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ASSESSMENT OF PROFITABILITY AND IMPACT OF RISKED VARIABLES ON THE VIABILITY OF AJAOKUTA-KADUNA-KANO GAS PIPELINE

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ABSTRACT: *The Nigeria Gas Master Plan (NGMP) was developed in 2008 as a result of the Country's resolve to become a major player in the international gas market as well as to lay a solid framework for gas infrastructure development within the domestic market. The full liberalization of the gas industry translates to a clear definition of the roles of the different stakeholders in the industry, viz. government, institutional financiers, investors, and others. In line with the core mandate of infrastructure development and market expansion of the master plan, the pipeline is identified as a major and significant infrastructure for natural gas transportation and distribution. The South-North pipeline, i.e., Ajaokuta-Kaduna-Kano (AKK) pipeline option, requiresa significant upfront investment running into billions of dollars and is also characterised by a long lead time as many years may elapse before revenues begin to accrue. Because of the large upfront expenditure required for this project, it is imperative that investors are well informed of the risk to which their capital is exposed. This research seeks to evaluate using appropriate techniques for the economic justification of AKK. In assessing the economics of the AKK pipeline option, the discounted cash flow analysis (DCF) was employed using the following project profit indices viz; NPV, IRR, and payback. Initial investment cost (IIC) comprises the cost of constructing pipelines and compressor stations. Based on industry practice, operations and maintenance costs were assumed to be 2% of IIC, the debt ratio was 60:40, and pipeline capacity was estimated using the Weymouth formula as provided in the pipeline's rule of thumb. The cost of equity and debt was accounted for using an average weighted cost of capital. Finally, a probabilistic analysis using "@risk" was run on key inputs to test their sensitivities. AKK was estimated to have an annual gas delivery of 2.3bcm, an investment cost of $2.009 billion, and a discount rate of 15% was used. The pipeline was found to be viable, with an NPV of $484 Million, an IRR of 17.7%, and a payback period of 7 years for forty years of operation. The pipeline cash flow model was sensitive to discount rate, CAPEX, and Pipeline capacity. The Ajaokuta- Kaduna-Kano pipeline has a positive NPV of approximately $484.40 million for forty years of operation. This results in an average of about $12.11 million present value of operating net cash flow per annum, which means that the business cash flow can meet all the operating costs and still return a positive net profit.*

KEYWORDS: Profitability, Risked variables, Viability, AKK.

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INTRODUCTION

Natural gas assumes an extremely important status worldwide, both as a source of cleaner energy and a major feedstock for many products. EIA-International energy outlook (2017) projects increased world consumption of marketed energy from fuel sources-except coal, with natural gas as the fastest growing fossil fuel. The report projects an annual global natural gas increase of 1.4 %/year to 2040. Most of the world's energy growth will occur in emerging economies where strong, long-term economic growth drives increasing demand for energy.

Africa is seen by many as the next emerging market. David McDonald (2017), founder of the global millennia on Quora, posits that a drastic shift toward financial sustainability is currently happening in Africa, leading many analysts to call it the next emerging market. Apart from the financial burst, energy demand is soaring. According to BP statistical review, Africa's energy consumption grew by 1.2 percent in 2016, faster than the global average of 1.0 percent. Its share in global primary energy consumption reached 3.3 percent, the highest in BP's record. The dominance of oil and gas resources in the total energy mix will continue up to 2040 in Africa, as reported in the IEA Africa energy outlook, due to the slow growth of their potential replacement and/or alternative (Adamu &Muttaqa, 2016).

Africa is endowed with vast quantities of both fossil and renewable energy resources. It is one of the continents in the world with frequent and substantial new findings on oil and gas. According to a report by Africa Development Bank and Africa Union, Oil and Gas in Africa, in the past 35 years, oil reserves in Africa grew by over 25 percent while gas grew by over 100 percent. Africa's rich oil and gas fields and the prospects for more discoveries have transformed it into an important player and a key target in global oil and gas production (Oil and Gas in Africa, 2015).

In particular, Nigeria's underdeveloped natural gas reserves are a logical target of the international giants in the sector and for utilization and monetization. Nigeria's abundant natural gas resources must be more fully utilised to meet the rapidly increasing demand for energy, domestically and internationally. Nigeria's Natural gas availability, versatility, accessibility, and, more importantly, its clean-burning characteristics, when compared to other fossil fuels, is a substantial driver for its further utilisation in the country (Chekezie and David, 2014). The mgas market has changed in the last couple of decades, and it is currently experiencing rapid market expansion compared to other fossil fuels (Economides and Wood, 2009). Investment in natural gas, especially in transportation and storage, continues to grow to respond to increases in demand from the three major demand components- electric power generation, industrial use, and export.

As Nigeria heightens its resolve to become a major player in the international gas market and lay a solid framework for gas infrastructure expansion within the domestic market, the Nigerian gas master plan of liberalisation was approved in 2008. By fully liberalizing the market, the different roles that the government will play in institutional financiers, investors, and other stakeholders in the Natural Gas industry are clearly spelled out and undergoing further review as the plan moves into the implementation stage (Akinpelu, Omole, and Falode 2010). In line with the core mandate of infrastructural development and market expansion of the master plan, the pipeline is identified as a major and significant infrastructure for utilising natural gas. Pipeline networks are important because they run

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across multiple states to bring fuels and gases to a variety of consumers, including homeowners, businesses, and power plants (Adamu, 2015).

The Ajaokuta-Kaduna-Kano pipeline option South-North requires a large upfront investment running into billions of dollars. It is also characterised by a long lead time, as many years may elapse before revenues begin to accrue. Because of the large upfront expenditure required for these projects, investors must be well informed of the risk to which their capital is exposed (Akinpelu and Isehunwa, 2016).

This research aims to appraise the economic justification of the AKK gas pipeline using different evaluation tools used in the oil and gas industry and to account for the uncertainties involved in the gas development project.

The research objective is to determine the economic viability of a key gas infrastructure project – the AKK pipeline project. Based on these economics, it will reveal if the gas pipeline project will make economic sense to investors for consideration as an investment option in the gas infrastructure expansion drive in the country. Another objective is to estimate the profitability of the gas route to find out how lucrative, intensive and sensitive these investments are compared to others in the industry in the country.

The research is significant as it provides empirical and analytical analysis of the proposed Ajaokuta-Kaduna-Kano gas pipeline. It presents a kind of conceptual structure indicating its viability or otherwise to government and prospective investors in the gas sector. It also informs the government and prospective investors on the resulting costs and benefits of the gas pipeline to guide them in making informed investment decisions. The research is also significant because it analysis the sensitivity of the gas project to different scenarios and exposes the risk involved in the gas project to investors.

Nigeria Gas Development Projects

In Nigeria, it is technically feasible to harness natural gas for social and economic development, like in most developed countries of the world. Christiansen and Haugland (2001) noted that it is common knowledge that to find outlets for some of the gas in the domestic and regional networks, there should be a deliberate policy on gas development to eliminate routine gas flaring that is synonymous with the oil and gas industry in Nigeria. Thus, natural gas gathering, transmission, and distribution infrastructure in the domestic, regional, and international networks are critical to gas utilization. The capture and use of natural gas represent the opportunity to plan and implement economic growth and environmental preservation for sustainable development in Nigeria. Undoubtedly, domestic, regional, and international gas development projects promote gas utilization and export, energy efficiency, and sustainable management of non-renewable resources.

The selection of an appropriate development concept is required for the effective development of the hydrocarbon gas field. A number of technological solutions and engineering concepts for handling and processing gas are available. Nevertheless, the economics of any gas project is determined by the following factors: available gas reserves, cost of field development and operation, gas price, sales contracts, and governing fiscal regimes. The main technologies currently used or planned in utilising stranded natural gas resources in Nigeria are; Liquefied Natural Gas, Compressed Natural Gas, Gas pipeline, etc.

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Gas pipeline

Currently, natural gas is transported to the markets by pipelines. Transporting natural gas by pipelines which accounts for 75% of the total volume of gas transported in the world (Deshpande and Economides, 2005), is convenient and economical for onshore purposes. Pipeline is the principal and most convenient method of transporting gas, either from an offshore location to onshore for processing or to interface with existing distribution grids. It is also used for the transportation of export gas. For offshore transport of natural gas, pipelines become challenging as the water depth and the transporting distance increase. The economics of gas transportation through a pipeline is a function of distance. Durr et al. (2007) reported the relative costs of gas delivery by pipelines versus LNG. Generally, a sub-sea pipeline is limited to transporting large gas volumes over relatively short distances. Similarly, for gas volumes less than 200 MMSCFD (million standard cubic feet), the use of pipelines will lose viability to other alternatives such as Compressed Natural Gas (CNG) and electricity conversion (gas-to-wire) (Eriksen et al., 2002).

Regional Delivery System

Pipeline delivery systems in Nigeria can be categorized into two- Regional delivery systems and Nigeria Natural gas delivery systems. The regional system is an export line that delivers gas to the African sub-region, and plans are underway to expand the system to Europe. The West African Gas Pipeline (WAGP) was established as an international gas transmission system to transport natural gas from Nigeria to consumers in Benin, Togo, and Ghana. Headquartered in Accra, WAPCo owns and operates the WAGP system, which consists of 691km of pipelines and associated processing/receiving facilities in Lagos, Itoki, Tema, Takoradi, Lome, and Cotonou.

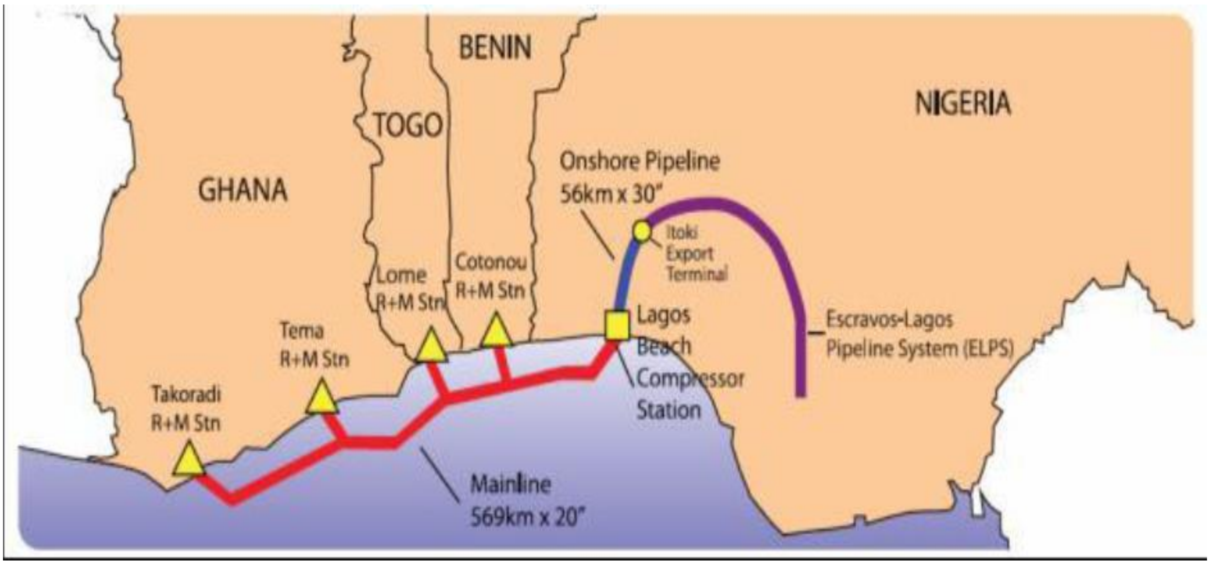

Figure 1: West Africa Gas Pipeline (WAGP). Sourced: WAGP value chain market forum.

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Gas shipped through WAGP is produced through a gas production agreement by NNPC/SPDC and NNPC/CNL. The produced gas is transmitted through ELPS, guided by a gas transport agreement. WAPCO takes delivery of the gas and delivers the same base on the provisions of a gas sales agreement to Volta River Authority (VRA) and CommuninauteElectrigue du Benin (CEB) at a cost of $8.358.

Trans-sahara Pipeline System

Nigeria, in collaboration with Niger and Algeria, proposes a trans-Saharan gas pipeline project aimed at transmitting natural gas from Nigeria's Niger Delta for delivery to the European Market. The 4,400 km pipeline project is poised to occupy a more important place in Europe energy balance. It is projected that natural gas imports may reach 85% of EU gas consumption by 2030 raising the issue of long-term security of supply (Fisoye, 2017). The supply of gas from Nigeria to the European Market would be approximately half the distance from Western Siberian fields and only 25% longer than the northern most offshore fields in Norway (Odumugbo, 2010). Therefore, Nigerian gas should be able to compete favourably in the European market, which already consumes Nigerian LNG. The Trans-Sahara Gas Pipeline (TSGP) project will help to integrate the economies of the sub-region in line with objectives of NEPAD, promote growth and poverty alleviation by opening up economic growth opportunities in the sub-region and assist in the fight against deforestation and desertification by preventing the widespread use of wood for energy (Fisoye, 2017). The project will also recover flared gas in Nigeria, which represents a loss of energy equivalent to 220.000 barrels/day with serious environmental consequences and emissions (EIE, 2017).

The proposed natural gas pipeline will be designed to connect to the existing Trans-Mediterranean, Maghreb-Europe, Medgaz, and Galsi pipelines across the Mediterranean Sea. The length of the pipeline is estimated at roughly 4,400 kilometers, with over 1000km in Nigeria, 840 km in Asia, 2300 km in Algeria, and 220 km connecting Algeria to Spain. The pipeline would initiate in the Niger Delta basin, crossing vast spans of the Sahel region and the Sahara desert before reaching HassiR'Mel, a natural gas and oil pipeline hub running to the Algerian coast.

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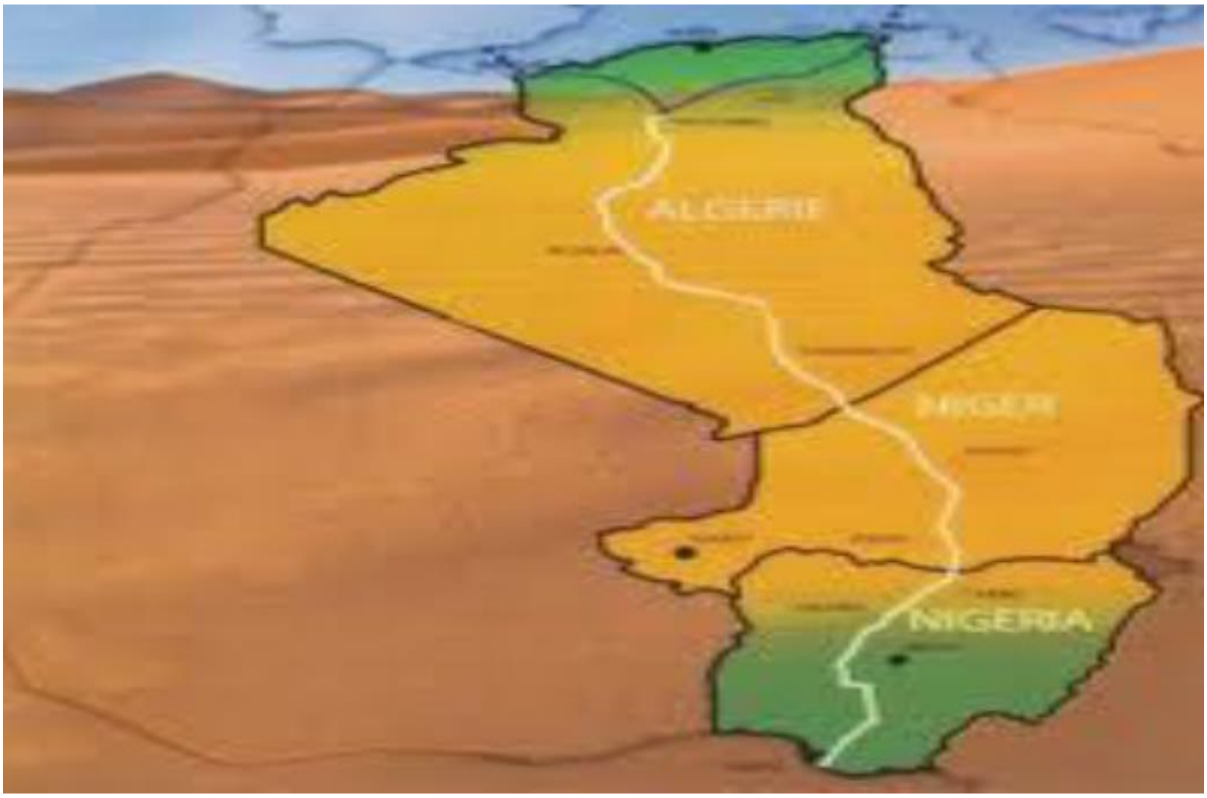

Figure 2: Trans-Sahara Gas pipeline. Sourced: Fisoye D., 2017.

Nigeria Natural Gas Delivery System

Nigeria Gas Company, a subsidiary of NNPC owns the over 1000 km gas transmission system in Nigeria comprised of the western network system, Northern network system, and Eastern network system. Majority of these pipelines are laid in the Niger delta region. Other pipelines beyond the gas-producing region are the Ajaokuta gas pipeline and the main Nigerian Escravos-Lagos Pipeline system that links the pipelines to the Lagos beach, which links to the West African gas pipeline.

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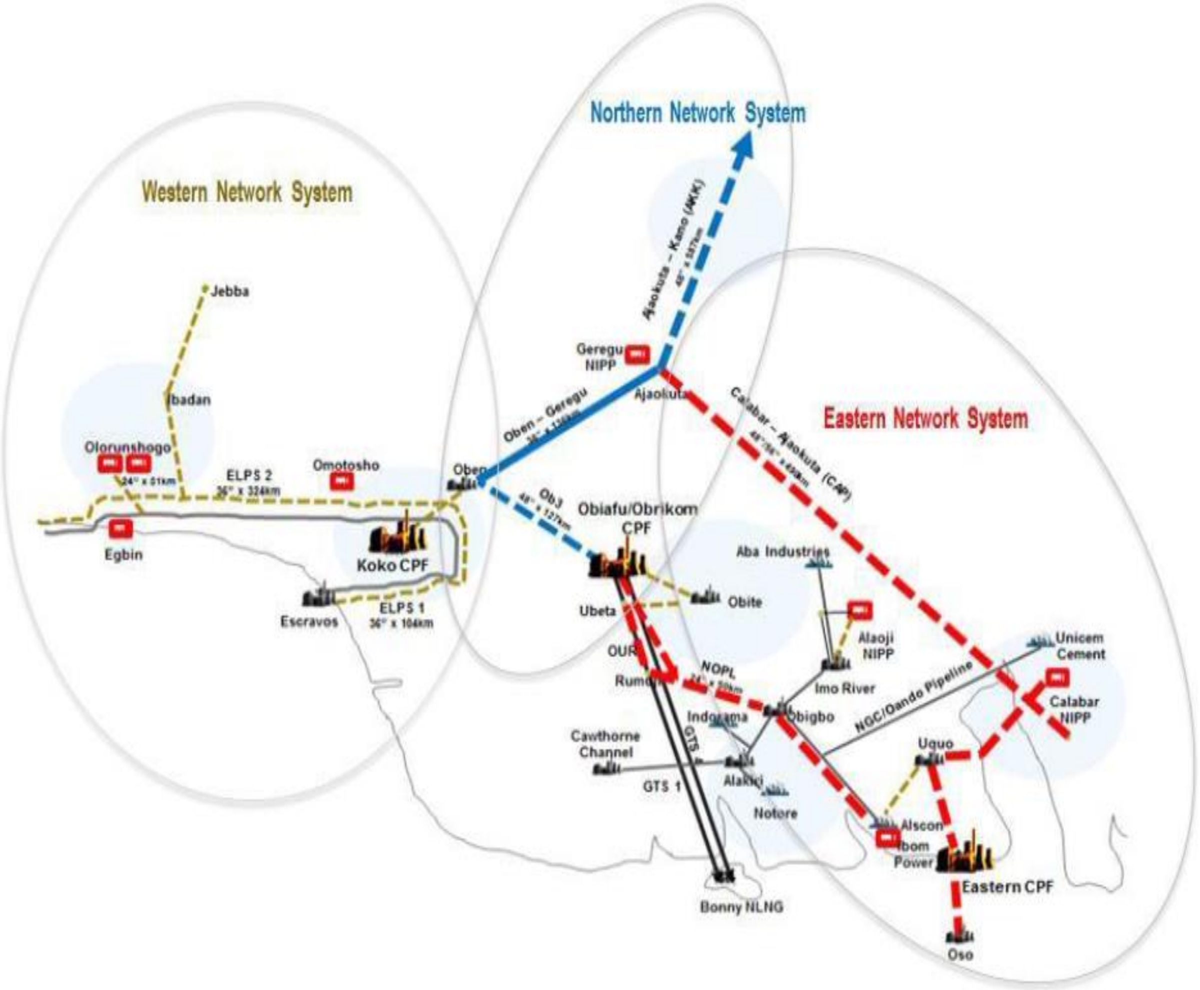

Figure 3: Nigeria Main Pipeline Systems. Sourced: Fisoye D., (2017).

Escravos-Lagos Pipeline System (ELPS)

Escravos-Lagos pipeline system (ELPS) is a natural gas pipeline built in 1989 to supply gas from the Escravos region of the Niger Delta area to Egbin Power Station, Lagos in Nigeria. The 800 mcf/d western infrastructure now feeds the southwest's s residential and industrial consumption centers and the West African gas pipeline. Subsequent spur lines from the ELP supply Delta power plant at Ughelli, Warri Refining and Petrochemical Company at Warri, the West African Portland Cement (WAPCO) Plant at Shagamu and Ewekoro, industries at Ikorodu, City Gate in Ikeja Lagos. Since the NIPP power plants emerged, ELPS has been the major gas supply artery to the power plants in Nigeria. ELPS is fed from two main systems: the Western Gas Gathering system and the southern Gathering system. The Western Gas Gathering System comprises compressor stations (CS) at Escravos Beach, Makaraba (Chevron), Jones Creek, and the Odidi CS/gas plant (GP). The Chevron Nigeria Limited Escravos Gas Plant is also connected to the gathering system that feeds gas to the Warri Gas Treatment Plant. The Southern Gas Gathering System consists of Utorogu Gas Plant. It includes a 12-inch spur line into the Ughelli metering station, which can supply gas to the NEPA Ughelli Delta VI Power Station. The Utorogu Gas Plant is connected via a 14-inch

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pipeline for the supply of AG gas into the Aladja collecting and distribution system of which the Ughelli NAG plant is part. Warri GP blends the gasses from the Western and Southern systems. The result is that the export pressure of Utorogu GP determines the export pressure into the ELPS from the Warri plant.

Escravo-Lagos Pipeline System (Expansion)

The ELPS expansion project aims to increase the ELPS system's pipeline capacity from about 1.1 bscfd to 2.2 bscfd. Phase1 of the expansion project involved looping the Escravos Node to Oben Node (PS1) segment of the ELPS. This was completed in 2013. The ongoing looping of the PS1 –PS5 segment of the ELP is ongoing, and nearing completion. After the complete looping of the ELPS, the mainline (PS1-PS5) segment will have the capacity of transporting about 2.2 bscfd with the right pressure regime.

Ajaokutoa-Kaduna-kano Gas Pipeline

AKK, also known as the trans-Nigeria gas pipeline is an extension of the south to the north gas pipeline. The south to the north gas pipeline is 56 inches and 48 inches diameter pipelines, from Calabar to Ajaokuta (of 490 kilometres), Ajaokuta to Kaduna (of 495 kilometres), and Kaduna to Kano. This is also part of the Nigerian gas master plan, which will ensure adequate gas supply to the north, improve gas infrastructure expansion within the domestic market and boost power generation (Ige, 2014). AKK is estimated to cost more than $2 billion with a debt and equity ratio of 60:40 (GMP, 2017).

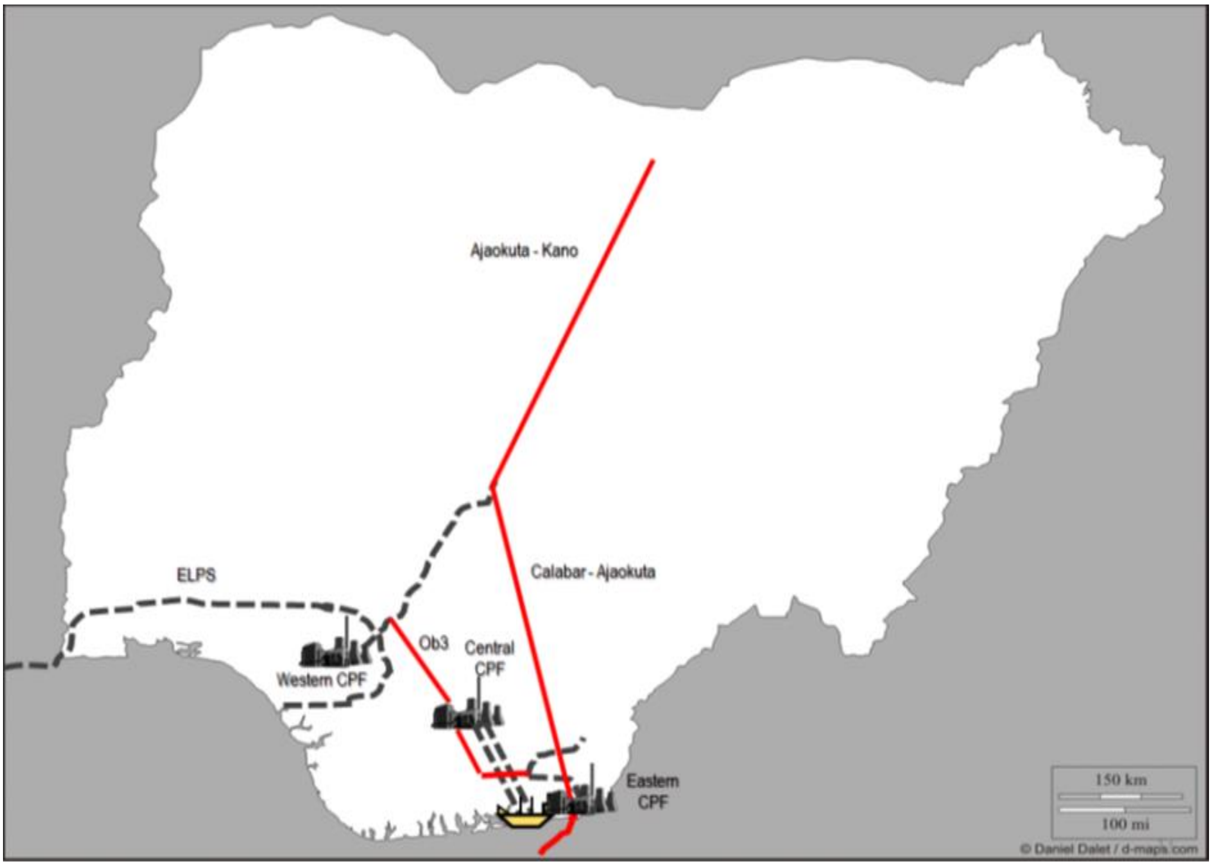

Figure 4: Nigeria Gas Transmission system. Sourced: Danieldalet/d-maps.com

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Commercial Framework

The gas pricing framework carefully balances the requirements of various stakeholder groups and comprises three sections – a regulated regime, a pseudo regulated, and a market-led regime. The figure below presents a schematic of the gas pricing framework approved by the Government. This framework can be applied generically to any sector. The framework plots the proposed gas price for the sector against a variable called the sector strategic saturation index, through which the capacity of a sector is measured against the demand for its products.

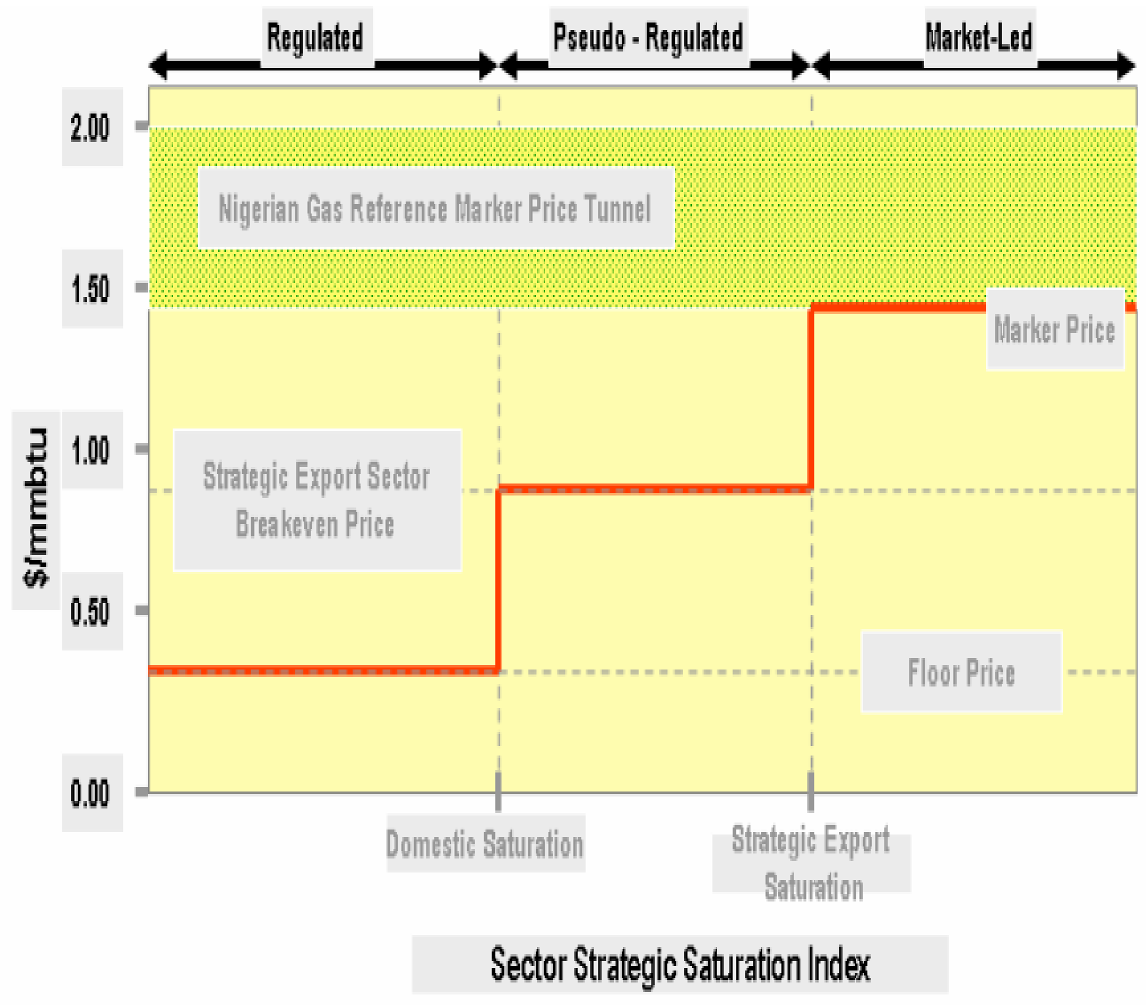

Figure 5: Sector Strategic Saturation Index. Sourced: Gas Aggregation Company of Nigeria.

METHODOLOGY

Here, the methodology in determining the economics of the Ajaokuta-Kaduna-Kano gas pipeline would be discussed. In determining the costs and benefits of the gas pipeline route, first, the capital structure comprising of debt and equity and the cost of capital of the gas pipeline will be estimated. This will be followed by an estimation of investment cost

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comprising gas pipeline material cost, pipe coating, wrapping cost, cost of constructing the compressor stations, gas delivery, and labour cost using models adjusted for inflation already existing in the literature.

The overall profitability of the proposed gas pipeline project will then be analysed using the NPV, IRR, and payback period methods.

Determination of Capital Structure and Cost of Capital

Capital structure reflects how much a project's financing results from debt as opposed to equity. Firms choose an appropriate (optimal) debt level based on a trade-off between benefits and the cost of debt (Krishnan and Moyer, 1997). Pierru, Roussanly, and Sabathier (2013) allude that the financing mix of projects is susceptible to vary substantially concerning the industrial sector. In project finance in the oil and gas industry, a typical financing mix consists of 20-40% equity, and the rest is raised as debt (Dailami and Liepziger, 1998). The average debt ratio is 67%, according to Kleimeier and Megginson (2001). The capital structure of the gas pipeline investment will be 60% debt and 40% equity, which is in line with the capital structure of most proposed domestic gas pipelines as contained in the Nigeria gas master plan. And it is also the capital structure of an average oil and gas listed company in the country.

So, the cost of equity and the cost of debt will be used to arrive at the cost of capital for the pipeline investment appraisal. For the cost of equity, there are various ways to calculate it. Here, the common approach, the capital asset pricing model (CAPM), in which an equity risk premium is added to the risk-free return, will be used (Oni, 2017). The cost of debt usually reflects the yield to maturity (or annual return) on the company's debt (Oni, 2017). Weighted Average Cost of Capita (WACC) will then be deployed to account for both cost of debt and the cost of equity, from which all cash flows will be discounted. WACC is used because it calculates the marginal cost of each source of capital marginal cost and then takes the weighted average of these costs (Oni, 2017).

$$WACC = ((E/V)*Ce) + (((D/V) * Cd) *(1-TX))$$

Where;

E is the total value of the equity,

V is the total value of the capital,

D is the total value of the debt,

C*e* is the cost of equity,

C*d* is the cost of debt and

Tx is the tax rate, which is 30 percent in Nigeria (FIRS, 2017).

Starting with the cost of debt, I will use the after-tax cost of debt going by (Oni, 2017), which is:

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$$cd = r * (1 - Tx)$$

Where:

r is the prime lending rate of the Nigerian commercial bank, which is 17.42. The prime lending rate of 17.42 is a one-year (May 2017- April 2018) average (CBN, 2018) and has been the average prime lending rate for some time now (Trending Economics, 2017). This rate is used based on the assumption that a bank will provide the debt to fund these projects within Nigeria.

The CAPM is a standard formula in finance, and it is stated as follows (Oni, 2017).

$$ke = rf + \beta(rm - rf)$$

Where:

ke is the expected rate of return on asset or cost of equity,

rf is the risk free rate of return,

rm is the expected market rate of return,

$(rm - rf)$ technically measures what is called the equity risk premium (ERP), which measures the additional compensation to the investor for taking the risk of investing in a riskier business, and β measures the rate at which the returns on your project fluctuates with that of the market. Beta is more project/asset specific. $rf$is the rate of return on short-term Government securities that the investor may wish to invest in, usually 90-day Treasury bill. However, the duration of your project might be better as a matching timeline for your risk-free asset (Oni, 2017). The yield on the Nigerian government bond is used as the risk-free interest rate. According to investing.com, the yield on the Nigerian government 5-year bonds has averaged around 15.61 percent for 52 weeks. The return on the bonds changes frequently; its 52 weeks range is 14.638-16.588.

The ERP, as mentioned, is the average return that investors require over the risk-free rate for accepting the higher variability in returns common for equity investments i.e., the ERP reflects a minimum threshold for investors to be willing to invest (KPMG, 2018). According to Moody's risk premium report, Nigeria's estimated equity risk premium has soared from 11.15 percent to 18 percent. So I used the latest ERP for this analysis, which is 18 percent. Therefore, the expected market portfolio return can be assumed to be 18 percent plus a 15.61 percent risk-free rate, giving 33.61 percent as the expected market portfolio return. This is the maximum return the investor will expect for investing in a riskier investment, and it will be the rm in the equation above. Rm accounts for some peculiar risk factors associated with running a business in the country. The next variable to explain is β (Beta). Beta measures the rate at which the returns on your project fluctuate with that of the market. It is calculated as the slope of a stock's return against the market's return (Oni, 2017). Beta is more project/asset specific. A Beta lower than one shows that the stock value is less volatile than the stock market, and if it is higher than 1, it shows that it is more volatile than the market. The formula for the Beta is given as follows

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$$\frac{Equity\ Beta}{1+\frac{1-tax}{debt}(\frac{debt}{equity})}$$

Because there is no available data from Nigerian stock market for domestic gas pipeline investment, as there are no listed gas pipeline companies in the country, the average $Beta$ of seven listed oil and gas companies (BOC Gases Nigeria PLC, Conoil PLC, Eterna Plc, Forte Oil Plc, Mobil Oil Nigeria Plc, MRS Oil Nigeria Plc, Oando Plc) in the country is used as the proxy Beta for the investments, which was 0.86 as at July 2015 (Adamu, 2015).

Because the capital structure contains debt, paying off the debt by gradual retirement will be accounted for using the amortization formula (Miam, 2004).

$$Av = pv\left[\frac{i(1+i)}{(1+i)-1}\right]^{t}$$

Where

t is the total number of periods.

i is the interest

Determination of Initial Investment Cost

The initial investment cost (IIC) of this pipeline is estimated using the equation by Shashi, 2005.

$$IIC = E(CCP) + E(CCMs)$$

Where:

E (CCP) is the expected cost of constructing/laying down the gas pipelines, and

E (CCMS) is the expected cost of installing compressor stations.

The cost of constructing the pipeline E (CCP) consists of fixed cost which is the cost of material, and right of way (ROW) if applicable. It also consists of the costs of process equipment, supporting facilities, direct/indirect labour etc. According to Shashi (2005), the pipeline construction cost formula is as follows:

$$E(CCP) = PMC + PCW + LC$$

Where:

PMC is the pipe material cost, and

PCW is the cost of pipe coating and wrapping, and

LC stands for the labour cost of installing the pipeline.

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The model established by Shahi Menon, (2005) will be adopted with adjustment for inflation using CPI, provided by the Bureau of labour statics of the USA, to estimate the cost of laying down a pipeline. He suggested that the costs of constructing a pipeline include the costs of pipe materials, pipe coating and fittings, and the cost of labour for installation. These parameters were incorporated in the equation above and are defined as follows:

$PCW = PMC * 5\%.$

Therefore, the PCW is 5% of the pipe material cost, which is defined in the equation below.

$$PMC = \frac{10.68(D-T)TLC * 5280}{2000}$$

Where:

D is the diameter (outside) of the pipe in millimeters (mm),

L stands for the length of the pipe in km,

T stands for the pipe wall thickness in mm and

C is the pipe material cost in $/metric ton (NGMP, 2013).

The labor cost during installation is proportional to a number of variables, such as terrain, length, and pipeline brand. The contractor estimates labour costs with a contingency and allowance and prepares a lump-sum bid to win the contract (Haneberge and Bruce, 2013). Data from some gas construction companies show a fixed amount for every diameter and distance of the pipeline, normally $15,000 as the average labour cost during installation (Mohipour, Golshang, and Murray, 2003). In line with the above and for the purpose of this research, the labour cost of pipeline installation will be estimated using the model by Shashi Menon, 2005.

$$LC = \$15000 * diameter\ (in) * length$$

A compressor station is installed to keep natural gas flowing continually. A compressor station is normally constructed every 50-100 miles along the pipeline (Interstate Natural Gas Association of America, 2010). The minimal interval is adopted for this work to maintain high pressure. The cost of constructing and installing compressor stations will be estimated using the model established by Shahi Menon (2005), which estimates the compressor cost as $2000 per Horsepower capacity of the compressor. This figure will be corrected for inflation. Therefore, the cost of compressors for a pipeline will be $2000 multiplied by the number of compressors and then multiplied by the Horsepower capacity of the compressors.

$$CCMS = \$2000 * Horsepower * number\ of\ compressors$$

The equation below will be used to determine pipeline thickness (t), this is as contained in Shashi Menon (2005), pipeline Hydraulics.

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$$t = DO - DI$$

Where:

DO is the diameter outside, and

DI is the diameter inside.

Operating and maintenance costs will be forecasted, Although the Ajaokuta-Kaduna-Kano pipeline is not operational. O and M cost consist of costs of labour, supervision, energy, telecommunication, miscellaneous, etc. An assumption is made based on existing literature: to adopt a fixed percentage of the investment cost to be the annual O and M cost. 2% of the costs of constructing the pipeline will be assumed to be the O and M costs annually (Krey and Minullin, 2010).

Depreciation will also be accounted for using the Straight-line depreciation method, which allocates an asset's cost over its productive lives (Libby, 2004). Under the Straight-Line method, an equal portion of an asset's depreciable cost is allocated to each accounting period over its estimated useful life, which is 40 years (Libby, 2004). However, because we will have a salvage value (SV) of the gas pipelines in our analysis, a salvage value will be considered, deducted from the value of the pipelines before applying the straight-line depreciation, and is given as follows (Elliot, 2008).

$$dr = (cost - sv) * \frac{1}{useful} life$$

$$Sv = iic * (1 - dr) time$$

Where dr is the depreciation rate and sv is salvage value.

Annual Flow of Gas

For the annual gas delivery of the gas pipeline, the availability rate will be multiplied by the annual gas delivery capacity to arrive at the actual gas delivery of the pipeline (MacAllister, 2009).

$$\sum_{n=1}^{N} \quad Availability\ factor * annual\ pipeline\ capacity\ (mcf)$$

The availability rate is applied base on the existing pipelines average availability rate in the country, which is 60% (NGC, 2017). This account for the number of days the pipeline will be operational. The Nigerian regulated gas transportation cost of $0.80/Mcf is used (GACN, 2018). To calculate the volume of gas/capacity of a pipeline, the Weymouth formula is used as provided in pipeline rules of thumb (MacAllister, 2009), which assumes that the optimum number of compressors are in place to achieve the desired pressure level of the gas at the destination using the lowest compressor station intervals. It is presented in the equation below:

$$Q = \frac{(871)(d^{\frac{8}{3}})\sqrt{P_1^2 - P_2^2}}{\sqrt{L}}$$

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Where:

Q is Cubic feet of gas per 24 hours

d is pipeline inside diameter in inches

P1 is Psi (abs) at starting point

P2 is Psi (abs) at ending point

L is Length of the pipeline in miles.

Investment Evaluation Criteria

The Net Present Value (NPVcostscounts for the difference between the initial investment cost and the present values of all the future cash inflows and cash outflows using the equation below (Akinpelu, 2017).

$$NPV = -C0 + \frac{C1}{(1+r)} + \frac{C2}{(1+r)^2 \dots + \frac{Ct}{(1+r)^t}}$$

Where:

$C0$ is the initial investment cost,

Cs are the net cash flows of respective periods,

r is the discount rate, and

t is the end period.

For the Internal Rate of Return (IRR), it is the maximum allowable rate of return on the investment; it is the discount rate that brings the business to breakeven, where NPV equals to zero. It is derived by trying so many discount rates, and the discount rate that makes the NPV zero is the IRR (Akinpelu, 2017).

The payback period is the number of years that the investor will have to wait to get back his/her initial investment. The discounted payback period is derived by dividing the absolute value of the last negative cumulative discounted cash flow by the discounted cash flow value in the following year and then adding the period of the last negative cumulative discounted cash flow, this is presented in the equation below (Akinpelu, 2017).

$$Discounted\ payback\ period = A + \frac{B}{C}$$

Where A is the period where last negative cumulative discounted cash flow was recorded,

B is the absolute value of the last negative cumulative discounted cash flow at period A, and C is the discounted cash flow value after the period A.

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Using all the above costs and benefits inputs, an annual cash flow of these investments will be derived and discounted to arrive at the net present value, IRR and Payback period, which will be used for analysis.

Analysis

Having presented models/formula to be used, the cost of the Ajaokuta-Kaduna-Kano gas pipeline would now be built. First, the pipeline thickness (t) will be calculated using the formula already presented in work. The pipeline network has a 40-inch diameter pipe.

$$t = \frac{40in - 39in}{2} = 0.5in\ (12.7mm)$$

Therefore, 0.5 in (12.7mm) will be adopted as wall thickness for AKK.

Pipeline Construction Cost

This cost over time has up to six variations but can be put under four headings- material, labour, Miscellaneous, and right of way (ROW). Each category is estimated under a separate head.

Material Cost

As established by Shahi (2005), pipe material cost (PMC) of $ 1036.36 per tonne is adopted. The cost per tonne is arrived at after treating $800/t for the effect of inflation. The PMC for the three segments of the gas pipeline are presented below:

Table 4.1: Computation of Pipe Material Cost

Pipeline	Diameter	Length (km)	Length (miles)	Pipeline Thickness(in	Cost per ton	PMC
Ajaokuta-Abuja	40	200	124.274	12.7	1036.36	71,718,830.49
Abuja-Kaduna	40	193	119.925	12.7	1036.36	69,209,011.92
Kaduna-Kano	40	221	137.323	12.7	1036.36	79,249,440.43
Total			381.522			220,177,282.80

Generally, pipes are supplied externally coated and wrapped, therefore an extra cost of say 5% is added to the bare pipe cost 220,177,282.80*0.05=11,008,864.14 . This will account for coating and wrapping costs and delivery costs. This will bring PMC to 231,186,146.98

Labour Cost

Going by Menon's (2005) equation on labour cost estimation, the cost of installing AKK is presented in table below:

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Table 4.2: Computation of Labour Cost

PIPELINE	DIAMETER (In)	LENGTH (MILES)	LABOUR COST ($/MILE)	TOTAL ($)
Ajaokuta-Abuja	40	124.274	19,431.74	96,594,402.27
Abuja- Kaduna	40	119.925	19,431.74	93,214,056.78
Kaduna- Kano	40	137.323	19,431.74	106,736,993.30
Total				296,545,452.30

For other construction cost such as road, rail, streams and river crossings, 5 % of the cost of installation will be charged, that is 296,545,452.30*0.05=14,827,272.62. This will bring the total installation cost to 311,372,724.95.

Miscellaneous

Main Valve Station

Six mainline valve stations will be installed for every 100 miles at $129,544.93 per station (Menon, 2005). The table below shows the estimates.

Table 4.3: Computation of Cost of Main Valve

Pipeline	Diameter	LENGTH (MILES)	Mainline valves	$129,544.93 per valve Station
Ajaokuta-Abuja	40	124.274	8	1,036,359.44
Abuja- Kaduna	40	119.925	7	906,814.51
Kaduna- Kano	40	137.323	8	1,036,359.44
Total				2,979,533.39

Meter Stations and Regulators

Meter stations are estimated in the table below at a fixed price of $388,634.79 per meter station and four meter stations are installed per 100 miles (Menon, 2005).

Table 4.4: Computation of estimated cost of Meter Station and Regulator

Pipeline	Diameter	Length (miles)	Number of Meter Station	$388,634.79 per meter station
Ajaokuta- Abuja	40	124.274	5	1,943,173.95
Abuja- Kaduna	40	119.925	5	1,943,173.95
Kaduna- Kano	40	137.323	6	2,331,808.74
Total		381.522		6,218,156.64

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Pressure Station

Two pressure stations are expected to be installed in every sections of the pipeline at a cost 750,000 per PRS. This gives 750,000*6=4,500,000.

Supervisory Control and Data Acquisition (SCADA) and Telecommunication Systems

This category is estimated as a percentage of the total project cost, which according to Menon (2005), ranges from 2-5%.

$$\$795{,}993{,}912.13 * 5\% = 39{,}799{,}695.61$$

Environmental and Permitting Cost

Environmental and permitting cost, according to Menon (2005), ranges from 10-15% of the pipeline cost. That is $\$835{,}793{,}607.74 * 15\% = \$125{,}369{,}041.16$

Right of Way

Menon (2005) states that most initial ROW cost ranges from 6-10 of the pipe construction cost. This would be $961162648.90 * 10\% = 96{,}116{,}264.89$

Engineering and Consultation Management

On a typical gas pipeline project, engineering and construction management costs range from 15- 20% of the total pipeline project (Menon, 2005). This will amount to $1{,}057{,}278{,}913.79 * 20\% = 211{,}455{,}782.79$

Contingency

This category includes costs such as legal and regulatory as well as categories not considered or envisioned when the gas project was conceptualized. Menon (2005) puts the estimation at 10-20% of the pipeline cost.

$$\$1{,}268{,}734{,}696.55 * 10\% = \$126{,}873{,}469.65$$

Working Capital

$$\$1{,}395{,}608{,}166.20 * 20\% = \$279{,}121{,}633.24$$

Allowance for Funds during Construction

AFUDC accounts for the cost associated with financing the project during various stages of construction. AFUDC cost estimate ranges from 10-20% (Menon, 2005).

$$\$1{,}674{,}729{,}799.44 * 20\% = \$334{,}945{,}959.89$$

Following from above, the expected cost of constructing the pipeline is

$$E(CCP) = 231{,}186{,}146.98 + 311{,}372{,}724.95 = 1{,}769{,}938{,}409.16$$

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Compressor Station

The cost of the compressor stations of the pipeline will be calculated in the table below. An average of 30,843.51 Horsepower (HP) capacity is used for each segment. The cost of compressor capacity is assumed to be $2,590.90 per HP, after adjusting for inflation. This takes care of material and equipment costs, labour costs for installing the compressors, equipment, instrumentation, and controls within the compressor stations.

Table 4.5: Computation of Estimated cost of Compressor Stations

Pipeline	Diameter	Length (km)	Compressor per 50 miles	Horsepower	Cost of Compressor@ $2590.90/ HP
Ajaokuta-Abuja		200	3	30843.51	79,912,450.06
Abuja-Kaduna		193	3	30843.51	79,912,450.06
Kaduna-Kano		221	3	30843.51	79,912,450.06
Total					239,737,350.18

The total cost of compressor station for the pipeline is 239,737,350.18

Therefore the total capital cost for the Ajaokuta-Kaduna-Kano is

$$IIC = \$1,769,938,409.16 + \$239,737,350.18 = \$2,009,675,759.33$$

Depreciation

Initial investment cost of pipeline will be depreciated annually using straight-line method formula as buttressed in the previous chapter. The depreciation rate is:

$$dr = \frac{2,009,675,759.33}{40} * \frac{1}{2,009,675,759.33} = 0.025.$$

Following from above, the rate at which the gas pipeline will be depreciated is 2.5% per annum. But the pipeline is expected to have scrap value at the end of its useful life. The scrap value is estimated as: $sv = \$2,009,675,759.33(1 - 0.025)^{40} = \$729,979,429.40$ Since 729,979,429.40 will be salvaged at the end of the useful life of the pipeline, it is pertinent that the said amount is deducted from initial investment cost before it is depreciated. That is

$$\$2,009,675,759.33 - \$729,979,429.40 = \$1,279,696,330.$$

Therefore, the total depreciable amount is 1,279,696,330, and the annual depreciation charge is $31,992,408.25

Operation and Maintenance

The cost associated with Operation and Maintenance of the pipeline will be estimated into fixed and variable below using the equation as stated earlier, which is 0.8 percent and 1.2 percent of IIC per annum respectively, each of which will be escalated by 2%

$$O \,\&\, M\ cost = 2,009,675,759.33 * 0.02 = 40,193,515.19\ p.a.$$

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Gas Volume

For the flow of gas in the pipelines, we will use an average °F79 (26°C) annual temperature in Nigeria (Timeanddate.com, 2018), and pressure of 60 bar at the starting point (GMP, 2008), with an expected drop of the pressure of 3.245 bar/100km (0.03245bar/km) provided the adequate number of compressors are provided based on our estimate of compressor intervals going by (McAllister, 2009).

Table 4.6: Estimated gas capacity/volume of AKK

Pipeline	Diameter	Length	Capacity (MCM)/y
Ajaokuta-Abuja	48	200	57476.185
Abuja-Kaduna	48	193	4552.976
Kaduna- Kano	48	221	4254.513
Total			66283.674

$$gas\ volume\ in\ Mcf\ = 2340797359073.2 * 0.80/1000 = 1{,}872{,}637{,}887.726p.a$$

The capacity in the table above represents an average level of service that can be maintained over an extended period of time and not the maximum throughput capability of a system.

Weighted Average Cost of Capital,

The cost of capital is accounted for using the WACC, from which the net cash flows will be discounted. We will first use CAPM, as described in the previous chapter, to calculate the gas pipeline cost of equity.

As earlier established, a Beta of 0.86 is used for the gas pipelines, a risk-free rate of 15.61%, and an expected market portfolio return of 18.0% are applied. For this project, and with reference to the proceeding chapter, the cost of equity (ke) is as follows:

$$Ke = 0.1561 + 0.86\ (0.18 - 0.16) = 0.18\ (18\%)$$

Therefore, the unweighted cost of equity for AKK is 18%. This tells potential investors of the opportunity cost of capital of their current or intended investment elsewhere. The cost of debt for the gas pipelines is presented in the equation below with reference to the equation in the previous section.

$$kd = 0.1742 * (1 - 0.30) = 12\%$$

Therefore, with reference to the proceeding chapter, the weighted average cost of debt and equity for the gas pipeline investments will be:

$$WACC = (0.40 * 0.18) + (0.60 * 0.12) = 0.15\ (15\%)$$

The WACC of the gas pipeline investment is 15%, and it is used as the discount rate to account for the cost of capital and time value of money.

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Amortization Cost

The amortization cost will then be, with reference to equation

$$Av = 1,205,805,455.60\left[\frac{0.174(1+0.174)^{40}}{(1+0.174)^{40}-1}\right] = 210.39$$

210.39 million is the annual amortization cost for the gas pipeline.

Cash Flow Analysis

Please see the appendix

Sensitivity Analysis

Sensitivity analysis was carried on NPV and changes when the discount rate varies. It was observed from the sensitivity studies that at a discount rate of 10%, AKK made $2,192.98 billion. When the discount was varied to 20%, AKK made a negative NPV of $286.97 million

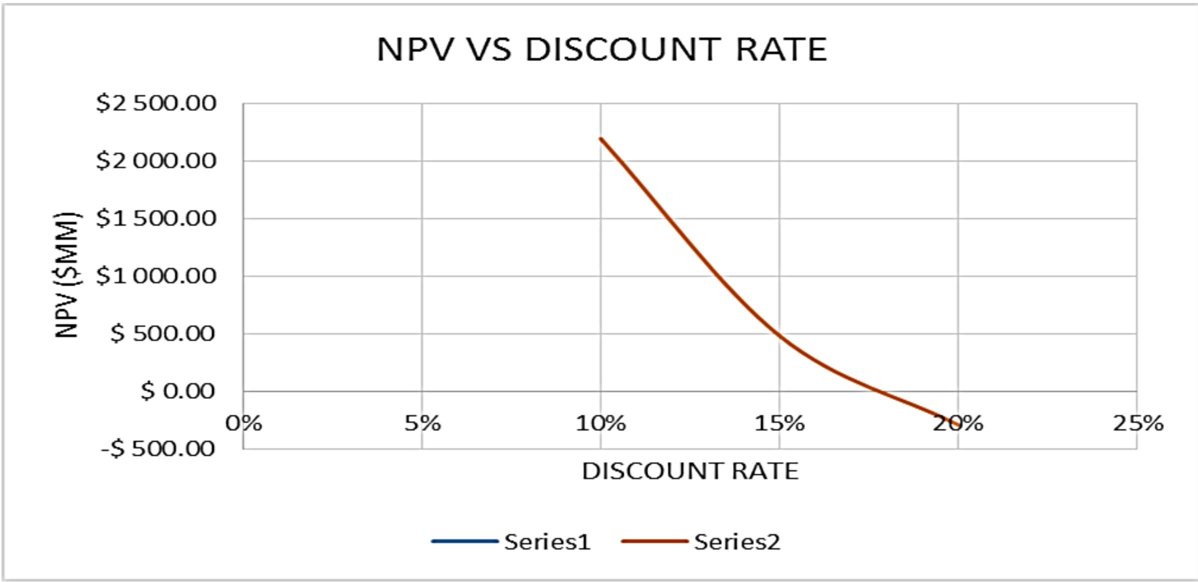

Figure 6: NPV Vs Discount Rate

Sensitivity analysis carried out to see how sensitive NPV would be to variations of Capex. The study showed NPV approaching zero as CAPEX approaches $3 billion.

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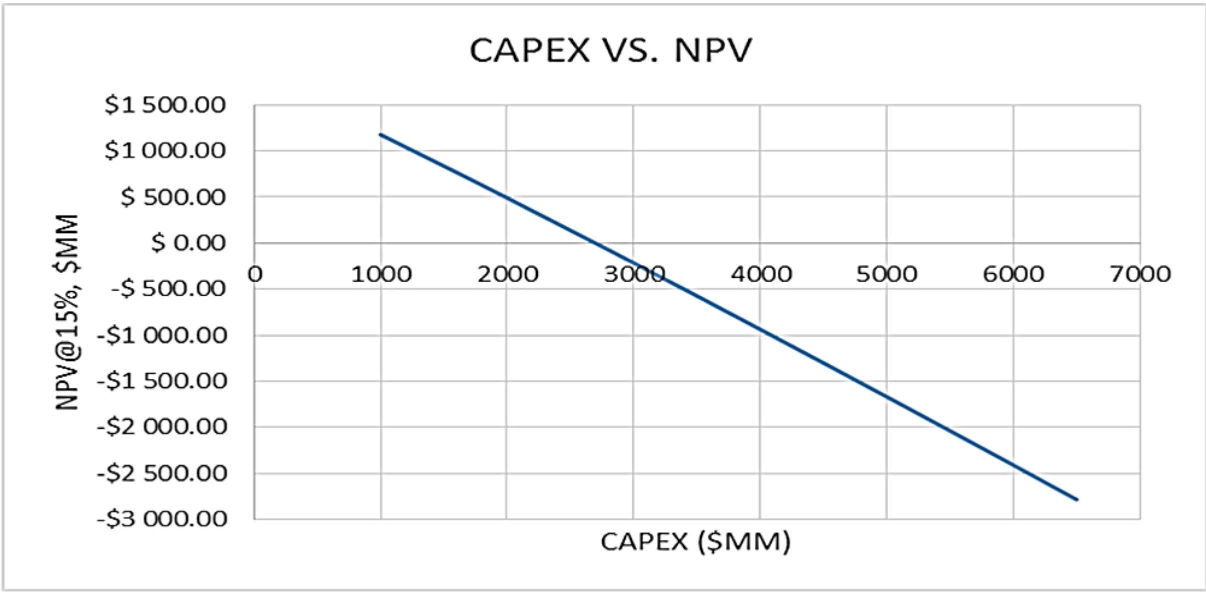

Figure 7: CAPEX Vs NPV

The figure below displays the sensitivity of IRR to CAPEX. The study shows an indirect relationship; as AKK's CAPEX increases, its IRR decrease and vice versa.

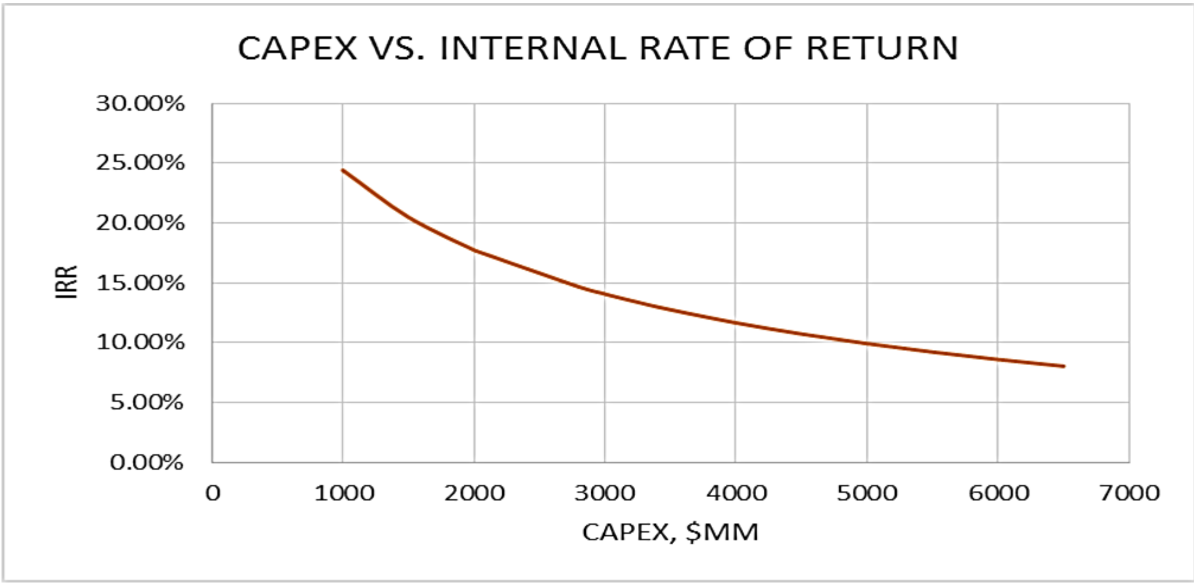

Figure 8: CAPEX Vs IRR

The figure below shows how sensitive PBP is to CAPEX. As CAPEX increased, PBP also increased.

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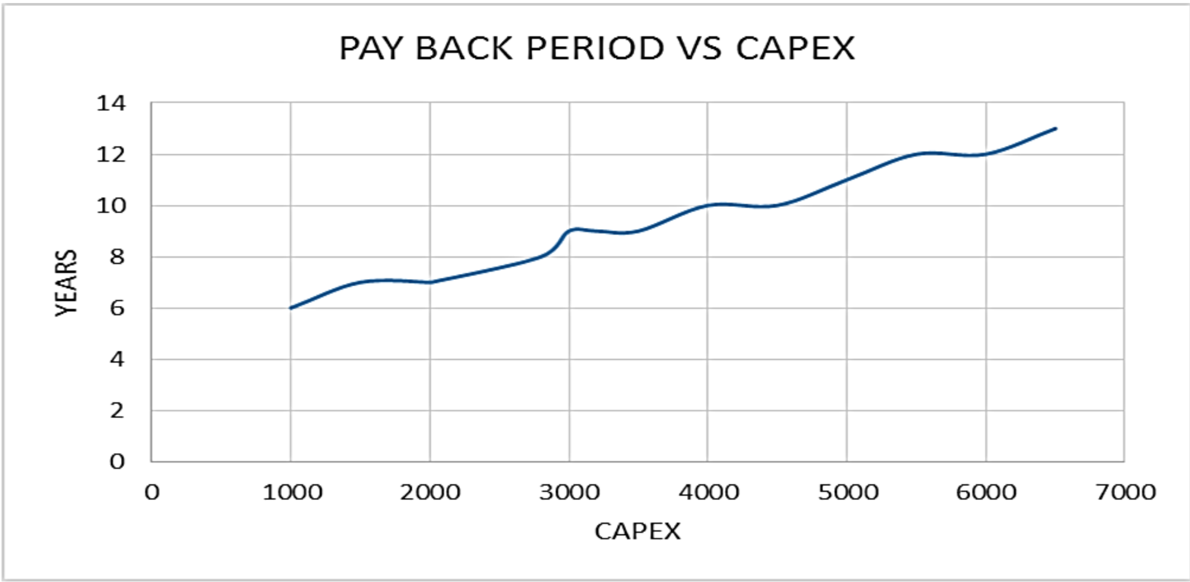

Figure 9: PAYBACKK Vs. CAPEX

Figure below analysis the sensitivity of PIR to CAPEX. PIR drops as more amount of CAPEX is spent.

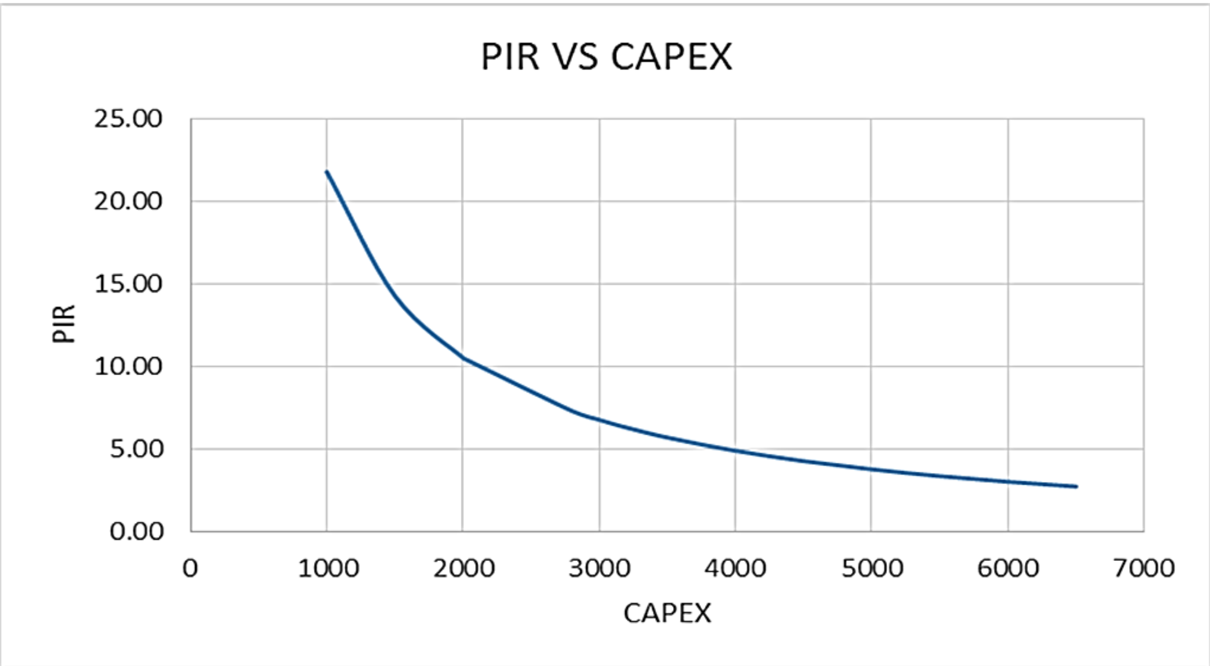

Figure 10: PIR Vs CAPEX

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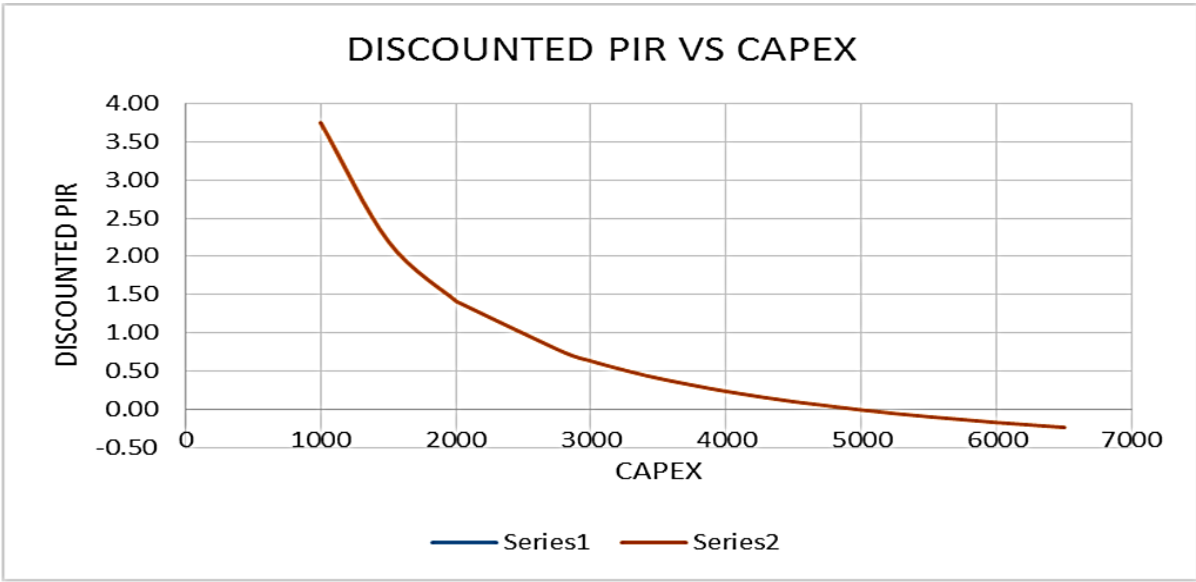

Figure 11: DPIR VS CAPEX

RISK ANALYSIS

Assumptions for Input Parameters for the Risk Analysis

The input parameters that are prone to uncertainties include the

i. Initial Capital Investment

ii. The Operating Expense (Fixed and Variable)

iii. The Cost Escalation Rate

It is assumed that transportation cost per unit volume, tax rates, and Amortization are parameters that must be established beforehand and may not be subject to market distortions.

Initial Investment Cost

A triangular distribution is assumed for the behaviour of the initial investment cost. The initial investment costs include facilities (pipeline, compressors, meters, etc.) and installation costs. The most likely cost (highest probability) is the static value used in the model, i.e., $2,009.68MM.

The minimum cost is assumed to be $1,000 MM, while the maximum cost is $6,500 MM. According to the @risk result in Figure 4.2.1, the 5th percentile is $1,080.74, while the 95th percentile is $6,389.69MM. The cost spike may arise from delay, sabotage or vandalization, inflation, and political crisis.

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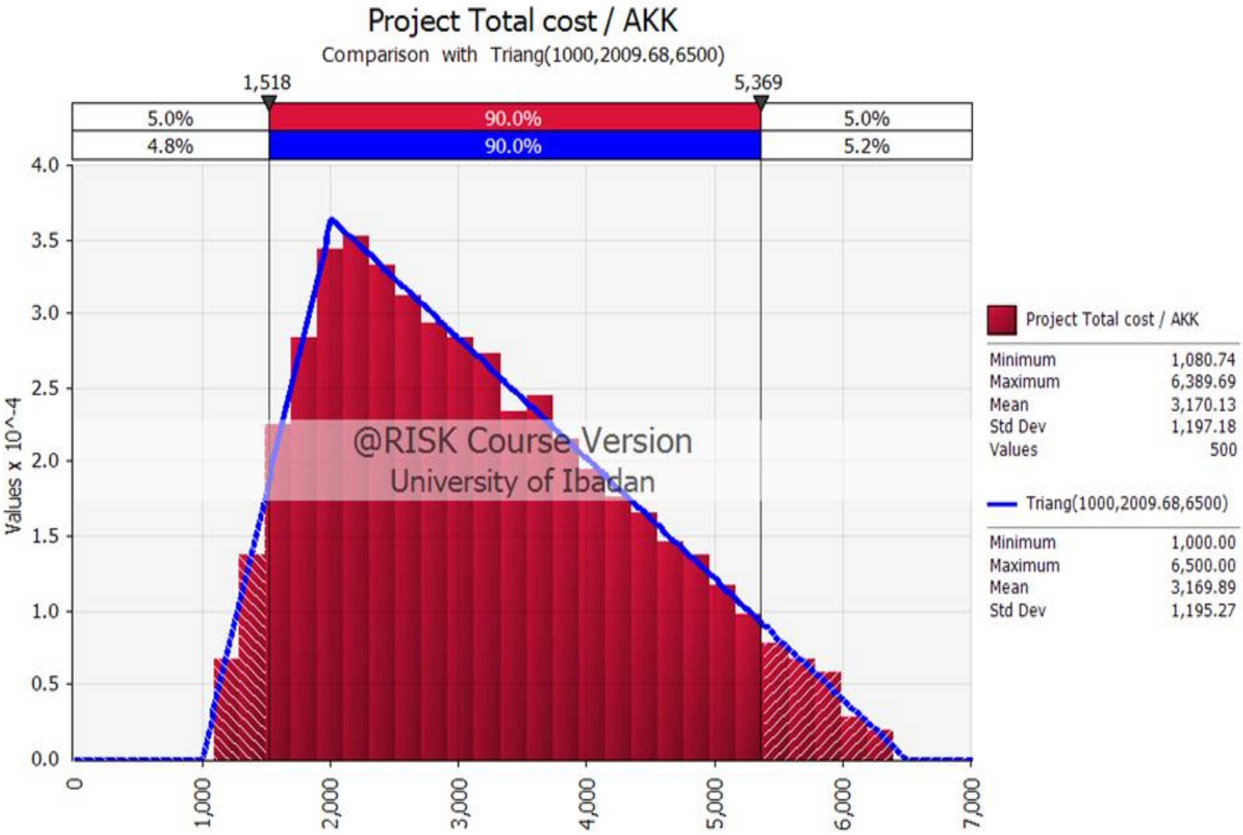

Figure 12: Probability Density Curve for the Initial Investment Cost

The Operating Expense (Fixed and Variable)

The operating expense is another uncertain variable prone to distortion by market factors. The normal distribution is assumed for this. The mean is $16.08MM, 0.8% of initial CAPEX, while the Standard deviation is approximately $1.61MM.

The fixed OPEX cost is not tied to gas movement as it is expended irrespective of whether gas is being transported or not. However, this proportion may increase or reduce depending on the prevailing market factors. From figure 4.2.2, the minimum and maximum fixed operating costs are $11.06MM and $1.61MM, respectively.

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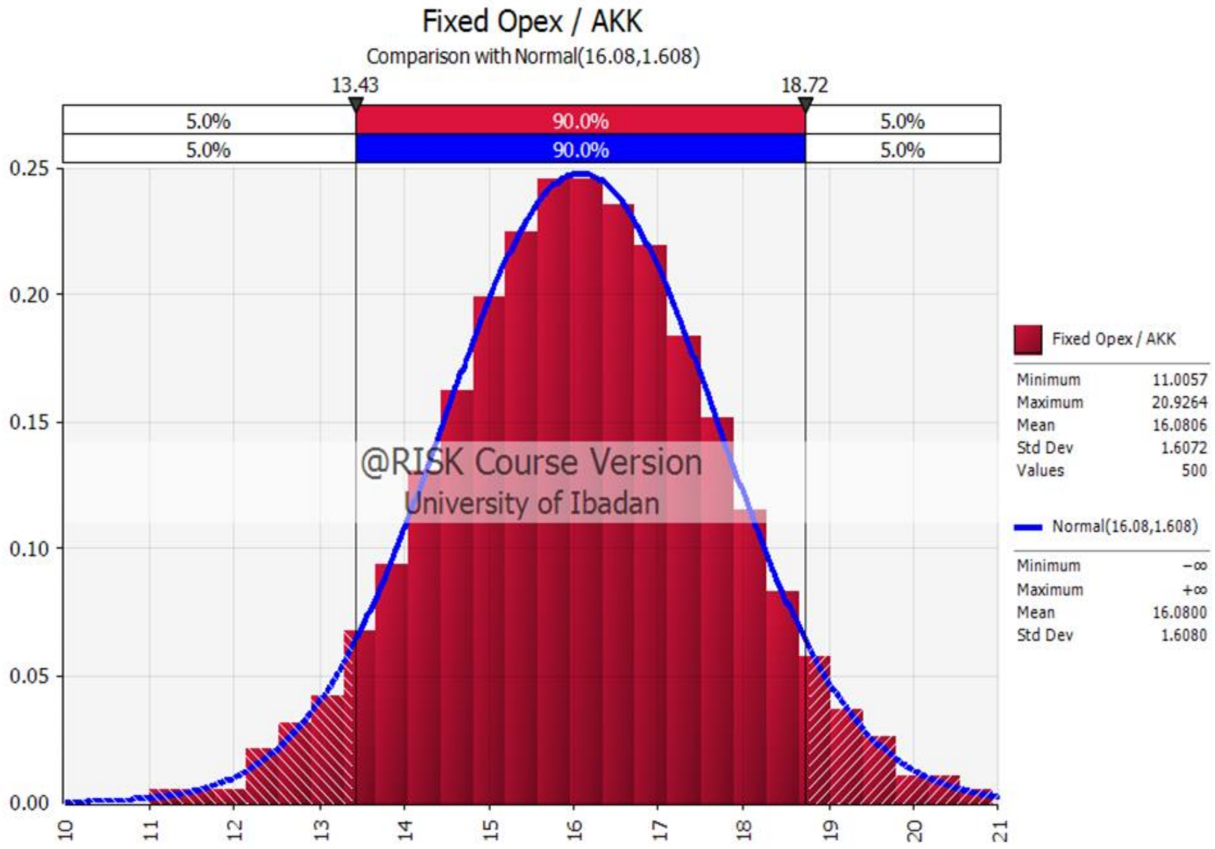

Figure 13: Probability Density Curve for Fixed Operating Cost

The variable OPEX, on the other hand, is assumed to be 1.2% of the initial investment cost and prone to uncertainties. A normal distribution with a mean of $24.12MM and a standard deviation of $2.412MM is also assumed for the variable OPEX. The minimum and maximum variable costs are $17.15MM and $31.73MM.

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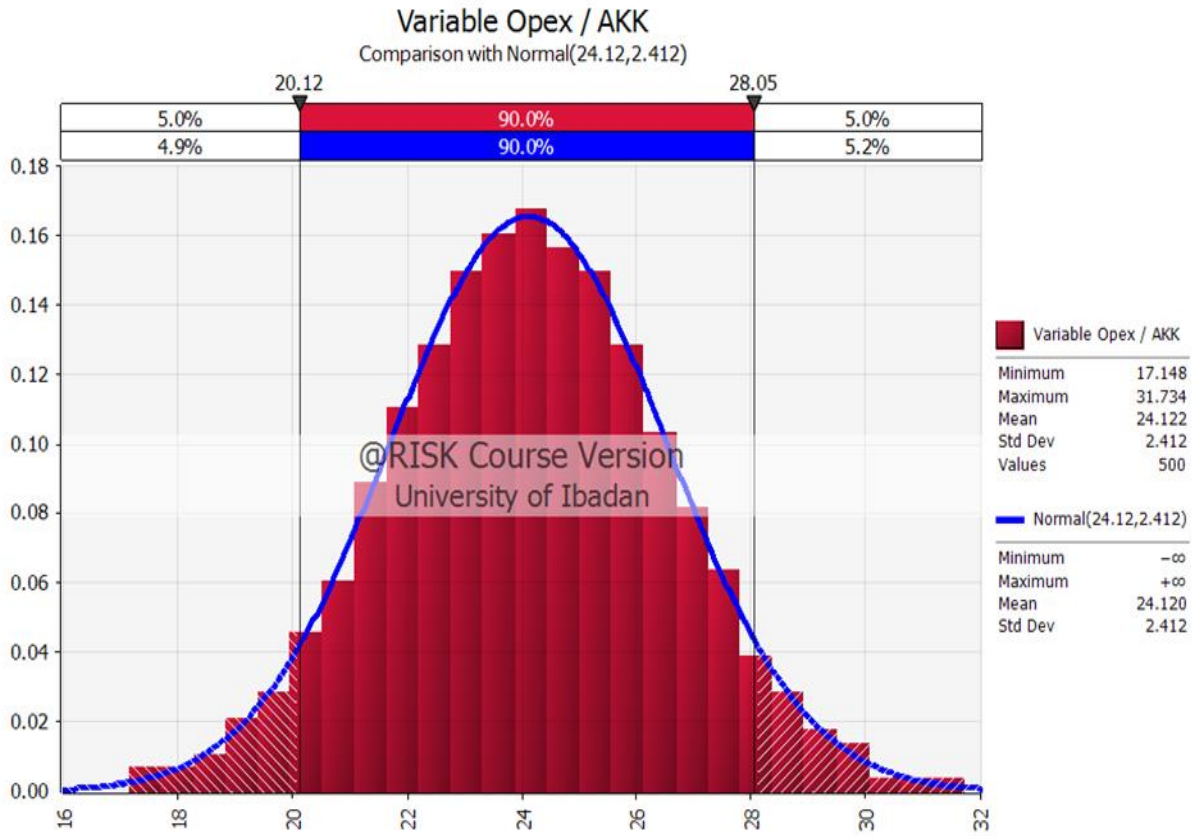

Figure 14: Probability Density Curve for Variable Operating Cost

Cost Escalator

The cost escalator is an input variable that may also be subject to distortions. The assumption of 2% may be conservative or optimistic. Hence, we assume uniform distribution with minimum and maximum value of 1.5% and 4.0%.

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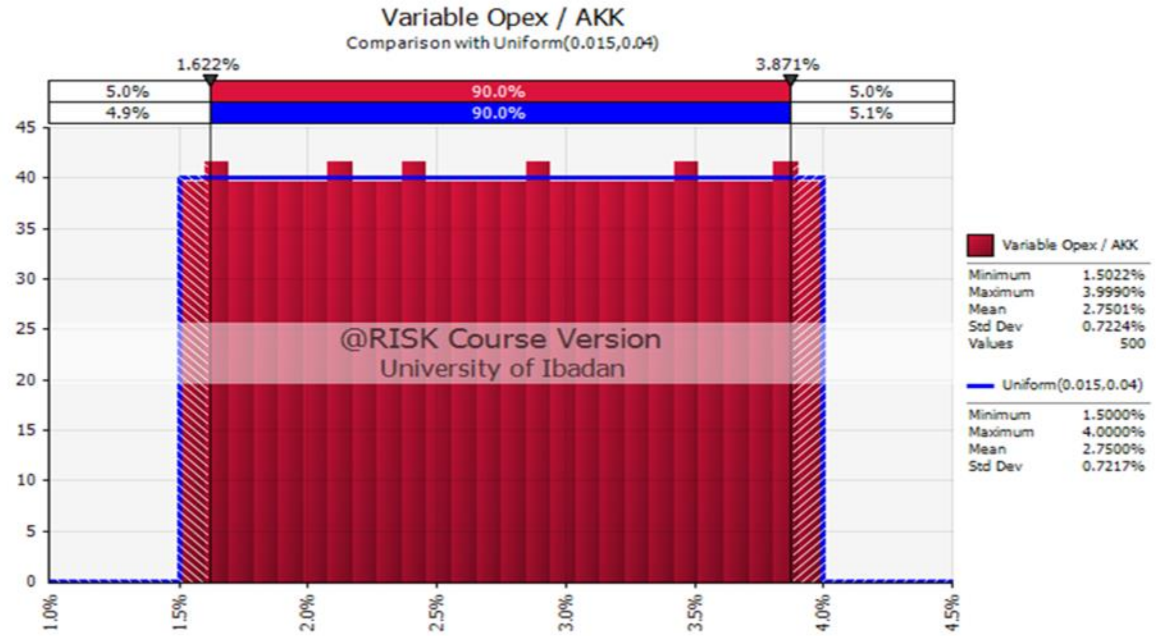

Table 15: Probability Density Curve for Variable Cost Escalator.

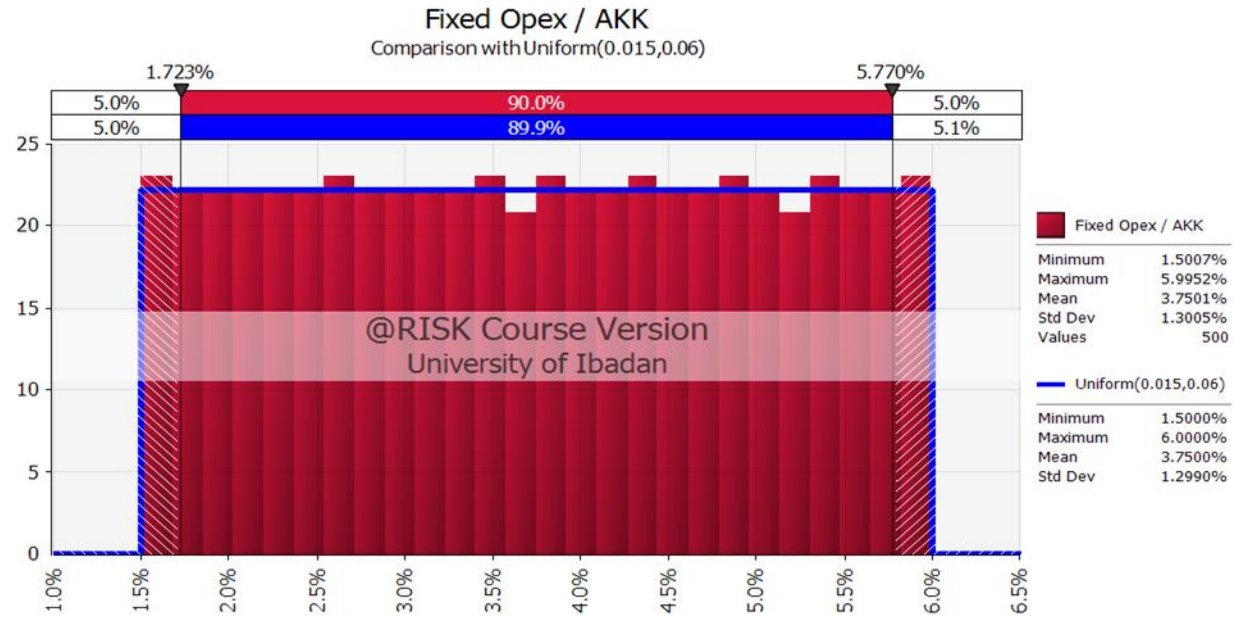

Figure 14: Probability Density Curve for Fixed Cost Escalator.

Risk Analysis Result

Net Present Value: Risk Analysis is performed on the NPV at the computed Weighted Average Cost of Capital.

Probability Density Histogram

The probability density histogram presents the probabilities of having a value less than a point of reference or a range of values. From figure 4.2.5, the NPV at the computed Weighted

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Average Cost of Capital (WACC) indicates a sizable probability of negative NPV, which is 58.1%.

There is also only a 36.9% chance of having a positive NPV ($0-$826 MM). This is expected because of the large range of CAPEX ($1000 MM to $6,500 MM) used.

Tornado Graph-Change in Output mean

The Tornado Diagram indicates the driver for NPV, which is the initial investment. From figure 4.2.6, the initial cost of capital is the greatest determinant of NPV. Other uncertain input parameters, such as fixed and variable OPEX, have less impact on the value of the project.

Spider Plot

The spider plot displays the mean value of the NPV against the cumulative percentiles of the input variables.

The steep trend shown by the percentiles of the initial investment cost indicates that it plays an important role in determining the project's overall value. Other input variables show an even trend and are not likely to impact the value of the project.

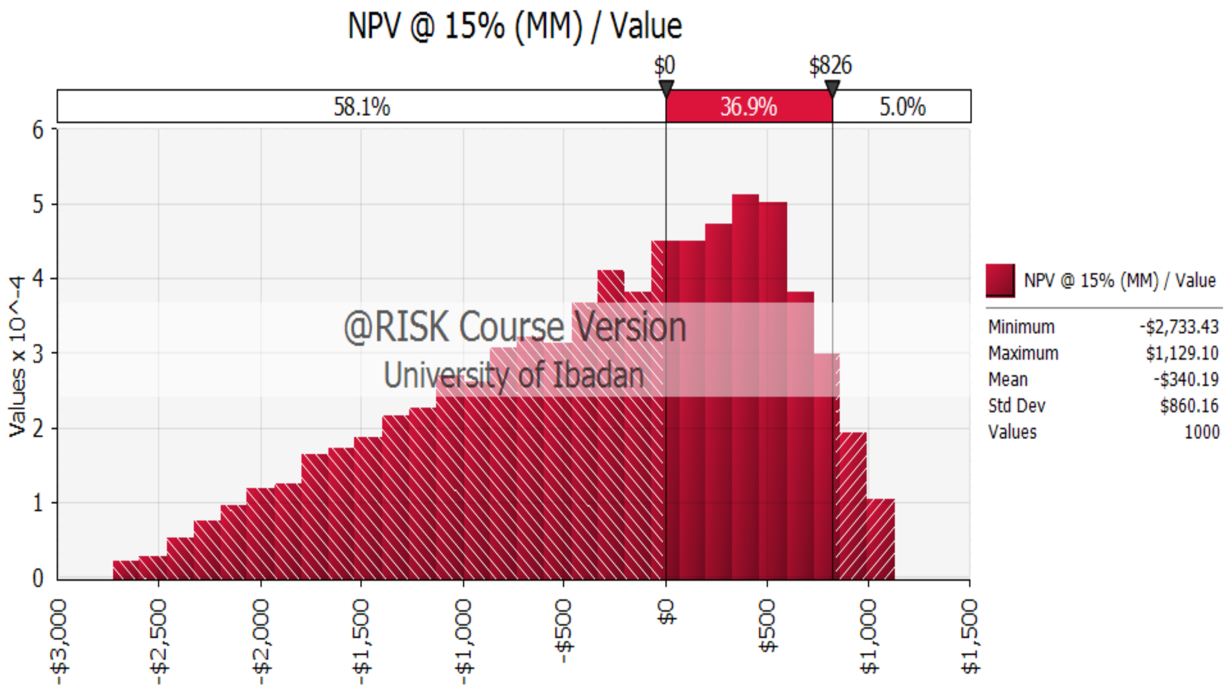

Figure 15: Probability Density Histogram of NPV @ 15%

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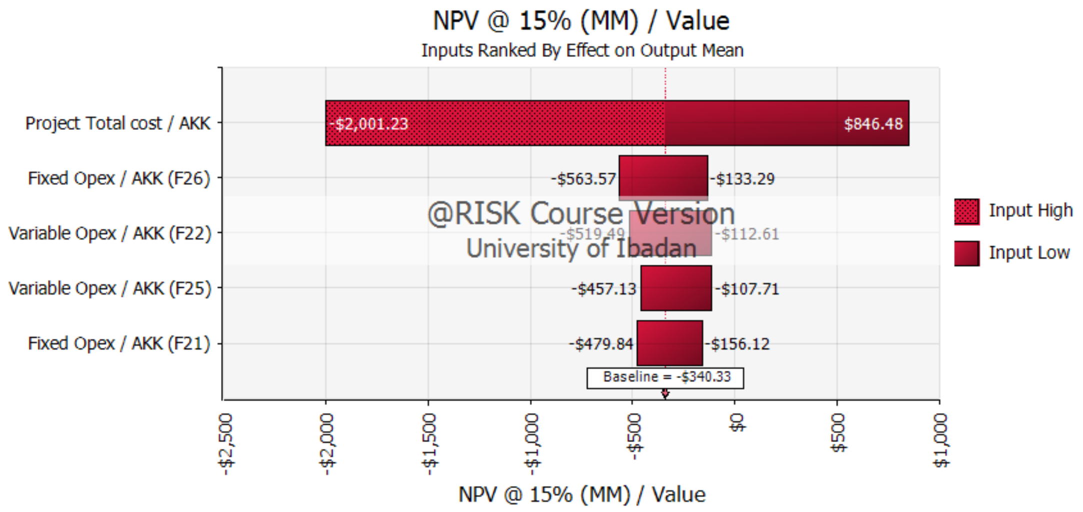

Figure 16: Tornado Graph-Change in NPV mean

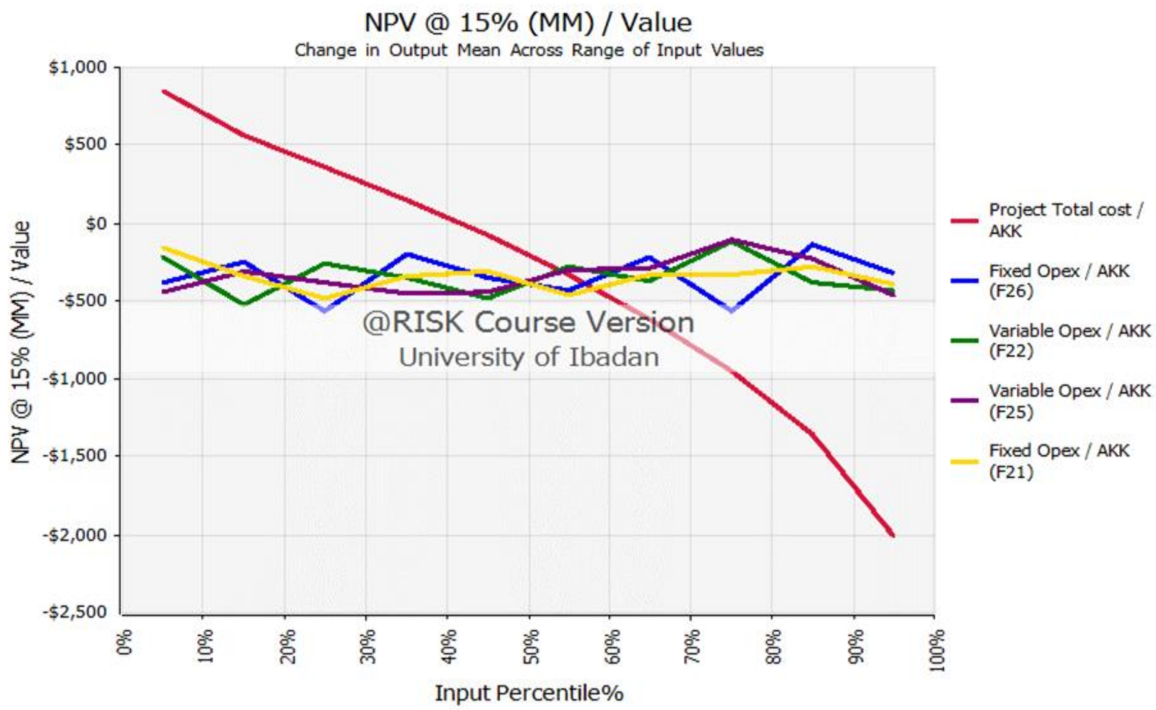

Figure 17: Spider Plot

Internal Rate of Return (IRR)

For a good project IRR must be greater than the WACC. The probability that IRR will be less than 15% is 58.3% which is quite sizeable.

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Conversely, there is 36.7% that IRR will lie between the lowest tolerable limit (15.00%) and the highest limit (20.31%).

The Tornado diagram and the Spider Plot for the IRR also indicate that CAPEX is the major determining factor for the rate of return.

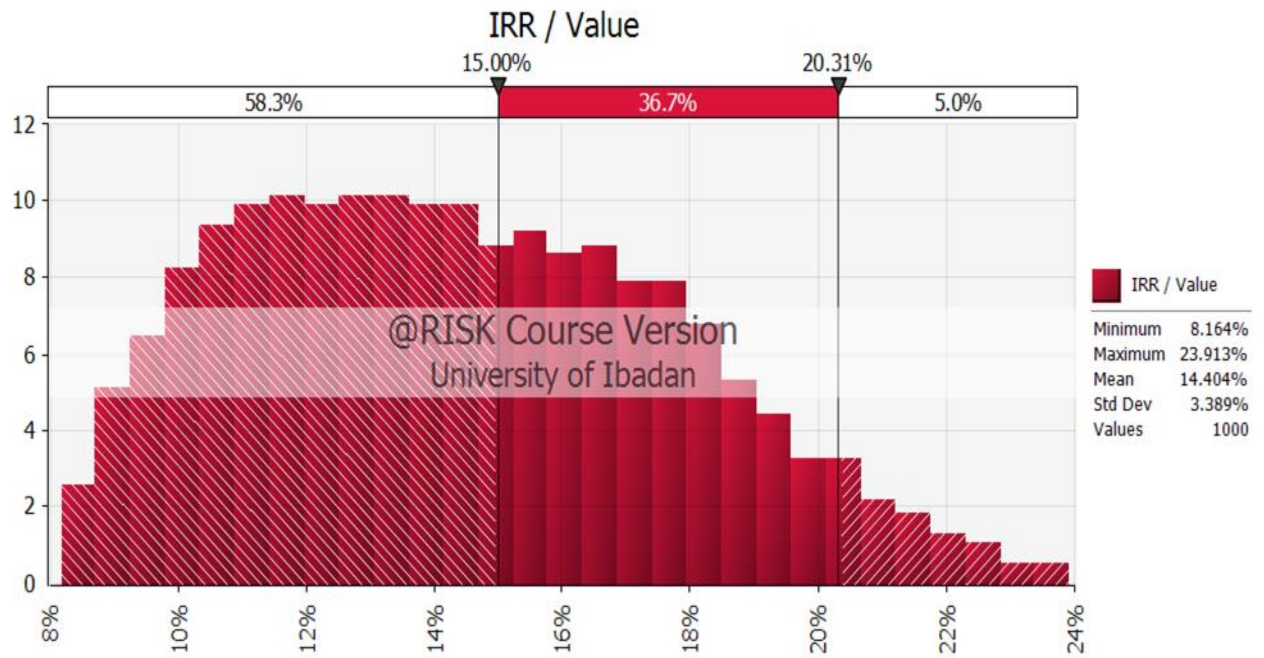

Figure 18: Probability Density Histogram for IRR

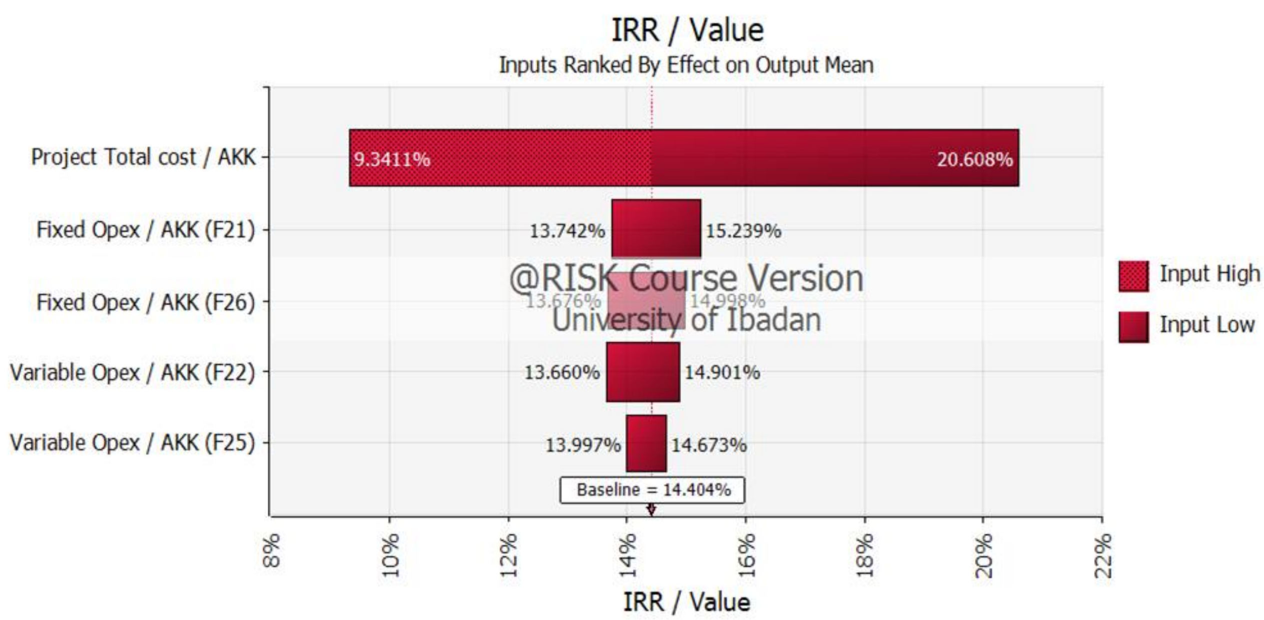

Figure 19: Tornado Graph-Change in IRR

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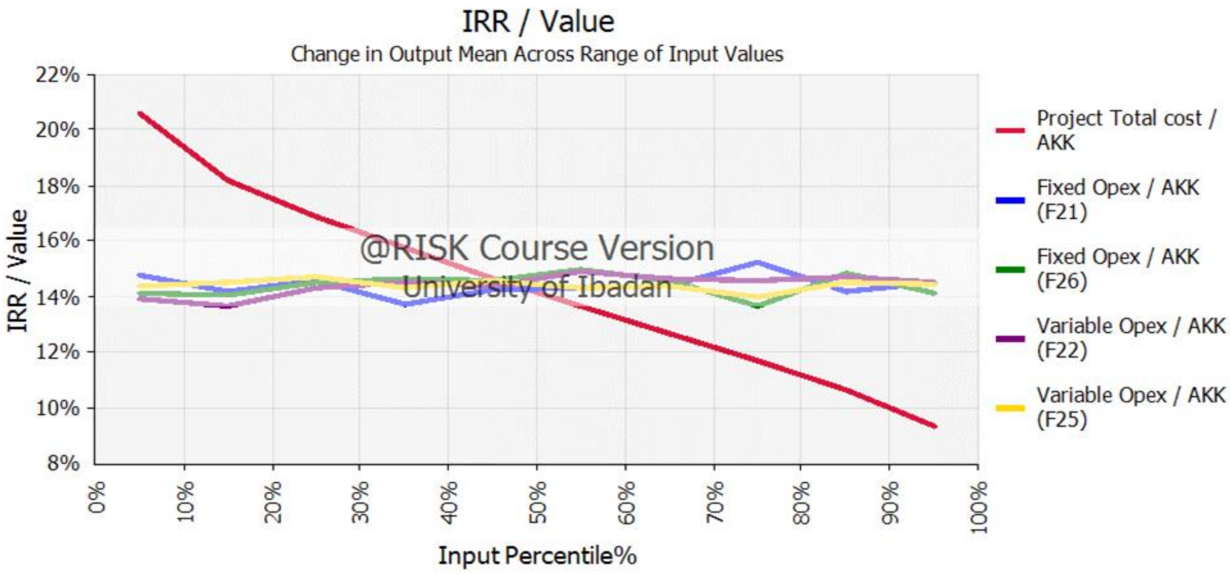

Figure 20: Spider Plot

Pay out Period

The mean pay out period is 8.84yrs. There is a 0% chance that the pay-out period is less than 5.65- that is the investor should not expect the project to yield any profit before this time

Tornado Plot

The Tornado plot indicates that the project's fixed cost contributes the highest as an input variable.

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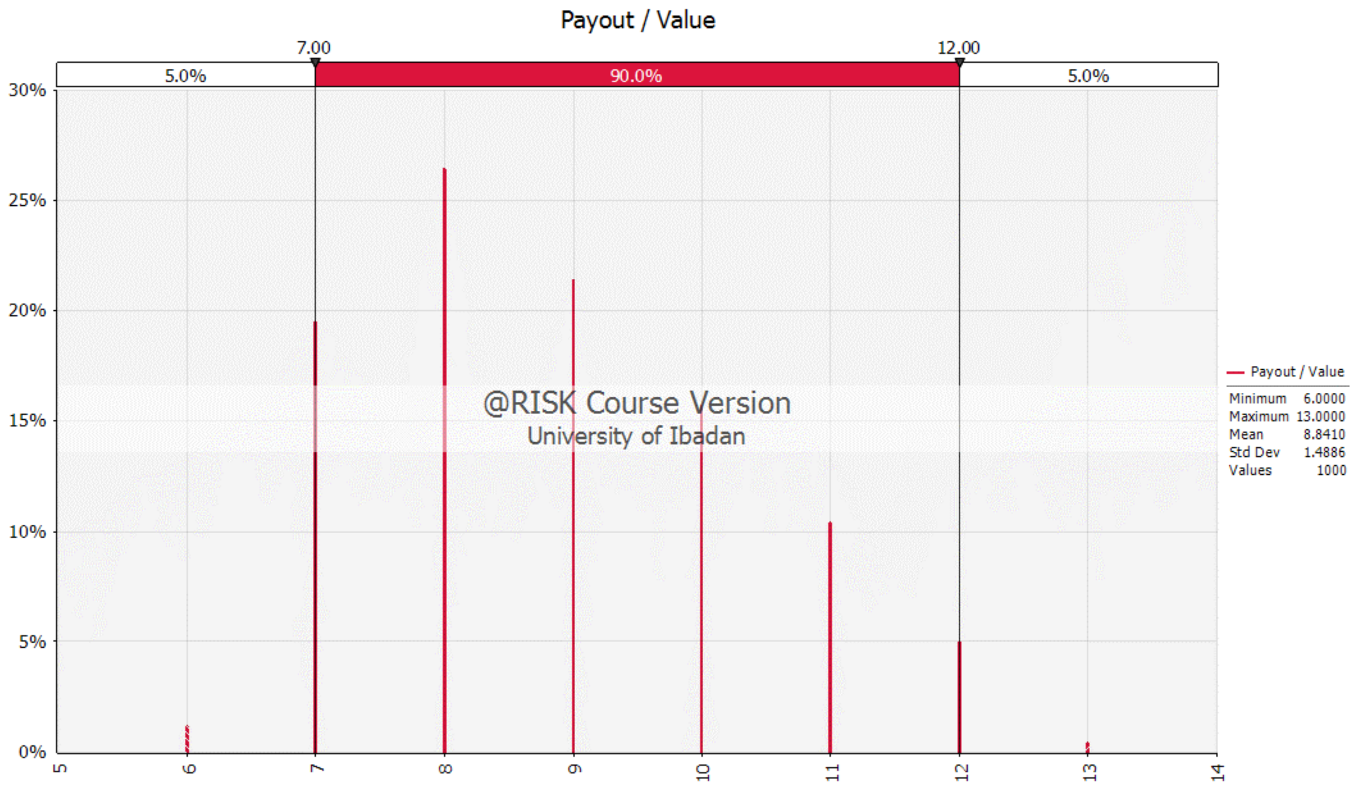

Figure 21: Probability Density Histogram for Pay-out Period

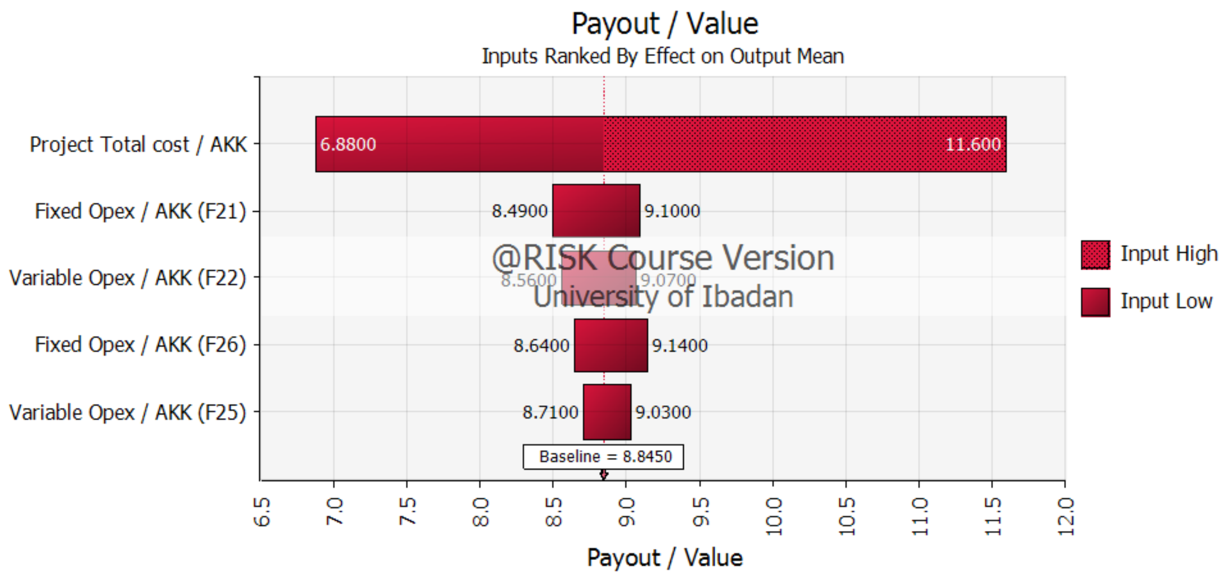

Figure 22: Tornado Graph-Change in Pay-out Period Mean

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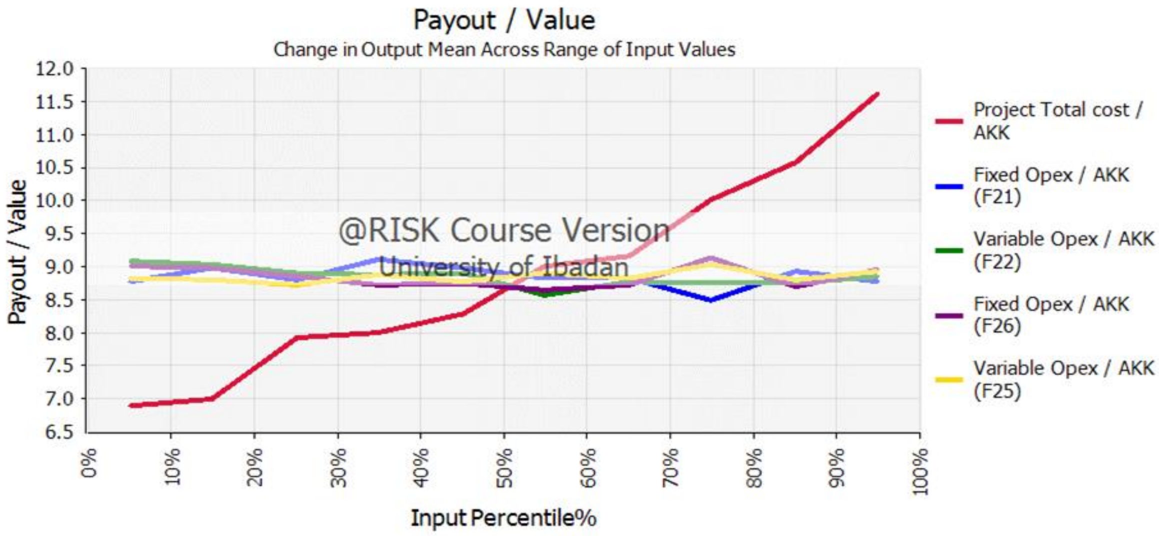

Figure 23: Spider Plot

Discounted Profit-Investment Ratio (PIR)

The project has a chance of 36.7% above the accepted value of 0, making the project worthwhile.

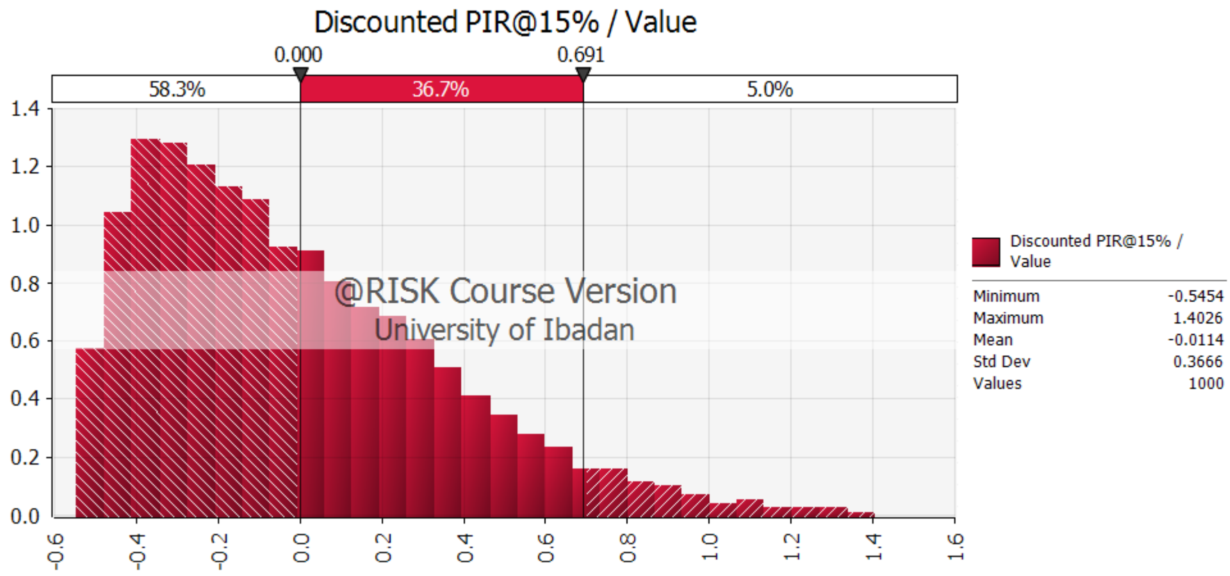

Figure 24: Probability Density Histogram for PIR

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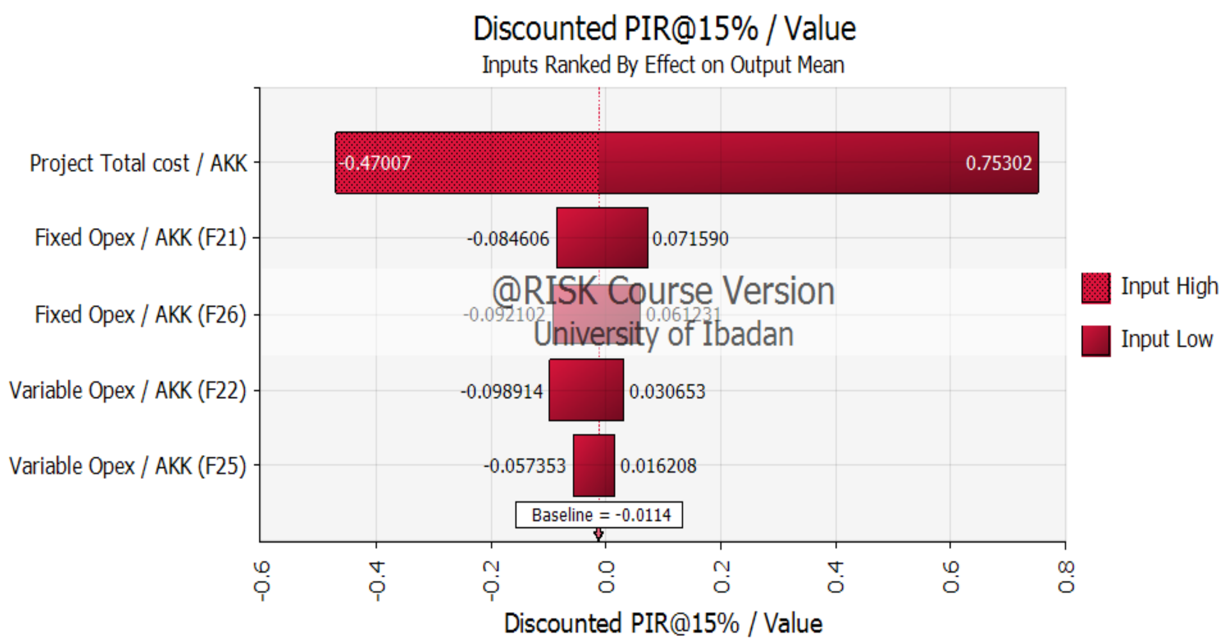

Figure 25: Tornado Graph-Change in PIR Mean

Figure 4.23: Spider Plot for Discounted PIR

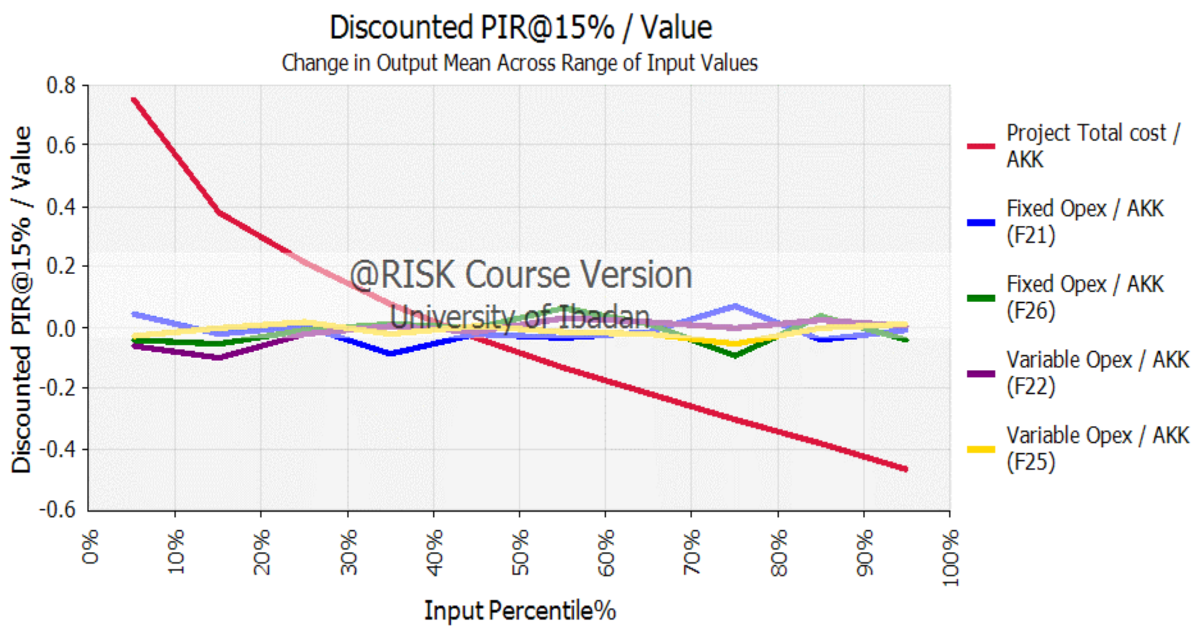

Figure 26: Spider Plot for Discounted PIR

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SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The research broadly studied how Nigeria can utilize its natural gas reserves to stimulate demand and thereby derive economic advantage and address its energy demand concerns within its territory. One of the vital projects that are key to achieving this objective of increased gas utilisation, as contained in the gas master plan, was identified to be the Ajaokuta-Kaduna-Kano gas pipeline. Consequently, this study analysed the costs and benefits of Akk on the scale of total investment costs, gas delivery as well as costs and benefits using NPV, IRR, and Payback period. In determining the costs and benefits of the gas pipeline route, first, the capital structure comprising of debt and equity and the cost of capital of the gas pipeline were estimated. Followed by an estimation of investment cost comprising of gas pipeline material cost, pipe coating, and wrapping cost, cost of constructing the compressor stations, gas delivery, and labour cost using models adjusted for inflation and already existing in the literature. The overall profitability of the proposed gas pipeline project was then analysed using the NPV, IRR, and payback period methods. The research found that AKK is indeed profitable.

Conclusion

The Ajaokuta- Kaduna-Kano pipelines have a positive NPV of approximately $484.40 million for forty years of operation. This averaged around $12.11 million present value of operating net cash flows per annum. This means that the business cash flow can meet up with all the operating costs and still return a positive profit. This also means that the present value of the future cash inflows is higher than the present value of the current and future cash outflows by $484.40 million. Its internal rate of return was estimated to be 17.70%, which is higher than the discount rate for forty years. This means this business's investment return can be up to 17.7%. The investors can aim higher investment return of up to 17.7% as the business only breaks even when the investment return is at 17.7%. This means the business can be well-preferred compared to other potential investments, which could offer lower IRR. The IRR is much higher than the discount rate, which means the business will not be tight by allowing investment return at the calculated discount rate and can even give higher investment return than the discount rate. The AKK investment also has a discounted payback period of seven years. These indicate that the AKK is highly viable.

Recommendation

Based on the findings from this study the following recommendations were made:

(1) The AKK gas pipeline is viable; the Government or investors should consider investing in the transmission system. It is also recommended that other possible route options should be developed; this will further expand the domestic gas market and also enables the spread potentials of gas development.

(2) Since AKK is sensitive to CAPEX, efforts should be concentrated on reducing such costs to make investments less vulnerable.

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(3) The AKK is also sensitive to the peak flow of gas; therefore, gas markets need to be secured to operate profitably at a high flow rate. Government should also ensure relative peace in the Niger Delta region as this will increase the availability factor of AKK.

(4) The regulatory framework in the Nigerian gas sector should strengthen and be more market-driven as this will minimize the prevalent uncertainties and accelerate investment decisions for development projects.

(5) Probability analysis should be carried out alongside deterministic economic analysis to give insight into the economic risks associated with gas development projects.

REFERENCES

Akinpelu O. A., Omole O.A. &Falode O. A., 2010. Exploring opportunities for indigenous participation in implementing the Nigeria Gas Master Plan, SPE International Conference, and exhibition.

Akinpelu L. O. &Isehunwa S. O., 2016. Modifying the Performance index in evaluating Risky Oil and Gas Investment, SPE international conference, and exhibition.

Akinpelu, L. (2017). Capital Budgeting. Lecture notes distributed in the course CEE719 Energy risk at Centre for Petroleum, Energy Economics and Law, University of Ibadan.

Ahmed A. &Muttaqa D., 2016. Economic Analysis of Gas Projects in Nigeria. Journal of economics and development.

Adegoke, A., Barrufet, M., Ehlig-Economides, C., 2005. GTL Plus Power Generation. The Optimal Alternative for Natural Gas Exploitation in Nigeria. In: Proceedings of the International Petroleum Technology Conference Held in Doha, Qatar, from 21st through 23rd November 2005.

Christiansen & Haugland, 2001. “Gas Flaring and Global public goods,” FNI Report, Fridtj of Nansen Institute (FNI), Lysaker, 2001.

British Petroleum, 2015. BP Statistical Review of World Energy.

Central Bank of Nigeria, Money Market Indicators (In Percentage). 2015.

Trending Economics. Lending interest rate (%) in Nigeria. World Bank Indicators - Nigeria – Interest Rates 2015 [cited 2015 26th June]; Available from:http://www.tradingeconomics.com/nigeria/lending-interest-rate-percent-wb-data.html.

Central Bank of Nigeria. Government Securities - FGN Bonds. Government securities 2015[cited 2018 5th June]; Available from:http://www.cenbank.org/rates/GovtSecuritiesDrillDown.asp?beginrec=1&endrec=10&market=Bonds.

Central Bank of Nigeria, Money Market Indicators (In Percentage). 2018.

Central Bank of Nigeria, Nigerian Government Securities. 2018.

EIA, Natural Gas Pipeline Capacity & Utilization US energy Information Administration,Editor. 2008.

Economides, 2012. The optimization of Natural Gas Transportation, SPE Hydrocarbon Economics and Evaluation Symposium: Canada.

Durr, C., Coyle, D., Hill, D., Smith, S., 2007. ‘LNG Technology for the Commercially Minded’, Gastech, 2005. Gastech, Bilbao, Spain.

Article DOI: 10.52589/BJMMS-WHROTHOW
DOI URL: https://doi.org/10.52589/BJMMS-WHROTHOW

Dailami, M.,Leipziger,D., 1998.Infrastructure project finance and capital flows: a new Perspective. World Development 26(7),1283–1298.

Esty, B.,2006. An Overview of Project Finance and Infrastructure Finance – 2006 Update.Harvard Business School Publishing Caseno.

Eriksen, R., Brandstorp, J.M., Cramer, E., 2002. Evaluating the Viability of Offshore LNG Production and Storage.

Federal Government of Nigeria. The National Domestic Gas Supply and Pricing Policy. FGN.

Gas Aggregation Company of Nigeria. Gas purchase process. GACN.

Kleimeier, S., Megginson, W. L., 2001. An Empirical Analysis of Limited Recourse Project Finance. Working Paper, University of Oklahoma.

Krey, W. and Y. Minullin, Modelling compeition between natural gas pipeline projects toChina. International journal of global environmental issues, 2010. 10(1).

International Energy Agency, 2017. Natural Gas Information. IEA, 2015. Nigeria Background.

International Energy Agency, 2014. Africa Energy outlook, A Focus on Energy Prospect inSub Saharan Africa.

International Energy Agency, 2017. International Energy outlook, an assessment of Long termWorld energy Markets.

Ibikunle, A., 2006. Reducing Green House Gas Emission-The Nigerian Approach.OPEC-EU CDM Conference Riyadh, KSA.

Nasir A., (2013) Economic Implication of Deploying Gas turbine in Natural Gas Pipeline Networks. Research gate Africa Development Bank and Africa Union, 2014 Oil and Gas in Africa

Nwaoha, C. & Wood, D. A., 2014. A review of the Utilization and Monetization of Nigeria'sNatural Gas Resources: Current Realities. Journal of Natural Gas Science andEngineering.

Nigerian Gas Company Limited. Existing pipeline System. 2012 [cited 16, December2012 December)

Nigerian Gas Company Limited. Future and ongoing Projects. 2012 [cited 16th December 2021)

Nigerian National Petroleum Corporation, Nigerian Gas Master Plan, M. Ventures, Editor.2013, NNPC.

MacAllister, E.W., Pipeline Rules of Thumb Handbook. 8th ed. Manual to quick and accuratesolution to everyday pipeline engineering problems. 2009: Elsevier.

Mohitpour, M., H. Golshan, and A. Murray, Pipeline Design and Construction. Vol. 2ndedition. 2003, New York: ASME Press.

Oni, D. (2017). Project Finance. Lecture Notes distributed in course CEE717- Project Finance,at Centre for Petroleum, Energy Economics and Law, 2017.

Odumugbo, C.A., Oyedoh, E.A., 2008. Compressed Natural Gas-Technology for theFuture, pp. 6e8. In: Proceedings of the 38th Annual Conference of NSChE, 30thOct.e1st Nov., 2008 Effurun, Delta State, Nigeria.

Rynn, P.G., Patel, H.N., Serratella, C., 2007. ABS Development of a Guide forCompressed Natural Gas Carrier.

Rynn, P.G., Patel, H.N., Serratella, C., 2007. ABS Development of a Guide forCompressed Natural Gas Carrier

Article DOI: 10.52589/BJMMS-WHROTHOW
DOI URL: https://doi.org/10.52589/BJMMS-WHROTHOW

Sylvie, C.G. and F.C. Marie, The challenges of further cost reductions for new supply options(pipeline, LNG, GTL), in 22nd World Gas Conference International Energy Agency,

Editor. 2003, Alexandre Rojey, InstitutFrançais du Pétrole and CEDIGAZ: Tokyo, Japan.

Shahi, E.M. and S.M. Pramila, Gas Pipleine Hydraulics. 2013, United State of America: Trafford.

Shahi, E.M. and S.M. Pramila, Gas Pipleine Hydraulics. 2013, United State of America: Trafford.

Shashi, E.M., Gas Pipeline Hydraulics. Chapter 10, ed. T.a. Francis. 2005, 6000 Broken SoundParkway NW, Suite 300: Tylor and Francis group.

W.C. Haneberg, B. Bruce, M.C. Drazba. Using Quantitative Slope Hazard Maps andQuantitative Probabilistic Slope Stability Models to Constrain Least-Cost Pipeline Route Optimization. Paper presented at the Offshore Technology Conference, Houston, Texas. OTC 23980, 2013.

Shashi, M.E., Gas pipeline hydoraulics. 2005: CRC press, Taylor and Francis Group.

Yar'adua, L.A., the Nigerian Gas Master-PlanEngr, Group Managing DirectorNigerian National Petroleum Corporation, Editor. 2007.

Article DOI: 10.52589/BJMMS-WHROTHOW
DOI URL: https://doi.org/10.52589/BJMMS-WHROTHOW