DESIGN AND FINANCIAL ANALYSIS OF 20" DN X 1000 PSIG X 25 KM PARALLEL LINE FROM MONOHORDI TO NARSINGDI-VALVE STATION 12

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ABSTRACT

The demand of gas in the downstream of Narsingdi Valve Station-12 is increasing day by day. During Peak Hours, in most of the days, as the operating pressure of the Ashuganj-Elenga, 24" x 1000 Psig x 125 Km Transmission Pipeline cannot be kept at the desired level (the source line of 20"DN x 1000 Psig x 25.0 Km M-N Transmission Line), the pressure at Monohardi goes down below 700 Psig. At the same time, Line Pressure at Narsingdi V.S.-12 becomes 460-472 Psig and at Siddhirganj RMS/TBS, it becomes as below as 145 Psig, which is much below the Minimum Design Pressure of Siddhirganj RMS/TBS. This results in acute low pressure or even 'no gas' problem throughout the area. In order to resolve this problem and to augment supply of gas to Narsingdi V.S.-12, construction of 20"DN x 1000 Psig x 25.0 Km Monohardi-Narsingdi Parallel line is necessary. In this project work, a design of 20" DN x 1000 Psig x 25.0 Km Monohardi-Narsingdi Parallel pipe line is proposed with definite diameter and thickness. A financial analysis has been built for finding net present value (NPV), benefit cost ratio (BCR), internal rate of return (IRR) with its graphical representation, payback period, gas supply per year and total income per year for the proposed design. The calculated diameter and the thickness are 20 inch and 11.02 millimeter respectively. Net present value (NPV), benefit cost ratio (BCR), internal rate of return (IRR), payback period are 40203.33 lakhs, 1.9565533, 48%, 4.1786 years correspondingly.

Keywords: *Pipe thickness, Pipe diameter, Transmission line, Design pressure, Payback period.*

1. INTRODUCTION

The services of natural gas industry include producing, moving, and selling gas. Moving gas is divided into two classes: transmission and distribution. Transmission of gas means moving a large volume of gas at high pressures over long distances from a gas source to distribution centers. In contrast, gas distribution is the process of routing gas to individual customers (Kabirian & Hemmati, 2007).

The typical design of a gas transmission pipeline involves a compromise among the pipe diameter, compressor station spacing, fuel usage, and maximum operating pressure. Each of these variables influences the overall construction and operating cost to some degree, hence an optimized design improves the economics of the construction and operation of the system and the competitiveness of the project (Mokhatab & Poe, 2012).

1.1 Study Area

To increase the operational capability of the Titas Transmission system as a whole, the designed pipeline is constructed to the Narsingdi Valve Station -12 from Monohordi DRS station, which is an important junction and nerve center of TGTDCL Transmission system. This pipeline was intended to supply gas to the Ashuganj, Ghorashal, Narsingdi and Greater Dhaka Areas. This Monohardi-Narsingdi-Siddhirganj Transmission Pipeline is the source line for Shibpur TBS/DRS, Narsingdi M&R Station, Tarabo TBS, Siddhirganj RMS/TBS. The same source line will also provide gas to newly constructed CGS at Dighibarabo Valve Station.

Figure 1: Location Map (Schematic)

1.2 Review of the History of Existing Pipeline

The first Transmission pipeline of TGTDCL, Titas Gas Field - Narsingdi V.S.12 - Demra CGS, 14"DN x 1000 Psig x 82.0 Km, was put in service during 1968. This pipeline was aimed to supply gas to the Ashuganj, Ghorashal, Narsingdi and Greater Dhaka Areas. A 14" lateral from the Transmission line at Narsingdi Valve No. 12 supplies gas to the Ghorashal Power Station and Fertilizer plants. As the load of Narsingdi/Ghorashal, Greater Dhaka Area increases, another Transmission pipeline, Titas Gas Field-Narsingdi, 16"DN x 1000 Psig x 46.31 Km was commissioned during 1985. With the passage of time and growth of load centers, Narsingdi V.S.-12 has become an important junction and nerve center of Titas Transmission system. Under The Third Natural Gas Development Project, Monohardi-Narsingdi, 20"DN x 1000 Psig x 25 Km Transmission Pipeline was commissioned during 2005, with further extension upto Siddhirganj Power Station through Narsingdi-Siddhirganj, 20"DN x 1000 Psig x 41.0 Km pipeline. This Monohardi-Narsingdi-Siddhirganj Transmission Pipeline is the source line for Shibpur TBS/DRS, Narsingdi M&R Station, Tarabo TBS, Sidhirganj RMS/TBS. The same source line will also provide gas to newly constructed CGS at Dighibarabo Valve Station.

Main consumers on the existing 20"DN x 1000 Psig Transmission line are 210 MW Siddhirganj Power Station, 22 MW Dorin Power Plant, 33 MW Purbachal Summit Power Plant. At the same time this line is presently supplying gas to the existing Gas Load Centers of Narsindhi/Ghorashal Area, Shibpur, Narayanganj, Fatulla, Panchabati, Pagla, Siddhirganj, Adamjee EPZ, Tarabo, Rupganj, Araihazar, Munshiganj, Mukhterpur, Shympur-Kadamtali, Jinjira and Keraniganj Areas.

1.3 Net Present Value

The net present value (NPV) method is widely favored by analysts, because it is the most foolproof. In finance, the net present value (NPV) or net present worth (NPW) is defined as the sum of the present values (PVs) of incoming (benefit) and outgoing (cost) cash flows over a period of time (Lin & Nagalingam, 2000). The NPV method of appraising real property is achieving greater and greater acceptance with the passage of time (Steiner, Tsudik, & Waidner, 1995).

The NPV of an investment is determined by calculating the present value (PV) of the total benefits and costs which is achieved by discounting the future value of each cash flow. NPV is a useful tool to determine whether a project or investment will result in a net profit or a loss because of its simplicity. A positive NPV results in profit, while a negative NPV results in a loss. The NPV measures the excess or shortfall of cash flows, in present value terms, above the cost of funds (Berk, DeMarzo, & Stangeland, 2015).

NPV= (discounted cash inflows from investment) – (discounted cash outflows or costs of investment) ≥ 0

$$NPV = CF_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \cdots + \frac{CF_T}{(1+r)^T} \quad (1)$$

Where, CF_t = the cash flow at time t, r = discount rate and t = number of time period (Khan,1993)

1.4 Benefit-Cost Ratio (BCR)

The BCR is another method of analyzing and choosing among investments. BCR is a figure that is used to define the value of a project versus the money that will be spent in doing the project in the overall assessment of a cost-benefit analysis. A BCR is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. All benefits and costs should be expressed in discounted present values (Green & Stellman, 2007).

Like NPV method is relies on the time value resources for its validity. It arranges the discounted benefits and costs as a ratio rather than as a difference. The higher the BCR the better the investment. General rule of thumb is that if the benefit is higher than the cost the project is a good investment. The rule is B ÷ C ≥ 1.0, Where B is present discounted benefits and C is present discounted costs (Steiner et al., 1995).
Formula: BCR = Discounted total benefits(PV) ÷ Discounted total costs(PV)

1.5 Internal Rate of Return (IRR)

IRR is perhaps one of the most difficult of methods if applying without computer, and the most disputable. However, it is also widely used because it employs a percentage rate of return as the decision variable. The internal rate of return on an investment or project is the "annualized effective compounded return rate" or rate of return that makes the net present value (NPV as NET*1/(1+IRR)^year) of all cash flows (both positive and negative) from a particular investment equal to zero. It can also be defined as the discount rate at which the present value of all future cash flow is equal to the initial investment or in other words the rate at which an investment breaks even (Steiner et al., 1995).

IRR calculations are commonly used to scope the desirability of investments or projects. The higher a project's IRR, the more desirable it is to undertake the project. Assuming all projects require the same amount of upfront investment, the project with the highest IRR would be considered the best and undertaken first. A project is brought under consideration to accept it if its internal rate of return is greater than an established minimum acceptable rate of return or cost of capital. In cases where one project has a higher initial investment than a second mutually exclusive project, the first project may have a lower IRR, but a higher NPV and should thus be accepted over the second project. IRR should not be used to compare projects of different duration.

As the internal rate of return is the percentage rate that causes discounted present value of benefits in a cash flow to be equal to the discounted present value of costs (Steiner et al., 1995)-

$$\sum_{n=0}^{n} \frac{B}{(1+r^*)^n} = \sum_{n=0}^{n} \frac{C}{(1+r^*)^n}, \quad (2)$$

$$\text{or, } NPV = \sum_{n=0}^{n} \frac{B}{(1+r^*)^n} - \sum_{n=0}^{n} \frac{C}{(1+r^*)^n} = 0 \quad (3)$$

Where, *NPV* = Net Present Value, *B* = discounted present value of benefits in a cash flow period n, n= 0 to n
C= discounted present value of costs in a cash flow period n, n= 0 to n, r^* = is the IRR

But, the problem is, we cannot isolate the variable r^* (=internal rate of return) on one side of the above equation. However, there are alternative procedures which can be followed to find IRR. One of the simplest of them is- Trail-And-Error Computation IRR (Steiner et al., 1995).
The steps are-

- Guess a rough estimated discounted rate (r) and calculate NPV
- If NPV is positive then taking a higher r calculate NPV and if negative do vice-versa
- If the new NPV is negative then go to next step or go to previous step
- That means the true IRR(r^*) must lie between the two r for which the NPV become positive and negative last time.
- The calculation of the interpolated IRR can be achieved by similar triangles.

1.6 Pay Back Period

Payback period in capital budgeting refers to the period of time required to recoup the funds expended in an investment, or to reach the breakeven point (Farris, Neil, Phillip, & David, 2010). Payback period is the length of time required to recover the cost of an investment. Payback period as a tool of analysis is often used because it is easy to apply and easy to understand for most individuals, regardless of academic training or field of endeavor. Payback period has a serious drawback; it does take into account the time value of money. The formula to calculate payback period of a project depends on whether the cash flow per period from the project is even or uneven ("Most Popular Accounting Topics", n.d.) In case they are even, the formula to calculate payback period is: Payback Period=Initial Investment ÷ Cash in flow per period.

When cash inflows are uneven, it is needed to calculate the cumulative net cash flow for each period and then the formula for payback period should be used, Payback Period = A+B÷C
In the above formula, A is the last period with a negative cumulative cash flow; B is the absolute value of cumulative cash flow at the end of the period A; C is the total cash flow during the period after A.

2. METHODOLOGY

Stages involving in designing the new pipeline with economical and financial analysis are given below:

2.1 Review the present & forecast supply & demand of gas in this area

Required data were found from the Development project proposal, which were provided by Titas Gas Transmission & Distribution Company Limited (TGDCL).
By reviewing present supply and demand, the pipeline was designed to increase the supply the gas through the Narsingdi and its nearest area.

2.2 Find out the correct pipeline system which is appropriate for this scenario

The diameter and thickness of the pipeline was calculated using following equation (Ikoku, 1991)-

Parallel pipeline, $\frac{q_t}{q_A} = [1 + (D_B/D_A)^{8/3}]$ (4)

Thickness, $t = \frac{DP}{2YFLJT}$ (5)

Considering L-mile, D_A-inch.internal pipeline diameter. Supposing a full length is paralleled with a new D_B inch. The old flow rate using only D_A inch line is q_A and the new flow rate with both line is $q_T = q_A + q_B$. The length L is constant. Using the Weymouth's equation (without f) with the ratio of new and old flow rate is,

$$\frac{q_T}{q_A} = \frac{q_A + q_B}{q_A} = \left(1 + \frac{q_B}{q_A}\right) = \left[1 + \left(\frac{D_B}{D_A}\right)^{\frac{8}{3}}\right] \quad (6)$$

Where, q_T = total flow rate, q_A = old flow rate using only D_A inch line, D_A = diameter of old line, D_B = diameter of new line, t = pipe wall thickness in inch, P = design pressure in psig, D = outside diameter of pipe in inch, Y = minimum yield strength in psig, F = design factor, L = location factor, J = joint factor, usually taken as 1, T = temperature derating factor.

2.3 Cost Estimation

Comparing the cost of pipeline diameter and other factors, the cost of constructing the new pipeline was calculated. Where, Total cost = Investment cost + Operating cost
Where, Investment Cost = Year wise Investment Cost (FC+LC) - Interest During Construction (IDC)
Operating Cost (PV) = Year wise Operating Cost – Interest–Depreciation
Here, FC = Foreign Currency, LC = Local Currency, PV = Present Value

2.4 Financial Analysis

Comparing the cost of pipeline diameter and other factors, the economical feasibility of the project was determined by calculating Net Present Value (NPV), Benefit Cost Ratio (BCR), Internal Rate of Return (IRR), Pay Back Period (PBP) of the project. In most cases, the numbers are taken to nearest integer.

3. CALCULATION

3.1 Design Calculation

Considering q_T = 375 MMSCFD, q_A = 180 MMSCFD, D_A = 20 inch

$\frac{q_T}{q_A} = \left[1 + \left(\frac{D_B}{D_A}\right)^{\frac{8}{3}}\right]$; or, $\frac{375}{180} = \left[1 + \left(\frac{D_B}{20}\right)^{\frac{8}{3}}\right]$; or, D_B = 20.61"

20" Diameter pipe is required to the proposed area as there is no pipe having diameter of 21 inch. Pipe thickness is calculated by using equation (5),
if, D = 20 inch, P = 1000 psig, Y= 60,000 psig, F= 0.8, L= 0.6 (for the cross country pipeline), J = 1, T = 1 (for temperature up to 250° F) then,

$t = \frac{20\times1000}{2\times60000\times0.8\times0.6\times1\times1}$ = 0.34722 inch = 8.81944 mm = (8.81944 + 3) mm

= 11.01944 mm, which is round up to 11.02 mm
Where 3 mm is considered as corrosion allowance. So, the pipe wall thickness is 11.02 mm.

3.2 Total cost estimation

In this project, Investment Cost Includes- Pre-Construction Expenditure [Land Acquisition, Land Requisition, Survey/ Design/ Drawing, IEE/EIA], Material Cost [Line Pipe & Casing Pipe, Valve & Fittings, Tape & Primer, CD/VAT (50% of Foreign Material Cost), Pre-shipment Inspection (0.17%), Handling, Transportation and Storage cost (5%), Miscellaneous charges relating to foreign procurement(5.5%)], Construction Cost [Pipeline Laying Cost, Pipeline Welding Cost, Highway Crossing, River Crossing, Canal/Khal Crossing, Fabrication &Installation of RCC, Scraper Station Construction (2 Locations), Valve Station Construction (2 Locations), Radiography Cost, CP construction, Tie-in at the Inlet & Outlet Line, Civil Construction (TBS/DRS Foundation, Boundary Wall), Testing & Commissioning, Construction and Installation of Marker Post], Road Restoration Charge [Payable to Road Owning Agency] and Other charges [Physical Contingency (2%), Price Contingency (8%)]. The total estimated investment cost of this project is about 9291.95 Lack Taka. The calculation is given in table no 1

Table 1: Total investment cost of the project

ITEM OF EXPENDITURE	QUANTITY	UNITE PRICE	ESTIMATED COST(In Lakh Taka)		
			LOCAL	FOREIGN	TOTAL
A. Pre-Construction Expenditure					
1. Land Acquisition (in Katha), 25 km x 10'	18.83	65.15	1226.77	-	1,226.77
2. Land Requisition (in Katha), 25 km x 20'	37.66 Acre		0.00	-	-
3. Survey/ Design/ Drawing	L.S		10.00	-	10.00
4. IEE/EIA	L.S		25.00	-	25.00
SUB - TOTAL (A):			1,261.8	-	1,261.77
B. Material Cost					
1. Line Pipe & Casing Pipe (Local & Imported)	25,288 Meter		6.90	2,559.22	2,566.12
2. Valve & Fittings	20% of pipe cost		-	507.08	507.08
3. Tape & Primer	15% of pipe cost		-	380.31	380.31
4. Scraper Station Materials	Lot		-	100.00	100.00
5. CP Materials	Lot		-	30.00	30.00
6. CD/VAT(50%of Foreign Material Cost)	Lot		1,788.3	-	1,788.31
7. Pre-shipment Inspection (0.17%)	Lot		-	6.08	6.08
8. Handling, Transportation, Storage cost (5%)	Lot		178.83	-	178.83
9. Miscellaneous charges relating to	Lot		196.71		

foreign procurement (5.5%)				
SUB - TOTAL (B):		2170.75	3582.69	5753.44
C. Construction Cost:				
1. Pipeline Laying Cost	25,000 Meter	912.73	-	912.73
2. Pipeline Welding Cost	2,560 Nos.	114.85	-	114.85
3. Highway Crossing	100 Meter	3.50	-	3.50
4. River Crossing	160 Meter	52.21	-	52.21
5. Canal/Khal Crossing	150 Meter	2.83	-	2.83
6. Fabrication & Installation of RCC	400 Meter	10.20	-	10.20
7. Scraper Station Construction (2 Locations)	2 Nos.	48.50	-	48.50
8. Valve Station Construction (2 Locations)	2 Nos.	20.30	-	20.30
9. Radiography Cost	12,750 Rft	191.26		191.26
10.CP construction	L.S	20.00	-	20.00
11.Tie-in at the Inlet & Outlet Line	L.S	2.50	-	2.50
12. Civil Construction (TBS/DRS Foundation, Boundary Wall)	L.S	9.00	-	9.00
13. Testing & Commissioning	25,000 Meter	27.75	-	27.75
14. Construction & Installation of Marker Post	850 Nos.	6.38	-	6.38
SUB - TOTAL (C):		1,422	-	1,422.01
D. ROAD RESTORATION CHARGE				
(Payable to Road Owning Agency)	L.S	10.00	-	10.00
SUB - TOTAL (D)		10.00	-	10.00
TOTAL (A+B+C+D)		4,864.5	3,582.69	8,447.22
Physical Contingency (2%)		97.29	71.65	168.94
Price Contingency (8%)		389.16	286.62	675.78
TOTAL INVESTMENT COST		5,351	3,940.96	9,291.95

Note:

1. Land acquisition and requisition cost have been calculated in the basis of current price and the quality of the land has been fixed as bare minimum base on the natural gas safety rule 1991 amended on 2003.
2. Construction cost has been calculated according to Petro Bangla Approved Rate, 2004.
3. Accommodation area and estimated cost for civil construction works have been prepared on the basis of Public Works Department (PWD) standard and schedule of rates- 2008.
4. LC = Local Price, FC = Foreign Price, Conversion rate 1 USD=80.00 Tk.

Operating Cost Includes- Cost of Gas, Duties and taxes, Other Costs (Depreciation Costs, Maintenance Costs, Interest, Miscellaneous, Unforeseen cost, Tax). The operating cost per year for this project is shown in table no 2.

Table 2: Operating Cost of the project

Year	**Cost Of Gas**		**Duties and Faxes**		**Other Cost**		**Total Cost**		**Total**	**Net operating cost transfer to financial analysis**
	LC	FC	LC	FC	LC	FC	LC	FC		
2011-12	1860	0.00	16227	0.00	11.02	9.44	18097	9.44	18107	1870
2012-13	3670	0.00	31952	0.00	13.02	9.44	35635	9.44	35644	3683
2013-14	5251	0.00	45797	0.00	13.02	9.44	51061	9.44	51071	5264
2014-15	5712	0.00	51104	0.00	13.02	9.44	56829	9.44	56839	5725
2015-16	6289	0.00	55837	0.00	16.02	9.44	62142	9.44	62151	6305
2016-17	6421	0.00	58172	0.00	16.02	9.44	64608	9.44	64618	6437
2017-18	7193	0.00	62631	0.00	16.02	9.44	69839	9.44	69849	7208

2018-19	7773	0.00	68169	0.00	16.02	9.44	75958	9.44	75967	7789
2019-20	7782	0.00	68254	0.00	18.02	9.44	76054	9.44	76063	7800
2020-21	7791	0.00	68348	0.00	18.02	9.44	76157	9.44	76166	7809
2021-22	8396	0.00	75345	0.00	18.02	9.44	83759	9.44	83768	8414
2022-23	8420	0.00	75593	0.00	18.02	9.44	84031	9.44	84040	8438
2023-24	8450	0.00	75890	0.00	20.02	9.44	84360	9.44	84370	8470
2024-25	8485	0.00	76247	0.00	20.02	9.44	84753	9.44	84762	8505
2025-26	8528	0.00	76675	0.00	20.02	9.44	85224	9.44	85233	8548
2026-27	9343	0.00	81579	0.00	20.02	9.44	90942	9.44	90952	9363
2027-28	9404	0.00	82196	0.00	24.02	9.44	91624	9.44	91634	9428
2028-29	9478	0.00	82936	0.00	24.02	9.44	92438	9.44	92448	9502
2029-30	9566	0.00	83825	0.00	24.02	9.44	93415	9.44	93424	9590
2030-31	9690	0.00	85078	0.00	24.02	9.44	94792	9.44	94801	9714
2031-32	9853	0.00	86724	0.00	26.02	9.44	96603	9.44	96613	9879
2032-33	10057	0.00	88781	0.00	26.02	9.44	98864	9.44	98874	10083
2033-34	10312	0.00	91353	0.00	26.02	9.44	101691	9.44	101701	10338

Table 3: Cost of Gas (in Lakh Taka)

Year	Domestic		Commercial		Industrial		Power		Captive		Total
	Consumption (MMSCM)	Cost of Gas	Consumption (MMSCM)	Cost of Gas	Consumption (MMSCM)	Cost of Gas	Consumption (MMSCM)	Cost of Gas	Consumption (MMSCM)	Cost of Gas	Cost of Gas
2011-12	21	52	50	125	183	459	306	765	183	459	1860
2012-13	22	55	100	251	367	917	612	1529	367	917	3670
2013-14	23	58	151	376	550	1376	917	2294	459	1147	5251
2014-15	24	61	151	376	734	1835	917	2294	459	1147	5712
2015-16	25	64	151	376	734	1835	917	2294	688	1720	6289
2016-17	28	70	201	502	734	1835	917	2294	688	1720	6421
2017-18	31	76	201	502	734	1835	1223	3058	688	1720	7192
2018-19	34	84	201	502	826	2064	1223	3058	826	2064	7773
2019-20	37	93	201	502	826	2064	1223	3058	826	2064	7782
2020-21	41	102	201	502	826	2064	1223	3058	826	2064	7791
2021-22	49	123	251	627	917	2294	1223	3058	917	2294	8396
2022-23	59	147	251	627	917	2294	1223	3058	917	2294	8420
2023-24	71	177	251	627	917	2294	1223	3058	917	2294	8450
2024-25	85	212	251	627	917	2294	1223	3058	917	2294	8485
2025-26	102	254	251	627	917	2294	1223	3058	917	2294	8528
2026-27	122	305	251	627	917	2294	1529	3823	917	2294	9343
2027-28	147	366	251	627	917	2294	1529	3823	917	2294	9404
2028-29	176	440	251	627	917	2294	1529	3823	917	2294	9478
2029-30	211	528	251	627	917	2294	1529	3823	917	2294	9566
2030-31	261	652	251	627	917	2294	1529	3823	917	2294	9690
2031-32	326	816	251	627	917	2294	1529	3823	917	2294	9853

The amount of gas supply per is represented in following figure-2 from table-3.

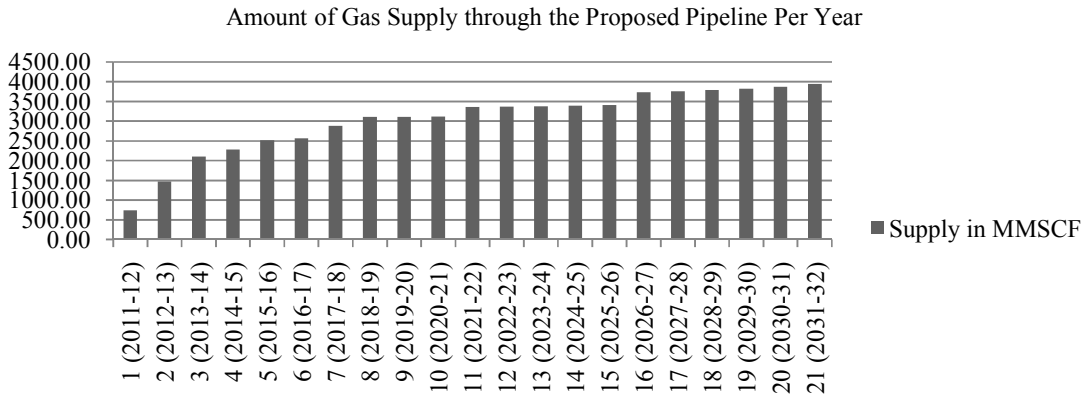

Figure 2: Graphical Representation of Gas Supply through the New Proposed Pipeline Per Year.

3.3 Financial Calculation:

In this project taking 15% discount rate(r), the Net Present Value is

$$NPV = -7487.22 + \frac{-1804.73}{(1+.15)^1} + \frac{2676.83}{(1+.15)^2} + \cdots + \frac{13990.52}{(1+.15)^{23}} = 40203.33$$

Calculation is given in table no 4 & 5. In this project taking discount rate, r = 15% , Discounted total benefits (PV) = 82232.71 Lakh Taka, Discounted total costs (PV) = 42029.37 Lakh Taka, Thus Benefit-Cost Ratio of this project is: 82232.71 ÷ 42029.37 = 1.9565533 (BCR)

Calculation is given in table 4 & 5. In this project taking discount rate, r = 48% & 49% we find- NPV = 76.89 & -215.84 respectively. Thus, the IRR lies between 48% & 49%.

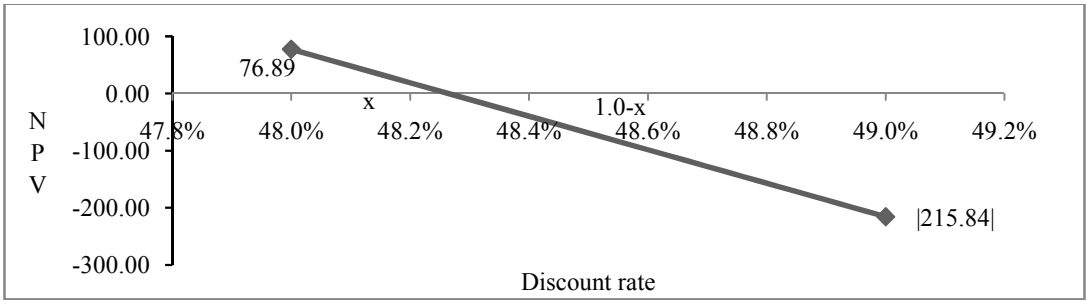

Figure 3: Calculating IRR

From this figure by taking similar triangles,

$$\frac{x}{76.89} = \frac{1-x}{215.84} \text{ or, } x = \frac{76.89}{292.73} \approx 0.2627$$

Thus, the IRR r^* = (48+0.2627) % ≈ 48.27% or 48% to the nearest whole percent.
Calculation is given in table 5, 6, 7, 8 & 9

In this project, The last period with a negative cumulative cash flow, A = 4, The absolute value of cumulative cash flow at the end of the period A, B = |-1347.75| = 1347.75, The total cash flow during the period after A, C = 7547.75

Thus Payback period = 4+1347.75÷7547.75 ≈ 4+0.1786 ≈ 4.1786
Calculation is given in table 4 & 5.

Table 4: Annual Value of Output of the Project (in Lakh Taka)

Year	Expected Quantity of Gas (MMSCM)						Distribution Company Margin					Total Annual Value of Output
	Dom	Com	Ind	Power	Captive	Total	Dom	Com	Ind	Power	Captive Power	
2011-2012	21	50	183	306	183	744	152	870	1752	688	1084	4547
12-13	22	100	367	612	367	1468	159	1741	3505	1376	2169	8950
13-14	23	151	550	917	459	2100	167	2612	5257	2064	2711	12811
14-15	24	151	734	917	459	2285	176	2612	7010	2064	2711	14572
15-16	25	151	734	917	688	2516	184	2612	7010	2064	4067	15937
16-17	28	201	734	917	688	2568	203	3482	7010	2064	4067	16826
17-18	31	201	734	1223	688	2876	223	3482	7010	2752	4067	17534
18-19	34	201	826	1223	826	3109	245	3482	7886	2752	4880	19246
19-20	37	201	826	1223	826	3112	270	3482	7886	2752	4880	19270
20-21	41	201	826	1223	826	3116	297	3482	7886	2752	4880	19297
21-22	49	251	917	1223	917	3358	356	4352	8762	2752	5422	21646
22-23	59	251	917	1223	917	3368	428	4352	8762	2752	5422	21717
23-24	71	251	917	1223	917	3379	513	4352	8762	2752	5422	21803
24-25	85	251	917	1223	917	3394	616	4352	8762	2752	5422	21905
25-26	102	251	917	1223	917	3411	739	4352	8762	2752	5422	22028
26-27	122	251	917	1529	917	3737	887	4352	8762	3441	5422	22864
27-28	147	251	917	1529	917	3762	1064	4352	8762	3441	5422	23041
28-29	176	251	917	1529	917	3791	1277	4352	8762	3441	5422	23254
29-30	211	251	917	1529	917	3826	1532	4352	8762	3441	5422	23510
30-31	261	251	917	1529	917	3876	1892	4352	8762	3441	5422	23870
31-32	326	251	917	1529	917	3941	2365	4352	8762	3441	5422	24343

Where, Dom = Domestic, Com = Commercial, Ind = Industrial, The annual value of output is shown in figure 4 From table 4. The calculated net income in lakh taka (black bars) of this project from 2009-10 to 2031-32 is given in the following figure.

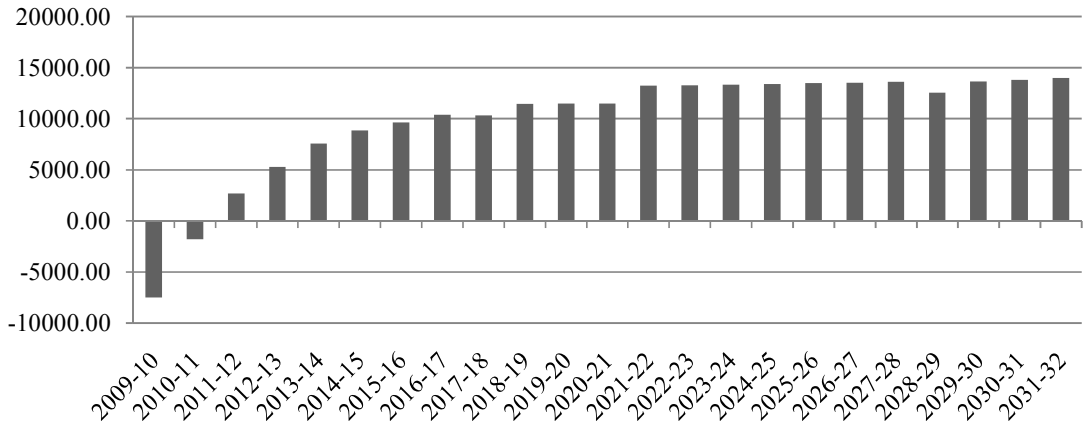

Figure 4: Graphical Representation of Net Income (Lakh Taka) Per Year

Table 5: Financial Analysis at 15% Discount Rate

Year	Investment Cost (PV)	Operating Cost (PV)	Total Cost (PV)	Total Benefit (PV)	Net Benefit (PV)	Discount Factor (49%)	Discounted Total Cost (PV)	Discounted Total Benefit (PV)
2009	7487	0.00	7487		-7487	1.0000	7487	0
2010	1805	0.00	1805		-1805	0.6711	1211	0
2011		1870	1870	4547	2677	0.4504	842	2048
2012		3683	3683	8950	5267	0.3023	1113	2706
2013		5264	5264	12812	7548	0.2029	1068	2599
2014		5725	5725	14572	8847	0.1362	780	1984
2015		6305	6305	15937	9632	0.0914	576	1456
2016		6437	6437	16826	10389	0.0613	395	1032
2017		7208	7208	17534	10326	0.0412	297	722
2018		7789	7789	19246	11457	0.0276	215	532
2019		7800	7800	19270	11471	0.0185	145	357
2020		7809	7809	19297	11488	0.0124	97	240
2021		8414	8414	21646	13232	0.0084	70	181
2022		8438	8438	21717	13279	0.0056	47	122
2023		8470	8470	21803	13333	0.0038	31.9	82
2024		8505	8505	21905	13400	0.0025	21.5	55.3
2025		8548	8548	22028	13481	0.0017	14.5	37.3
2026		9363	9363	22864	13501	0.0011	10.6	26
2027		9428	9428	23042	13613	0.0008	7.2	17.6
2028		9502	9502	22028	12527	0.0005	4.9	11.3
2029		9590	9590	23254	13664	0.0003	3.3	8
2030		9714	9714	23510	13796	0.0002	2.2	5.4
2031		9879	9879	23870	13991	0.0002	1.5	3.7
	9291.95				227,624		14,442	14,226

Table 6: Financial Analysis at 48% Discount Rate

Year	Investment Cost (PV)	Operating Cost (PV)	Total Cost (PV)	Total Benefit (PV)	Net Benefit (PV)	Discount Factor (48%)	Discounted Total Cost (PV)	Discounted Total Benefit (PV)
2009	7487	0	7487		-7487	1.0000	7487	0.00
2010	1805	0	1805		-1805	0.6757	1219	0.00
2011		1870	1870	4547	2677	0.4565	854	2076
2012		3683	3683	8950	5267	0.3085	1136	2761
2013		5264	5264	12812	7548	0.2084	1097	2670
2014		5725	5725	14572	8847	0.1408	806	2052
2015		6305	6305	15937	9632	0.0952	600	1516
2016		6437	6437	16826	10389	0.0643	414	1082
2017		7208	7208	17534	10326	0.0434	313	762
2018		7789	7789	192456	11457	0.0294	229	565
2019		7800	7800	19270	11471	0.0198	155	382
2020		7809	7809	19297	11488	0.0134	105	259
2021		8414	8414	21646	13232	0.0091	76	196
2022		8438	8438	21717	13279	0.0061	52	133
2023		8470	8470	21803	13333	0.0041	35	90
2024		8505	8505	21905	13400	0.0028	24	61
2025		8548	8548	22028	13481	0.0019	16	41.6
2026		9363	9363	22864	13501	0.0013	12	29.15
2027		9428	9428	23042	13613	0.0009	8	19.8
2028		9502	9502	22028	12527	0.0006	5.5	12.8
2029		9590	9590	23254	13664	0.0004	3.8	9.15

2030		9714	9714	23510	13796	0.0003	2.6	6.25
2031		9879	9879	23870	14000	0.0002	1.77	4.29
	9292				227,624		14,651	14,728

Table 7: Financial Analysis at 49% Discount Rate

Year	Investment Cost (PV)	Operating Cost (PV)	Total Cost (PV)	Total Benefit (PV)	Net Benefit (PV)	Discount Factor (49%)	Discounted Total Cost (PV)	Discounted Total Benefit (PV)
2009	7487	0.00	7487		-7487	1.0000	7487	0.00
2010	1805	0.00	1805		-1805	0.6711	1211	0.00
2011		1870	1870	4547	2677	0.4504	842	2048
2012		3683	3683	8950	5267	0.3023	1113	2706
2013		5264	5264	12812	7548	0.2029	1068	2599
2014		5725	5725	14572	8847	0.1362	780	1984
2015		6305	6305	15937	9632	0.0914	576	1456
2016		6437	6437	16826	10389	0.0613	395	1032
2017		7208	7208	17534	10326	0.0412	297	722
2018		7789	7789	19246	11457	0.0276	215	532
2019		7800	7800	19270	11471	0.0185	145	357
2020		7809	7809	19297	11488	0.0124	97	240
2021		8414	8414	21646	13232	0.0084	70	181
2022		8438	8438	21717	13279	0.0056	47.3	122
2023		8470	8470	21803	13333	0.0038	31.9	82
2024		8505	8505	21905	14000	0.0025	21.5	55.3
2025		8548	8548	22028	13481	0.0017	14.5	37.3
2026		9363	9363	22864	13501	0.0011	10.6	26
2027		9428	9428	23042	13613	0.0008	7.2	17.6
2028		9502	9502	22028	12527	0.0005	4.87	11.3
2029		9590	9590	23254	13664	0.0003	3.3	8
2030		9714	9714	23510	13796	0.0002	2.24	5.4
2031		9879	9879	23870	13991	0.0002	1.53	3.7
Total	9292				227,624		14,442	14,226

4. CONCLUSIONS

Presently supply cannot meet the present demand. To meet the present demand and future increasing demand it needs to increase supply rationally. Presently only maximum 180 MMSCFD gas can be supplied through the existing pipe line which is reducing day by day with the increasing gas demand along the pipeline route. After completing the proposed pipeline, it could be supplied around 375 MMSCF gas per day. After the calculation, diameter of the proposed pipeline and pipe wall thickness is calculated as 20" and 11.02 mm respectively. The Internal Rate of Return IRR Is 48%. Along side benefit cost ratio, net present value and pay back period of the project are 1.9565533, 40203.33 lakhs and 4.1786 years respectively.

Successful implementation of the project will result in improvement of operational flexibility and reliable supply of gas to the customers downstream of Narsingdi V.S.-12. With the completion of planned installation of Compressor Stations at Muchai and Ashuganj within three years, the pressure at Ashuganj MPS is expected to increase significantly. This will also improve the operating pressure of 24"DN x 1000 Psig x 125 Km, Ashuganj-Elenga Transmission Pipeline (Source line of proposed Monohardi-Narsingdi Parallel/Loop Line). In the altered situation, considering the minimum pressure at Monohardi to be 800 Psig and minimum pressure at Narsingdi V.S.-12 to be 600 Psig, the minimum capacity of the proposed pipeline will be approximately 375 MMSCFD. This will definitely improve the supply and pressure situation, downstream of Narsingdi V.S.-2 to a great extent.

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