

ROLE OF PUBLIC AWARENESS ON ADOPTION OF NATURAL GAS VEHICLES IN TANZANIA

Yasmine Mnyimwa Ramadhani¹

Dennis Hyera²

Philipina Kiwala³

yasmineramadhan@gmail.com

dennis.hyera@iaa.com

philipinatemba95@gmail.com

Department of Accounting and Finance

Institute of Accountancy Arusha

ABSTRACT

This study intended to examine the role of public Awareness on adoption of NGVs in Tanzania. The study employed both primary and secondary data. The primary data were collected through a questionnaire and interview. while secondary data was obtained from various sources magazines, relevant reports, publications, and other documents like files and office records. Quantitative data collected through questionnaire was analyzed using descriptive statistics with aid of Microsoft Excel. Qualitative data were analyzed using content analysis. Findings depicted that when the government comes to be the first to adopt NGVs, the public is likely to be in line with the adoption. Government agents can influence the consumers' adoption decision through government procurement, stimulating early or sophisticated demand, technical standards, regulation of products and services. Moreover, words of mouth and advertisement are found to contribute much on NGVs adoption. This study, therefore, concludes that the stakeholders can best influence adoption of NGVs when different initiatives like policy making by the government and programs on NGVs advertisements, workshops, training and the use of words of mouth is in place.

Keywords: Natural Gas Vehicles, Public Awareness, Adoption

1. Introduction

Over the past few years, significant concern has been shown regarding the concentration of one major greenhouse gas (GHG) carbon dioxide. In 2007 the transportation sector was responsible for 23% of the total Carbon dioxide emissions worldwide (Wang, 2007). A reduction in global greenhouse gas emissions is currently not the goal of environmentalists only but also of the government in the world. In 2012 over 192 countries adopted the Kyoto protocol, the goal was to reduce greenhouse gas emissions by 55% of the 1990 levels by 2012. Environmental and climate policies also justify the expansion of gas in the global energy mix agreed at the international level. Natural gas has been identified as the "bridge fuel" towards a fully decarbonized energy sector (Diefenderfer, Arora and Singer, 2016).

Many countries worldwide experience local air quality problems arising from high traffic congestion. Conventional fueled vehicles, specifically petrol and diesel vehicles, contribute much on the emission of particulate matter and Nitrogen Oxides which is harmful to human health, nature, and buildings. According to (Engerer and Horn, 2010) Natural Gas Vehicles (NGVs) are a possible solution to this problem, because these vehicles have almost no Nitrogen Oxide and particulate matter emissions. NGVs also decrease the oil dependence which is becoming a problem in the current geopolitical situation. In recent years the major automobile manufacturers have spent an increasing share of their Research and Development expenditures to develop competitive alternatives to gasoline/diesel vehicles (Petschnig, Heidenreich, and Spieth, 2014). The vehicles include different types like electric, hybrid, natural gas, and multiple fuel vehicles. One of the essential reasons for this is government regulations and the acknowledgment that the world's resources of oil are limited which are believed being cheaper than diesel and petrol (Dagsvik, Wennemo, Wetterwald and Aaberge, 2002).

According to Hekkert, Negro, Heimeriks and Harmsen (2011) a successful diffusion of an innovation is a combination of technology push and demand pull. It involves the influences of many different actors in and between the technology side and the demand side. The Technological Innovation System (TIS) framework captures these influences. The central idea of this study has centered at the Technological Innovation System theory with the idea that an actor does not innovate on his/her own, but actions from other actors in the system also have an influence (Petschnig et al., 2014). According to Khan, Yasmin and Shakoor, 2015) the established infrastructure by the government and the manufacturers and the conversion centers play an essential role in the diffusion of natural gas.

According to Yeh (2007) examples of countries where a network of natural gas stations which have successfully implemented and where consumers have adopted natural gas vehicles are Italy (580,000 vehicles), Argentina (1.7 million), Pakistan (2 million). Italy was the first country in the world to introduce NGVs at the beginning of World War II, but due to low gasoline prices in the 1950's the use of NGVs declined. However, Italy experienced two periods of growth in the 1970's with the oil crisis and the 1990's due to improvements in the NGV technology (Le Fevre, 2014). Argentina started its NGV program in 1984. Lastly, the development in the Pakistani system is the most impressive with growth from 0 in the year 2000 to 2 million NGVs at the end of 2008. All of these countries have experienced a positive adoption of NGVs, a technology which has brought

with them benefits like increase in government revenue and alternative solution for environmental conservation (Yeh, 2007).

Argentina is one of the countries mentioned that succeeded in NGVs technology, according to (Curran, Wagner, Graves, Keller and Green, 2014). The main reason for their success was the belief that the use of NGVs would make it possible to export more oil and so increase national revenues. The national government played an important role in Argentina by performing the first conversions on governmental vehicles and by ensuring fuel quality and a low natural gas price. The development in the Pakistani system is the most impressing with growth from 0 in the year 2000 to 2 million NGVs at the end of 2008 (Engerer and Horn, 2010). This growth started when the government sought to replace diesel with natural gas and established a price advantage for natural gas at the beginning of the 2000's (Yeh, 2007).

In promoting NGVs, the government as one of the key stakeholders frequently use market creation programs that require a mandatory target for the achievements of particular market penetration. The rate of the NGVs within a specific time frame through seminars on the importance of alternative fuel vehicles and the advantages it has to the public regarding the costs, advertisements, loan for conversion of the cars to hybrid vehicles and open many gas stations to fill cars. According to Yeh (2007), Brazil and Argentina created markets example through direct government investments in refueling stations, pipeline infrastructures, and conversion kits. Also, the government often provide incentives for construction of natural gas pipelines that also help municipalities address other needs. With this regard, the perceived willingness of the government is paramount important towards the adoption of NGVs in Africa.

The use of alternative fuels particularly natural gas for the promotion of the use of clean fuels due to the abundance of natural gas deposits in Tanzania, the public is advised to convert their petrol or diesel-fueled vehicles to natural gas, to save cost and reduce carbon emissions. Tanzanian Petroleum Development Corporation (TPDC) is now working on the transition to shifting from the use of petroleum fuel to the use of Compressed Natural Gas (CNG) or both (Nyari, Pogrebnaya and Wilson, 2015).

Therefore, the utilization of gas and development in technologies in Tanzania might be marketed differently compared to the countries selected in the case study. According to Yeh (2007), the key stakeholders of the NGVs, including the government, manufacturers and the conversion centers are inseparable when it comes to adoption of Natural Gas Vehicles This study was therefore designed to fill the gap by examining the issue role of public Awareness on adoption of NGVs in Tanzania. Adoption.

2. Literature Review

A natural gas vehicle (NGV) is an alternative fuel vehicle that uses compressed natural gas (CNG) or liquefied natural gas (LNG) as a cleaner alternative to other fossil fuels. Most natural gas vehicles use the same type of combustion engine as gasoline and diesel vehicles. Compressed natural gas (CNG) or as liquefied natural gas (LNG) are the forms which natural gas used in cars. CNG is volatile natural gas stored at very high pressures (around 200 bars), and LNG is liquid natural gas stored at low temperatures (under -162°C) (Zhang et al., 2011). The pressure of CNG is very high,

and the CNG tanks in the cars take more space than gasoline or diesel reservoirs. Most of the gas stations take gaseous natural gas from the distribution network and compress it to the CNG form, whereby filling up takes about 2-3 minutes due to a stock of compressed natural gas at the stations (Peterson, Barter, West and Manley, 2014). It is also possible to refuel NGVs at home with a Phill installation (a small compressor) which requires about 6 hours taking the natural gas from the network and compresses it to the required 200 bar hence becoming favorable to people with a garage and the possibility to refuel during the night (Frick, Axhausen, Carle and Wokaun, 2007). There are three types of natural gas vehicles, the first type is, dedicated NGVs (these vehicles are designed to run on natural gas only). The second type is, bi-fuel NGVs (these vehicles have two separate fueling systems that enable them to run on either natural gas or gasoline/petrol). The third type is dual-fuel NGVs which are traditionally limited to heavy-duty applications, have fuel systems that run on natural gas and use diesel fuel for ignition assistance (Yeh, 2007).

Zhang et al. (2011) defined public awareness as the share of information experience and knowledge between the different parties involved in the innovation system. There are four aspects are used to define NGVs public awareness. Direct transfer of specialized knowledge (A consumer gets access to knowledge which can increase his or her willingness to adopt technology), Experience sharing where an intermediary organization carries experience and ideas from one location to another in which consumers learn about new technologies which used elsewhere. Articulate and define the needs where an intermediary organization can help consumers define their needs (firms or government) who have difficulties understanding their needs and problems.

3. Methodology

The study employed a pragmatism research philosophy. This study used a descriptive research design. In this study the population consist of the NGVs users (100 NGV users) staffs of Natural Gas department from organizations (that is, the government institutions and agencies namely EWURA (21), and TPDC (16) and the oil and gas companies including, Pan African energy 9 and GASCO 6 respondents) and the conversion centers BICO (4), DIT (6) and Triangle limited (5). Hence the total number of the population was 167. For collecting respondents, the simple purposive and random sampling was used. For the purpose of this study the sample size of 112 respondents was considered reasonable and affordable. The researcher employed Stratified sampling and Purposeful sampling techniques in selecting the sample size. The study employed both primary and secondary data. The study employed both primary and secondary data. The primary data were collected through a questionnaire and interview. while secondary data was obtained from various sources magazines, relevant reports, publications, and other documents like files and office records. Quantitative data collected through questionnaire was analyzed using descriptive statistics with aid of Microsoft Excel. Qualitative data were analyzed using content analysis. The primary findings of this study were presented using tables.

4. Results

The study employed a number of 112 respondents from among the key stakeholders namely the organizations (regulators, oil and gas companies), NGV users and conversion centers to assess the Public Awareness on NGVs Adoption. Findings are presented in the table below;

Table 1: Public Awareness and NGVs Adoption

Statements	Percentages (public awareness)									Means (public awareness)		
	NGVs Users			Organizations			Conversion Centers			User s	Org	Cent
	D	N	A	D	N	A	D	N	A	Mea n	Mea n	Mea n
Perception												
If Government is the first to adopt NGVs will help in the adoption of NGVs by the public through market demonstration	18.6	35.7	45.7	6	16	76	40	0	60	3.27	3.68	3.20
Word of mouth will contribute to the adoption of NGVs by the public	4.3	15.7	80	8.0	28.0	64.0	0	6.7	93.3	3.76	3.56	3.93
Advertisement of NGVs will contribute to the adoption by the public	7.1	31.4	61.4	8.0	4.0	88.0	6.7	6.7	86.7	3.54	3.80	3.80
Trainings are enough to support the public to understand the advantages of NGVs which influences them to adopt NGVs	25.7	50.0	24.3	32.0	32.0	36.0	6.7	33.3	60.0	2.99	3.04	3.53
Current situation	L	M	H	L	M	H	L	M	H	Mea n	Mea n	Mea n

To what extent have the government succeeded in the market demonstration to influence adoption of NGVs	67.1	32.9	0	60.0	40.0	0	40.0	60.0	0	2.33	2.40	2.60
To what extent have the stakeholders succeeded in advertising the NGVs	52.9	47.1	0	64.0	36.0	0	53.3	40.0	6.7	2.47	2.36	2.53
To what extent has word of mouth provided by the stakeholders to influence the adoption of NGVs	35.7	62.9	1.4	66.7	33.3	0	40.0	40.0	20.0	2.66	2.33	2.80
To what extent are the trainings provided to influence the adoption of NGVs	79.7	15.9	4.3	68.0	28.0	4.0	73.3	13.3	13.3	2.25	2.36	2.40

The findings in Table 1 indicated that the government had not done much in NGVs market demonstration by taking initiatives to be first to convert their cars to NGVs. In this case, the great number of NGVs users 67.1% demonstrated that there is a low level of public awareness through market demonstration by the government of Tanzania. Low level of a market demonstration by the government obtained from the findings from the staffs of organizations which was (60%), and staffs from conversion centers were (60%). The people interviewed affirmed the influence of market demonstration. For example, one of the respondents from CNG gas station, said:

"At first the cars from TPDC the national oil company were using NGVs, but currently they are not seen at the Gas filling station meaning that they are using the alternative fuels".

Additionally, the results in Table 1 above revealed that the respondents have a feeling that if the government comes to be first to the adoption of NGVs, it will set an example and influence adoption of NGVs in Tanzania. In this case, 45.7% of the NGVs users (customers) agreed to this fact. Majority of respondents from organizations (76%) and conversion centers (60%) had the same opinions as the NGVs users. This finding shows that if the government implement what was said in the natural gas utilization strategy, there is a possibility for the adoption of NGVs to increase.

On the other hand, the results on the mean indicated the perception of NGVs users organizations and conversion centers agreed if the government is the first to adopt NGVs will influence the public to adopt NGVs through market demonstration as their average scores were above 3 (Table 1). This shows that if the government converts the first their cars it will stimulate adoption of NGVs. Compared to the current situation were by the mean indicated that the government market demonstration done by the government is low as the average scores from the users and organizations were 2.33 and 2.40 while the mean from conversion centers rated it moderately. Hence the government should increase market demonstration by being the first to adopt NGVs which will help in stimulating adoption of NGVs.

Moreover, the stakeholders indicated that the level of NGVs advertisement to influence the conversion of cars to NGVs in the country is low. Concerning this fact, the majority of respondents from users (52.9%) acknowledged that the rate at which the stakeholders advertise NGVs is low while the remaining 47.1% admitted that the rate is moderate. As the NGVs users, 64% of the respondents from organizations and 53.3% from conversion centers indicated a low level of advertisement by the stakeholders with 40% who indicated a moderate level of advertisement. The respondents affirmed on the extent to which the companies have succeeded in the advertisement. For example one respondent among the NGV user said:

“The staffs from oil and gas companies only showcase once a year at saba saba which is not enough to stimulate adoption of NGVs”

The results in Table 1 further revealed that though the rate of an advertisement is low, the respondents have a feeling that the use of advertisement in stimulating conversion of cars to NGVs in the country is essential. In this case, about 64% of user respondents acknowledged the importance of advertisement whereas the majority of respondents from organizations (84%) and conversion centers (86.7%) acknowledged the importance of advertisement.

On the other hand, the results on the mean indicated that the perception of NGVs users organizations and conversion centers agreed that advertisement of NGVs will stimulate the public to adopt NGVs as their average scores were above 3 (Table 1). This shows that if advertisement is done effectively it will stimulate adoption of NGVs. Compared to the current situation where by the mean indicated that currently NGVs advertisement in the country is low since the mean is below average for users and organizations while that of the conversion centers was moderate. This shows the advertisement is not done effectively but if advertisement is improved it will stimulate adoption of NGVs.

From table 1 the data shows that, the users (62.9%) and conversion centers (40%) that the stakeholders have used the words of mouth at moderate. Additionally, majority of respondents from organizations (66.7%) and the other (40%) of staffs from conversion centers admitted to have seen

low level initiatives towards the words of mouth. However, the creation of awareness on NGVs through the words of mouth was perceived by the respondents as being the most critical aspect in adoption of NGVs in Tanzania. Table 4.2 above indicated that majority of respondents from among the users (80%), organizations (76%) and conversion centers (93.3%) revealed that the use of the words of mouth would be necessary for stimulating adoption of NGVs. Therefore, there is a need from companies and regulators to increase the level of public awareness through the words of mouth.

Again, the results in Table 1 the results on the mean indicated that the perception of NGVs users organizations and conversion centers agreed that the word of mouth will contribute to the adoption of NGVs by the public as their average scores were above 3 (Table 1). This shows that word of mouth does stimulate adoption of NGVs. Compared to the current situation where by the mean indicated there is moderate use of the word of mouth by the users and conversion centers while that of the organization is low. This shows the word of mouth is spread mostly among users and conversion centers than organizations but when this is done effectively it will help in influencing adoption of NGVs. Regarding the word of mouth as an influence to stimulate adoption of NGVs. Participant from Triangle ltd said:

“Word of mouth has helped in influencing conversion of the cars in Tanzania since many of our customers are brought by their friends”

On the other hand, the findings in Table above indicated that NGVs users are uncertain that training will support the public to convert the cars to NGVs while the staffs from organizations and conversion centers have a different feeling. In this case, 50% of the user respondents are not sure to whether training will be necessary for stimulating the adoption of NGVs. Contrary to the findings from the users, the majority of the respondents from organizations (36%) and conversion centers (60%) agreed that training is essential for the adoption of NGVs. These contradictory findings may be attributed to the fact that the users are the trainees while the other stakeholders are expected to conduct the training. The knowledge on the advantages of NGVs is far in-depth to the members of organizations and conversion centers. Therefore, it can be reported that training is essential to the adoption of NGVs. However, 79.7% of NGVs users demonstrated that training on NGVs had been provided at a low level. Likewise, 68% of the respondents from organizations and 73.3% from conversion centers indicated a low level of initiatives on training.

Again, the results in Table 1 the results on the mean indicated that the perception of organizations and conversion centers agreed that trainings are enough to support the public to understand the advantages of NGVs which will influence the adoption of NGVs as their average scores were above 3 (Table 4.2) but users slightly agreed as the mean was slightly below average. This shows that trainings will stimulate adoption of NGVs in Tanzania. Compared to the current situation where by the mean of users, organizations and conversion centers were low since they are below average. Which means trainings are being provided but they are inadequate, hence the stakeholders should add more trainings which will help in stimulating adoption of NGVs. Regarding the influence of training on adoption of NGVs which is still low. A participant from GASCO said that:

“The government, oil and gas companies are not doing enough training, they should provide education on awareness to convert petrol engine car to natural gas and also create good policies which will encourage people to convert their cars”

4.1 Discussion of Findings

The government as the early adopter was perceived influencing the adoption of NGVs. This may be the case as when the government is the first to adopt the technology, the policies, regulations, and financial incentives will be able to be instituted appropriately. However, the current situation reveals that the government of Tanzania has failed in a market demonstration by being the first to adopt NGVs. Other studies arrived at the same finding that the government agents played a significant role in other countries especially. According to Yeh (2007), the government in Argentina had a clear goal and influenced consumers and other actors in the system in order to reach that goal. The different theoretical concepts of political influence were all executed in the Argentine system. The first conversions were effectuated on governmental vehicles to show the political commitment to the new technology (Sahin, 2006).

Again, the results of the study show that the stakeholders have a feeling that advertisement is positively related to adoption on NGVs in Tanzania. However, the current situation dictates that the stakeholders have failed to advertise NGVs in a rate that can influence its adoption. This finding complies with the study by Janssens and De Pelsmacker (2005) and Lee (2014) who suggested that any new technology reasonably have new features that a customer need to aware of, the advertisement may trigger communication between the producers/suppliers and their potential customers.

On the other hand, the findings of the study reveal that even though the stakeholders do not well practice the words of mouth in the country, words of mouth can influence the adoption of NGVs in Tanzania. This is because the words of mouth can easily reach individuals through household discussions and meetings. The findings comply with the study by Engerer and Horn (2010) which was conducted in Europe. They argue that the use of the words of mouth has the power to spread in human sensations than other initiatives.

The results further reveal the stakeholders are skeptical on the influence of training on adoption of NGVs. On the other hand, the current state dictates that the Tanzanian NGV stakeholders provide training at a low level. Different from these findings Popp, Hascic and Medhi (2011) reported that it is essential to conduct on training the safety measures, usability, advantages and unique features of the new product to the potential users before and during its diffusion especially the environmentally sensitive products of which NGVs is among.

5. Conclusion and Recommendations

Findings depicted that when the government comes to be the first to adopt NGVs, the public is likely to be in line with the adoption. Government agents can influence the consumers' adoption decision through government procurement, stimulating early or sophisticated demand, technical standards, regulation of products and services. Moreover, words of mouth and advertisement are found to contribute much on NGVs adoption. This study, therefore, concludes that the stakeholders

can best influence adoption of NGVs when different initiatives like policy making by the government and programs on NGVs advertisements, workshops, training and the use of words of mouth is in place. The study recommended that, government as one among the key stakeholders has first to be a source of procurement meaning that the government is one of the largest buyers of technology in the country; therefore, it has to play its role by adopting NGVs itself before any initiatives to influence the citizens. The NGV policies need to be imposed for right change in all sectors and agencies of the government within effects on the country economy; the government agencies will be able to place more effort on purchasing the products related to NGVs. Therefore future research should best focus on the other stakeholders too. Moreover, the research explained the influence on adoption of NGVs. However, given the assumption that customers are going to adopt, it is clear that other researches need to be conducted on the economic and environmental effects/benefits of NGVs in the Tanzanian context in comparison to other prosperous countries in NGVs.

REFERENCES

- Curran, S. J., Wagner, R. M., Graves, R. L., Keller, M., & Green, J. B. (2014). Well-to-wheel analysis of direct and indirect use of natural gas in passenger vehicles. *Energy*, 20(5),63-73. <https://doi.org/10.1016/j.energy.2014.07.035>
- Frick, M., Axhausen, K. W., Carle, G., & Wokaun, A. (2007). Optimization of the distribution of compressed natural gas (CNG) refueling stations: Swiss case studies. *Transportation Research Part D: Transport and Environment*, 9(4),347-359. <https://doi.org/10.1016/j.trd.2006.10.002>
- Hekkert, M., Negro, S., Heimeriks, G., & Harmsen, R. (2011). Technological Innovation System Analysis. Technological Innovation System Analysis A *Manual for Analysis*,(November),16 .<https://doi.org/10.1139/z81-098>
- Janssens, W., & De Pelsmacker, P. (2005). Advertising for new and existing brands: The impact of media context and type of advertisement. *Journal of Marketing Communications*. <https://doi.org/10.1080/1352726042000306847>
- Le Fevre, C. N. (2014). Prospects for Natural Gas as a Transportation Fuel. *Oxford University Press*,11(2),91-100.
- Lee, B. C. Y. (2014). Critical decisions in new product launch: Pricing and advertising strategies on consumer adoption of green product innovation. *Asian Journal of Technology Innovation*,5(4),28-37.<https://doi.org/10.1080/19761597.2014.907862>
- Nyari, E. A., Pogrebnaya, T., & Wilson, L. (2015). Energy Sector and Solar Energy Potential in Tanzania. *International Journal of Emerging Technologies and Engineering*,4(6),75-82.
- Petschnig, M., Heidenreich, S., & Spieth, P. (2014). Innovative alternatives take action - Investigating determinants of alternative fuel vehicle adoption. *Transportation Research Part A: Policy and Practice*,50,528-539. <https://doi.org/10.1016/j.tra.2014.01.001>
- Popp, D., Hascic, I., & Medhi, N. (2011). Technology and the diffusion of renewable energy. *Energy Economics*. <https://doi.org/10.1016/j.eneco.2010.08.007>

Sahin, I. (2006). Detailed Review of Rogers' Diffusion of Innovations Theory and Educational Technology: Related Studies Based on Rogers' Theory. *The Turkish Online Journal of Educational Technology* 17(2),120-136. <https://doi.org/10.1287/mnsc.43.7.934>

Yeh, S. (2007). An empirical analysis on the adoption of alternative fuel vehicles: The case of natural gas vehicles. *Energy Policy*, 35(11), 5865–5875. <https://doi.org/10.1016/j.enpol.2007.06.012>

Zhang, Y., Yu, Y., & Zou, B. (2011). Analyzing public awareness and acceptance of alternative fuel vehicles in China: The case of EV. *Energy Policy*, 23(2),93-106. <https://doi.org/10.1016/j.enpol.2011.07.055>