1. Introduction

Traffic flow is a critical aspect of modern transportation systems, and understanding its dynamics is essential for optimizing traffic management and reducing congestion. Traffic congestion is a prevalent issue in urban areas worldwide, significantly affecting daily commute times. In Indonesia, high vehicle density often causes significant traffic flow problems. For instance, in Bojongsoang, a district in Bandung, West Java, Bojongsoang Highway is a critical highway that frequently experiences traffic jams. Traffic congestion here is exacerbated by the large number of vehicles on narrow roads, numerous intersections, and infrastructure challenges.

In recent years, traffic issues have been a significant area of study. Research has particularly concentrated on key aspects such as the vehicle routing problem, dynamic assignment problem, and traffic congestion, among others [18]. To better understand the intricate behaviors of traffic, various traffic flow models have been developed, including partial differential equations (PDE), cell transmission, the kinematic LWR equation, and others. (see [20, 21, 5] for more details).

The relationship between density and velocity in traffic flow is a fundamental aspect studied in traffic theory. Density refers to the number of vehicles per unit length of road, while velocity is the speed at which these vehicles are traveling. Several studies have explored this relationship, highlighting that the product of velocity and density determines the traffic flow per unit time [15, 1]. In congested traffic phases, there is a critical density where all velocity values have the same probability, corresponding to half the maximum allowed traffic density [17]. Additionally, some models present a linear or nonlinear density-velocity relationship to describe traffic flow [13, 12, 9].

Traffic flow is typically characterized using three types of models, namely macroscopic, microscopic and mesoscopic. Macroscopic models focus on the collective behavior of vehicles and are commonly employed to analyze velocity, traffic flow, and density [14]. Then, microscopic models examine individual vehicle behavior by utilizing parameters like time and distance headways, position, and velocity [2]. While mesoscopic models serve as a hybrid between microscopic and macroscopic models, incorporating characteristics from both [10].

This paper focuses on examining the relationship between density and velocity in traffic flow. The velocity function will be derived by approximating observational data using the linear regression method. This data reflects the relationship between vehicle density and velocity, collected through real observations on Bojongsoang Highway in Bandung, West Java, Indonesia. A linear approximation function will be employed to determine the velocity function.

As detailed in reference [8], the velocity-density function is employed in traffic flow models to simulate vehicle density movement on the road. This study utilizes the macroscopic Lighthill, Whitham, and Richards (LWR) model.

The aim of this research is to analyze and simulate a traffic flow model using velocity-density functions derived from observational data. In contrast to generalized traffic models, this study targets the unique traffic patterns and conditions of a specific urban road that is known for its frequent congestion. By concentrating on this localized area, the research aims to generate actionable insights that can be directly utilized by local authorities for traffic management and infrastructure planning. The findings of this study can be serve as a practical resource for traffic engineers and urban planners focused on alleviating congestion in comparable urban environments.

The paper is organized as follows: Section 2 presents a macroscopic model of traffic flow. Section 3 discusses numerical methods, including linear regression and upwind scheme. Section 4 demonstrates numerical approaches and simulations. Finally, Section 6 presents the conclusions drawn from the study..