International Journal of Operations Research and Information Systems
Volume 14 • Issue 1

Truck Fuel Consumption Prediction Using Logistic Regression and Artificial Neural Networks

Sheunesu Brandon Shamuyarira, National University of Science and Technology, Zimbabwe
Trust Tawanda, National University of Science and Technology, Zimbabwe*
https://orcid.org/0000-0003-2665-9711
Elias Munapo, North West University, South Africa

ABSTRACT

Rising international oil costs and the transport industry's recovery from the effects of Covid-19 resulted in the efficient management of fuel by logistics companies becoming a significant concern. One way of managing this is by analyzing the fuel consumption of trucks so as to better utilize the costly resource. Twenty-three driving data variables were gathered from 210 freight trucks and analyzed this data. Relevant variables that impact truck fuel consumption were extracted from the initial 23 variables gathered using stepwise regression, and then a prediction model was built from the identified relevant variables utilizing a binary logistic regression model. In addition, a back propagation neural network was employed in this study to create a second model of truck fuel use, and comparisons between the two models were made. The outcomes showed that the binary logistic regression model and the back-propagated neural network model prediction accuracy were 68.4% and 77.2%, respectively.

KEYWORDS

Artificial Neural Networks, Fleet Management System, Logistic Regression, Truck Fuel Consumption Prediction

1. INTRODUCTION

The invasion of Ukraine by Russia has had a negative ripple effect in the global oil market. Russia has been one of the world's largest oil producing country and now the war combined with economic sanctions on Russia, has had huge repercussions on the global economy as Ukraine and Russia are major players in the food, energy and mining sectors. Since Zimbabwe does not mine petroleum, it is a net importer and as such a price taker of the foregoing global oil prices, thus the efficient management of fuel by logistics companies has become a significant concern. One way of managing this is by analyzing the fuel consumption of trucks so as to better utilize the costly resource. The freight

DOI: 10.4018/IJORIS.329240 *Corresponding Author

industry in Southern Africa is largely dominated by road transport and there are many cross-border transporters with both domestic and international origins. Transportation networks have become the major lifeline of modern societies, not only by ensuring individual well-being, but by also fostering economic growth through fast and reliable transportation activities, Muriel-Villegas *et al.* (2019) Since freight trucks carry the majority of commodities by road, they often consume much more fuel than other kinds of vehicles because of their characteristics such as large loads and long distance travel. Zimbabwe does not mine petroleum, thus it is a net importer of fuel and as such a price taker of the ongoing global oil prices. Since Russia invaded Ukraine there has been a turbulence in the global petroleum market which has been causing global spikes in crude oil prices. To add on this, Zimbabwe has had the highest regional fuel prices thus there is need for management to address the increasing cost of operation rising from both high fuel consumption and high fuel cost. Moreover, to reduce emissions thus lowering the carbon footprint, as the sustainable growth of the environment and energy has become a requirement all over the world, particularly in the transportation sector.

2. LITERATURE REVIEW

The fuel consumption of freight trucks is influenced by a number of different factors. Fuel consumption can differ significantly from truck to truck, even when comparing two that are of the same make, model, year, and fuel type. There are a number of factors that may contribute to this. Some of them fall under many categories, including those relating to drivers, weather, traffic, travel, and vehicles, among others. Barbado and Corcho (2021) evaluated the literature on a number of factors that might affect a vehicle's fuel consumption. Considering the effects related to travel factors, the authors identified eco-routing as a crucial element in reducing fuel consumption. By considering the optimum route, one could save fuel not only in terms of distance and travel time, but also in comparison to other viable routes. According to Faria *et al.* (2019), with regards to driver related factors, aggressive driving compared to calmer driving can account for up to 40% of a vehicle's fuel consumption. A mesoscopic fuel consumption estimation model was created by, Chen *et al.* (2017), that took into account factors like the number of lanes and free-flow speed that had previously received little attention. The study's findings demonstrated that these elements had an effect on motor vehicle fuel consumption as well. Freight transport companies now employ telematics services to track their trucks and keep an eye on variables like fuel usage in an effort to minimize the costs connected with fuel consumption. The data gathered by this state-of-the-art digital monitoring and collection technology is more diverse and accurate than manual recording. It is crucial for fleet managers to process and make use of the data generated by the fleet intelligent management system. By carefully examining the data and learning the rule of fuel consumption during truck operation, it is possible to lower the fuel consumption of trucks to a certain extent. Malekian *et al.* (2016) developed a wireless on-board diagnostic system (OBD II) fleet management system. The system was aimed at measuring speed, distance, and fuel consumption of vehicles for tracking and analysis purposes. The findings demonstrated that the system could successfully read a variety of parameters and analyze, transmit, and display readings. In order to anticipate the fuel consumption of diesel buses, Sun *et al.* (2021) computed the relevant fuel consumption model utilizing real-time driving and fuel consumption data collected by on-board sensors. Based on the mobile phone terminals and on-board diagnostic system (OBD) installed in taxis, Yao *et al*. (2020) extracted driving behavior and fuel consumption data and were able to predict vehicle fuel consumption based on mobile phone data. Many scholars have volunteered their time to estimate and calculate the fuel consumption of trucks in an effort to identify the best driving behaviors that can reduce both fuel consumption and greenhouse gas emissions. These can be divided into two categories namely historical models and modern data driven models. Examples of historical models include Vehicle Specific Power (VSP) Model, Comprehensive Modal Emission Model (CMEM), and Emissions from Traffic (EMIT) Model. Zhang *et al.* (2023) by using vehicle acceleration and jerk as the defining parameters, created a unique computational model for the volatile condition (defined by