PERCEPTION OF STAKEHOLDER AND INFLUENCE OF TECHNOLOGICAL INVESTMENT ON ADOPTION OF NATURAL GAS VEHICLES IN TANZANIA

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ABSTRACT

This study assessed the perception of stakeholder and influence of technological investment on adoption of Natural Gas Vehicles 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 of the study show that the existing filling stations are not enough to support the adoption of NGVs, investment in technology regarding NGVs is required to support its adoption. This is because the dependence of consumers on suppliers is based on the number of suppliers on the market. The study concludes that the investment in new technical skills, training on safety measures and the availability of new technical information are important factors in stimulating the adoption of NGVs in the country.

***Keywords*: Natural Gas Vehicles, Technology, Investments**

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 decarbonizes 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 impressing 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).

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 analyzing the perception of regulators, NGV users, conversion centers and oil and gas companies on the influence of technological investment 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 –162ºC) (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).

Several groups of stakeholders are key to NGV adoption: the main ones are regulators, NGV users, conversion centers, research institutions, and oil and gas companies (Ogunlowo, Bristow and

Sohail, 2015). Different stakeholders have an interest in more substantial NGV adoption. The gas industry in Tanzania wants to promote NGVs in order to increase their market share, and the government has expressed the goal of converting 20% of all petrol vehicles to use natural gas. As the stakeholder, therefore, this research takes the government as being centered under the Ministry of Energy and Minerals. Different agencies under the ministry are considered to be part of the ministry; they include the Energy and Water Utility Regulatory Authority (EWURA) and Tanzania Petroleum Development Corporation (TPDC).

On the other hand, the study views energy companies as all the companies responsible for the production and marketing of the NGVs and their assemblies. They include the suppliers of equipment including systems, components, and Original Equipment Manufacturers (OEM) vehicles and the natural gas industry/fuel suppliers. Therefore the conversion centers viewed in this study as the firms that are interested in the adoption of NGVs, through assisting NGV users to convert their cars to NGVs (Ogunlowo et al., 2015).

According to Ma, Geng, Li, Liu, and Li (2013), defines investment as the act of placing capital into a project or business with the intent of making a profit on the initial placing of capital. An investment may involve the extension of a loan or line of credit, which entitles one to repayment with interest, or it may involve buying an ownership stake in a business, with the hope that the business will become profitable. On the other hand, According to Glaeser and Ponzetto (2018), defined investment as an act of incurring an immediate cost in the expectation of future rewards, in this sense a firm that constructs the plant, infrastructure and pays for inputs in a supply chain amount to an investor. Investments share three common features, irreversible as the initial amount invested is at time sunk, uncertainty over the future rewards and leeway on the timing of investment. Investment decisions are supposed to be based on a comparison of this "risk-adjusted" or "certainty equivalent" yield with the market rate of interest. No satisfactory explanation has yet been provided, however, as to what determines the size of the risk discount and how it varies in response to changes in other variables. This study adopted the definition as it covers all the aspect as far as technological investment is concerned (Glaeser and Ponzetto, 2018). Investment in this study included investment in technical skills, gas filling stations, and conversion centers by the government, oil and gas.

2.1 Theoretical Literature Review

The technological Innovation system Framework was the main focus of the theoretical literature review for this study (Markard and Truffer, 2008; Hekkert et al., 2011). This is because the study was based on the customers' external influence on the adoption of NGVs and the theory explains the influence of the external actors**.**

The most important insight that has dominated the field of innovation studies in recent decades is the fact that innovation is a collective activity. It takes place within the context of a wider system. This wider system was coined ‘the innovation system' or ‘the innovation ecosystem.' The success of innovations is to a large extent determined by how the innovation system is build up and how it functions (Markard and Truffer, 2008; Hekkert et al., 2011). Technological Innovation System (TIS) framework states that an actor (consumer) does not innovate on his own, but actions from

other actors in the system also have an influence. In the TIS framework, different actor blocks are interacting with each other such as the governmental sub-system, the knowledge infrastructure, the intermediary infrastructure, the supply side and the demand side (Hekkert et al., 2011). The concept of the innovation system stresses that the flow of technology and information among people, enterprises, and institutions is key to an innovative process. It explains the sorts of interaction among different players in turning the technological idea into a real attained service, product or process in the marketplace.

This study was based on the role of the key stakeholders among the actors; therefore the focus of this study is based on the actions of the NGVs users, conversion centers, regulator, oil and gas companies and the emphasis is on the processes within both the supply side in interaction with the demand side (customers). Governmental agents play an essential role in the consumer decision process. These agents can be local, regional, national or international. Together, these different governmental agents are responsible for the nature of the social system in Rogers' theory, because they set the norms and maintain the communication network structure. According to Sahin (2006) government agents can influence the consumers' adoption decision through government procurement, stimulating early or sophisticated demand, technical standards, regulation of products and services.

The knowledge agents influence the consumer decision process with the information from their research. They are responsible for the content of the information sent by the different other agents in the system and so for the content of the *communication channels* in Rogers' theory. Two kinds of research influence the consumers in their decision process; the knowledge agents can research the effects of the new technology directly; the knowledge agents can perform research on competing technologies, which can influence the way consumers look at the new technology (Sahin, 2006).

The supply side (in this case the energy companies) influences consumer adoption by its marketing, which is the process of exciting consumers in a product or service. Supplier agents are responsible for the *change agents' promotion efforts* in Rogers' theory with their marketing process. The relationship between supplier agents and consumers should be based on dependence, trust, and commitment in order to achieve a positive marketing result (Sahin, 2006). The relationship between the supplier agents and consumers is based on dependence, trust, and commitment to achieve a positive marketing result. This implies the willingness of the key stakeholders to make short-term sacrifices to realize long-term benefits (Sahin, 2006; Yeh, 2007; Hekkert et al., 2011).

This study therefore, analyzed the perceptions of regulators, NGV users, conversion centers and oil and gas companies on the readiness of the key stakeholders especially by looking at the financial incentives provided by the government agents such as tax exemptions/reductions to reduce natural gas prices, and loan for vehicle conversion on the willingness of consumers to adopt NGVs. The actions by the energy companies in their total commitment before and after conversion, through the provision of training and workshops on filling up issues, provision of maintenance services on time, and increasing the number of gas refilling stations, marketing and promotion.

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 perception of the readiness of key stakeholders to stimulate car users' conversion to NGVs through investment in the new technology. This objective thought to analyze whether the key stakeholders accept investment in new technology as a way of supporting users to adopt NGVs. The results were analyzed and summarized in Table 1.

Table 1: The Roles of Stakeholders through Investment in Technology on NGVs Adoption

Statements	Percentages (public awareness)									Means (public awareness)		
	NGVs Users			Organizations			Conversion Centers					
										Users	Org	Cent
	D	N	A	D	N	A	D	N	A	Mean	Mean	Mean
The investment in new technical skills will increase adoption of NGVs	13.9	20.8	65.3	20	24	56	13.3	33.3	53.3	3.51	3.36	3.40
Availability of cost reduction on equipment	13.9	23.6	62.5	12	24	64	26.7	20	53.3	3.49	3.51	3.20

will encourage adoption of NGVs												
The existing filling stations are enough to influence the public to adopt NGVs	97.1	2.9	0	92.0	4.0	4.0	66.7	13.3	20.0	2.06	2.12	2.53
Availability of information regarding the new technology will help in the adoption NGVs	76.5	19.1	4.4	72.0	16.0	12.0	53.3	26.7	20.0	3.28	3.40	3.67
Current situation	**L**	**M**	**H**	**L**	**M**	**H**	**L**	**M**	**H**	Mean	Mean	Mean
To what extent is the available technical skills is enough to influence the adoption of NGVs	91.4	4.3	4.3	70.8	25.0	4.2	40.0	46.7	13.3	2.13	2.33	2.73
To what extent can the available cost reduction on equipment influence the adoption of	75.4	13.0	11.6	25.0	41.7	33.3	46.7	26.7	26.7	2.36	3.00	2.80

NGVs in Tanzania?												
To what extent are the available filling stations influence adoption of NGVs	94.3	2.9	2.9	75.0	4.2	20.8	40.0	26.7	33.3	2.09	2.40	2.31
To what extent the available information in the new technology of NGVs influence adoption of it	90.0	7.1	2.9	54.2	41.7	4.2	33.3	46.7	20.0	2.13	2.50	2.87

The results in Table 1 above reveal that the stakeholders have a feeling that when there massive investment in new technical skills, adoption of NGVs will increase. In the same vein, majority of NGV users (65.3%) regulators and staffs from oil and gas companies (56%) and the respondents from conversion centers, 53.3% agreed to believe that when new technical skills receive massive investment, adoption of NGVs will increase. The findings in Table 4.4 indicate that of the users, 91.4% admitted that the rate at which the available technical skills is enough to support the public to convert to NGVs or support who have already converted is low while 70.8% of the staffs from organizations indicated the low level. Contrary to the findings from the users and organizations, the majority of the employees in the conversion centers admitted that the available technical skills could moderately support the public to convert to NGVs.

The results in Table 1 the results on the mean indicated that the perception of NGVs users, organizations and conversion centers agreed on the investment in new technical skills will increase adoption of NGVs as they are above 3 average. This shows that investment in new technical skills will increase adoption of NGVs. Compared to the current situation where by the mean of the users and organization is low which indicates that investment in new technical skills is still low in Tanzania. While the mean of the conversion centers indicated the investment in new technical skills is moderate. This means for the conversion centers the technical skills are better. Hence investment in new technical skills by stakeholders will influence adoption of NGVs.

Investment in new technical skills by stakeholders will influence adoption of NGVs was affirmed all participants. Example one respondent from Triangle limited said:

"*If the stakeholders invests in new technical skills it will help in influencing adoption of NGVs. Currently there is only one CNG inspector at BICO, more experts are needed in this project*"

The results in Table 1 further revealed that the stakeholders believe that the availability of cost reduction on equipment will encourage adoption of NGVs. In this case, the high number of NGV users (62.5%) agreed to the statement whereas 64% of respondents from organizations and 53.3% from conversion centers agreed that cost reduction on equipment would encourage adoption of NGVs. However, the findings further show that the high number of users (75.4%) and conversion centers (46.7%) admitted that the availability of cost reduction would influence the adoption of NGVs in Tanzania. Different from the users, a majority of the respondents from organizations (41.7%) indicated that the available cost reduction moderately influences adoption of NGVs.

Again, the results in Table 1 the results on the mean indicated that the perception of NGVs users, organizations and conversion centers agreed on the availability of cost reduction on equipment will encourage adoption of NGVs as they are above 3 average. This shows that the availability of cost reduction on equipment will encourage adoption of NGVs. Compared to the current situation where by the mean of the organizations is high since it is above 3 the average, this shows that there are cost reductions on equipment to the organizations. While the mean of the users was low, which means the cost reductions on equipment to users is low and that of the conversion center was moderate. Hence cost reduction should be available to both suppliers and buyers so as to stimulate adoption of NGVs.

Cost reduction should be available to both suppliers and buyers so as to stimulate adoption of NGVs. This view was supported by all the interviewed respondents' .Example one of the Uber driver said:

"*Currently there are no cost reduction on equipment to the NGV stakeholders, but if the government provide this incentive it will stimulate adoption of NGV since importation will be cheap and conversion cost will be reduced*"

In the same category of the roles of the key stakeholders, the majority of users (97.1%) have the feeling that the existing filling stations are not enough to influence the public to adopt NGVs. Furthermore, among the respondents from organizations, 92% and 66.7% from conversion centers disagreed that the existing filling stations are enough to influence the public to adopt NGVs. However, the results in Table 4.4 indicated that the available filling stations are not enough to support the adoption of NGVs in Tanzania. In this case, a majority, 94.3% of the users, 75% of respondents from organizations and 40% of respondents from conversion indicated that the available filling stations influence adoption of NGVs at a low level.

Moreover, the results on the mean indicated that the perception of NGVs users and organizations disagreed that the existing filling stations are enough to support the public to convert to NGVs as they are below average, while that of the conversion centers was neutral. This shows that the available filling stations are not enough to support NGVs adoption. Compared to the current situation where by the mean of the NGVs users, organizations and conversion centers are below

average. This shows that the existing filling station is not enough to stimulate adoption of NGVs hence the stakeholders should build more stations to influence adoption of NGVs. Concerning the current status of available filling stations to influence adoption of NGVs an Uber driver said:

"*There is only one filling station and it is closed too early at 6:30 PM, the government, oil and gas companies can work as a joint venture and build more stations which can help in motivating people to adopt NGVs*"

The results in Table 1 details that 76.5% of user have a feeling that availability of information regarding the new technology will help in adoption of NGVs whereas 72% of respondents from organizations and 53.3% from conversion centers disagreed that availability of information regarding the new technology will help in adoption of NGVs. However, 90% of the user respondents admitted that the available information in the new technology of NGVs influences its adoption at a low level. Likewise, 54.2% of the respondents from the organizations indicated the low rate in the same category while 46.7% of respondents from conversion centers revealed contradictory findings from NGVs users and organization by indicating a moderate level. These contradictory results may be because it is the conversion centers that know the rate of conversion compared to users. However, the general results do not support the adequacy of NGVs filling stations.

Lastly, the results on table 1 the mean indicated that the perception of NGVs users, organizations and conversion centers agreed that the availability of information regarding new technology will help in the adoption of NGVs as they are above average. This shows that availability of information regarding new technology will help in the adoption of NGVs. Compared to the current situation where by the mean of the NGVs organizations and conversion centers are moderate. Which shows that the availability of information in new technology is moderately available. While the mean of the users is low. Which means the information is available low to the users. Hence, the availability of information regarding new technology will help in the adoption of NGVs.

Generally, the investment in infrastructure, filling stations, technology, and others if given priority it will encourage the adoption of NGVs. In this case, one of the respondents from GASCO said:

"*Infrastructures are not enough since, "they need first an enabling environment to ensure the conversion is done, have more expertise and improvements in technology and infrastructure, one conversion center, one inspector of the converted cars and one station are not enough to motivate people to adopt NGVs*"

4.1 Discussion of Findings

From the findings, investment of technology for the adoption of NGVs reported that the available cost reduction on equipment moderately influences adoption of NGV. However, the respondents believe that cost reduction on equipment can influence the adoption of NGVs. This is because the Tanzanian customers are price sensitive. Therefore a reduction in cost will attract them to adopt NGVs (Edvardsson, Kristensson, Magnusson and Sundström, 2012). Other studies that found similar findings was the study by (Sahin, 2006) who detailed that NGVs cost reduction was a success factor in Switzerland.

Another aspect revealed that the available filling stations are not enough to support the adoption of NGVs. However, the availability of enough filling stations may influence the availability of NGVs adoption. This supports the ideas by other researchers that NGV users will not find NGVs attractive without ready access to fuel, parts, and repair services, but energy producers, automakers and governments will not invest in NGVs technology and infrastructure without the prospect of a large market the so-called chicken and egg problem (Sierzchula et al., 2014).

The findings reported that investment in new technical skills would influence the adoption of NGVs. However, the results for the current situation of NGVs show that the stakeholders have not succeeded in technical skills investment. These findings comply with the study by Nasir, Ali, Noording and Nordin (2011) and Riem, Boet, Bould, Tavares and Naik (2012) who explained that there is no success in technological innovation without investment in technical skills by the staffs and the potential stakeholders.

Also, the findings reported on the current situation that information availability shows that information on new technology is moderately available. However, the findings show that the respondents believe that the availability of information will promote the adoption of NGVs. Information is power; without reliable and relevant information nothing can be done. According to Venkatesh, Morris, Davis and Davis (2003) availability of information in new technology may trigger the sense of the current technological reliability.

5. CONCLUSION AND RECOMMENDATIONS

Findings of the study show that the existing filling stations are not enough to support the adoption of NGVs, investment in technology regarding NGVs is required to support its adoption. This is because the dependence of consumers on suppliers is based on the number of suppliers on the market. When there are only a few suppliers, consumers are dependent on these suppliers, and they will adapt their products more efficiently. As Hekkert et al. (2011) argued that the Technological Innovation System (TIS) explains the relationship between the supplier agents and the consumers is based on dependence, trust, and commitment to achieve a positive marketing result. All these factors play a great role in influencing adoption of NGVs. The study concludes that the investment in new technical skills, training on safety measures and the availability of new technical information are important factors in stimulating the adoption of NGVs in the country. This conclusion is more related to the suggestions by According to Hekkert et al. (2011) which depicts that the knowledge agents and the government in place can research the effects of the new technology directly, research on competing technologies, and finance think on assisting the investors to properly set infrastructures as explained in the Technological Innovation System (TIS). The stakeholders need to develop a program that promotes investment of more conversion centers and filling station for NGVs. It will help to motivate the users to convert their cars as there will be many conversion centers and gas filling station which will be convenient for them compared with the current situation of having one gas filling station which discourages the potential customers due to convenience problems. Also, it will show the suppliers can provide services even after conversion one conversion center and one gas filling station brings many questions regarding sustainability.

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

Dagsvik, J. K., Wennemo, T., Wetterwald, D. G., & Aaberge, R. (2002). Potential demand for alternative fuel vehicles. *Transportation Research Part B: Methodological*, 36(4), 361–384. https://doi.org/10.1016/S0965-8564(01)00013-1

Demierre, J., Bazilian, M., Carbajal, J., Sherpa, S., & Modi, V. (2015). Potential for regional use of East Africa's natural gas. *Applied Energy*, 9(3),81-93.https://doi.org/10.1016/j.apenergy.2015.01.012

Diefenderfer, J., assumptions Vipin Arora, M., & Singer, L. E. (2016). International Energy Outlook 2016 Liquid fuels. *DOE/EIA*-0484, 34(18),1323-1330 .https://doi.org/www.eia.gov/forecasts/ieo/pdf/0484(2016).pdf

Edvardsson, B., Kristensson, P., Magnusson, P., & Sundström, E. (2012). Customer integration within service development - A review of methods and an analysis of insitu and exsitu contributions. In *Technovation* (Vol. 32, pp. 419–429). https://doi.org/10.1016/j.technovation.2011.04.006

Engerer, H., & Horn, M. (2010). Natural gas vehicles: An option for Europe. *Energy Policy*,64(6),165-174. https://doi.org/10.1016/j.enpol.2009.10.054

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

Glaeser, E. L., & Ponzetto, G. A. M. (2018). The political economy of transportation investment. *Economics of Transportation*, 17(1),47-60. https://doi.org/10.1016/j.ecotra.2017.08.001

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

Le Fevre, C. N. (2014). Prospects for Natural Gas as a Transportation Fuel. *Oxford University Press*,11(2),91-100.

Ma, L., Geng, J., Li, W., Liu, P., & Li, Z. (2013). The development of natural gas as an automotive fuel in China. *Energy Policy*,87,313-323. https://doi.org/10.1016/j.enpol.2013.06.066

Markard, J., & Truffer, B. (2008). Technological innovation systems and the multi-level perspective: Towards an integrated framework. *Research Policy*,35(10),4178-4186. https://doi.org/10.1016/j.respol.2008.01.004

Nasir, A. N., Ali, D. F., Noording, M. K., & Nordin, M. S. (2011). Technical skills and non-technical skills : predefinition concept. In *Proceedings of the IETEC 11 Conference*,7(2),55-60. https://doi.org/10.1109/BCGIn.2011.145

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.

Riem, N., Boet, S., Bould, M. D., Tavares, W., & Naik, V. N. (2012). Do technical skills correlate with non-technical skills in crisis resource management: A simulation study. *British Journal of Anaesthesia*,2(9),23-27. https://doi.org/10.1093/bja/aes256

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

Sierzchula, W., Bakker, S., Maat, K., & Van Wee, B. (2014). The influence of financial incentives and other socio-economic factors on electric vehicle adoption. *Energy Policy*, 2(7),18-23.https://doi.org/10.1016/j.enpol.2014.01.043

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *Source: MIS Quarterly*,25(5)345-359.https://doi.org/10.2307/30036540

Wang. (2007). Climate Change 2007 Synthesis Report. Intergovernmental Panel on Climate Change [Core *Writing Team IPCC*,6(1),348-354. https://doi.org/10.1256/004316502320517344

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