Development of sustainable transportation model in Indian scenario: A review of literature

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Abstract: With the increasing awareness of greenhouse gas emissions, transportation with alternative fuel, especially vehicle electrification has attracted attention from more and more researchers, planners and practitioners. However, the feasibility of using electric vehicles for public transit is hard to assess as electric buses vary significantly in terms of costs and performance. A comprehensive assessment framework is needed to evaluate feasibility of electric bus. The study establishes such an evaluation framework and selects assessment criteria based on comprehensive literature review and data from multiple sources including research reports, manufacture consultation, and surveys. A profound list of bus performance measurements are quantified to reflect the latest transportation technological advancements and emerging concerns on emissions, noise and energy consumption. The study finds that electric buses' indirect impact on environment (through power generation) and their high costs should also be considered.

Index terms: electric buses; alternative fuels; emissions; energy consumption; sustainable.

I. INTRODUCTION

The total no. of registered motor vehicles in India has boom over the past decade (2001-2011) from 55 million in 2001 to 142 million in 2011. This increase is presented in figure *(Ministry of road transport and highways 2012b)*.

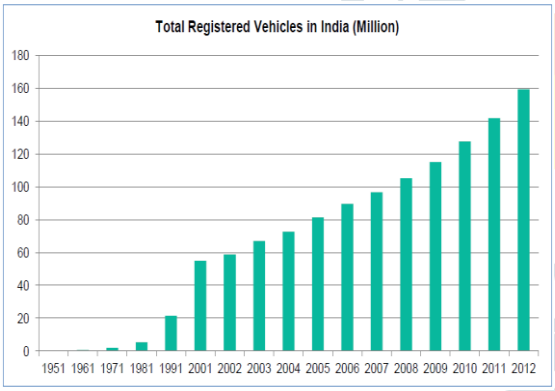

Figure 1 Registered vehicles in India

Urbanization, rise in per capita income, inadequacy of reliable public transport service, etc, are some of the major causal factors that have impacted the rapid motorization rates. The growth rates of population and registered vehicles are different for various categories of the cities in India. The National Urban Policy, 2006, maintained the development of public transport and non – motorized transport in various urban areas to reduce motorization rate and promote sustainable transport.

Over the previous decade, India's cities have been observing a growing trend in motorization with drop in air quality and have been calls to encourage public transport as a way out of the severe traffic congestion. It is in the context that electric buses can play a productive role as there are diverse benefits linked with the swift from conventional diesel buses to electric buses in respect of reduction in local pollution, noise and fuel consumption. In spite of the many feasible benefits connected to the electric bus technology, certain challenges remains.

The current policy climate in India is rightly addressing the challenges of electric buses, providing a environment to accelerate their adoption and implementation. However, like any new technology, policy implementers such as State Road Transport Undertakings (SRTUs) need a better understanding of technology and policy landscape, along with a robust assessment of the benefits. The SRTUs in India manages over 1, 00,000 buses across India registering over 524 billion passenger km annually. The National Electric Mobility Mission Plan (NEMMP) launched by the Government of India in 2013 aims to realize around 6-7 million electric vehicles on Indian roads by the year 2020 (*Press Information Bureau, 2015)*.
structure.

II. LITERATURE REVIEW

Wang and González (2013) found that electric buses can be an environmental friendly transportation mode to enhance the quality of life in small and medium size communities due to its several advantages such as low noise and zero tailpipe emissions. However, the indirect environmental impact of electric buses is considerably high and electric buses are more expensive than CNG and hybrid buses. Whether or not electric buses are feasible is eventually determined by the weights that the stakeholders want to designate to different factors. The general performance of electric buses is ideal for small and medium sized communities, but if financial constraint and the upstream environmental impacts are of concern, electric buses may not be the best choice. Factors such as the peak demand of public transit and the conditions of the power generation system can differ significantly for some communities. In-depth investigation on these factors is needed before evaluating the feasibility of electric buses. The information provided will be very helpful to planners and policy makers with plans of assessing the feasibility of electric buses in their communities.

In this study by *Kunith et al.(2017)*, an advanced optimization model for planning a fast-charging infrastructure for an urban bus network is introduced. A mixed-integer linear optimization model was developed to minimize the electrification costs, incorporating the trade-off between battery capacity and charging infrastructure. The applied model determines the minimum number and respective location of charging stations as well as the optimal battery sizes for each bus line of a real network while ensuring a sufficient energy supply for daily operations. In order to assess the economic

impacts of operational and technology related constraints, several scenarios were examined.

Sheth and Sarkar (2019) research work has explored the life cycle costs involved in the procurement and operation of in favour of electric buses. It furnish to the academic and professional world in terms of creating perception of the long-term ease of using electric vehicles. Therefore, considering durable benefits, electric buses appear to be quite a feasible option as a mode for sustainable transportation over other conventional fossil fuel- based modes of public transport. Detailed cost-benefit and value engineering analysis can be made to further validate the feasibility of electric and diesel buses.

Sven Boren (2019) aimed at investigating sustainability effects, noise, energy use and costs of electric buses during at least one year when used in public transport. It was found through a developed strategic life cycle assessment method with new sustainability principles that when compared to other buses, electric buses have significantly lower sustainability impacts during the use phase when the fuel for heating the interior and the electricity for propulsion stems from renewable sources. According to the results in this initial screening process, these impacts where quantified in a life cycle assessment and then used as input to a developed approach to life cycle costing calculations that were based on in-real life date regarding energy use and other costs related to bus operations.

III. BASIC STRUCTURE OF BEC LOGIC

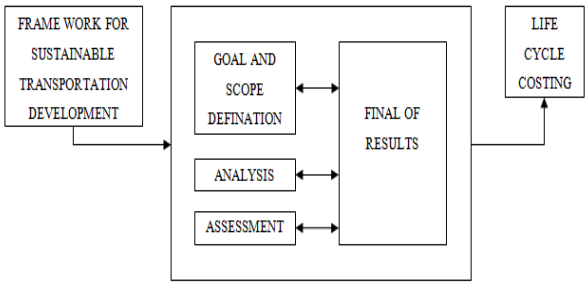

Figure 2 Conceptual framework

IV. CONCLUSION

Reviewing existing literature, it has been observed that electric buses are emerging as an effective and pragmatic option for reducing emissions and providing other benefits, however the electric bus movement is currently still in its early stages and experiencing growing pains. To date, electric bus adoption has been uneven and varied in scale, and implementation has not accelerated fast enough for the world to meet transport-related climate objective. Thus for environmental benefits, electric buses can help cities to improve energy efficiency and help in reducing dependencies on fossil fuels. Electrifying municipal bus presents a unique opportunity to reduce greenhouse gas emissions in transportation sector while also bringing co benefits to the cities making the transitions.

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