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Modelling electric vehicle usage intentions: an empirical study in Malaysia

Yew-Ngin Sang, Hussain Ali Bekhet*

Graduate Business School, College of Graduate Studies, Universiti Tenaga Nasional (UNITEN), Malaysia

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ABSTRACT

In the new global economy, carbon emission has become an important worldwide issue. One key reason for this is the magnification of the transport sector, as millions of gasoline-based vehicles are plying on roads producing carbon emission throughout day and night. In order to impede these vulnerabilities and promote a more sustainable economy, one solution is to switch from gasoline-based vehicles to using green technology vehicles. There is growing agreement that electrification and the ability to 'decarbonize' this sector seems to be significant, as it helps to mitigate the high reliance on fossil fuels and reduce carbon emissions. The introduction of electric vehicles has led the automotive industry to a whole new echelon, one with zero fuel dependency and increased fuel efficiency. While the usage of greener and cleaner vehicles, such as electric vehicles, is well supported with government policies and programmes, it is surprising that little information is divulged about the public acceptance of electric vehicles from the social perspective. Public acceptance and diffusion of this new green technology is relatively fresh and unknown in Malaysia. In fact, public acceptance can appear as a prevailing obstacle for market diffusion and encumber the development of technology adoption. The rationale of this paper is to conduct an exploration to determine the key predictors affecting the usage of electric vehicles acceptance in Malaysia. Malaysia has been referred to here, as electric vehicles are just being introduced as one of the initiatives to encourage a low fossil carbon technology within the transportation sector. More specifically, an empirical study using a survey questionnaire was distributed to 1000 private vehicle drivers in Malaysia. An electric vehicle usage model was proposed based on a literature review and a multiple regression model. The results demonstrated that electric vehicles acceptance in Malaysia can be explained as being significantly related to social influences, performance attributes, financial benefits, environmental concerns, demographics, infrastructure readiness and government interventions. In addition, the study offers a valuable wealth of information on the public acceptance of automotive players planning to market electric vehicles in Malaysia. It also offers sensible guidelines for the formulation of marketing strategies that will address the real wants and needs of future electric vehicles users. In the meanwhile, policy-makers should concentrate on the appropriate intervention and policy to encourage the development of electric vehicles as part of the strategy towards a transition to a low carbon society in Malaysia.

1. Introduction

It has been extensively recognized that climate change and carbon emission are by far the biggest ordeals of the new millennium. The amplification in the number of automobiles is one of the key reasons and it was reported that there are currently almost 1 billion vehicles globally, consuming about 60 million barrels of oil per day (about 70% of the total oil production). On average, private vehicles consumed petroleum at about 36 million barrels/day and so emitted roughly 14 million tons of carbon dioxide daily. In addition, these same vehicles emitted 114 trillion British Thermal Units (BTU) of heat every day (Reisinger and Emadi, 2013). Emissions generated in such quantities raises serious concerns about global climate change and air quality, especially in high-density urban and suburban areas, where most of the mobility activities take place. This was made worse by the fact that the current

* Corresponding author.
E-mail addresses: eugenesyn@hotmail.com (Y.-N. Sang), profhussain@uniten.edu.my (H.A. Bekhet).

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internal combustion engines vehicle technology can only provide a maximum efficiency of 30% (Emadi, 2011).

For the Malaysian scenario, energy demands from the transportation sector increased sharply between 1990 and 2012. The share in energy demand in the year 2012 was recorded at 36.8% and was the highest among all of the sectors in the country (Energy Commission, 2014). In addition, the average growth rate of newly registered private vehicles stood at 8.7% (Road Transport Department, 2012). In terms of CO_2 emissions, the transportation sector continued to be one of the largest emitters in the country (Lim and Lee, 2012). Previous findings on the transportation sector reported that energy efficiencies from this sector were merely at 18.88% (Saidur et al., 2007). In addition, it was reported that only 12.6% of the total energy is used as a useful exertion in terms of automobile internal combustion (Mahlia et al., 2012). This situation was further worsened by ineffective public transportation, which has resulted in extreme reliance on private vehicles. The usage of public transportation in the country was reported at only 16%; this is considered the lowest, among other Asian peers (Ong et al., 2012). An uncertain future of fossil fuel accessibility and stricter rulings on carbon emissions are presently a real concern. It is also the biggest challenge faced by automotive industries worldwide. With the current challenges of the uncertainty in oil prices and the desire for a security policy in many countries dependent on oil imports, finding an alternative solution is necessary for sustainable transportation (Electrification Coalition, 2009).

Governments worldwide are imposing strategies and plans to reduce carbon emission (Ustun et al., 2011). By the year 2020, the United Kingdom is targeting to reduce carbon emissions by 45% (Huang and Infield, 2009). European Union (EU) countries are planning to trim down their emissions by 20% (European Commission, 2010). As for Malaysia, the government pledged during the United Nations Climate Change Conference (UNFCCC) in Copenhagen in 2009 to reduce its carbon emissions by as much as 40%, based on their 2005 levels, by the year 2020. Green technology application in automotives has been identified as a viable solution to impede these vulnerabilities and promote a sustainable economy. Presently, one of the most prominent sustainable answers to strongly reduce oil consumption and carbon emissions lies in electric vehicles (EVs). These vehicles are propelled, either partially or fully, by electricity through energy storage systems, such as electrochemical batteries, which need to be charged from the grid (Wang et al., 2013). The well-known advantages and some of the reasons why EVs are starting to be popular include zero direct emissions, a reduction in oil dependency, and silent operation. The availability of the technologies required for EVs and the demand for higher efficiency has created a genuine interest for EVs in the car market. Consequently, it has encouraged almost all car manufacturers to develop their own EV models (Ustun et al., 2013).

The introduction of EVs into the Malaysian market has led the automotive industry to a whole new echelon in zero fuel dependency and increased fuel efficiency. Although EVs may reduce the tailpipe emission from the vehicle, the advantages in term of total emission are rather marginal if coal is still used to power the electricity generation. Therefore, the government has intensively promoted the wider use of renewable energy such as biomass and solar to reduce dependency on coal besides to have a better mix of electricity generation within the country (MEGTW, 2009). While the usages of greener and cleaner vehicles, such as EVs, are well supported with government policies and programmes, little information is divulged about the public acceptance of EVs from the social perspective. As the introduction of EVs is relatively new in Malaysia, there is no prior study or investigation that was carried out on Malaysian drivers to gauge the public acceptance levels and usage intentions of this new vehicle technology. As a matter of fact, public acceptance can emerge as a powerful impediment for market diffusion and can hinder the development of EV adoption in Malaysia.

Driven by the desire to investigate this under-researched area and with a view to highlight the major predictors that will affect public acceptance towards EVs usage intentions, the current research was conducted to better understand and bridge the gap between EV supply and demand issues. More specifically, this study extends the framework of the Theory of Planned Behaviour (TPB) to explore EVs acceptance in Malaysia. In order to develop an appropriate research model for the current study, a literature review relating to TPB and the factors that may lead to usage intentions were undertaken. This will be followed by the hypotheses development and research methods. Subsequently, the results and policy implications are presented and discussed.

2. Literature review

The TPB seems to be the model that was extensively used to predict usage intentions in the context of the transportation research domain. This includes studies on speeding intentions (Cristea et al., 2013; Horvath et al., 2012), travel mode choices (Chen and Chao, 2011; Hsiao and Yang, 2010), drink and drive behaviour (Moan, 2013; Rivis et al., 2011) and seat belt usage (Okamura et al., 2012). In this current research, the TPB extension is used as the underlying model, proposing a conceptual framework to explain the usage intentions of EVs in Malaysia.

The TPB posits that human action is guided by three kinds of reflections: beliefs about the likely outcomes of the behaviour (behavioural beliefs), beliefs about the normative expectations of others (normative beliefs), and beliefs about the presence of factors that may further or hamper the performance of the behaviour (Ajzen, 1991). Collectively, behavioural beliefs produce a favourable or unfavourable attitude toward the behaviour; normative beliefs result in a subjective norm; and control beliefs give rise to the perceived behavioural control of performing the behaviour. In combination, the attitude, subjective norm, and perceived behavioural control lead to the formation of a behavioural intention. The TPB also permits for the inclusion of additional variables, provided that these variables make a noteworthy input to the explanation of the behaviour provided by the model (Ajzen, 1991).

Existing consumer theories have provided a collection of insights into the principles that influence the preference of the consumers. Various models have been developed and tested over time to explore the multiple issues relevant to consumers' reactions in relation to technology adoption. In order to better understand public acceptance from the viewpoint of usage intentions, it is necessary to understand all the external and internal influences around it (i.e. the technology, the consumers and the environment) (Faiers et al., 2007). The adoption of new alternative fuel vehicles is dependable on a number of dynamics. These dynamics include: (a) should they be perceived in upbeat reflection provisions; (b) should they be comparable or perform better than existing fuels and technologies; (c) should they be competitively priced within the reach of the average consumer; (d) should they present minimum impacts on social, economic or environmental sustainability; (e) should they offer adequate infrastructure and support systems for charging and maintenance; and (f) should they receive consistent support from public policies (Browne et al., 2012; Montalvo, 2008).

Based on this assertion, we expand the usage intention paradigm by incorporating variables, such as social influences, performance attributes, financial benefits, environmental concerns, demographics, infrastructure readiness and government interventions, to be investigated directly in this study. As EVs are relatively new in Malaysia, the current number of EVs plying on the