

# STAKEHOLDERS, FINANCIAL INCENTIVES AND NATURAL GAS VEHICLES ADOPTION

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## **ABSTRACT**

*This was done by assessing the perception of regulators, NGV users, conversion centers and oil and gas companies on the influence of financial incentives on NGVs adoption. Quantitative data collected through questionnaire was analyzed using descriptive statistics with aid of Microsoft Excel. Qualitative data were analyzed using content analysis. The findings of the study show that individuals are uncertain about the effects of financial incentives like loans. However, the results further show that subsidies, tax incentives, cost reduction, and financial information availability were found having an influence on NGVs adoption in Tanzania. The study, therefore, concludes that for the stakeholders especially the oil and gas companies, regulators and conversion centers to stimulate adoption of NGVs they have to put in place attractive financial incentives and make sure that the information is available to users.*

**Keyword: Natural Gas Vehicles, Stakeholders, Financial Incentives.**

## 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 regards, 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, Pogrebnyaya 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

As pinpointed by Hekkert, Negro, Heimeriks and Harmsen (2011) the successful diffusion of innovation involves the influences of many different actors in and between the technology side and the demand side. Moreover, the previous studies conducted in the countries that has succeeded in diffusion of NGVs revealed that the key stakeholders (government, energy companies/manufacturer and the conversion centers) contributed significantly to the adoption of NGVs in their countries. This adds value to this study since the study aims to analyze the readiness of the key stakeholders to support the public to adopt NGVs in Tanzania.

According to the study conducted by Demierre, Bazilian, Carbajal, Sherpa, and Modi (2015), about 70% of car owners in Tanzania (customers) declared their interest in converting their cars to Natural Gas uses. However, most of them further admitted that their decision is highly dependent

on the support that they get before and after adoption, mainly mentioned; enough training, education, and workshop, cost advantageous (subsidies, financial incentives) and suppliers commitment like availability of post-purchase maintenance services by the producers. This study adds value to this research on how the key stakeholders support influences the public to convert their cars to Natural Gas Vehicles.

Even though the successful breakthrough of NGVs in the world leading countries like Italy, Argentina and Pakistan give the researcher valuable insight for the stimulation of NGV adoption in Tanzania through the key stakeholders supports, the adoption of NGVs is not at a proper position (Nyari et al., 2015). Again, these world leading countries are not entirely comparable to Tanzania, since they have different technology, economic, political, demographics and automotive sectors, which implies the transfer of the successful policies will be different. This study adds value to this research since some of the successful policies will be measured and see how the key stakeholders support the public to adopt NGVs.

Although the importance of key stakeholders (regulators, conversion centers, NGV users, and oil and gas companies) are significant in enhancing diffusion of technology in the country, the knowledge on the importance of these stakeholders on the diffusion of NGVs in Tanzania is limited. It could be because the NGVs usage in the country is still low. This study was therefore designed to fill the gap by identifying the support given to the public by the key stakeholders to influence adoption of NGVs in Tanzania. This was done by assessing the perception of regulators, NGV users, conversion centers and oil and gas companies on the influence of financial incentives on NGVs adoption.

The Roles of Stakeholders through Financial Incentives on NGVs 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  $-162^{\circ}\text{C}$ ) (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).

A financial incentive is defined Sierchula, Bakker, Maat and Van (2014) as the monetary benefit offered to consumers, employees and organizations to encourage behavior or actions which otherwise would not take place. On the other hand, the financial incentive is defined as a benefit given to customers or companies to get them to do something they usually wouldn't. It is money offered to get them to try something new offered. The event might not have happened without the incentive (Bendor and Ford, 2006). In this study, financial incentives include the loan, subsidies, tax exemptions, tax reductions and others provided by either the government or conversion centers or oil and gas companies to users or other stakeholders in the process of NGVs adoption that reduces the actual cost of car conversion to NGVs. A financial incentive motivates actions which otherwise might not occur without the monetary benefits.

### **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 objective of the study was to assess the perceived readiness of key stakeholders to stimulate car users' conversion to NGVs through financial incentives. The descriptive analysis of the data on the current practices and the role of key stakeholders through financial incentives on adoption of NGVs in the Tanzanian context were analyzed and summarized in the form of frequencies and percentages in Table 1.

Table 1: The Roles of Stakeholders through Financial Incentives on NGVs Adoption

| Statement  | Percentages (financial incentive) |          |          |               |          |          |                    |          |          | Means (financial incentives) |                  |                  |
|--|-----------------------------------|----------|----------|---------------|----------|----------|--------------------|----------|----------|------------------------------|------------------|------------------|
|  | NGVs Users                        |          |          | Organizations |          |          | Conversion Centers |          |          | User s                       | Org              | Cent             |
|  | D                                 | N        | A        | D             | N        | A        | D                  | N        | A        | Mea<br>n                     | Mea<br>n         | Mea<br>n         |
| Subsidies to the people/stakeholders will stimulate adoption of NGVs                                   | 15.3                              | 37.5     | 47.2     | 20            | 24       | 56       | 20                 | 13.3     | 66.7     | 3.32                         | 3.36             | 3.49             |
| Loans provision will influence the adoption of NGVs  | 57.1                              | 27.1     | 15.7     | 52.0          | 24.0     | 24.0     | 28.6               | 35.7     | 35.7     | 2.59                         | 2.72             | 3.07             |
| Availability of financial information to the potential customers will influence their adoption of NGVs | 11.4                              | 17.1     | 71.4     | 48.0          | 20.0     | 32.0     | 7.1                | 21.4     | 71.4     | 3.60                         | 2.84             | 3.64             |
| Gas prices can be increased to compensate loans granted to the individuals to repay conversion cost.   | 30.0                              | 25.7     | 44.3     | 32.0          | 24.0     | 44.0     | 21.4               | 21.4     | 57.1     | 3.14                         | 3.12             | 3.36             |
| <b>Current situation</b>   | <b>L</b>                          | <b>M</b> | <b>H</b> | <b>L</b>      | <b>M</b> | <b>H</b> | <b>L</b>           | <b>M</b> | <b>H</b> | <b>Mea<br/>n</b>             | <b>Mea<br/>n</b> | <b>Mea<br/>n</b> |
| To what extent the provided subsidies influence in the adoption of NGVs                                | 77.1                              | 15.7     | 7.1      | 48.0          | 28.0     | 24.0     | 21.4               | 71.4     | 7.1      | 2.30                         | 2.76             | 2.86             |
| To what extent can the provided loan influence in the adoption of NGVs                                 | 65.7                              | 28.6     | 5.7      | 32.0          | 44.0     | 24.0     | 50.0               | 28.6     | 21.4     | 2.40                         | 2.92             | 2.71             |

|  |      |      |     |      |      |      |      |      |      |      |      |      |
|--|------|------|-----|------|------|------|------|------|------|------|------|------|
| To what extent is the available financial information influence the adoption of NGVs                             | 27.1 | 67.1 | 5.7 | 28.0 | 36.0 | 36.0 | 14.3 | 50.0 | 35.7 | 2.79 | 3.08 | 3.21 |
| To what extent increase in gas price given helps in covering the loans granted during conversion of cars to NGVs | 68.6 | 28.6 | 2.9 | 56.0 | 40.0 | 4.0  | 64.3 | 28.6 | 7.1  | 2.14 | 2.47 | 2.79 |

The results in Table 1 indicated that the respondents have a feeling that subsidies and tax incentives to stakeholders will positively influence the adoption of NGVs. In this case, the majority of all the NGVs users (47.2%), 56% from organizations and 66.7% from conversion centers agreed that provision of subsidies and tax incentives to stakeholders would stimulate adoption of NGVs. About the current situation, the stakeholders have proved failure on the provision of subsidies for the adoption of NGVs. In this case, the majority of NGV users (77.1%) and regulators/staffs from oil and gas companies (48%) admitted that the provided subsidies and tax incentives influence adoption of NGVs at a low level. Contrary to users and organizations, 71.4% of respondents from conversion centers indicated that the provided subsidies moderately influence adoption of NGVs.

The results in Table 1 the results on the mean indicated that the perception of NGVs users organizations and conversion centers agreed that subsidies will stimulate adoption of NGVs as their average scores were above 3 (Table 1). This shows that subsidies to the public or stakeholders will stimulate adoption of NGVs. Compared to the current situation where by the mean of the organizations and conversion centers indicated currently subsidies are being given moderately while that of the users is low. This shows subsidies provided are few but if the government provides subsidies to both the public and stakeholders it will stimulate adoption of NGVs.

The findings in Table 1 above further indicated that the stakeholders have a feeling that availability of financial information to the potential customers will influence their adoption of NGVs. In this case, majority of all the users (71.4%) and conversion centers (71.4%) believe that availability of financial information to the potential customers will influence their adoption of NGVs. In the same vein, there is a contradiction as the majority of regulators, and respondents from oil and gas companies (48%) believe that the availability of financial information has nothing to do with the adoption of NGVs. However, the stakeholders moderately influence adoption of NGVs by making sure that financial information is available. In this case, 67.1% of the NGV users and 56.9% of respondents from conversion centers admitted that the available financial information moderately influences adoption of NGVs. The regulators and respondents from oil and companies (36% and the other 36%) admitted that the available financial information influence adoption at a moderate level and high level respectively.

The results in Table 1 the results on the mean indicated that the perception of NGVs users and conversion centers agreed that the availability of financial information to the potential customers will influence the adoption of NGVs as their average scores were above 3 (Table 1). While that of the organization was moderate. This shows if the financial information is available it will influence the public to adopt NGVs. Compared to the current situation where by the mean of the

organizations and conversion centers indicated currently financial information availability is high as the mean is above average while that of the users is moderate. This shows the financial information is available but they should increase sharing of the information so to stimulate adoption of NGVs and get more users. Financial information is available but they should increase sharing of the information so to stimulate adoption of NGVs and get more users. One of the NGVs User said:

*“We normally get consultancy, and financial information when we visit the conversion centers and TPDC since the cost of conversion but apart from those we cannot get financial information elsewhere”*

Regarding loan provision, the respondent's results show that majority of the NGVs user were 57.1% and organization 52% disagreed that loans provision will influence the adoption of NGVs. The respondents from the conversion center brought about a contradictory result by showing that majority 35.7% agreed and the other was uncertain 35.7% that loans provision would influence adoption of NGVs. The current situation on loan provision for adoption of NGVs shows that the stakeholders have not succeeded in this area as to the nature, type and amount of loans provided for the adoption of NGVs. In this case, 65.7% of NGVs users indicated that the provided loan has low impacts towards adoption of NGVs while majority of respondents from regulators, oil and gas companies (44%) indicated that the provided loans moderately influence adoption of NGVs and from conversion centers (50%) admitted that the type of loans provided could influence adoption of NGVs at low level.

The results in Table 1 the results on the mean indicated that the perception of NGVs users and organizations are neutral on if loan provision will influence adoption of NGVs. While the mean indicated the perception of the conversion centers agreed with loan provision will influence adoption of NGVs since it is above average. This shows if loan provision will be available it will influence adoption of NGVs. Compared to the current situation where by the mean of the organizations and conversion centers indicated currently loan provision is moderate and that of the users is low. Hence if loan is available it will influence adoption of NGVs. Regarding loan provision to influence adoption of NGVs. One of the NGV user said:

*“We need loan so as we can be able to convert the cars and also because we can not pay the conversion cost at lump sum since we have low level of income and conversion is expensive”*

The results on gas price increase revealed that majority of users (44.3%) agreed that gas price could be increased to compensate loans granted to the individuals to repay conversion cost. Again, the respondents from organization and conversion centers were in the same vein of which the high number of respondents from organizations (44%) and conversion centers (57.1%) agreed to the statement.

The results on the current situation indicate that the government and other stakeholders have not placed their focus towards gas price increase for coverage of loans taken during conversion. In this case, the results in Table 4.3 above reveal that 68.6% of users admitted that there is a low level of gas price increase purposely for covering the loans granted during conversion of the car to NGVs in Tanzania. Again, 56% of respondents from organizations and 64.3% from conversion centers



indicated that the low initiatives for the gas price increase to cover loans. Although the respondents are in favor of price increase to cover the loans during conversion to NGVs, there are low initiatives towards this fact. The oil and gas companies are concerned about the price sensitivity of the customers. With this fact, there is a need for the NGVs provider to think of how they can accommodate price increase to support adoption on NGVs.

Lastly, the results in Table 1 the results on the mean indicated that the perception of NGVs users, organizations and conversion centers agreed on gas price can be increased to compensate loans granted to the individuals to repay conversion costs as the mean were above average. This shows that the gas price could be increased so as the people can compensate the loans for conversion. Compared to the current situation where by the mean of the conversion centers indicated on gas price increase was moderate and that of the users and organizations were low. Which shows currently the increase of gas price to compensate loans is small, hence they should increase gas price to compensate the loans which will help in adoption of the NGVs.

Regarding if gas price will be increased to compensate loans will influence adoption of NGVs. One of the NGVs User said:

*“Some of the NGVs users can afford the increase of gas price to cover their loan, but some may fail since we differ in the level of income and the cost benefit analysis may favor the use of other sources of energy if we have to pay more for gas to cover the loan”*

Generally, the influence of financial incentive on the adoption of NGVs was affirmed by one of the regulators. Example a respondent from TPDC said:

*"I currently see no any assistant financial initiative in place, however, once the right policies, laws, and incentives are in place I see that NGVs conversion centers would see a wider business opportunity for conversion of the vehicles to NGV”*

#### **4.1 Discussion of Findings**

The findings indicated that the current status of the financial information available is low. However, the availability of financial information is expected to influence the adoption of NGVs. This is because the government and other stakeholders may decide to provide different financial incentives, but the problem comes to be the accessibility of the required information. The findings are consistent with the study by Sierzchula et al. 2014 who demonstrated that the availability of information related to finances is what calls for initiatives by the target beneficiaries. Again, the findings indicated that the current provision of subsidies and incentives would moderately influence adoption. However, the respondents have a feeling that provision of subsidies and incentives can influence the adoption of NGVs. These findings are attributed to the fact that when the government provided incentive, the customers will be able to purchase the NGVs products. The finding on subsidies is consistency to the study in other countries as recognizing the many reinforcing feedbacks, some argue for incentives in the form of subsidies to consumers, automakers, or fuel providers to prime the pump and overcome the chicken-egg problem (Sierzchula et al., 2014). The results also show that there is a feeling among the stakeholders that loan provision has nothing to do with the adoption of NGVs in the country. Currently, the available

loan provisions have a low effect on adoption. Contrary to these findings other studies reported that the loan provider could enhance the adoption of new technology (Comin and Hobijn, 2010; Samy, 2016). The difference in findings may be attributed to the sensitive nature of the Tanzanian especially on loan repayment.

## 5. CONCLUSION AND RECOMMENDATIONS

The findings of the study show that individuals are uncertain about the effects of financial incentives like loans. However, the results further show that subsidies, tax incentives, cost reduction, and financial information availability were found having an influence on NGVs adoption in Tanzania. The study, therefore, concludes that for the stakeholders especially the oil and gas companies, regulators and conversion centers to stimulate adoption of NGVs they have to put in place attractive financial incentives and make sure that the information is available to users. Moreover, the stakeholders have to put in place different initiatives for different cost reduction incentives, subsidies and other financial incentive and the most important aspect not to forget is to make this information accessible by the customers and other potential users of NGVs. With the availability of the information of NGVs users, the public may be able to think of the advantages and compare costs for opportunity costs evaluation. 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.

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