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Research Article

THE INFLUENCE OF TECHNOLOGICAL FACTORS ON MARGINAL OIL FIELD DEVELOPMENT IN NIGERIA

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ABSTRACT

The use of innovative technologies has been cited by various scholars as one the key determinants of marginal oil field development. The specific objective of the study was to determine the influence of technological factors on the development of marginal oil fields in Niger Delta region of Nigeria. The result indicates that capacity building which is a component of technological factoris related to marginal field operation as demonstrated by chi square analysis. Among the constructs fortechnological factors, inadequate manpower development has a stronger association ($X2=48.44$ $P<0.05$) compared to inadequate local content policy ($X2=31.56$, $P<0.05$). Availability of technical data was found to be insignificant for marginal field development in Niger Delta region. The regression analysis showed that technological factors account for 96% of the variance in marginal field development. Analysis of variance ANOVA confirm that this model has a good fit and exists (since $F = 43.6$ and $P<0.05$). The findings underscore the need to formulate policies in support of technological development in the country which will also aid the development of Marginal oil fields in Niger Delta region.

Key words: Technological factors, Innovative technologies, Capacity building.

INTRODUCTION

Oil and gas exploration has been on going in Nigeria since 1930 and many oil and gas fields termed marginal fields have been left undeveloped by the international oil companies because the volume of their reserves is not of commercial quantity. And that such fields may not yield adequate rate of return. According to Toyin (2009), there is a reported huge reservoir of marginal oil fields in Nigeria conservatively estimated to contain over 2.3 billion barrels of Stock Tank Oil Initially In Place (STOIIP) strewn over 183 fields. Bidemi (2009) explained that, these fields are discoveries located in the acreages operated by International Oil Companies (IOCs) and had remained undeveloped for alleged limited profitability of the discoveries due to the size and the difficult terrain encountered in the course of exploitation. In 2003 when the Federal Government handed over the operations of these fields to local hands, many had welcomed the development with the hope that the confidence of local experts would be bolstered in oil exploration and production activities. After the deal was finally formalised with the oil majors in 2004, the majority of these fields have not changed from the undeveloped state.

Statement of the problem:

In order to reduce the abandonment of depleting oil and gas fields, the Federal government of Nigeria introduce the marginal field program in 2001. According to Business day report (2013) and Wood Mackenzie Report (2012), since 2004, only ten of the 24 marginal fields awarded in the round have been brought on stream or are under development and account for just 2.1 percent of the country's total daily crude production.The study sought to determine why some of the marginal oil fields in Nigeria could not be successfully developed. Current literature does not fill this gap though it points to technological factors as probable factor influencing the development of the marginaloil fields in Nigeria. The study investigates the influence of technological factors on the development of marginal oil field in Nigeria.

The marginal fields' development initiative in Nigeria has not been fully successful due to several factors among which are limited local organisational competence for oil and gas development within the concession winners, socio-political environment, funding, fiscal regime, legal and regulatory framework, and Institutional barriers both at governmental and industry level, in addition to inadequate technological factors.Also Ayo (2013) maintained that it is the inability to recognise the exact technology that marginal field operators need at a specific time that is a challenge. Inadequate technology for marginal field development result in the importation of technology and services required for oil and gas development, this results in the increase in the cost of operations for marginal field development in Nigeria.

Objectives of study: The aim and objective of study is to evaluate the influence of technological factors on the economic development of marginal oil field in Nigeria.

The specific objectives are:

- To assess the role of technology in evaluating the profitability of marginal oil fields development in Nigeria
- To discuss how investment in capacity building contribute to economic development of marginal oil field
- To examine the impact of the availability of technical data on marginal field development in Nigeria
- To discuss local content development and marginal field development
- To make recommendations on technological factors and marginal oil field development in Nigeria.

Research hypothesis:

The study undertook to test the following hypothesis to determine the influence of the independent variable on the dependent variable

Ho: There is no significant difference between the influence of technological factors andthe economic development of marginal oil field in Nigeria.

LITERATURE REVIEW

Technology has been defined as the systematized practical knowledge, skills, methods, activities and artefact by means of which man pushes back his limitations and extends his capability. Ibibia (2002) posited that technology may involve, but is by no means restricted to equipment, patents, processes and copy rights. It is rather a hosted of intricate and interconnected factors that traverse equipment, patents, processes copy rights and most importantly, the knowledge of how to invent, manipulate and use the above mentioned factors towards the attainment of definite goals.Technology for marginal field development or operation is therefore defined as the knowledge and information needed for developing these fields, including knowledge for necessary input, the skill and procedures by which the input are transformed into the desired output. Technological factors connotes how the technological inventions, technical equipment and skills affect the way marginal field operators resources are converted to output. In the context of marginal field development, technological factors include the methods, techniques and approaches adopted for the development of the marginal oil fields. This has to do with the skills, knowledge, and competence in human being. This is in line with Akinwale (2016) submission that technological factors implies in terms of the nature of technology and innovation used, strategies and machinery adopted among others.

For any oil field to be developed properly, adequate technology has to be in place. Marginal fields also require unconventional equipment and technology. Though available, technologies needed for marginal field development to increase return on investment are inaccessible for the operators in Nigeria due to high cost. These technologies include Extended reach, Infill drilling, Slim-hole drilling, Coil tubing, Down hole electric

submersible pump, Surface multiphase pump, Intelligent well completion, Lease production facilities – a-fit-for purpose production facility on a leased operated and maintained basis (Offia, 2011). Marginal field development requires unconventional technology, these equipment and technologies are not readily accessible throughout the oil industry. Furthermore since the required tool is unconventional, it is considerably more expensive, with the result that the cost of recovery (operational cost) may be as great as to render the venture unprofitable.

Evaluating the role of technology in marginal field development:

Kaiser and Pulsipher (2006) opined that technological advances raise the proportion of a field which can be economically recovered, while improvement in infrastructure allow smaller and or deeper fields and less productive wells to be economically developed. Improving technology will continue to make more reserves available. The benefits of technology include increased production. It leads to increased efficiency of productive factors and also reduced environmental foot print.

Technology can make marginal and stranded fields economical and reduce cost of development and operation of the field. There are several technologies which can be used in marginal field development to improve recovery and increase production at the lowest possible cost. Coiled tubing intervention and releasable production systems, including subsea completion with tiebacks to existing infrastructure, floating production systems and backups, multiphase flow, allowing a well producing liquids to steam directly into a pipeline. Slim hole drilling, horizontal and extended reach wells, multilaterals and seismic advances, subsea processing, and use of minimum platform, better reservoir characterization.

The main objectives of these proposed technologies are to make development of marginal oil and natural gas cost effective, more efficient, and more protective of the environment. Uses of appropriate technologies will also help find new reserves, improve drilling efficiency, reduce costs, and increase production. The proposed technologies have had positive environmental benefits in reducing negative impacts on lands, surface waters and aquifers, wildlife, and air quality. Innovations in drilling technology will significantly reduce the environmental impact.

This can be achieved, for example, by using smaller drilling pads, smart wells, and measurement while drilling technologies. Better drilling technology can produce more oil and gas from fewer wells. Fewer wells means less land disturbed by drilling operations and the associated surface infrastructure and transportation systems.

Economic Implications of the role of technology in marginal field development:

For marginal field operators profitability is very crucial for the sustainability of the marginal field oil

field development. Profitability is regarded as overall measure of effectiveness and also efficiency with which the productive asset and resources are being maintained and utilized. Profitability is essential for proper allocation of corporate resources and necessary to support continuing investment required to develop and produce the marginal fields. In summary the role of technology in marginal field development help in reducing the development cost (and improving profitability) through the following:

i. Reduced Capital Investment and less Operational cost
ii. Reducing drilling costs:
iii. Reducing Facilities costs:
iv. Optimizing the operating cost:
v. Reducing abandonment cost:
vi. Increase and accelerate the production rate:
vii. Reduce environmental foot print and improve safety:
viii. Create new opportunities:

Capacity building:

Human capital is defined here as the totality of what the individual collectively know and it is fundamentally dependent on the competence and commitment of the individual/collective competence (or capability). It deals with two aspect of know-how that professional/technical competence and social know-how. Commitment deals with the application of know-how that is enabled by the individual or collective motivation. Competence is the key to the development of human capital which is the most important factor of production. When company invests in human capital, value increases. The knowledge from human capital can be used to produce wealth, multiply output of physical asset, gained competitive advantages and or enhances values of other types of capital. The human capital that people bring to the work place-skills, knowledge and ideas can drive productivity.

Human capital formation is the process of acquiring and increasing the number of persons who have skills, education and experiences which are critical for economic development of a country. It is associated with investment in man and his development as creative and productive resources. Human resource development is particularly important aspect of technology absorption. Qualified engineers and scientist, middle level technicians and skilled labour provide the base for the transfer, adaption and assimilation of technology. The oil and gas industry requires highly skilled labour.

In the context of marginal field development the business goal of marginal field developers can only be achieved through the performance of human capital in it since the performance of human capital is pivotal

to the success of the organisation. According to Osten (2012), capability and capacity issues are some of the hindrances to the development marginal fields. Capacity building is all it takes to make a sustainable business.

Technical data:

Also a major problem being faced by marginal field developer is inadequate technical data. This is in line with Africa Oil and Gas Report, (2009), that besides the financial hurdles, another problem being faced by marginal field developer is inadequate technical data on field from the major oil companies that farm out the fields to them. This is because the indigenous company may not have easy access to seismic, petro physical and production data on the field that is to be developed.Some of the Niger Delta fields have remained marginal and unproductive over the years due to incorrect estimate in recovery and economics occasioned by erroneous estimate in basic input parameters for example temperature and viscosity as observed by Anthony (2008) who performed a study of the basic property of the Niger Delta region. The study detailed how the geological location of any marginal field in Niger Delta is enough to fairly estimate its basic pressure volume temperature (PVT) properties. It showed further through dynamic simulation model built for marginal fields, that previous estimation, recoveries and development for the case study of marginal fields were pessimistic. The case study revealed that other marginal fields in Niger Delta will benefit from a PVT, recovery and development economics reviewed and their development can produce enough net income.

Local content policies:

According to Jesse (2013) local Content has been referred to as a set of policies that increase the utilisation of national human and material resources and domiciles economic activity, previously located abroad, in the country.The oil and gas business is technology driven and Nigeria is making frantic effort to hook on to the international grid of technology driven economies. Emphasis therefore has shifted to human, technical and financial capability in the oil and gas development. Business success depends upon the ability of companies to develop local content, build a competitive local supplier base and deliver lasting social-economic benefits where they operate. This phenomenon underscores the central role of local content policy in the oil and gas business and hence marginal field operation (Oruwari and Adewale2016).

Conceptual framework:

A conceptual framework focuses on the main dimension of things to be studied, the factor of variables, and the presumed relationship between them or in order words something that explains, either graphically or in narrative form the main things to be studied. Based on the presented theories in the literature review the concepts that are perceived as the most significant will be chosen, in order to turn the research questions posed into something that data can be collected on. All selected concepts have been chosen based on their potential strengths as something that data can be collected on.

Economic development of marginal oil field in Nigeria (Dependent variable)	**Technological factors (Independent variables)**
	Role of technology. Right technology for field development to enhance recovery rate of marginal fields
	Capacity building. Resources assessment e.g. Develop human capacity in the oil and gas to develop and manage marginal oil fields
	Availability of Technical data
	Local content policy

Table 1: Conceptual frame work: Source: Author's computation August 2017

MATERIAL AND METHODS

Research design:

The study utilized a descriptive research design technique. Cross sectional approach was used in this study where data was collected at one point in time.Qualitative and quantitative data from primary and secondary sources to facilitate triangulation

Name of population	**Sample frame**
International Oil companies (IOC)	5
Independent and medium operators (IMO)	10
Marginal fields operators (MFO)	10
Government Institutions	8

Table 2: Sample Frame Source: Author's Computation, May, 2016

Majors operators	**Independent and local/**	**Marginal field operators**	**Government institutions**
SPDC	Moni pulo	Umusadge (Mid-Western oil and Gas corporation	Nigerian Petroleum Development company
Exon- Mobil	Seplat	Umusati (Pillar Oil limited)	Department of petroleum Resources (DPR)
Agip	Conoco exploration and production	Ibigwe (Walter Smith Petroman	National Petroleum Investment Management System (NAPIMS)
Chevron-Texaco	Amni	Egboma (Platform)	Central Bank of Nigeria (CBN)
Total Elf	Oriental energy	Obodugwa/Obodeti (Enrgia Petroleum/Oando)	Nigeria Content Development and Monitoring Board (NCDMB)
	Peak petroleum industries Nig. Ltd	Ajapu (Britannia-U)	NNPC-Abuja
	Con oil producing	Ogbelle (Niger Delta Petroleum resources)	Nation oil and gas higher institution
	Pan ocean	Ebok (Oriental energy	Consultants to oil and gas company
	Staff of marginal field Operating companies	Oando PLC	Federal Inland revenue FIR
	Afren	Universal energy service	

Table 3: List of selected Nigerian upstream Operators and government institutionsSource authors computation May, 2016

Sample and sampling techniques:

The researcher used purposive sampling technique to select the participants. The methods that were adopted include the questionnaires and document analysis. Selection of these tools was guided by the nature of data collected, time available and objectives of the study. The data was organized, edited, analyzed and interpreted using descriptive statistics and inferential statistics.

Data analysis:

The researcher used the computer programme SPSS to code, enter and analyse quantitative data. Qualitative data from documents were analysed using content analysis method. Data analyzed was presented using tables, percentages, charts and graphs. Chi square analysis was used to compute the relationship

between the predictor and independent variables while multiple regression was applied for computation of the influence of independent variable on the dependent variables.

RESULT AND DISCUSSION

Case study on the role of technologies:

Use of sustainable technology to produce oil and to meet environmental regulations has developed new, improved techniques and strategies that accomplish both goals. The use of technology also makes good business sense and helps protect the environment.

Locations	Description	Solution	Result
Gemsa field (Egypt)	High operating cost for a marginal reserve	Cable deployed ESP	Reducing work over cost
July field (Egypt)	Located in a complex structure area (UP-dip attic oil reserve)	Horizontal drilling	Development of an estimated attic oil reserve of about 5MMBO
October field (Egypt)	High operating cost for a marginal reserve	Slim hole technology	Reduced the drilling cost and saved 80% of the cost of a conventional completion.
Gesium field	High operating cost for a marginal reserve	Convert jack-up rig to offshore platform	Operating cost reduced to 1.el to 12,000 BOPD
Semberah field (Indonesian)	Difficulty in detailed reservoir study	Extreme over balance perforating	Oil production increased from 5,000 bar rate increased from 36 BOPD to 104 BOPD
Albert field, Canada	Technical challenges	Horizontal wells, water injection , dual ESP system, subsea tie back technology and subsea multiphase metering	Horizontal wells produced 15: 20000
The younis field	High operating cost for marginal field	Using of coil tubing	Reduced the cost of pipes and time needed for pipe installation

Table 4: Unconventional Case Histories of marginal oil field developmentSource: SPE Egyptian section

Chi-square analysis results:

A. Technological factors

The results were presented using inadequate technical data, inadequate manpower, inadequate and inadequate local content policy as the technological barriers to marginal field development in Nigeria.

Factors	5(VH)		4(H)		3(H)		2(L)		1(VL)		Total
	No	%	No	%	No	%	No	%	No	%	
Inadequate technical data	17	23.3	14	19.2	21	28.7	12	16.4	9	12.3	73
Inadequate manpower	31	42.4	27	37	5	6.85	7	9.5	3	4.1	
Inadequate local content policy	25	34.42	27	36.98	10	13.69	8	10.9	3	4.11	

Table 5: Distribution by Technological barriers

Factors	**R**	**DF**	**L.S**	**χ2 table**	**χ2**	**Conclusion**
Inadequate technical data	6	4	0.05	9.488	5.83	Not Significant
Inadequate Manpower	1	4	0.05	9.488	48.44	Significant
Inadequate local content policy	2	4	0.05	9.44	31.56	Significant

Table 6: Significance tests and conclusion on Technical barriers to marginal field development

Table 5 indicates the extent to which inadequate technical data constitute technological barriers to marginal field operations in terms of no of responses on a scale of 1 (minor) to 5 (major), and a MS ranging between 1.00 and 5.00. It is notable that for a total of 73 no responses, 31 responses indicate high (17 very high and 14 high) indicates that in general the respondents may be deemed to perceive inadequate technical data as a barrier as opposed to not important 17 no response. A chi square analysis indicates that inadequate technical data constitute a barrier to the production of oil and gas in marginal field development.

Table 6 indicates the extent to which inadequate manpower constitute technological barriers to

marginal field operations in terms of no of responses on a scale of 1 (minor) to 5 (major), and a MS ranging between 1.00 and 5.00. It is notable that for a total of 73 no responses, 58 responses indicate high (31 very high and 27 high) indicates that in general the respondents can be deemed to perceive inadequate man power as a barrier as opposed to not important. This indicates that inadequate manpower constitutes a near major to major barrier to the production of oil and gas in marginal field development.

Tables 5 and table 6 present distributions of factors responsible for the technical barriers to marginal field development in Nigeria and a summary of statistical tests respectively. Inadequate local content development is one of the significant factors affecting marginal field development. The survey indicates that 70.4% agree that inadequate local content policy is a technological barrier to marginal field development, while 14.91% are of different view and 13.69% are not sure if inadequate local content development is a barrier to marginal oil field development. The findings is in agreement with Iledare (2008) submission that : In most oil producing provinces of the world, using local content inputs of production, skilled labour, local material, and local business entrepreneurs are the key factors for reduction in production cost.

Encourage local engineering design and fabrication of equipment and spares in Nigeria or the use of local content, for example encouraging the use of locally available materials, such as bentonite and barites as drilling fluid. In the pursuit of the objective of increasing local content in all oil and gas project carried out in the industry and maximizing the industry value addition to the entire Nigerian economy, the "Nigerian Content Development policy" was introduced in the industry in the year 2000 by the Nigerian Government.

Also Agiza et al (1995) observed that the more condensed use of national technical staff and companies can cut costs in the development of marginal oil field in the Egypt. The response table indicates that inadequate manpower appears to be one of the most significant factors responsible for the hindrance to marginal field development in Nigeria over 79.4 % agree that inadequate manpower is a significant factor in marginal field development while, 13.6 % disagree with this view and 13.6% are not sure. More over the chi square test reveals that inadequate manpower is a significant factor in marginal field development X2 calculated>X2 table value (48.44>9.44) at 5 percent confidence interval. This finding is in line with Osten (2012) submission that, capability and capacity issues are some of the hindrances to the development marginal fields. Capacity building is all it takes to make a sustainable business. The notion of human capital management, rest on the assumption that people are treated as asset rather than costs, and support the importance of adopting an integrated and strategic approach to managing people – which is the concern of all stakeholder in an organisation.The most interesting and revealing is the statistical insignificance of inadequate data since X2 calculated <X2 table value (5.83<9.48) at 5 percent level of test. Moreover, apart from 27.8 percent of respondents who are undecided, over 42.5 percent agree that inadequate technical data is not a significant factor.

Regression analysis results:

The specific objective of this study is to determine the influence of technological factors on the economic development of marginal oil fields in Nigeria. The study hypothesized that:

Ho: There is no significant influence of technological factors on marginal field development in Nigeria.

The model Y= Bo+BiXi+e was applied in order to text the hypothesis. The ability of technological influence to explain the variance in marginal field development in Nigeria is explained by the constant (Bo= -10.250, p<0.05) and coefficient of technological factors(Bi= 2.125 , p<0.05) as shown in the table 7.

Model Summary:

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.967[a]	.936	.914	4.94975

a. Predictors: (Constant), TECHNOLOGICAL_FACTORS

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1069.300	1	1069.300	43.645	.007[b]
	Residual	73.500	3	24.500		
	Total	1142.800	4			

a. Dependent Variable: MARGINAL_OIL_FIELD_DEVELOPMENT

b. Predictors: (Constant), TECHNOLOGICAL_FACTORS)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-10.250	5.250		-1.952	.146
	TECHNOLOGICAL_FACTORS	2.125	.322	.967	6.606	.007

Table 7: Regression of marginal oil field development and Technological influence in Nigeria

The resulting model is: MFD= 2.125TF-10.25+e

Where =MFD= Marginal field development

TF=Technological factors

e = Error term

The prediction power of this model is significant since both the constant and technological influence have P<0.05. Based on this result the null hypothesis is rejected and the alternate hypothesis accepted that, there is statistically significant influence of technological factors on marginal field development in Nigeria. In the model, technological factors explain approximately 93.6% of the variance in marginal field development. The model is a good fit as shown through analysis of variance (ANOVA) since F values equal 43.6 and P<0.05)

The‘t’values show the significant and comparatively high relatedness of predicting variable and criterion variable. The results show that the beta values for Technological factors is 2.125. Therefore technological factors significantly influence the effective economic development of marginal oil field. The study concludes that technological factors have a significant positive influence on marginal field development in Nigeria.

From the result analysis table, R-squared value is =0.936. This means that 93.6% of the variation on the Marginal oil field can be explained by Technological factors. Since the R-Squared value is high, we can say that additional variables to Technological factor to predict marginal oil field development might not be necessary, because it will only result to little or no additional information..

Conclusion: Since the significant values are all less than 5% significant level, we have the statistical reason to reject $H_o$and conclude that economic development of marginal oil field significantly depends on technological l factors (humancapital or skilled manpower and the use of innovative technologies).

CONCLUSION AND RECOMMENDATIONS

Conclusion: The following conclusion has been made.

- The role of technology in marginal field development is to reduce cost and increase the profitability of marginal oil field.
- Inadequate capacity building or inadequate manpower development impedes the development of marginal oil fields.
- Inadequate local policy also negatively affect marginal field development

Recommendations: The following recommendations are made:

- Capacity building will help to enhance the development of marginal oil field in any economy. The development of institutional capacity of oil and gas for engineers and technician is essential- encouraging universities to develop curriculum and facilitating of dialogue between industry and research institution and universities. This could include establishing a network of centres of educational excellence,

expansion of fellowships and scholarships and developing program of collaborative research.

- In the short run the Nigeria government should assist the oil and gas companies in gathering information about Nigeria in Diaspora who have these skills set that oil companies are looking for. In the long run, they should improve and accelerate the training programms at Warri Petroleum Training institute in order to meet the goal or adequate labour need for the sector.
- Efforts must be made to promote the value of the need for collaboration, building on those achievements and communicating success stories to different stakeholders, particularly policymakers, in order to justify the allocation of resources for further cooperative activities. Also local content policy should be improved.
- Productive enterprise both public and private can contribute to overcoming knowledge gap by promoting technical change and encouraging enterprise and innovation. Possible areas of focus include joint production arrangement and R&D with transnational corporation in oil and gas, promotion of small and medium enterprises; setting up consortia of consultancy and design firms; and promoting link between research institutions and productive enterprise to enhance the commercial use of research results.

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