

Upstream and Downstream Integrated Supply Chain: Its effect on improving efficiency in supply of oil and gas products in Tanzania

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Ikisiri

Lengo la utafiti huu lilikuwa ni kuchunguza athari za muunganiko wa mnyororo wa ugavi kati ya vyanzo vikuu vya upatikanaji wa bidhaa na wateja wa mwisho ili kubaini kama kuna tija katika ugavi wa bidhaa za mafuta na gesi. Utafiti huu ulifanyika katika jiji la Dodoma kwa kutumia utafiti muhula (cross-section survey) ukihusisha sampuli ya washiriki 80 wanaofanya kazi kwenye vituo vya mafuta na gesi. Mbinu nasibu ilitumika kuwapata washiriki kwenye utafiti ambapo dodoso maswali lenye vipimo kati ya moja hadi tano lilitumika kukusanya taarifa toka kwa washiriki. Taarifa zilichakatwa kwa kutumia anuai rejeshi (multiple regression) ili kubaini vigezo vyenye mchango mkubwa katika kuleta tija kwenye mnyororo wa ugavi. Matokeo ya utafiti huu yanaonyesha kuwa vigezo vitatu kati ya vinne (mfumo taarifa, mfumo sheria na mfumo usafirishaji) vina mchango mkubwa katika kuongeza tija kwenye ugavi wa mafuta na gesi. Utafiti unahitimisha kuwa muunganiko wa mifumo hii kati ya wauzaji wakubwa na wateja wa mwisho ni muhimu sana katika kuongeza tija kwenye mnyororo wa ugavi wa mafuta na gesi. Utafiti huu unapendekeza kuwa wahusika wote kwenye mnyororo wa ugavi waunganishe mifumo kikamilifu ili kuongeza tija zaidi kwenye ugavi wa mafuta na gesi nchini Tanzania.

Abstract

The purpose of this study was to examine the integration between upstream and downstream supply chain of oil and gas products and determine its effect on improving efficiency. The study was conducted in City Council of Dodoma (CCD) and it adopted a cross-sectional survey design involving a sample size of 80 staff working at oil and gas service stations. The study employed simple random sampling technique to get respondents. Structured questionnaires scaled to 5-point Likert scale were used to capture data from the respondents. Data were analyzed by using Multiple Regression Model to determine whether

the four independent variables have significant contribution on improving efficiency in supply chain management. The results indicate that three variables out of four (i.e. information, transport and legal systems) have a significant contribution on efficiency ($p=0.000$; $p=0.000$ and $p=0.028$ respectively). The study concluded that effective integration of information, transport and legal systems between upstream and downstream partners is essential for improving efficiency in oil and gas supply chain. The paper recommends that upstream and downstream supply chain partners should effectively integrate their systems to improve efficiency in supplying of oil and gas products in Tanzania.

Key words: Upstream; downstream; supply chain; efficiency; oil and gas

1.0. INTRODUCTION

Supply-chain management (SCM) can be defined as the configuration, coordination and continuous improvement of a sequentially organized set of operations (Lyson and Farrington, 2019). The goal of supply-chain management is to provide maximum customer service in time and at the lowest cost possible. In a supply-chain, a company links to its suppliers upstream and to its distributors downstream in order to serve its customers. Since the goal of the firm is to maximize profit, the firm must get goods and services in time and minimize costs along the supply-chain by ensuring that the flow of materials, information, capital, labor, technology and financial resources are well integrated in the supply chain (Guillen *et al*, 2006).

Supply of oil and gas products has a crucial role on improving social-economic condition of the people therefore integration of operating systems such as information, legal, transport and financial factors between upstream suppliers and downstream customers is a prerequisite in supply chain of oil and gas products as this allows all functions be performed efficiently. Following criticality of these products to the economy many governments including Tanzania have established policy for the purpose of ensuring that supply of these products are obtained economically, at right quality and at the right time. For example, the mission of Oil and Gas Policy in Tanzania is to create enabling conditions for the supply and effective utilization of oil and gas products to all market segments across the entire

value chain in an efficient manner. That is, to ensure that the service delivery of these products is fast, transparent, economical and meets high quality standard. However, it has been argued by Tanzania scholars that in recent days the oil and gas industry have entered an era of crisis due to frequent fluctuation in supply of oil and gas products. This has consequently been causing scarcity and then unnecessary increase in the market price (URT, 2011). The oil and gas industry has very long supply chains that need to be effectively managed so as to avoid fluctuation in supply; in order to overcome such challenges in supply of oil and gas products the government of Tanzania has put some strategies in supply of these products including use of bulk procurement system as well as dividing the oil and gas industry into two areas namely upstream and downstream operations to simplify management and ensure efficiency (EWURA, 2020).

Effective implementation of policies and strategies for the oil and gas sector requires an unusual high level of coordination of decision-making in operating activities. Such coordination may be difficult in any government due to the different set-up of involved parties in oil and gas industry. For example, in Tanzania there are many institutions involved in supply of oil and gas products such as Ministry of Energy as the lead policy and administrative institution, Tanzania Petroleum Development Corporation (TPDC) which regulates upstream activities, the Energy and Water Utilities Regulatory Authority (EWURA) regulates downstream activities, the Ministry of Finance as the lead policy institution in setting royalty and profit sharing terms, Tanzania Revenues Authority collects income taxes and National Environment Management Council manages environmental issues (URT, 2020). Such many institutions sometimes may cause difficulty coordination and consequently cause lengthy delays in supply of oil and gas products. Therefore, all institutions involved in oil and gas industry need to work together and harmonized their operating systems so as to ensure effective and efficient coordination of operations.

Despite the efforts of Tanzania in developing policies and strategies in oil and gas products, there are still some problems in the sector which in one way or another affects the supply of oil and gas products in Tanzania (URT, 2020). One of the main problems facing the Tanzanian petroleum sub-sector is the high cost of delivery of petroleum products into the national economy. According to Kojima *et al* (2010) price of a petroleum product are

affected by a number of factors such as market size and unfavorable economies of scale, poor mode of product transport, controlled pricing, protectionism to domestic suppliers, degree of competition, import duties, imposed fees, unstable legal framework and ineffective monitoring. Oil and gas marketing statistics in Tanzania indicate that the retail price of petroleum products is at 150% over the landed price; as a result of the extremely high prices, smuggling of products in the country is about 30% of Tanzania's entire petroleum sales (EWURA, 2020). Theft is one of the critical issues in oil and gas sector and in addition to theft, issue of contaminated diesel and petroleum products has been a continuing problem in the industry whereby unscrupulous people do mix the original product with other unauthorized materials such as cotton waste, kerosene, water, etc. (URT, 2020).

Consequently, such bad practices make the oil and gas products to be in poor quality and not suitable for vehicle consumption thus causing major risk to people and the environment. In addition, a delay in supply of oil and gas makes the products to be sold in high prices thus affecting socio-economic condition of the people (EWURA, 2020). Following existence of the problems such as increase in price, theft and contamination in supply of oil and gas, there are studies that have been conducted in oil and gas industry including Cust (2017); Must (2018); Jacob *et al* (2020) but most of them have slightly touched the issue of examining the integration of upstream and downstream logistics for efficient product delivery in the country. Therefore, this study intends to assess the role of supply chain integration for efficient performance in supply of oil and gas products in Tanzania.

2.0. LITERATURE REVIEW

2.1. Theoretical Literature Review

2.1.1. Integrated Agile Supply Chain Model

Integrated Agile Supply Chain Model developed by Christopher and Towill in 2001 presents three level frameworks which contains all elements of an Agile Supply Chain. The first level identifies the two key principles that support the Agile Supply Chain, i.e. quick replenishment and postponed fulfillment. The second level specifies the individual programs such as flexible response and organizational agility which must be implemented to achieve the principles in level one. The third level represents individual actions such as

time compression, information enrichment and waste elimination to support the programs in level two. These approaches and practices enable the activities within supply chain to be speeded up and thus increasing efficiency in the organization. This model was chosen in the current research because it comprises various interesting concepts which are needed to reduce lead-times in the supply chain.

2.1.2. Upstream and Downstream Integration in Oil and Gas Industry

The upstream and downstream supply chain linkage represents the interface between companies and materials that flow through the supply-chain from the source to the final destination, namely the end customer. As long as oil companies need a group of suppliers to keep their systems continuously re-supplied, there has been a supply-chain whereby within each stage there are many operations such as production operations, refining operations, procurement operations, marketing and distribution operations (Cust, 2017). Each stage of the link can be a separate company or a unit of an integrated firm. The common goal along the links in the oil and gas industry supply-chain is economics; weighing benefits versus costs along the chain so that efficiency is achieved in the supply chain and thus ensure maximum customer service at the lowest possible cost (Bishoge *et al*, 2018). Therefore, it is important to ensure that each operator along the supply-chain respond quickly to the exact material needs of its customers, protect itself from problems with suppliers and buffer its operations from the demand and supply uncertainty it faces (Must, 2018).

Supply-chain management involves configuration and coordination of various operations; that is, it involves ensuring supplier effectiveness in cost, timeliness, quality, setting appropriate targets for inventory, capacity, monitoring demand and supply conditions, communicating market and performance results to customers and suppliers (Bishege *et al*, 2018). Since the goal of supply-chain management is to provide maximum customer service at the lowest possible cost, it has been advocated that the supply-chain be managed as an integrated and coordinated system (Forrester, 1961). This would further reduce costs by eliminating unnecessary requirements which are loads on the chain (Christopher, 2007).

In supply chain of oil and gas products, integration and cohesiveness among the stakeholders is important to ensure that the products flow rapidly from point of manufacture

to the final customers. This demand for better and faster customer service and the availability of information technology in supply chain which increase speed, reduce costs and leading to a more efficient system (Mason and Lalwani, 2006). Oil and gas products are very critical items in relation to demand and supply perspectives whereby any shortage of these products may affect the economy of the country. Therefore, supporting this necessary and important issue of oil and gas products in supply chain calls for a need to visualize, link, and manage the acquisition, exploration, production, transportation and distribution functions of an oil company in a more integrated, cohesive, and balanced manner (Christopher, 2007).

A supply-chain configuration strategy for oil and gas companies involves the development of boundaries and parameters that determines the relationships within its chain of customers and suppliers. Vertical integration is the joining of one firm with another to which it either sells an output or from which it buys an input and it works very well in an industry such as the oil and gas industry where the output from one firm is the input to the other firm along the supply-chain (Jacob *et al*, 2020). There are many benefits to upstream and downstream integration which include greater control over product quality, greater coordination of operations along the value chain, access to new technologies, and other intelligence of strategic importance, plus the potential for larger total profit margins (Christopher, 2007).

2.2.3 Information flow integration

In supply chain management there is a large number of information exchange on sales and inventory amounts and forecasts, ordering transport, confirmation and invoicing as well as various types of contracts and terms of delivery. Supply chain can be perceived as information flow that starts with customer demand forecast or its realization, which moves along the chain to factory, raw material suppliers, warehouse and drivers and to other service providers and subcontractors (Lyson and Farrington, 2019). In addition, authorities such as customs and tax authorities need some information from importers to enable them determine the tax to be paid by the parties. Therefore, all supply chain parties should receive adequate information to be able in meeting customer needs in a timely manner (BMI, 2016). In addition, information flow in supply chain includes a huge number of

different contracts, confirmations and change notifications, so that the products are in required order and at the right time in the next phase of supply chain. Also, information flow provides necessary data relating to products such as information on packaging, content, sender and destination thus facilitating smooth service delivery in supply chain (Must, 2018). Following the role of information flow in supply chain, the following hypothesis is formulated:

Null hypothesis 1 (H₀₁): Integration of Information Systems among supply chain partners does not enhance efficiency in Supply Chain

Alternative hypothesis 1 (H_{a1}): Integration of Information Systems among supply chain partners enhances efficiency in Supply Chain.

2.2.4 Legal systems integration

Regulatory environments exert important influences and constraints on supply chain design and execution (EWURA, 2020) Aspects of unseen upstream, downstream, and cross-functional policy decisions affect costs in delivering goods from one point to another (Waller and Fawcett, 2012). For example, import tariffs and other trade restrictions are among a most prominent policy issues that threatened importation of goods from one country to another. Legal issues established in different countries have implications in supply chain and are seen to be tremendously costly (Pham, 2018; Swanson, 2018). In addition, a number of regulatory policies related to SCM appear to be ripe for reform. For example, policy regarding public investment in canals, ocean transport, and railroads has often resulted in failure and waste, while similar, privately funded endeavors have flourished (Folsom, 2013). Therefore, policy and legal issues have affected some firms in the movement of goods along the supply chain (Szakonyi, 2017). Following relevance of legal integration in supply chain the following hypothesis is developed:

Null hypothesis 2 (H₀₂): Integration of Legal Systems among supply chain partners does not enhance efficiency in Supply Chain

Alternative hypothesis 2 (H_{a2}): Integration of Legal Systems among supply chain partners enhances efficiency in Supply Chain.

2.2.5. Financial systems integration

Financial system integration optimizes cross-company financial processes using collaborative and automatic transactions between suppliers, customers as well as financial and logistics service providers. They are essential and important activities because they ensure financing of production and distribution operations. Financial factors have a strong impact on the configuration of supply chain. Issues such as corporate income taxes, transfer prices, currency exchange rates are some of the key components that a supply chain design model in the global context should take into account (Hammami *et al.*, 2008). Integration of financial aspects in supply chain allows for better services in performing various financial operations thus providing a competitive advantage in the company (Guillen *et al.*, 2006). Therefore, collaboration on financial systems between buying side and supply side has a potential benefit that can improve efficiency in supply chain. In this case, the following hypothesis is developed:

Null hypothesis 3 (H₀₃): Integration of financial systems among supply chain partners does not improve efficiency in Supply Chain

Alternative hypothesis 3 (H_{a3}): Integration of financial systems among supply chain partners improves efficiency in Supply Chain

2.2.6. Transport Systems Integration

A more joined up approach to the management of transport with other supply chain echelons could lead to many other advantages, such as improved vehicle turnaround times and reduced vehicle waiting at loading and dropping points, such as warehouses or ports. Transport performs a critical role in the more time-sensitive, controlled and closely integrated modern supply chains and networks (Mason and Lalwani, 2006). Transport integration is a key factor to increase supply chain efficiency and effectiveness as it enables transport and storage costs reduction as well as quick response leading to higher customer satisfaction. Transport equipment compatibility between buy side and supply side is very important because it avoids stoppage in operations in the supply chain during delivery of goods from upstream to downstream points (BMI, 2016). The logistics planning can be done with aid of advanced software tools to analyze complex transport scenarios in supply

chain using geographical information system thus being able to provide geographical data such as location of ports, shippers, carriers, warehouses, as well as choice of vehicle routing. If managers have access to inbound and outbound freight movement plans, they can identify opportunities to combine freight to build volume shipments and hence ensuring speed in delivery of goods along the supply chain (URT, 2013). Therefore, in relation to relevance of transport system, the following hypothesis is developed:

Null hypothesis 4 (H_{04}): Integration of Transport systems among partners does not improve efficiency in Supply Chain

Alternative hypothesis 4 (H_{a4}): Integration of Transport systems among partners improves efficiency in Supply Chain.

Based on the literature reviewed, the conception framework was developed (Figure 1). The conceptual framework shows how the integration of legal, transport, information and financial systems along upstream and downstream supply chain of oil and gas. This integration leads to efficiency in the supply chain of oil and gas products.

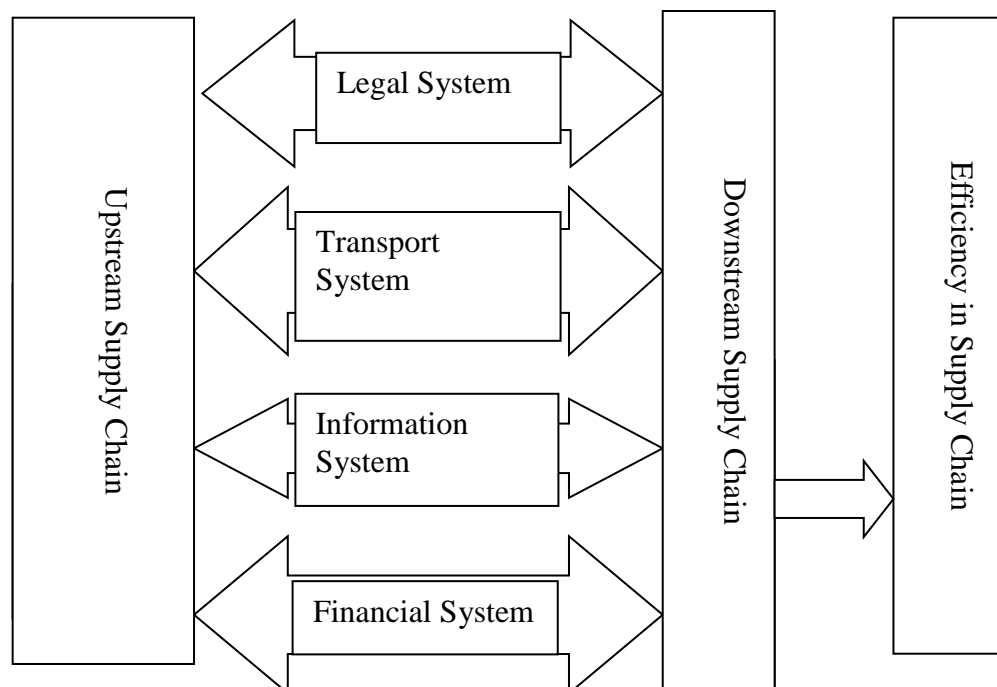


Figure 1: Conceptual framework of supply chain integration of oil and gas

Source: Developed from literature review (National Research Council, 2000)

3.0. METHODOLOGY

This study was conducted in the City Council of Dodoma (CCD) following increase in demand of oil and gas products in this region after shifting the capital city from Dar es Salaam to Dodoma (URT, 2020). The study employed a cross sectional survey design by collecting data from one point at once. With regard to the methodological choice for this study, a quantitative approach was employed involving a population of 200 staff; according to government report on oil and gas of 2018-2020 it indicates that there are 35 service stations in Dodoma urban with an average of 4-6 staff per station (URT, 2020).

The respondents included administrative and technical staff such as Sales personnel, Maintenance, Distributors, Accounts and fuel dispensers. All these staff is familiar in oil and gas industry due to directly involved in service delivery of fuel products to the end-customers. From the population, a sample size of 80 respondents was obtained by using a formula developed by Yamane (1967) and this study employed simple random sampling procedure in establishing respondents from whom data were collected. The procedure was preferred because it avoids biasness in research thus making the study become more valid and reliable (Yin, 2014). The data extracted from the cross-section of oil and gas service stations were collected by using structured questionnaires that was scaled to 5 point-Likert scale and ranging from strongly agree to strongly disagree. In this case, the Likert scale enabled to obtain responses from respondents with regard to questions relating to variables of the study.

The data from respondents were analyzed by using Multiple Regression Model to determine if there are significant causal-relationships between the independent variables of interest in integration of supply chain and increase in efficiency in supply of oil and gas products as a dependent variable. Before doing the analysis, assumptions of the Regression model was checked to determine its fitness in the study. With regard to normality, data were found to be normally distributed; outliers were checked by using scatterplot which fall in the range of 3.3 to -3.3 while VIF had the range of 1.092 to 1.512 suggesting absence of multi-collinearity. In all cases of the analysis, SPSS version 21 was used to assist in the data analysis. The Multiple Regression Model was represented using the following formula:

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \dots + \varepsilon_i$$

y_i = Efficiency in Supply Chain (Dependent Variable)

β_0 = Constant, $\beta_1, \beta_2, \beta_3, \beta_4$ = Regression coefficients; x_1 = Information flow factor, x_2 = Legal factor, x_3 = Financial factor, x_4 = Transport factor (Independent variables) ε_i = Estimated error.

4.0. RESULTS AND DISCUSSIONS

In Table 1, the R Square shows how much of the variance in the dependent variable (Efficiency in procurement) is explained by the model which includes the independent variables information system, legal system, financial system and transport system. In this case the value is .577. This means that the model explains 57.7% of the variance in efficiency in procurement which is quite a respectable result to justify that the model was fit to examine the role of upstream and downstream integration in supply chain of oil and gas products. Furthermore, model fitness was checked by using ANOVA test which tests the null hypothesis that multiple R in the population equals 0. The results in Table 2 shows statistical significance (sig = .000, this means $p < 0.005$).

Table 1: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error
1	.760 ^a	.577	.555	.62583

Table 2: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	40.113	4	10.028	25.604	.000 ^b
	Residual	29.375	75	.392		
	Total	69.488	79			

The results from the regression model with regard to each independent variable are presented in Table 3. To start with, the variable of information system has a positive beta

coefficient value of 0.326 meaning that a unit change in information system will increase efficiency in procurement by 32.6%. On the other hand, the p-value is significant ($p=0.000$). Following the results, alternative hypothesis was accepted with a view that integrated information system between upstream and downstream supply chain has a significant contribution on improving efficiency in procurement on oil and gas products. This is useful information in business setting by considering that the emergence of information and communication technology has helped many organizations to excel and achieve competitive advantages. According to Guillen *et al* (2006), the use of integrated information system between suppliers and buyers plays a significant role in improving efficiency in supply chain. This shows that effective integrated information system between suppliers (upstream) and buyers (downstream) will help the parties to communicate fast and thus increase speed in delivery of oil and gas products in Tanzania.

With regard to variable of legal system the results indicate that it has a positive beta coefficient value of 0.095 meaning that a unit change in legal system will increase efficiency in procurement by 9.5%. The p-value is significant ($p=0.028$) leading into acceptance of alternative hypothesis with a view that integrated legal system between upstream suppliers and downstream buyers has a significant role on improving efficiency in procurement. Importation of goods including oil and gas products follows different rules and regulations that have been established in the exporting country (supplier) and importing country (buyer). The use of different rules and regulations that are applicable in different countries can be an obstacle in supply of oil and gas products. It is in this view that some countries have harmonized their legal systems for the purpose of eliminating unnecessary obstacles in delivery of goods from one country to another. Therefore, if legal systems including customs duties being applied in Tanzania are harmonized with legal systems applied in exporting countries (i.e. having similar rules and regulations) it will enable buyers and sellers of oil and gas products to have an integrated legal system that will make them deliver the goods timely and in an economical manner.

With regard to the variable of financial system the results indicate that there is a positive beta coefficient value of 0.149 implying that a unit change in integrated financial system will increase efficiency in supply chain of oil and gas products by 14.9%. On the other

hand, the p-value is not significant ($p=.111$) thus leading into acceptance of the null hypothesis with a view that integrated financial systems in upstream and downstream has no significant contribution on improving efficiency in supply chain of oil and gas products. However, insignificant relationships between financial systems and efficiency in supply chain might be contributed by perceptions of respondents in relation with the use of currencies in conducting import and export business. Normally, each country has got its local currency and many countries have a tendency of protecting and promoting its own local currency but when the issue of import and export business is undertaken the popular currency such as US dollar, Steering Pound and EURO are preferred.

Lastly, the variable of transport system has a positive largest beta coefficient value of 0.495 meaning that a unit change in integrated transport system will make the strongest unique contribution of 49.5% on improving efficiency in supply chain of oil and gas products when the variance explained by all other variables in the model is controlled. The p-value is significant ($p=0.046$) thus leading into acceptance of alternative hypothesis with a view that integrated transport systems between upstream and downstream logistics has a significant contribution on improving efficiency in supply chain of oil and gas products.

Table 3: Regression Results on Effect of Upstream and Downstream Integration

Variables	B	S.E.	t	Sig.
Information System	.326	.073	3.863	.000
Legal System	.095	.071	1.076	.028
Financial System	.149	.075	1.613	.111
Transport System	.495	.060	6.307	.000
Constant		.331	2.032	.046

5.0. CONCLUSION AND RECOMMENDATIONS

Supply chain of oil and gas products need effective integrated systems such as information, legal, financial and transport. The study concludes that the variables such as information, legal and transport systems have significant relationship with efficiency in supply chain.

That is, these variables enable upstream and downstream supply chain partners to interact smoothly and fast thus increasing efficiency in terms of speed, price and quality of oil and gas products in Tanzania.

The policy makers involved in oil and gas industry should update legal, transport and information systems to comply with international standards as such a strategy will enable use of best practices that are economical and fast in supply of oil and gas products in Tanzania. The study recommends practitioners working at downstream to effectively integrate their transport systems with those of suppliers operating in the upstream as this variable has the strongest unique contribution on improving efficiency in supply chain of oil and gas products. The government should put effective legal systems in monitoring and evaluation of oil and Gas products. Such strategies will ensure quality, stability in supply as well as maintaining low price in the market.

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