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Modeling Indian four-wheeler commuters' travel behavior concerning fuel efficiency improvement policy

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ABSTRACT

The present study examines the relation between the Indian commuters' travel behavior and their support for vehicle fuel efficiency improvement policy towards energy conservation and environment protection. Data was collected through an attitudinal questionnaire survey conducted among selected commuters in south India. The set hypotheses were tested using structural equation modeling approach. The data analysis results revealed that the Indian commuters have a supporting attitude for vehicle fuel efficiency improvement policy towards fuel consumption and emission abatements. The modeling results also show that this policy has a positive influence in shaping the travel behavior of the commuters. This in turn shows that the implementation of this policy will modify the commuters behavioral intention leading to a travel behavior of having more car trips and hence longer travels. Besides the awareness over the threats of fuel consumption and emissions, the Indian commuters are interested in having more travel activities with fuel efficient cars. This shows the existence of direct rebound effect in the Indian personal transport sector. This behavior of the commuters can offset the benefits, which are expected out of the fuel efficiency improvement policy and reduced car use, of fuel consumption and greenhouse gas emission abatements in the country.

1. Introduction

Fuel vulnerability, increasing fuel consumption and skyrocketing greenhouse gas (GHG) emissions are some of the issues currently faced by the world. This has kept and keeps policy makers motivated to increase fuel efficiency standards around the globe. The United States Congress has decided to increase the fuel efficiency of new four-wheelers by ten miles per gallon over the next 10 years (Barla et al., 2009), and to attain a fuel efficiency of fifty-four miles per gallon for four-wheelers by 2025 (CFA, 2015). The Canadian government has announced the introduction of new mandatory standards on fuel efficiency improvements over the existing voluntary agreement with the industry (Barla et al., 2009). Japan is implementing regulations requiring automakers to improve fuel efficiency by 20 percent by 2015. Moreover, Japan also requires a 'parking space certificate' before a car can be registered. The larger cities in China such as Beijing, Shanghai and Guangzhou have introduced quotas for the number of four-wheelers that can be registered per month (Ghate and Sundar, 2014). The European Commission has proposed a new clean air policy package for Europe with the aim to further improve Europe's air quality by 2030 (EEA, 2014).

Presently, India also faces the problems of fuel shortages due to stagnant production in the existing oil fields (Choudhary and Shukla, 2006). Fuel consumption in the country is very high with the majority consumed by the Indian transport sector (Ghosh, 2005). Due to this high consumption levels and low availability, more than 80 percent of India's fuel requirements are met through imports. As a result India is slowly turning into a country which is almost entirely relying on the import of transport fuel. Moreover, the high fuel consumption has resulted in high emission levels in the country. This has motivated the Indian government and the vehicle manufacturers to adopt the policy of improving the technical fuel efficiency of the vehicles (Anand, 2008; Ritterspach and Ritterspach, 2009). In June 2009, Indian government announced that it would soon make fuel efficiency labeling of cars mandatory (BEE, 2009; Kojima, 2009; Menon and Mahanty, 2012).

The success of vehicle fuel efficiency improvement policy is not only determined by the fuel quality but also by the travel behavior of the people (Kahn and Morris, 2009; Onoda, 2008). The influence of fuel efficiency improvements on travel behavior and it leading to energy conservation and emission abatements are researched world wide (Chiu and Carr, 2011; Golob and Hensher, 1998;

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Hensher and Smith, 1986). The above researchers set their objectives to assess commuters' attitudes concerning the threat of increasing energy consumption and emissions, and that towards vehicle fuel efficiency improvements to mitigate the same; and also to assess the influence of the vehicle fuel efficiency improvement policy on commuters' travel behavior. Unfortunately, similar studies in this line have not been carried out in the context of India. The present study aims to answer specific questions like: (1) what is the effect of commuters' awareness of the threat of increased energy consumption and emissions on their intentions to reduce car travel and have a mode choice of public transport?; (2) are the commuters aware of and supporting the car fuel efficiency improvement policies towards the energy consumption and emission abatements in the context of India?; (3) are the commuters aware of the advantages of having increased fuel efficiency for their cars?; (4) is there any effect on the commuters' travel behavior when they are provided with the real time fuel efficiency improvement information in the context of India?; and (5) is the Indian commuter's travel behavior influenced only by their social responsibility to reduce the fuel consumption and emissions?. Therefore the present study is conducted in India on environmental/energy attitudes to model the commuters' travel behavior. The study considers the personal transport sector and thus it is confined only within the users of personal cars in India.

The rest of the article is organized as follows. Section 2 is on the importance of four-wheeler ownership levels in India and Section 3 is on the development of a theoretical based model. The Section 4 is on materials and method used and Section 5 presents the results. The Section 6 briefly discusses the structural equations model developed. Finally conclusions are laid out.

2. Importance of four-wheeler (car) ownership levels in India

The present study is a part of a larger research work in the four-wheeler personal transport sector in India thereby considering only four-wheelers in the study. This study was initiated as the four-wheeler population in India is growing day by day as the disposable income of the Indian commuters is increasing since the last several years. The studies have shown that for one per cent growth in per capita income, the level of four-wheeler/car ownership grows by 1.7 per cent (Ghate and Sundar, 2014; TERI, 2006). As the disposable incomes rise, a car owner tends to buy a second or a third car. This is the same scenario that has happened in the developed world which took the car-dependent path for growth (Ghate and Sundar, 2014). Presently there are about 15 million four-wheelers in India which is equivalent to 13 cars per 1000 population. Even though this is not high, it is to be noted that this is a national average and cities like Delhi, Chennai, and Coimbatore presently have more than 100 cars per 1000 population. The car ownership in Delhi is 157 cars per 1000 population, followed by Chennai with 127 cars per 1000 population, and Coimbatore with 125 cars per 1000 population. The cities like Pune with 92 cars per 1000 population, Thane with 98 cars per 1000 population, Bangalore with 85 cars per 1000 population, and Hyderabad with 72 cars per 1000 population are fast approaching the 100 cars per 1000 population level. The Indian cities of Delhi and Bangalore register more than 30,000 cars per month or 1000–1200 cars per day (Ghate and Sundar, 2014; GoI, 2011; MoRTH, 2012). The estimates show that the car ownership level in the country will increase from 13 cars per 1000 population to about 35 cars per 1000 population by 2025. This will increase the car population from 15 millions to 45–60 millions in the country with some cities having the car ownership levels more than 300 cars per 1000 population (Ghate and Sundar, 2013, 2014).

The reductions in price due to the indigenous production of four-wheelers (for example the ford motor plant in Chennai, Fiat plant in Pune, and the acquiring of Jaguar cars by TATA recently) in India has also resulted in increasing car sales in the country. The launch of low priced compact cars by TATA (TATA Nano) and Mahindra (Mahindra Reva) have further boosted the car sales in the country. Moreover the city of Mumbai alone has witnessed a 51 percent growth rate in car population since 2007 which was an alarming increase for automobile experts and policy makers of India (The Times of India, 2013). The car ownership levels per 1000 population in Indian cities and compound annual growth rates in four-wheelers and two-wheelers in India are depicted in Figs. 1 and 2 respectively. The exponential growth in the car population levels is sure to have serious implications in terms of energy security, emissions and atmospheric pollution for India. These externalities have motivated to exclusively consider four-wheelers for the present research.

3. Development of a theoretical based model

The attitudes of the commuters towards the increasing fuel consumption and GHG emissions; and its abatement possibilities have considerable influence on their pro-environmental travel behavior. This in turn is expected to influence the extent of success of these abatement policies towards the energy conservation and environment protection in a country. Travel behavior has been mainly looked upon as a function of socio-demographic attributes and transport system characteristics (travel costs, travel time, etc.); but several researchers in the last few decades have argued that individuals' attitudes and perceptions have a great influence in predicting it (Pronello and Camusso, 2011). Garling et al. (2001) explores decision making involving driving choices thereby testing the links among attitude towards driving, and frequency of choice of driving. Nilsson and Kuller (2000) investigated the impact of environmental knowledge on driving distance, travel behavior and acceptance of various traffic restrictions. Golob and Hensher (1998) assessed the dichotomy between individual's behavior and attitudinal support for policies which are promoted as benefiting the environment. The hypothesized model for the present study can be visualized in Fig. 3.

3.1. Behavioral intention mediates the relationship between social awareness and travel behavior

The relationship among the variables of social awareness and travel behavior, and the mediator variable of behavioral intention has not been tested in the context of Indian personal transport sector. Increasing GHG emissions out of the high fuel consumption levels is definitely a social problem. The personal benefits of having car for travel time saving and convenience is private; but the negative effects of increased fuel consumption and GHG emissions are social (Engel, 2004). The behavioral intention variable involves a commuter's commitment to reduce fuel consumptions and GHG emissions towards improving the air quality by reducing the travel activity. Hence the commuter's social awareness of the threats of fuel shortages and increasing GHG emissions can influence the commuters' behavioral intentions of willingness to reduce car travel and change their travel mode to public transport (Golob and Hensher, 1998; Hensher, 1993; Martin and Michaelis, 1993; Nordlund and Garvill, 2003; Taylor and Ampt, 2003).

The travel behavior of a commuter is in turn influenced by the behavioral intention variable (Anable, 2005; Garvill et al., 2003; Golob and Hensher, 1998). In personal transportation, consumer behavior is the commuters' travel behavior itself; and travel behavior is all about usage of cars. For the present study, the travel behavior is defined by the commuter's decisions of using their cars (Kahn and Morris, 2009; Silva et al., 2006; Silva and Goulias, 2009).