IJER © Serials Publications
12(4), 2015: 1043-1050
ISSN: 0972-9380

CONSUMER'S ADOPTION OF ALTERNATE FUEL VEHICLES – AN EXPLORATORY STUDY IN KOLKATA

Debasish Sarkar[*], Ayasa Kanta Mohanty[**] and Kalyan Kumar Sahoo[***]

Abstract: *India has already started moving towards alternative transport system like other developed countries. During last couple of years several policies have been adopted by the states and central government in India to promote alternative mode of sustainable transport. However alternative fuel vehicle has not been very popular among Indians. The present study aims to explore the different aspects towards adoption of alternative fuel vehicles (AFV). Kolkata is one of the most polluted cities in India and having wide cultural diversity in population size. So the present study is conducted in Kolkata the capital city of West Bengal. We have collected data from field survey, by using judgmental sampling approach. Exploratory factor analysis and confirmatory factor analysis was applied to develop a scale for consumer adoption towards AFV. The findings of the study will have practical implications for policy makers, AFV manufacturers and alternate fuel producers and also for AFV users.*

Key Words: *Alternative fuel vehicle, Green house gases, Exploratory factor analysis, Confirmatory factor analysis.*

INTRODUCTION

The urgent need to diversify away from conventional oil is driving governments to promote alternative fuels as transport fuel. The enormous availability of natural gas reserves and its strong economical advantage over gasoline, encouraging South American govt. to provide additional incentives to promote the adoption of alternative fuel vehicles (Dondero and Goldemberg, 2005; Matic, 2005). The AFV adoption patterns and the evolution of pertinent market structures in eight countries: Argentina, Brazil, China, India, Italy, New Zealand, Pakistan, and the US. Now the adoption of AFVs depends on policy instruments and factors that are pertinent to consumers' choices,

* Senior Research Fellow of UGC, Govt. of India, Faculty of Management Sciences, Siksha 'O' Anusandhan University, Bhubaneswar, Orissa, India, *Email: 2dev.sarkar@gmail.com*

** Associate Prof. of IBCS, Faculty of Management Sciences, Siksha 'O' Anusandhan University, Bhubaneswar, Orissa, India, *E-mail: ayasakantamohanty@soauniversity.ac.in*

*** Dean of Kings School of Business, Ghana, *E-mail: kalyan46@rediffmail.com*

including refueling infrastructure density, fuel prices and payback periods (Yeh, 2007). To mitigate air pollution and to protect environmental hazardous, researchers (Baulsara and Priya, 2014) had developed green business models. Eco-friendly innovations such as alternative fuel vehicles (AFVs) hold the potential to solve a number of climate changes that relate to emissions caused by transportation sector (Graham-Rowe et al., 2012). These benefits are seen as particularly attractive in countries where local urban air quality is poor, especially in many cities in Brazil, India, and China, where air pollution levels are significantly higher than the World Health Organization's air quality standards (Soubbotina and Sheram, 2000). A recent study (Alnsour, 2015) shows the alternate way to reduce energy consumption by the local government in Jordon, to mitigate pollution. While environmental issues are low down the list of considerations for conventional new car buyers (Lane and Banks 2010), recent literature suggests that this may be misleading in terms of early adoption of EVs. A number of studies show that the perceived compatibility of EVs with an individual's values plays a key role in stimulating an intention to purchase and use an EV (Graham-Rowe et al, 2011). Schuitema et al, (2013) found that the 'green' image of EVs may play an important role for some early adopters, especially if this aligns with their self-image. However, there is still a gap between policy incentives and the market delaying wider use of renewable alternative sources of energy in vehicles fleet.

GOVT. POLICIES AFFECTING AFV ADOPTION PROCESS

The Chinese government has taken an important role in promoting liquefied petroleum gas (LPG) and compressed natural gas (CNG) fuels in public fleet buses through various R&D programs, direct investments, incentive programs (Matic, 2005). To reduce urban vehicles pollution and increase energy security, the Latin American countries like Brazil and Argentina had seen strong governmental push for natural gas vehicles (NGVs) to replace conventional fueled vehicles. Today, these two countries combined have more than half of the world's total NGVs (IANGV, 2006a). To encourage reliable, affordable and efficient electric vehicles (EVs) that meet consumer's performance and price expectations through strong Government policy and Industry collaboration for promotion and development of indigenous manufacturing capabilities required infrastructure, consumer awareness and affordable technology. These helping Indian auto majors to emerge as a leader in two wheeler and four wheeler electric vehicles (EVs) market in the world by 2020. To achieve energy security Indian govt. is providing incentives to the EV consumers and tax benefits to the manufacturers, thus it needs to sale of 6-7 million units of EVs by next five years to achieve global EV manufacturing leadership (SIAM, 2013).

In general, previous studies have shown that (despite some variation according to region) the decision-making process for private conventional car purchases is predominantly driven by financial and performance considerations including purchase price, practicality, size and capability, comfort, running costs, safety, style, brand and reliability (Lane and Potter 2007).

INFRASTRUCTURES OF ALTERNATIVE FUELS ACROSS INDIA

Continued growth in demand for conventional gasoline based transport system faces a numbers of long term challenges like global warming, deterioration of urban air quality, energy preservation and imported high priced petroleum fuel sources (Melaina and Bremson, 2008). Much needed approach is to establish easy availability of refueling stations is one of the many inputs required to support the adoption process of AFV technology (Norberg-Bohm, 2002; Popper and Wagner, 2002). Refueling stations of LPG and CNG are not densely located across India, it can be accessible only few parts of India.

Green fuels such as CNG and LPG were implemented in public transport system by the Chinese government through various direct investments, incentive programs, various R&D projects and targets to promote green fuel vehicles (Yeh, 2007). One research (Matic, 2005) was revealed that the Beijing's civic transport authority has pledged to replace 90 percent of their 18,000 urban buses by CNG before the Olympic Games in 2008, and other Chinese cities are also followed similar kind of attachments for the international events.

CNG refueling stations concentrated only in Maharastra, Gujrat and NCT Delhi, where as few parts of Andhra Pradesh, Uttar Pradesh, Madhya Pradesh and West Bengal have limited numbers of CNG refueling stations. But in case of LPG almost every state has easy availability of LPG dispensing stations. The domestic sales figure of CNG cars is very poor because of low density of CNG refueling stations in eastern parts of India as compare to central and western parts of India. Indian automobile majors like Maruti-Suzuki, Tata Motors and Hyundai Motors are targeting for their LPG variants in Southern and Eastern parts of India due to high concentration of LPG refueling stations. Faster recharging infrastructures setup is mandatory across the refueling outlets to encourage widely adoption of EVs.

RESEARCH METHODOLOGY

As the present study was exploratory in nature so a lot literature was surveyed to generate items for the development of consumer/ customer adoption of AFV. Questionnaires' were distributed near refueling stations of alternate fuel. Although 460 questionnaires were distributed but only 393filled in questionnaires were received. However we finally selected 219 filled in questionnaires were finally selected for the study and the rest had to be discarded as they were either incompletely filled or were biased. We used judgmental sampling approach looking at the complexity of the study. Exploratory factor analysis was applied to generate the items or variables for the scale development purpose by using, statistical package for social sciences (SPSS) and AMOS version 22. Confirmatory factor analysis was applied to validate the scale. The reliability of the scale was also tested by using the Cronbach's alpha coefficient.

RESULTS AND DISCUSSIONS

Most of the respondents were graduates (50%) followed by under graduates. Similarly the respondents comprised (Table 1) of mainly corporate employees (44%) followed by govt. employees (31%).

Table 1
Sample Profile

Sl. No	*Demographic variables*		*Frequency*	*Percentage %*
1	**Gender**	Male	181	83
		Female	38	17
2	**Marital status**	Married	131	60
		Unmarried	59	27
		Others	29	13
3	**Education**	Under graduate	63	29
		Graduate	109	50
		Post graduate	21	10
		Others	26	11
4	**Occupation**	Govt. employee	67	31
		Pvt. employee	97	44
		Self employed	33	15
		Others	22	10
5	**Monthly Income**	Rs.12,000 – Rs.24,000	59	27
		Rs.25,000 – Rs.35,000	24	11
		Rs.36,000 – Rs.46,000	93	42
		Rs.47,000 and above	43	20

Table 2
KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.890
Bartlett's Test of Sphericity	Approx. Chi-Square	575.292
	df	15
	Sig.	.000

Table 3
Total Variance Explained

Component	*Initial Eigenvalues*			*Extraction Sums of Squared Loadings*		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	3.706	61.772	61.772	3.706	61.772	61.772
2	.556	9.274	71.047			
3	.533	8.881	79.928			
4	.477	7.948	87.876			
5	.389	6.486	94.362			
6	.338	5.638	100.000			

Extraction Method: Principal Component Analysis.

Table 4
Component Matrix[a]

	Component
	1
Suitable availability	.757
Government subsidy	.801
Reduce Pollution	.796
Environmental Pollution	.811
Comparative advantage	.773
Zero emission	.777

Extraction Method: Principal Component Analysis.
a. 1 components extracted.

Table 5
Model Fit indices (Confirmatory factor analysis)

Model	*NPAR*	*CMIN*	*DF*	*P*	*CMIN/DF*
Default model	12	15.794	9	.071	1.755
Saturated model	21	.000	0		
Independence model	6	582.867	15	.000	38.858

Table 6

Model	*RMR*	*GFI*	*AGFI*	*PGFI*
Default model	.032	.976	.945	.418
Saturated model	.000	1.000		
Independence model	.540	.405	.167	.289

Table 7

Model	*NFIDelta1*	*RFIrho1*	*IFIDelta2*	*TLIrho2*	*CFI*
Default model	.973	.955	.988	.980	.988
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Table 8

Model	*PRATIO*	*PNFI*	*PCFI*
Default model	.600	.584	.593
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

Table 9

Model	*RMSEA*	*LO 90*	*HI 90*	*PCLOSE*
Default model	.059	.000	.106	.333
Independence model	.417	.388	.446	.000

Before applying exploratory factor analysis data was checked for normality which is an essential condition for parametric tests in multivariate data analysis. The Bartlett's test of sphericity was significant (Table 2) which indicated that correlations existed between different variables. The Kaiser-Meyer-Olkin measure (KMO) value 0.890 (Table 2) and which is above the acceptable cut of value as mentioned by Malhotra (1981), which implied the sample adequacy for the test. We have selected those factors whose factor loading were above .06, although many researchers even consider factor loading values as low as .05. The Eigen value of 3.706 (Table 3) implies that 61.772% of the variance is explained by the variables. To test the validity of the scale we have used only content validity and convergent validity. The items in the questions were validated by subject experts, who recommended some changes and their recommendations were incorporated in the study. To calculate the convergent validity average variance extracted (AVE) was calculated (Table 4) which was 0.62 and it was also above the cut off value of 0.5 as suggested by Hair *et al.* (2010). Divergent validity was not tested as only one dimension evolved in the exploratory factor analysis. The non significant Chi-square test statistics ($x = 15.794$; $df = 9$; $p = .071$) provided sufficient evidence that there was no difference between the estimated and observed model. The model was reflective in nature and it was also an over identified model as there were more than three variable or items that loaded on the factor. Similarly the different fit index like Goodness of fit index (GFI) is 0.976 (Table 6), Adjusted goodness of fit index (AGFI) is .945 (Table 6) Confirmatory fit index (CFI) is 0.988 (Table 7), Tucker lewis index (TLI) is .980 (Table 7), Normed fit index (NFI) is .973 (Table 7), Parsimony confirmatory fit index (PCFI) is .593 (Table 8) and the Root mean square error of approximation (RMSEA) is .059 (Table 9) which are also above the acceptable level as suggested by Hu & Bentler (1999). The reliability was calculated by the Cronbach's alpha statistics which was 0.87 and above the cut of value of 0.6 as suggested by Nunnally & Bernstein (1994). Hence we come to the conclusion that the above developed AFV adoption scale is valid as well as reliable.

CONCLUSIONS

Consumer adoption of AFV is a grey area which requires the attention of policy makers, manufacturers, marketers, and academicians as well. The findings of the above study provided a valid and reliable scale to measure consumer's adoption of AFV. The AFV adoption measure developed in the study can be a potential tool for marketers to make strategic decisions. Future researchers are encouraged to make further study in this area. The researcher can even conduct the same study in different parts of India to make it more generalize.

References

Dondero, L., Goldemberg, J., (2005), Environmental implications of converting light gas vehicles: the Brazilian experience. Energy Policy 33, 1703–1708.

Matic, D., (2005), Global Opportunities for Natural Gas as a Transportation Fuel for Today and Tomorrow */http://www.iangv.org/component/option, com_docman/task, doc_details/gid,114/S.*

Soubbotina, T.P., Sheram, K.A., (2000), Beyond Economic Growth: Meeting the Challenge of Global Development. The World Bank Washington, DC.

IANGV, (2006a), Latest International NGV Statistics */http://www.iangv.org/content/view/17/35/S.*

Melaina, M., Bremson, J., (2008), 'Refueling availability for alternative fuel vehicle markets: Sufficient urban station coverage', Elsevier, Energy Policy 36, 3233-3241.

Bulsara, H.P., Priya, M.S., (2014), "Scale development to access the impact of Green business functions on Green brand Equity". International Journal of Economic Research Volume 11, Issue 3, 2014, Pages 651-662.

Yeh, S., (2007), An empirical analysis on the adoption of alternative fuel vehicles: the case of natural gas vehicles. Energy Policy 35, 5865–5875.

Norberg-Bohm, V. (Ed.), (2002), The Role of Government in Energy Technology Innovation: Insights for Government Policy in the Energy Sector. BSCIA Working Paper 2002-14, Energy Technology Innovation Project, Belfer Center for Science and International Affairs.

Popper, S.W., Wagner, C.S., (2002), New Foundations for Growth: The US Innovation System Today and Tomorrow. Science and Technology Policy Institute, RAND, Arlington, VA.

Alnsour, J., (2015), "The relationship between dwelling area and energy consumption in Jordan", Top ofBottom of FormInternational Journal of Economic Research, Volume 12, Issue 1, 2015, Pages 61-76

Society of Indian Automotive Manufacturer's (SIAM) report on 17th September, 2013.

Lane B, and Banks, N, (2010), Low CVP Car Buyer Survey: Improved environmental information for consumers: *http://www.lowcvp.org.uk/assets/reports/LowCVP-Car-Buyer-Survey-2010-Final-Report-03-06-10-vFINAL.pdf*

Lane B, and Banks, N, (2012), Low CVP Car Buyer Survey: Testing alternative fuel economy labels. Conducted by Ecolane and the Centre for Sustainable Energy (CSE) supported by the University of Aberdeen. Commissioned by Low Carbon Vehicle Partnership, 2012. Un published.

Lane B, and Potter S, (2007), The adoption of cleaner vehicles in the UK: exploring the consumer attitude-action gap. *Journal of Cleaner Production.* Vol. 15, 1085-1092.

Schuitema G, Anable J, Skippon S, Kinnear N, (2013), The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles. *Transportation Research*, Volume 48A, February 2013.

Graham-Rowe E, Gardner B , Abraham C, Skippon S, Dittmar H, Hutchins R, Stannard J, (2011), Mainstream consumers driving plug-in battery-electric and plug-in hybrid electric cars: A qualitative analysis of responses and evaluations. *Transportation Research Part A* 46 (2012) 140–153.

Hu, L., & Bentler, P.M. (1999), Cut off criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6* (1), 1-55.

Hair, J.F., Anderson, R.E., Tatham, R.L., & Black, W.C. (2010), Multivariate data analysis: A global perspective (7th ed). New Jersey: Pearson education.

Malhotra N.K. (1981), A scale to measure self-concepts, person concepts, and product concepts. J Mark Res, 18. 454–64.

Nunnally, J. C., & Bernstein, I.H. (1994), *Psychometric theory* (Third Ed.). New York: McGraw-Hill.