the road. Then, the yellow car is a vehicle that wants to cross to enter the mall. Then there are large vehicles such as trucks and buses. Meanwhile, other vehicles passed as usual.

This study will focus on observing the relationship between velocity and density in traffic flow in the presence of obstacles that can cause congestion. The velocity function depends on the vehicle velocity, as shown in Fig.1. Therefore, the second-order polynomial function approximates the velocity function from the observed data. The velocity function is obtained from the relationship between the average velocity (v) of vehicles and the density (ρ) in the traffic flow.

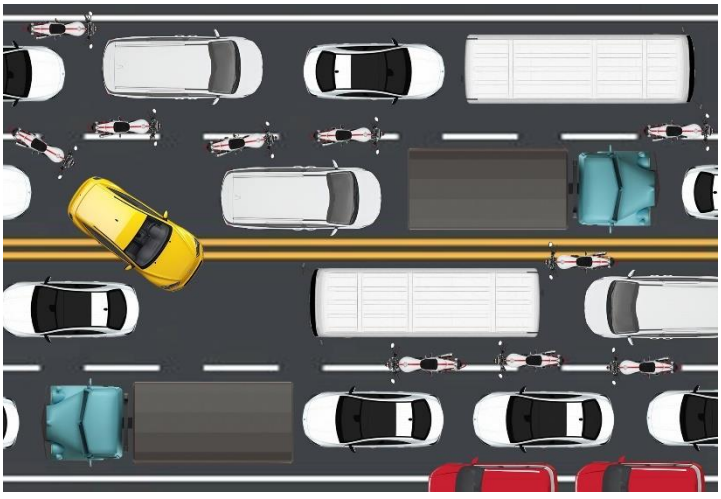

Fig 1. The illustration of the obstacle conditions on the Bojongsoang

This study aims to explore and simulate a traffic flow model with a velocity-density function approach obtained from observed data. Velocity functions in the presence of obstacles, and the absence of obstacles will be provided. This paper is organized as follows: Section 2 presents the model and numerical scheme of traffic flow with observed data. Section 3 presents the analysis and methodology. The final section of the paper will present the conclusions, which are included in section 4.