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## Performance of Low Speed Electric Two-wheelers in the Urban Traffic Conditions: a Case Study in Kolkata

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### Abstract

The present study discusses the performance of the electric two-wheeled vehicles on the basis of their running conditions in present day traffic in the urban regions. In this study, survey based results and experimental outcomes were compared with that of the conventional IC engine counterpart for the road conditions in the city of Kolkata. The specific energy consumption of the electric variants were found to be 155.64 kJ/km and 114.5 kJ/km from the experimental and survey results, respectively, compared to 810 kJ/km of the conventional two-wheelers. The specific energy cost and the specific CO<sub>2</sub> emission were also obtained from the study.

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*Keywords:* Electric two-wheelers; specific energy consumption; specific CO<sub>2</sub> emission; specific cost; road transport

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### 1. Introduction

The rapid economic development of India has been accompanied with increase in the road transportation activities in urban and rural areas of the country. About 80% of the total passenger transportation has been reported to be shared by road transport sector [1]. The major transportation activities have been reported in the urban and adjoining areas. Along with the economic progress, privatized mode of transport has experienced much preference

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**Nomenclature**

pkm passenger-kilometer

among the commuters. The maximum share among the privatized mode of transport has been marked by the two wheeled vehicles, which consist of mopeds, motorcycles, and scooters, playing the most important role in this sector. The low energy consumption compared to other forms of heavier vehicles, smaller size, and easy maneuverability in the heavy traffic conditions have been the major advantages of two-wheelers for the transportation of one or two passengers at a time [2]. The energy intensity for conventional two-wheelers in India varies from 0.55 to 0.45 MJ/pkm for 2 stroke and 4 stroke models, respectively [3]. By the end of March, 2010, the total number of registered two-wheelers was 71.8 million, which constituted 50.63% of total vehicle fleet in India [4]. Again, 50% of the total gasoline consumption of the country has been reported to be consumed by the two wheel vehicle fleet and the average daily travel for a two-wheeler in India has been reported to be 24 km [2].

Presently, electric two-wheelers have penetrated the two-wheeler vehicle market, which are undoubtedly an energy efficient mode of transport. Electric two-wheelers have two major variants; the low speed and the high speed models. According to the daily average distance as recorded for the two-wheelers in India, the electric scooters may be quite suitable for parallel running along with that of the conventional two-wheelers. But the lower load carrying capacity and shorter distance travel per charge are the two major drawbacks for the electric two-wheelers.

Earlier study on small scale electric scooter trial showed that the energy consumption for electric scooters has been 0.45 MJ/ km and that zero emission can be achieved if the electricity for charging can be derived from renewable sources [5]. But the trial electric scooters had motor ratings of 3 kW, which are mainly the high speed variants. Greaves et.al [6] studied the suitability of Battery Electric Vehicles (BEVs) with prevailing traffics, based on GPS data records of daily driving patterns in the city of Sydney. The results encourage the adoption of BEVs among the vehicle owners. Again the impact of real-world driving pattern has been studied by Amjad et.al on the energy consumption pattern of a hybrid electric two-wheeler, in the city of Coimbatore [2]. The study estimated the fuel efficiency and all electric range for a prototype and its simulated performance for both Indian Driving Cycle and real-world driving cycle. Regarding the use of two-wheelers in India a recent study suggested that, two-wheelers would be the preferred mode of transport in 2035 and that electric two-wheelers of low cost and limited range were mostly suitable for intra city driving [7]. In the present study the suitability of low speed electric two-wheelers with the present urban conditions have been analyzed for the traffic conditions at Kolkata city in West Bengal.

Government of India has launched the National Electric Mobility Mission Plan (NEMMP) for the development of electric and hybrid vehicle technology in the country and its acceptance in the transport sector, and from the recent financial year the subsidy under this scheme has been implemented to reduce the capital cost of the electric vehicles. Thus the cost involved in the electric vehicle may reduce leading to the market penetration of electric vehicles.

**2. Methodology**

The present study comprised of two separate procedures; firstly, the data for the operating conditions of the electric two-wheelers were collected by conducting primary surveys among the vehicle owners with formatted questionnaires. The daily travel data have been recorded from the available odometers, over a month. The energy consumption data were also provided by the owners and were also estimated from the battery capacity. A daily pattern of utilization of electric two-wheelers was thus obtained. Secondly, the real time performance of an electric two-wheeler was studied as a part of the experiment, for obtaining the energy consumption data and the performance characteristics with the present traffic conditions. The experiment has been conducted based on a low speed electric two-wheeler available in the market. The data from the electric two-wheeler study has been analyzed to obtain its pattern of energy consumption at different loading conditions, its performance in present day traffic and to check the suitability with different traffic conditions. The specification of the vehicle under study as shown in Fig.1 has been provided in Table 1.

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