DEPARTMENT OF BUILDING, CIVIL & ENVIRONMENTAL ENGINEERING

BLDG 6561 – BUILDING ECONOMICS I

VARIABLE INVESTMENT IN COMMERCIAL SECTOR

Submitted To:
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1. EXECUTIVE SUMMARY

The main objective of this project is to study and utilize the variable investments available in commercial sector. This project also tries to study, analyze, determine and justify the investments made in the commercial sector by studying several alternatives available in commercial sector and to determine whether investing in any one of them is profitable or not. This project is also tries to justify the investments made by doing several feasibility studies and analysis such as Present Worth Analysis and Equivalent Uniform Annual Worth Analysis. Four Investments or Alternatives were selected and finalized. These four alternatives are in different parts of Montreal City. This project has an analysis period of 20 Years. During the process of calculations, quite a few assumptions were made, and the calculations were determined based on these assumptions. All these calculations are shown in the report.

2. INTRODUCTION

Building Economics is a fast-developing field in today's world. Many new projects and constructions are being started and many new studies are being conducted in which building economics plays a crucial role. With the help of Building Economics, one can easily predict whether one can make a profitable investment or not by undertaking various economic analysis techniques in the field of Building Economics. There is huge demand and pressure on the economic analysts for conducting surveys and analysing them to help the investor make a profitable investment. New theories and studies are being conducted due to the fast-growing significance of Building Economics and its importance.

This paper considers the investments made in commercial sector. Commercial sector is always a lucrative market and many innovative and advanced constructions are taken up by this sector. Every investor wants to be a part of this sector for its highly profitable returns. seeing the increase in demand in commercial spaces as stated by statistics Canada investment in commercial construction rose in Montreal during the third quarter of 2017 to $1.35 billion, (i.e., 12.9-percent increase from the equivalent period in 2016 and a 9.8-percent increase from the equivalent period) tempts us to find investment opportunities in commercial sector. Commercial sector has been allocated 30 million dollars by the Quebec Government. There is a rise of $1.3 billion in Commercial sector in the third quarter of 2017 [1].

Economic analysis can be both simple and complex depending on the type of investment problem. Complex economic analysis sometimes requires and in-depth and detailed study of the investment. Many new models must be developed, and each model is to be studied critically giving an account of the economic study. Every economic analysis must be carefully studied because a simple mistake may change the entire alternative which might result in wrong decisions being made.

To avoid such a scenario, there are different types of analysis which one can choose to study every scenario perfectly. The net worth of any alternative can be studied with the help of three methods; which are Present Worth Method, Equivalent Uniform Annual Worth Method and Future Worth Method.
The various analysis which should be part of any economic analysis are given as follows: -

1. Cash Flows Before and After Tax
2. Interest Rate Calculation
3. Selection of MARR
4. Depreciation calculation
5. Benefit to Cost Ratio Calculation
6. Internal Rate of Return
7. Pay Back Period
8. Sensitivity Analysis
9. Risk assessment
10. Simulation

This paper has also studied and considered all the above-mentioned analysis methods to choose the best possible outcome.

3. PROBLEM STATEMENT

We have selected four different alternatives of commercial buildings from all the available options which are to be analysed for a period of 20 years. We must select the best one by comparing the alternatives through various economic analysis techniques on each of them. Else we will consider a fifth alternative as an investment of $12 M in TD Bank with an interest rate of 3.45% [2].

4. ASSUMPTIONS

- Decision horizon or time- period of 20 years.
- The Income Tax Consideration from Revenue Canada.
- Opportunity cost based on new construction in downtown.
- Data that was necessary for the analysis which we could not find out.
- We have selected Double Decline Method to find the terminal value.
- We have selected the fifth alternative with and opportunity cost of 2.5%.

5. ROLES AND RESPONSIBILITIES

- Adit Singh- Data collection, presentation video, decision for uncertain parameters, risk analysis, discrete analysis and simulation analysis.
- Anoop Chander Singarapu- Data collection, presentation video, MARR calculation, Pay-back period, decision for uncertain parameters, after tax calculations.
- Dhruvin Jayantibhai Savaj- Data collection, presentation video, NPW, IRR, BCR and sensitivity calculations. decision for uncertain parameters.
- Harwinder Singh- Data collection, presentation video, decision for uncertain parameters, risk analysis, discrete analysis and simulation analysis.
- Hetasvi Javiya- Data collection, presentation video, NPW, IRR, BCR and sensitivity calculations. decision for uncertain parameters.
- Vivekkumar Chatrola- Data collection, presentation video, NPW, IRR, BCR and sensitivity calculations. decision for uncertain parameters.
- Naga Sai Sashank Ganti- Data collection, presentation video, MARR calculation, Pay-back period, decision for uncertain parameters, after tax calculations.

6. DECISION ALTERNATIVES

As mentioned in problem statement, we have four different alternatives out of which one can be selected, which has the maximum profits. Three alternatives are located in Downtown Montreal which can be considered as a commercial hub in Montreal. One alternative is located slightly away from the City. Following are the alternatives which we have chosen,

6.1. A 1- PLACE VILLE MARIE 4

Figure 1 [4]

6.2. A 2- 16, PLACE DU COMMERCE

Figure 2 [5]

6.3 A 3- 780 RUE WELLINGTON

Figure 3 [6]

6.4. A 4-1360 RENE LEVESQUE

Figure 4 [7]

7. DATA AND DATA COLLECTION PROCEDURE

7.1. DATA COLLECTION PROCEDURE

Data is gathered from different websites such as Centris Canada. The data for Alternative 1 was collected by personnel visits to the site. By sending emails to the officials concerned, the management has provided us some of the data required while the rest was assumed for calculations. Alternative 2 had their data available on Yellow Pages website and the rest of the information which was unavailable was assumed for calculations. All the data for Alternative 3 was provided by visits to the site as well as from Centris Canada. A well-known contact was available at Alternative 3 which provided critical data. Alternative 4 had their own website which provided the required information. Site visits were also undertaken and thus all accurate information was acquired.

7.2. DATA

Table 1 Data Collection Sheet

	Alternative 1	**Per Unit**	**Alternative 2**	**Per Unit**	**Alternative 3**	**Per Unit**	**Alternative 4**	**Per Unit**
Year of construction	1962		1992		2010		2004	
Class	B		A		A		A	
Total area	**75091**	S.F.	**165000**	S.F.	**188700**	S.F.	**52487**	S.F.
Number of Floors	7		10		17		4	
Age	56		26		8		14	
Useful life (year)	80		85		85		85	
Remaining useful life	24		59		77		71	
Cost								
Total Initial Cost ($ M)	**$22.50**		**$16.50**		**$21.25**		**$18.50**	
Annual O&M cost ($ M)	**$1.05**		**$1.07**		**$1.23**		**$0.52**	
Overhaul cost ($ M)	**$0.90**	Every 6th Year	**$1.04**	Every 6th Year	**$1.19**	Every 8th Year	**$0.31**	Every 8th Year
Debt								
Bank loan amount($ M)	**$7.50**		**$1.50**		**$6.25**		**$3.50**	
Bank repayment($ M)	**$9.48**	7th Year	**$1.90**	7th year	**$7.90**	7th year	**$4.42**	7th year
Bond amount($ M)	**$3.00**		**$3.00**		**$3.00**		**$3.00**	
Bond repayment($ M)	**$0.17**	Yearly	**$0.17**	yearly	**$0.17**	yearly	**$0.17**	yearly
Bond repayment final year($ M)	**$3.17**	20th Year	**$3.17**	20th Year	**$3.17**	20th Year	**$3.17**	20th Year
Profit								
Revenue ($ M)	**$4.51**	Yearly	**$3.56**	Yearly	**$4.53**	Yearly	**$3.15**	Yearly
Terminal value @ 20 year (DDB) ($ M)	**$0.36**		**$0.29**		**$0.33**		**$0.30**	
CCA(%)	5%		6%		6%		6%	
Depreciation rate	0.083		0.034		0.026		0.028	

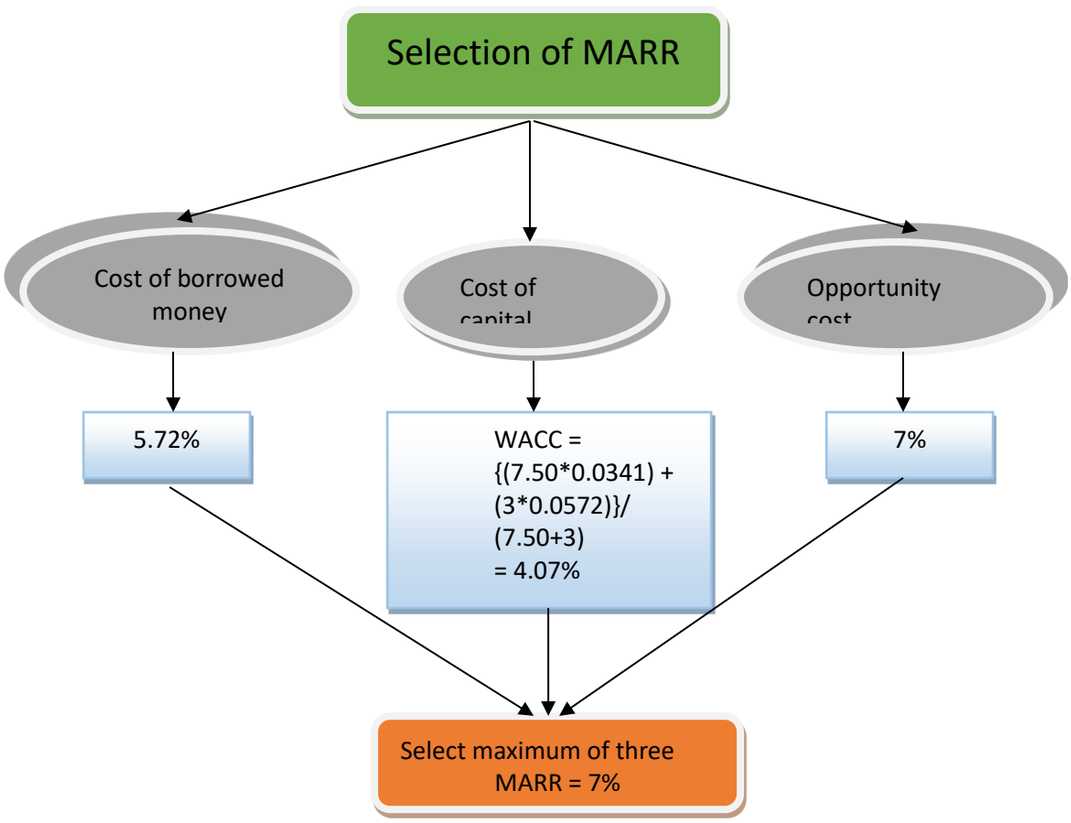
Table 2 Data Collection

Decision horizon	20 Year
Bank Interest rate	3.41%
Bond Interest rate	5.72%
WACC (%)	4.07%
Opportunity cost	7.0%
MARR before tax	7.0%
Income tax	38.0%
MARR after tax	4.34%

Alternative-5: Do nothing. (Deposit of $ 12M in a bank for 20 years at i=2.5% will give the future value of $ 19.66M.)

8. SELECTION OF INTEREST RATE

The analysis period for this project is 20 Years. Hence, we must select an interest rate which confirms with the entire timespan considering several other factors such as inflation. Since this project involves commercial sector, the sole motto of commercial sector is "Maximization of Profits" which can be achieved by selecting an appropriate interest rate which will help us in achieving this motto. Several banks were consulted, and a detailed survey was conducted.
The entire profitability can be calculated with the help of Benefit to Cost Ratio which will provide us with an accurate value. We have calculated the WACC which was 4.07%. If all the alternatives are not feasible then we have a fifth alternative with an opportunity cost of 7%. Taking all these factors (WACC, Capital Cost and Opportunity Cost) into consideration an interest rate of 7% is taken which can be subjective. The interest rate is 3.45 % from TD Bank which is subjective [3].



9. ECONOMIC ANALYSIS OF ALTERNATIVES

The economic analysis of alternatives was done with the help of following parameters-

a) Net Present Worth
b) Internal Rate of Return
c) Benefit to Cost Ratio
d) Pay Back Period
e) Taxation Calculation
f) Sensitivity Analysis
g) Risk Analysis

9.1 NET PRESENT WORTH

Net Present Worth Before Tax for all alternatives have been compared as below;

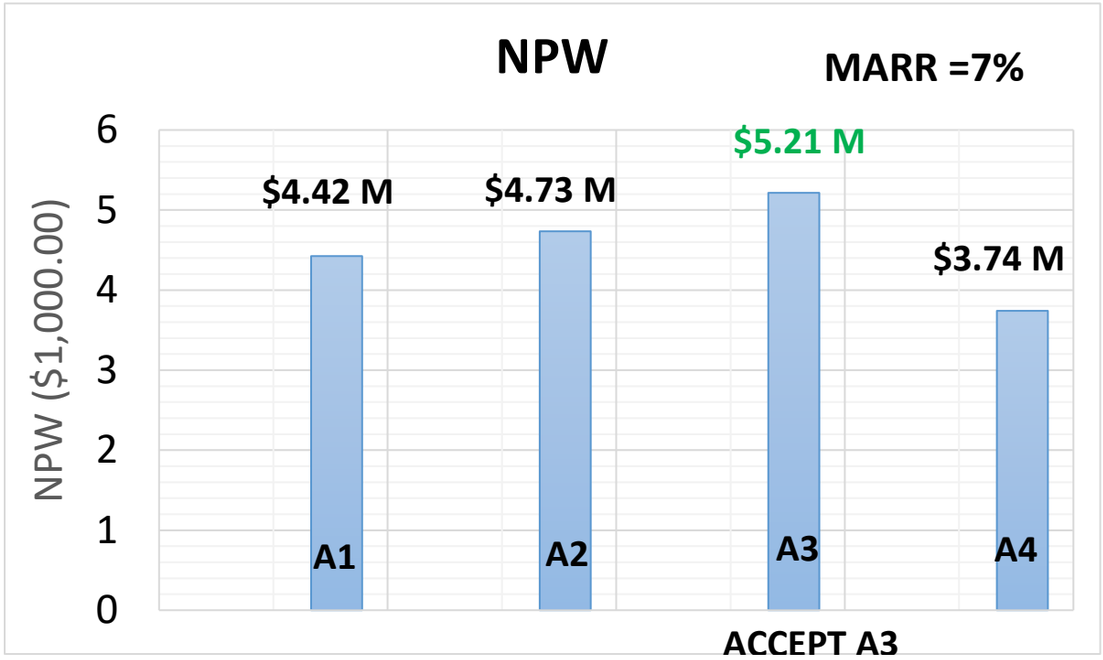


Figure 5 NPW before tax

9.2 INTERNAL RATE OF RETURN

Internal rate of return for all alternatives.

Table 3 Incremental IRR

	A1-A3	A3-A4	A4-A2
ΔIRR	-1%	14%	2%
	Select A3	Select A3	Select A4

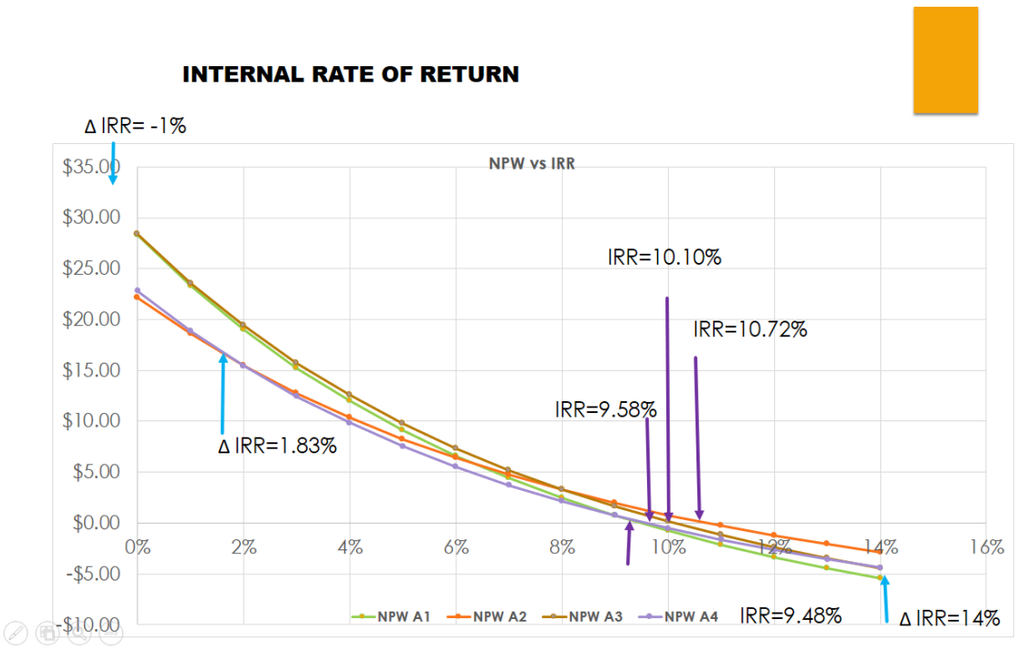


Figure 6 NPW vs IRR

9.3 BENEFIT TO COST RATIO

Benefit to Cost ratio for all alternatives which are above B/C=1 line.

Table 4 Incremental BCR

	A1-A3	A3-A4	A4-A2
ΔBCR	-0.44	1.11	1.29
	Select A3	Select A3	Select A4

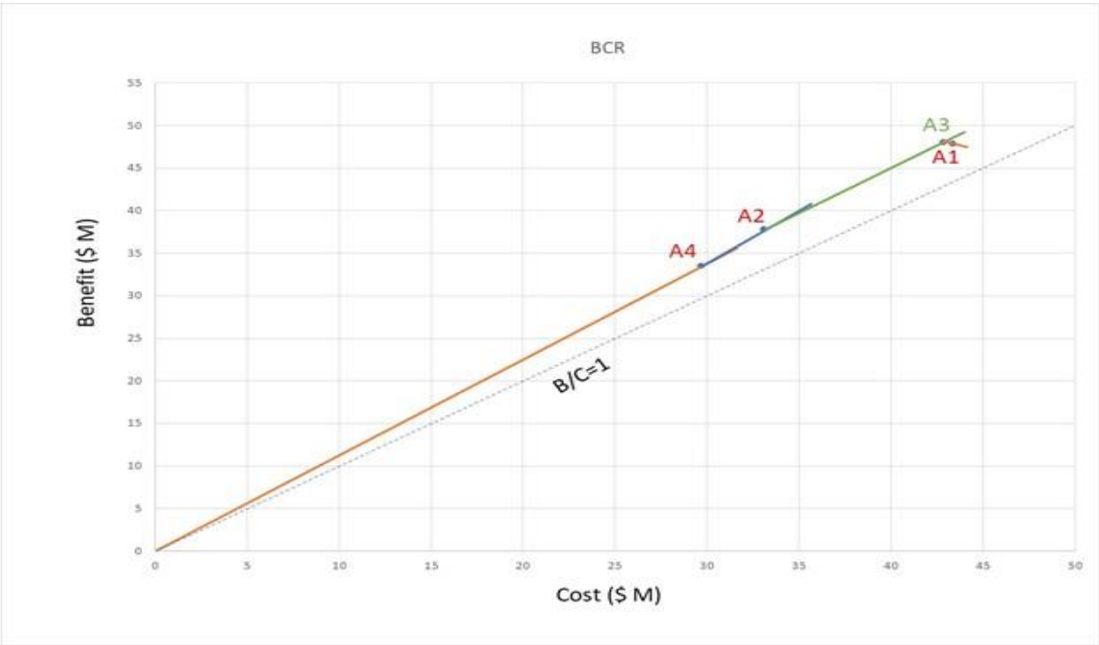


Figure 7 Incremental BCR Graph

9.4 PAYBACK PERIOD

Payback period for all alternatives are given below.

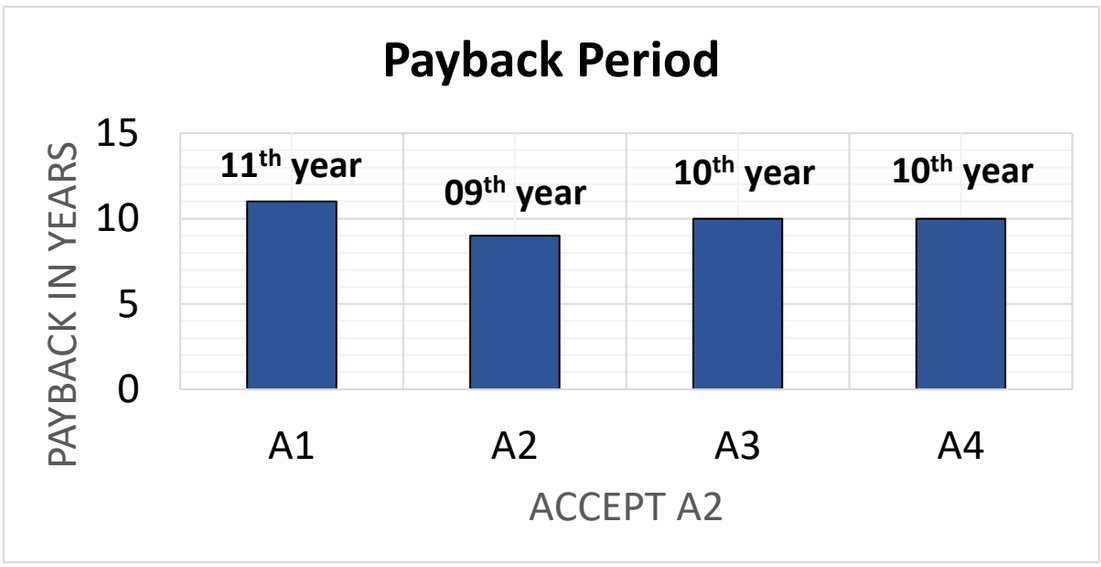


Figure 8 Payback Period

9.5 TAXATION CALCULATION

Net present worth after tax for all alternatives have been calculated. **ACCEPT A3**

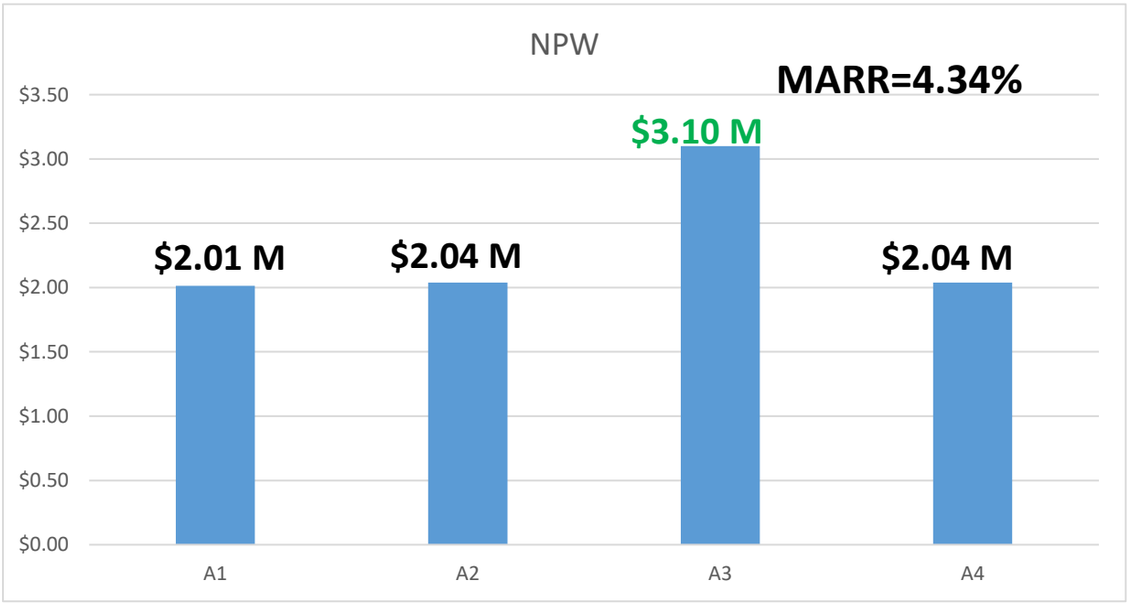


Figure 9 NPW after tax

9.6 SENSITIVITY ANALYSIS

The sensitivity of parameters can be analyzed with the help of Spider Graph and Tornado Graph. Sensitivity analysis is the graph to analyze the uncertain parameters and able to determine most uncertain parameters. Here we have considered revenue, overhaul cost, O&M cost, salvage value, and MARR as uncertain parameters. Tornado graph of sensitivity analysis for all alternatives are given below.

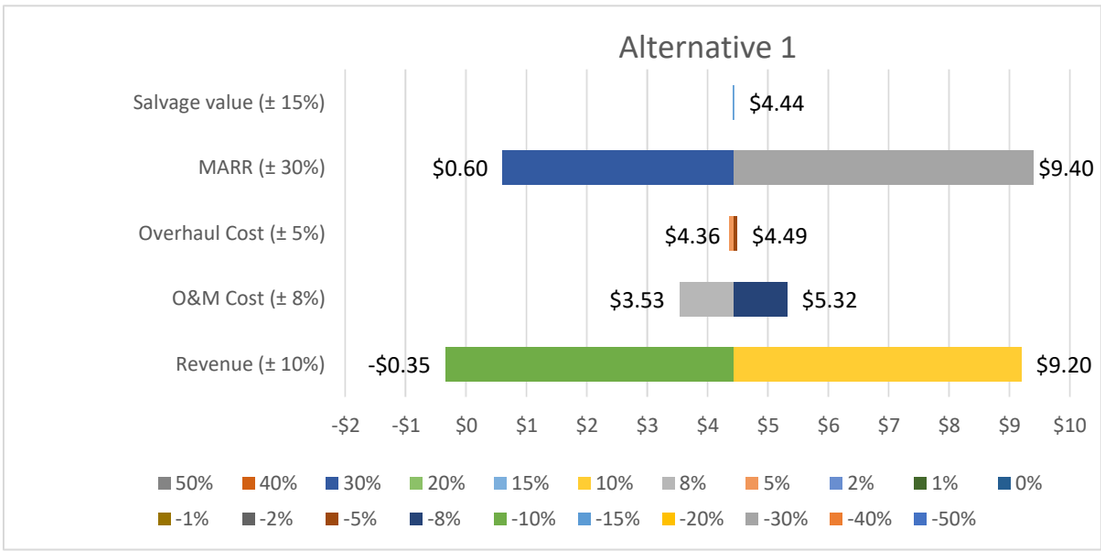


Figure 10 Sensitivity Analysis of A1

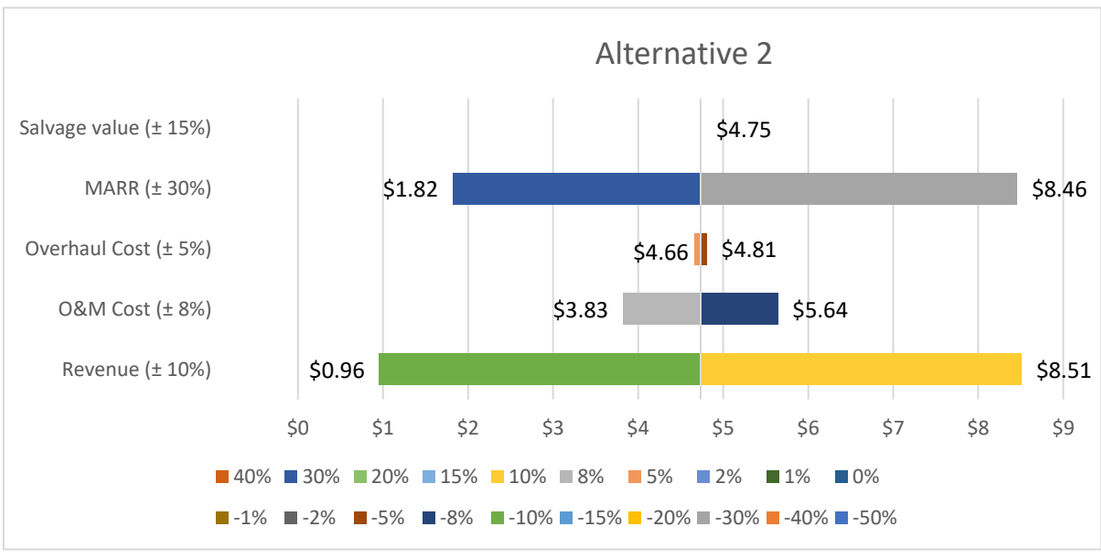


Figure 11 Sensitivity Analysis of A2

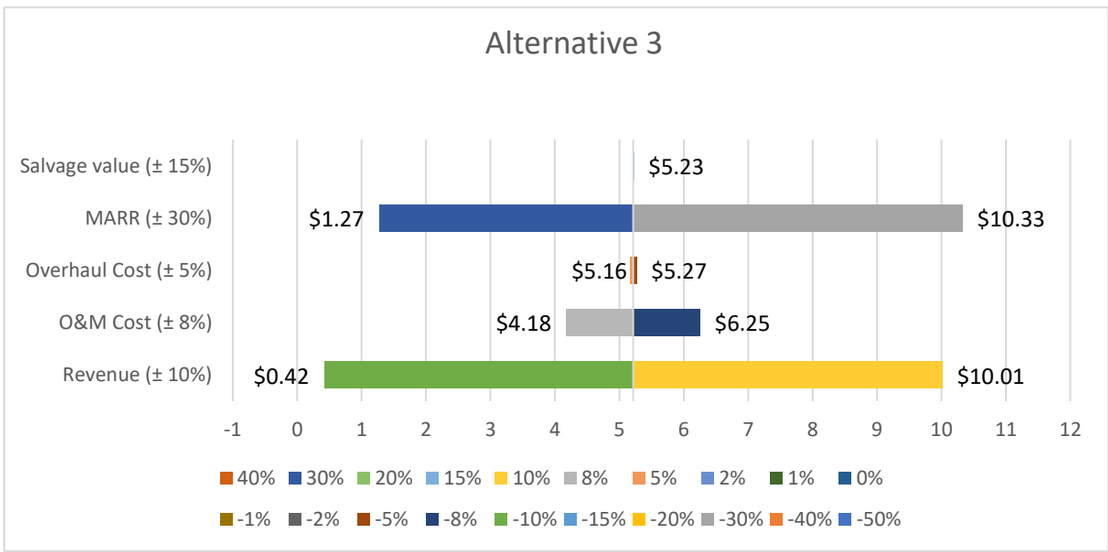


Figure 12 Sensitivity Analysis of A3

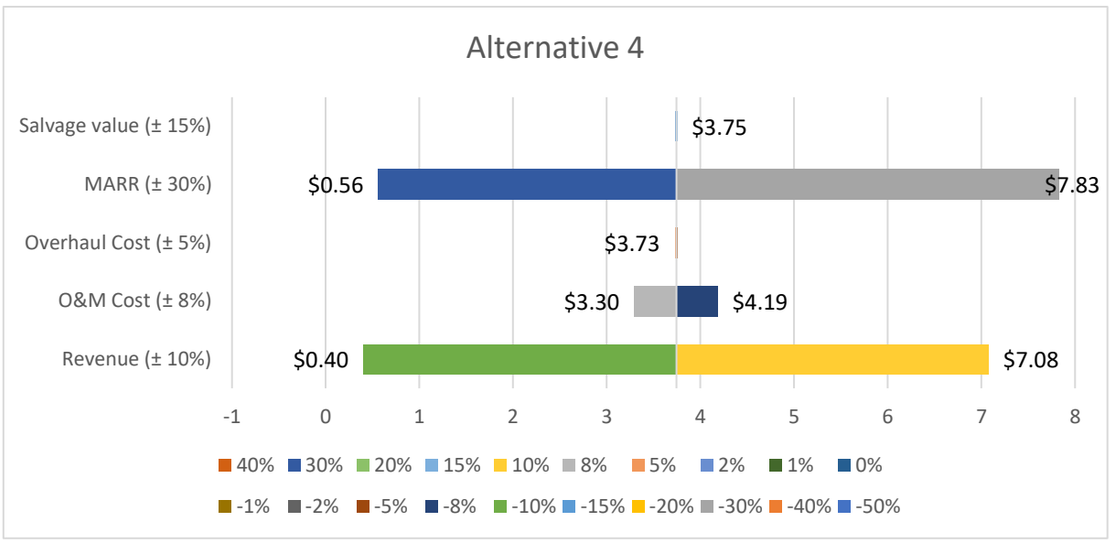
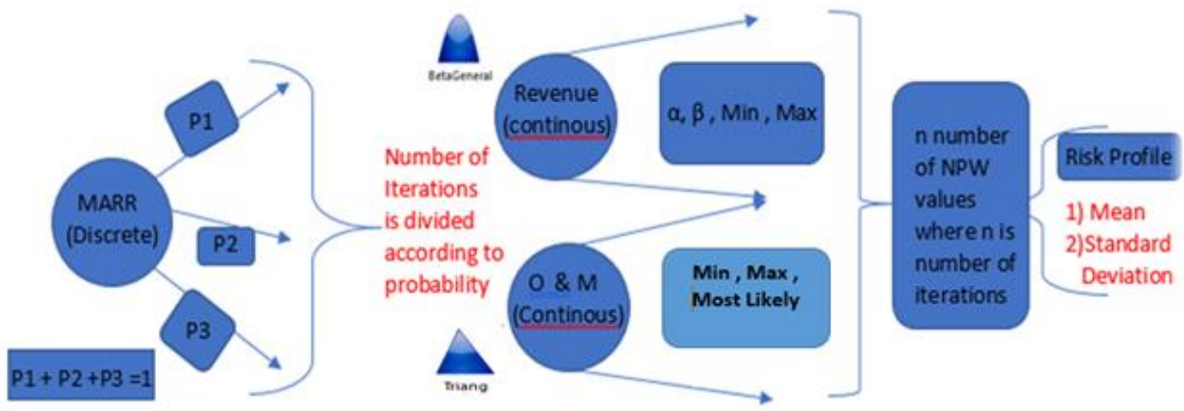


Figure 13 Sensitivity Analysis of A4

9.7 UNCERTAINITY ANALYSIS AND RISK ASSESSMENT

In our case the most sensitive parameters in cashflow diagrams of different alternatives are Revenue, operation & Maintenance and MARR, means their uncertainty would result in selection of undesirable alternative. So, we need a best guess estimate for these uncertain sensitive parameters.
Data is collected to define the behaviour of variation (uncertainty) of these parameters.

PARAMETERS	DATA TYPE	DATA SOURCE	DATA BEHAVIOUR
MARR	Sample data	Historical Data of Alternative	Discrete
REVENUE	Subjective Data	Expert Judgement	Continuous
OPERATION & MAINTENANCE	Subjective data	Expert judgement	Continuous



For every alternative, the number of iteration are divide according to the probability of MARR (Empirical Distribution), then for each iteration random variables are extracted out from probability distribution curves (Theoretical Distribution) of uncertain parameter of continuous nature. The resultant NPW of each iteration is used to determine the most frequent interval, which is then concluded as most expected interval. The Expected value is the average of all the iterations which is then compared with its standard deviation to analyse Risk associated.
For all alternatives, 10,000 iterations are used which is further divided as 6,000 for 7%, 3,000 for 6% and 1,000 for 8% MARR. The Random values for Revenue & O/P are extracted from beta normal continuous curve and Triangular curve respectively. The resultant NPW for each iteration is used for risk profile.

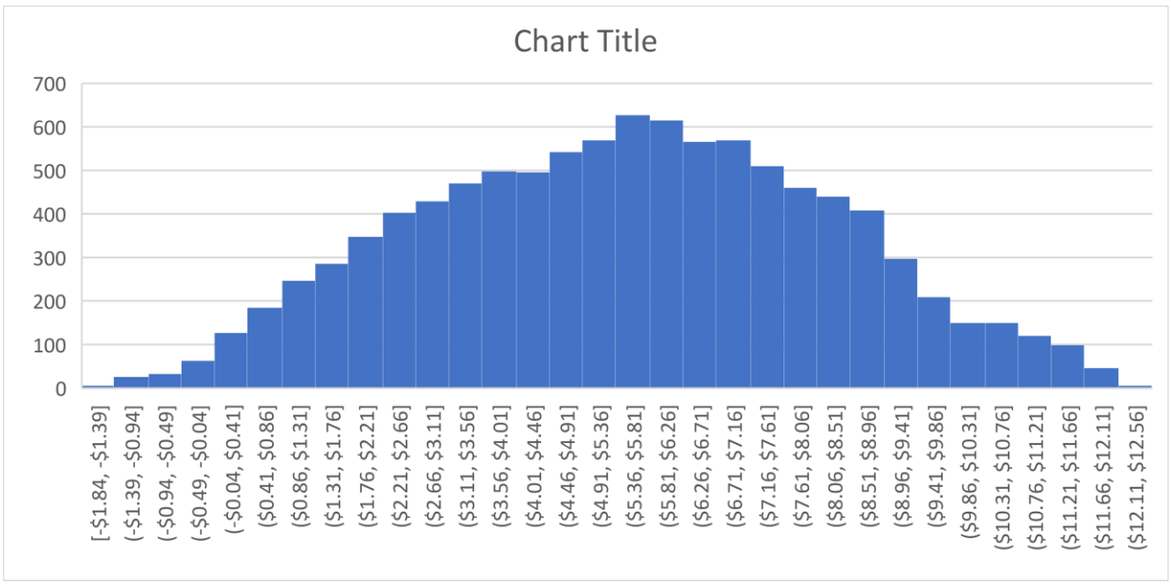


Figure 14 Monte-Carlo Simulation for A1

EV = 5.49, SD=2.7841; EV>2SD [5.49>2 X 2.7841] = False = Risk prone

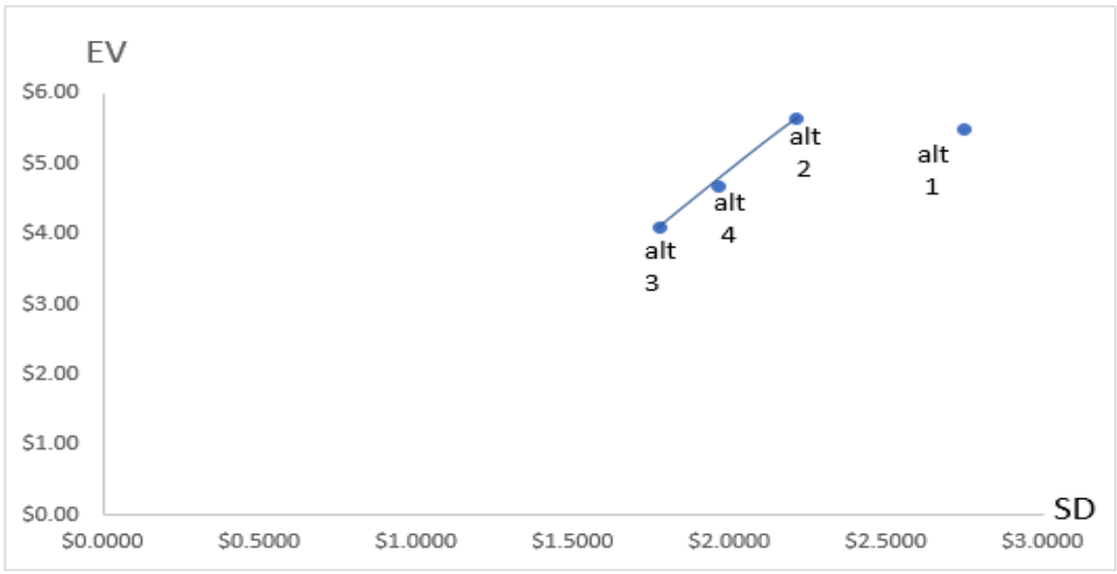


Figure 15 PARETO Graph

Clearly from the above pareto graph alternative 1 & alternative 4 can be disregarded. Either of Alternative 3 and Alternative 2 can be selected depending upon the tolerance for risk.

10. SUMMARY AND CONCLUSION

After conducting all the above economic analysis and selecting a range of parameters, we have concluded that alternative 1 and alternative 4 can be discarded based on NPW, IRR and BCR for before tax and after-tax analysis.
The before tax and after tax NPW for alternative 3 is greater than all other alternatives which clearly states that alternative 3 is the best one to invest money. It is more profitable than alternative 2 based on incremental IRR and BCR analysis.
We have selected 6 uncertain parameters for analysis and performed sensitivity analysis on all alternatives. Out of those 6 indeterminate parameters, we chose 3 most sensitive parameters (MARR, Revenue and O&M cost) for risk analysis. We selected sample data-discrete behaviour for MARR and subjective data-continuous behaviour for revenue and O&M cost. Random values for Revenue & O/M are extracted from beta normal continuous curve and Triangular curve respectively.

From risk assessment EV>2SD for all the alternatives except alternative 1. Based on risk analysis, alternative 2 has higher risk than alternative 3. Overall, after taking all economic analysis into consideration, we have decided to invest our money on alternative 3.

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APPENDIX- A

Before Tax Cash Flows of different alternatives are given below;

Table 5 CFD A1

alterntive 1								
EOY	Initial Cost (1 M)	annual maintananace cost	Overhaul Cost (1 M)	Bank Repaymen t (1M)	Bond Repayment(1M)	Annual Rvenue(1 M)	Terminal Value	Cash Flow(1 M)
0	-$22.50							-$22.50
1		-$1.05			-$0.17	$4.51		$3.28
2		-$1.05			-$0.17	$4.51		$3.28
3		-$1.05			-$0.17	$4.51		$3.28
4		-$1.05			-$0.17	$4.51		$3.28
5		-$1.05			-$0.17	$4.51		$3.28
6		-$1.05	-$0.90		-$0.17	$4.51		$2.38
7		-$1.05		-$9.48	-$0.17	$4.51		-$6.20
8		-$1.05			-$0.17	$4.51		$3.28
9		-$1.05			-$0.17	$4.51		$3.28
10		-$1.05			-$0.17	$4.51		$3.28
11		-$1.05			-$0.17	$4.51		$3.28
12		-$1.05	-$0.90		-$0.17	$4.51		$2.38
13		-$1.05			-$0.17	$4.51		$3.28
14		-$1.05			-$0.17	$4.51		$3.28
15		-$1.05			-$0.17	$4.51		$3.28
16		-$1.05			-$0.17	$4.51		$3.28
17		-$1.05			-$0.17	$4.51		$3.28
18		-$1.05	-$0.90		-$0.17	$4.51		$2.38
19		-$1.05			-$0.17	$4.51		$3.28
20		-$1.05			-$3.17	$4.51	$0.36	$0.64
						NPW		**$4.42**
						IRR		**9.48%**
						BCR		**1.10**

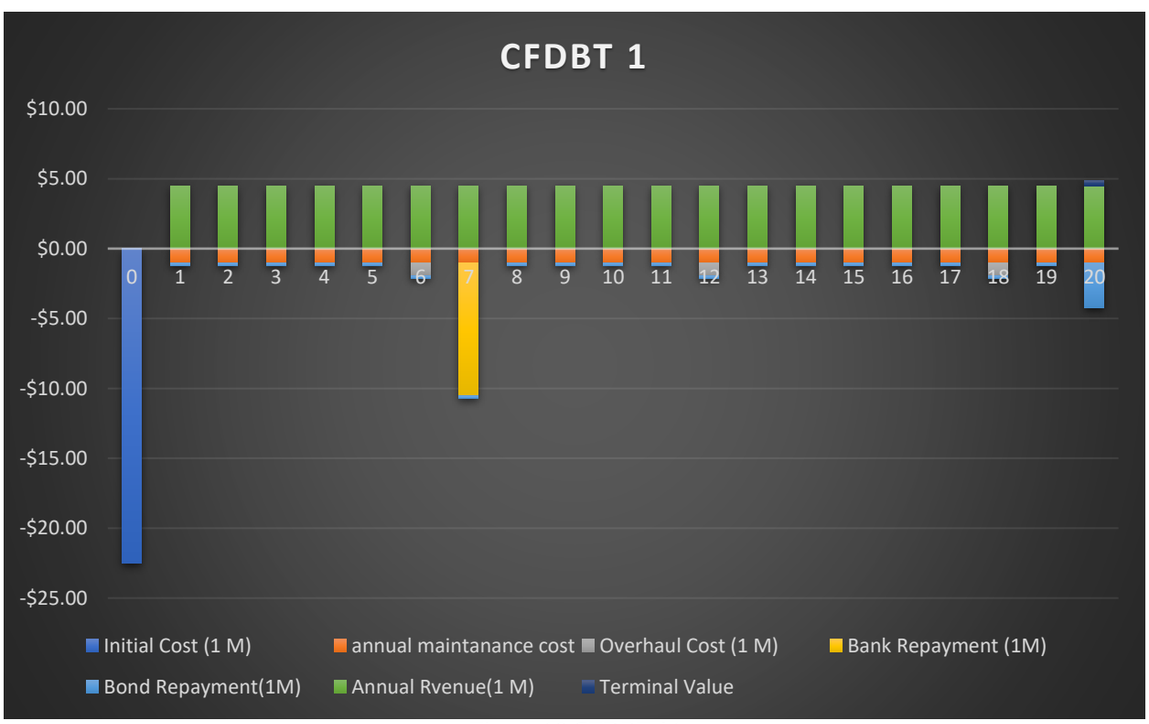

Figure 16 CFDBT A1

Table 6 CFD A2

alterntive 2								
EOY	Initial Cost (1 M)	annual maintananace cost	Overhaul Cost (1 M)	Bank Repayment(1 M)	Bond Repayment(1 M)	Annual Rvenue(1 M)	Terminal Value	Cash Flow(1 M)
0	-$16.50							-$16.50
1		-$1.07			-$0.17	$3.56		$2.32
2		-$1.07			-$0.17	$3.56		$2.32
3		-$1.07			-$0.17	$3.56		$2.32
4		-$1.07			-$0.17	$3.56		$2.32
5		-$1.07			-$0.17	$3.56		$2.32
6		-$1.07	-$1.04		-$0.17	$3.56		$1.28
7		-$1.07		-$1.90	-$0.17	$3.56		$0.42
8		-$1.07			-$0.17	$3.56		$2.32
9		-$1.07			-$0.17	$3.56		$2.32
10		-$1.07			-$0.17	$3.56		$2.32
11		-$1.07			-$0.17	$3.56		$2.32
12		-$1.07	-$1.04		-$0.17	$3.56		$1.28
13		-$1.07			-$0.17	$3.56		$2.32
14		-$1.07			-$0.17	$3.56		$2.32
15		-$1.07			-$0.17	$3.56		$2.32
16		-$1.07			-$0.17	$3.56		$2.32
17		-$1.07			-$0.17	$3.56		$2.32
18		-$1.07	-$1.04		-$0.17	$3.56		$1.28
19		-$1.07			-$0.17	$3.56		$2.32
20		-$1.07			-$3.17	$3.56	$0.29	-$0.39
						NPW		**$4.73**
						IRR		**10.72 %**
						BCR		**1.14**

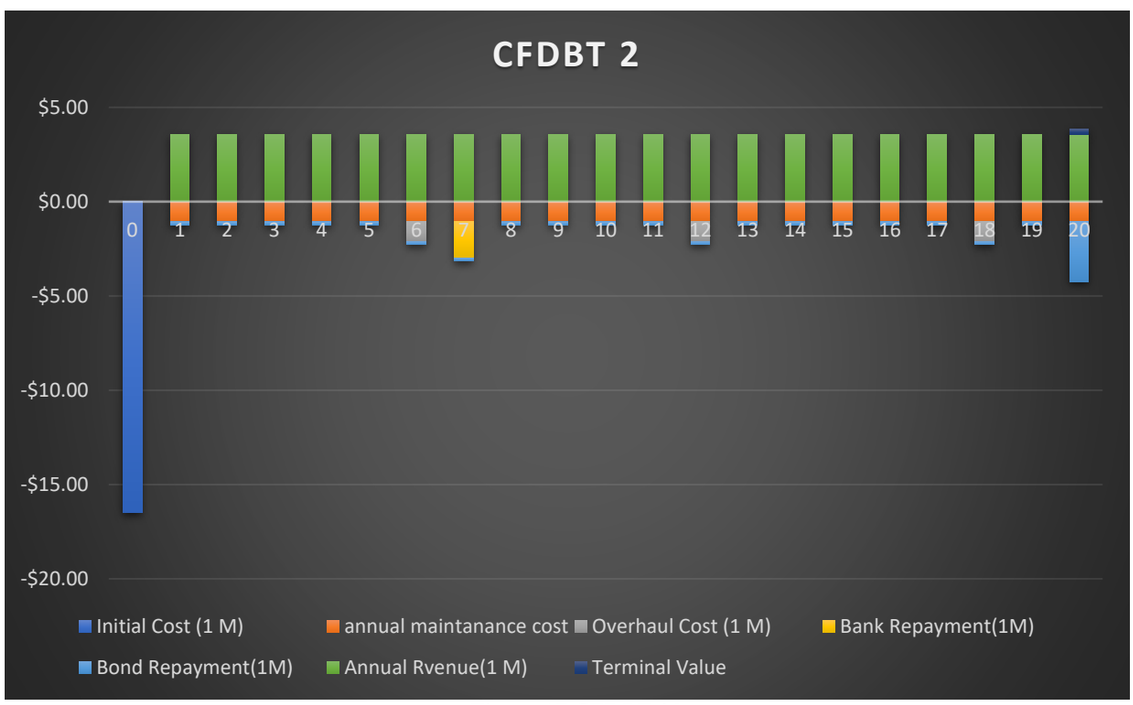

Figure 17 CFDBT A2

Table 7 CFD A3

alterntive 3								
EOY	Initial Cost (1 M)	annual maintanance cost	Overhaul Cost (1 M)	Bank Repayment	Bond Repayment	Annual Rvenue(1 M)	Terminal Value	Cash Flow(1 M)
0	-$21.25							-$21.25
1		-$1.23			-$0.17	$4.53		$3.13
2		-$1.23			-$0.17	$4.53		$3.13
3		-$1.23			-$0.17	$4.53		$3.13
4		-$1.23			-$0.17	$4.53		$3.13
5		-$1.23			-$0.17	$4.53		$3.13
6		-$1.23			-$0.17	$4.53		$3.13
7		-$1.23		-$7.90	-$0.17	$4.53		-$4.77
8		-$1.23	-$1.19		-$0.17	$4.53		$1.94
9		-$1.23			-$0.17	$4.53		$3.13
10		-$1.23			-$0.17	$4.53		$3.13
11		-$1.23			-$0.17	$4.53		$3.13
12		-$1.23			-$0.17	$4.53		$3.13
13		-$1.23			-$0.17	$4.53		$3.13
14		-$1.23			-$0.17	$4.53		$3.13
15		-$1.23			-$0.17	$4.53		$3.13
16		-$1.23	-$1.19		-$0.17	$4.53		$1.94
17		-$1.23			-$0.17	$4.53		$3.13
18		-$1.23			-$0.17	$4.53		$3.13
19		-$1.23			-$0.17	$4.53		$3.13
20		-$1.23			-$3.17	$4.53	$0.33	$0.47
						NPW		**$5.21**
						IRR		**10.10 %**
						BCR		**1.12**

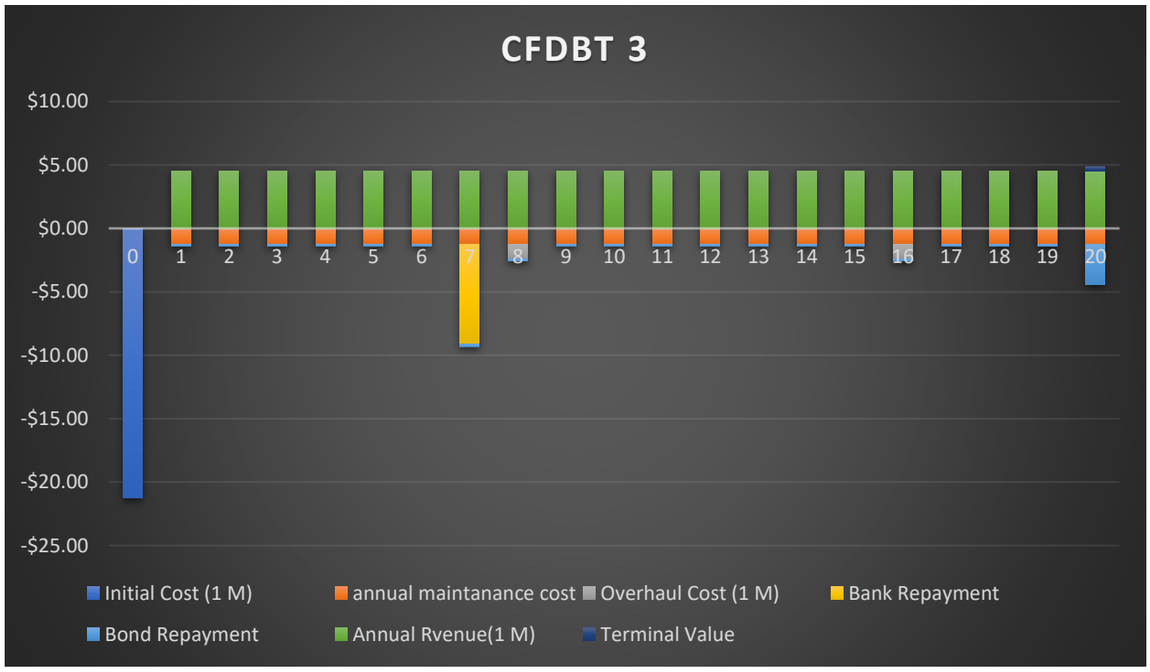

Figure 18 CFDBT A3

Table 8 CFD A4

alterntive 4								
EOY	Initial Cost (1 M)	annual maintanance cost	Overhaul Cost (1 M)	Bank Repayment	Bond Repayment	Annual Rvenue(1 M)	Terminal Value	Cash Flow(1 M)
0	-$18.50							-$18.50
1		-$0.52			-$0.17	$3.15		$2.45
2		-$0.52			-$0.17	$3.15		$2.45
3		-$0.52			-$0.17	$3.15		$2.45
4		-$0.52			-$0.17	$3.15		$2.45
5		-$0.52			-$0.17	$3.15		$2.45
6		-$0.52			-$0.17	$3.15		$2.45
7		-$0.52		-$4.42	-$0.17	$3.15		-$1.97
8		-$0.52	-$0.31		-$0.17	$3.15		$2.14
9		-$0.52			-$0.17	$3.15		$2.45
10		-$0.52			-$0.17	$3.15		$2.45
11		-$0.52			-$0.17	$3.15		$2.45
12		-$0.52			-$0.17	$3.15		$2.45
13		-$0.52			-$0.17	$3.15		$2.45
14		-$0.52			-$0.17	$3.15		$2.45
15		-$0.52			-$0.17	$3.15		$2.45
16		-$0.52	-$0.31		-$0.17	$3.15		$2.14
17		-$0.52			-$0.17	$3.15		$2.45
18		-$0.52			-$0.17	$3.15		$2.45
19		-$0.52			-$0.17	$3.15		$2.45
20		-$0.52			-$3.17	$3.15	$0.30	-$0.24
						NPW		**$3.74**
						IRR		**9.58%**
						BCR		**1.13**

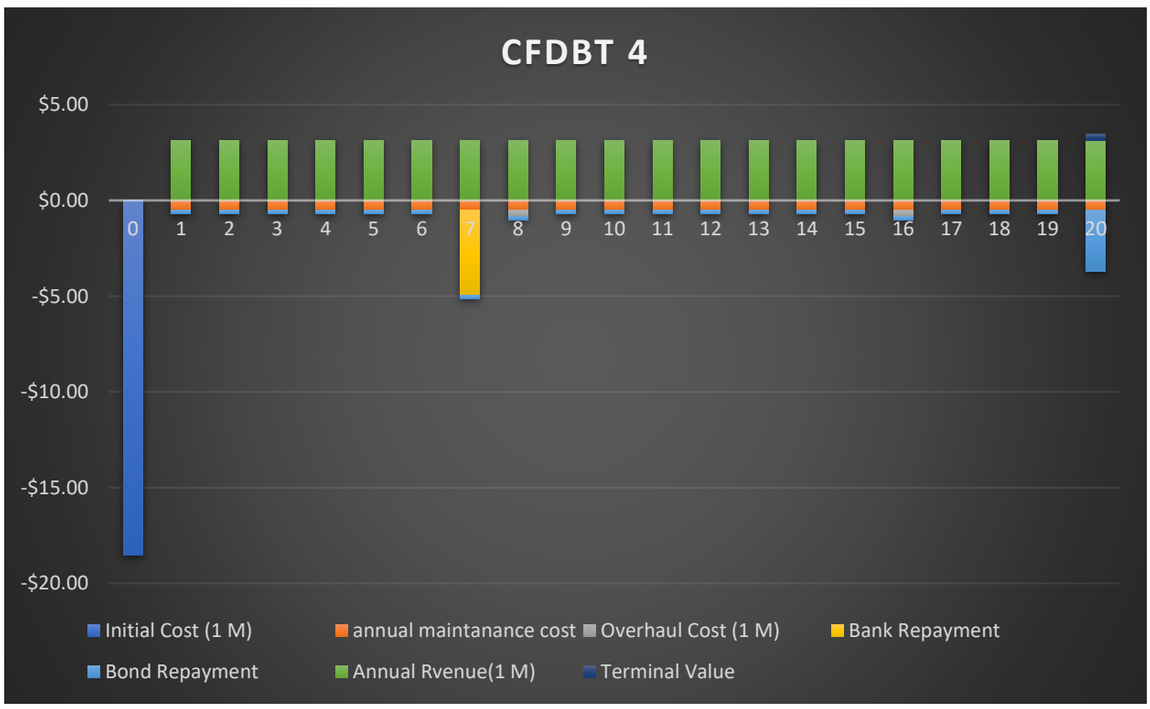

Figure 19 CFDBT A4

Table 9 INCREMENTAL IRR

	IRR CALCULATION			
	A1	A3	A4	A2
	A1-A3	A3-A4	A4-A2	
	-$1.25	-$2.75	-$2.00	
	$0.15	$0.68	$0.13	
	$0.15	$0.68	$0.13	
	$0.15	$0.68	$0.13	
	$0.15	$0.68	$0.13	
	$0.15	$0.68	$0.13	
	-$0.75	$0.68	$1.17	
	-$1.43	-$2.80	-$2.40	
	$1.34	-$0.20	-$0.18	
	$0.15	$0.68	$0.13	
	$0.15	$0.68	$0.13	
	$0.15	$0.68	$0.13	
	-$0.75	$0.68	$1.17	
	$0.15	$0.68	$0.13	
	$0.15	$0.68	$0.13	
	$0.15	$0.68	$0.13	
	$1.34	-$0.20	-$0.18	
	$0.15	$0.68	$0.13	
	-$0.75	$0.68	$1.17	
	$0.15	$0.68	$0.13	
	$0.18	$0.71	$0.15	
ΔIRR	-1%	14%	1.83%	
	Select A3	Select A3	Select A4	
ΔBCR	-0.44	1.11	1.29	
	Select A3	Select A3	Select A4	

Table 10 INCREMENTAL BCR

BENEFIT TO COST RATIO CALCULATION		**BENEFIT TO COST RATIO CALCULATION**					
A1		A3		A4		A2	
COST	**BENEFIT**	**COST**	**BENEFIT**	**COST**	**BENEFIT**	**COST**	**BENEFIT**
-$22.50	$0.00	-$21.25	$0.00	-$18.50	$0.00	-$16.50	$0.00
-$1.22	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$1.24	$3.56
-$1.22	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$1.24	$3.56
-$1.22	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$1.24	$3.56
-$1.22	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$1.24	$3.56
-$1.22	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$1.24	$3.56
-$2.12	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$2.28	$3.56
-$10.70	$4.51	-$9.30	$4.53	-$5.12	$3.15	-$3.14	$3.56
-$1.22	$4.51	-$2.59	$4.53	-$1.01	$3.15	-$1.24	$3.56
-$1.22	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$1.24	$3.56
-$1.22	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$1.24	$3.56
-$1.22	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$1.24	$3.56
-$2.12	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$2.28	$3.56
-$1.22	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$1.24	$3.56
-$1.22	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$1.24	$3.56
-$1.22	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$1.24	$3.56
-$1.22	$4.51	-$2.59	$4.53	-$1.01	$3.15	-$1.24	$3.56
-$1.22	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$1.24	$3.56
-$2.12	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$2.28	$3.56
-$1.22	$4.51	-$1.40	$4.53	-$0.70	$3.15	-$1.24	$3.56
-$4.22	$4.86	-$4.40	$4.86	-$3.70	$3.45	-$4.24	$3.85
-$43.40	**$47.82**	**-$42.85**	**$48.06**	**-$29.70**	**$33.44**	**-$33.10**	**$37.83**

APPENDIX- B

After tax cash flows for all the alternatives are as below;

Table 11 After Tax Cash Flow for Alternative 1

A-1					
EOY	**BEFORE TAX CF**	**CCA**	**TAXABLE INCOME**	**INCOME TAX**	**AFTER TAX CF**
0	-$22.50	$0.00			-$22.50
1	$3.28	$0.56	$2.72	$1.03	$2.25
2	$3.28	$1.10	$2.19	$0.83	$2.45
3	$3.28	$1.04	$2.24	$0.85	$2.43
4	$3.28	$0.99	$2.29	$0.87	$2.41
5	$3.28	$0.94	$2.34	$0.89	$2.39
6	$2.38	$0.89	$1.49	$0.57	$1.82
7	-$6.20	$0.85	-$7.05	-$2.68	-$3.52
8	$3.28	$0.81	$2.48	$0.94	$2.34
9	$3.28	$0.77	$2.52	$0.96	$2.33
10	$3.28	$0.73	$2.55	$0.97	$2.31
11	$3.28	$0.69	$2.59	$0.98	$2.30
12	$2.38	$0.66	$1.72	$0.66	$1.73
13	$3.28	$0.62	$2.66	$1.01	$2.27
14	$3.28	$0.59	$2.69	$1.02	$2.26
15	$3.28	$0.56	$2.72	$1.03	$2.25
16	$3.28	$0.53	$2.75	$1.04	$2.24
17	$3.28	$0.51	$2.77	$1.05	$2.23
18	$2.38	$0.48	$1.90	$0.72	$1.66
19	$3.28	$0.46	$2.82	$1.07	$2.21
20	$0.64	$0.44	$0.21	$0.08	$0.56
				NPV	$2.01

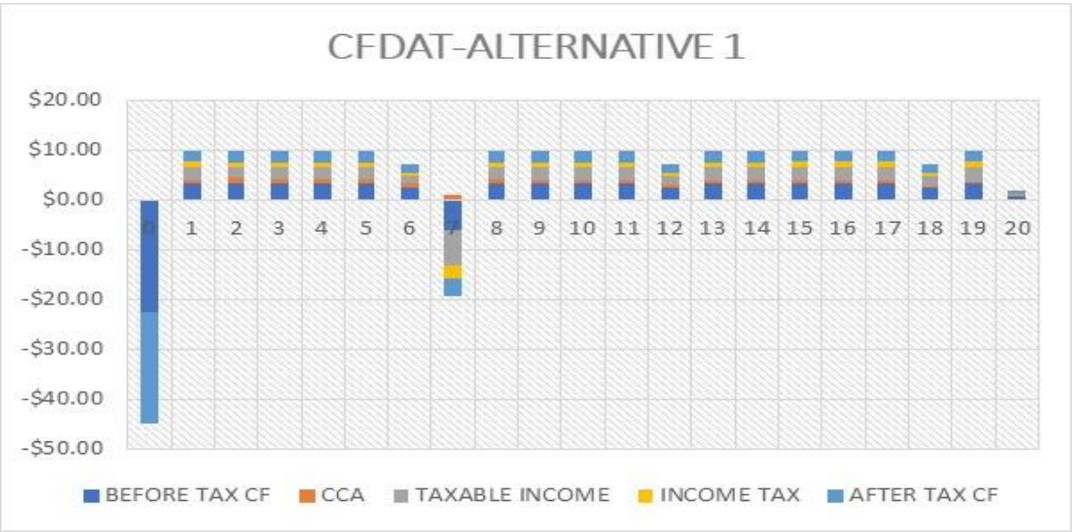

Figure 20 After Tax Cash Flow Diagram Alternative 1

Table 12 After Tax Cash Flow Diagram Alternative 2

A-2					
EOY	**BEFORE TAX CF**	**CCA**	**TAXABLE INCOME**	**INCOME TAX**	**AFTER TAX CF**
0	-$16.50	$0.00			-$16.50
1	$2.32	$0.50	$1.82	$0.69	$1.63
2	$2.32	$0.96	$1.36	$0.52	$1.80
3	$2.32	$0.90	$1.42	$0.54	$1.78
4	$2.32	$0.85	$1.47	$0.56	$1.76
5	$2.32	$0.80	$1.52	$0.58	$1.74
6	$1.28	$0.75	$0.53	$0.20	$1.08
7	$0.42	$0.70	-$0.28	-$0.11	$0.53
8	$2.32	$0.66	$1.66	$0.63	$1.69
9	$2.32	$0.62	$1.70	$0.64	$1.67
10	$2.32	$0.59	$1.73	$0.66	$1.66
11	$2.32	$0.55	$1.77	$0.67	$1.65
12	$1.28	$0.52	$0.76	$0.29	$0.99
13	$2.32	$0.49	$1.83	$0.70	$1.62
14	$2.32	$0.46	$1.86	$0.71	$1.61
15	$2.32	$0.43	$1.89	$0.72	$1.60
16	$2.32	$0.40	$1.92	$0.73	$1.59
17	$2.32	$0.38	$1.94	$0.74	$1.58
18	$1.28	$0.36	$0.92	$0.35	$0.93
19	$2.32	$0.34	$1.98	$0.75	$1.57
20	-$0.39	$0.32	-$0.70	-$0.27	-$0.12
				NPV	$2.79

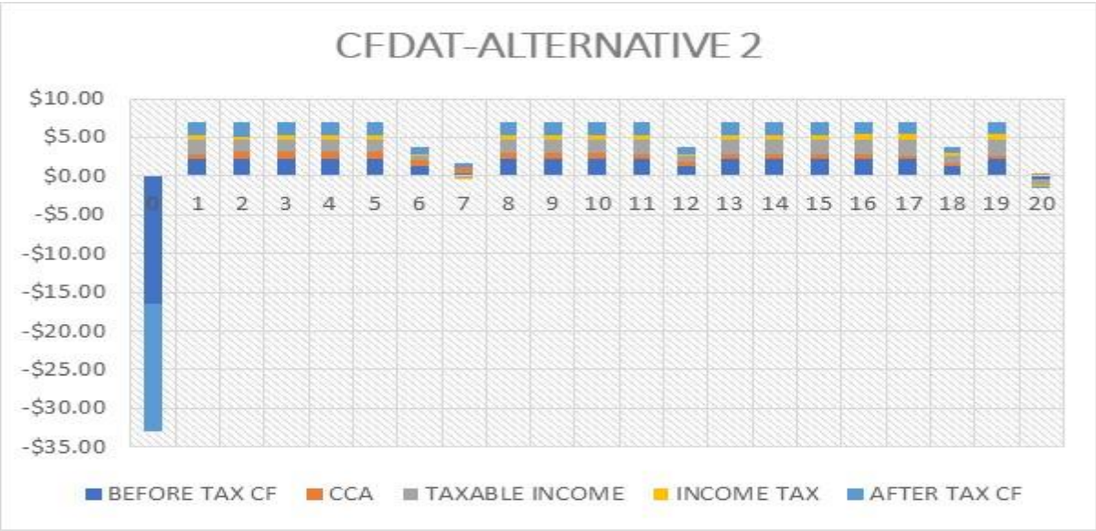

Figure 21 After Tax Cash Flow Diagram Alternative 2

Table 13 After Tax Cash Flow Diagram Alternative 3

A-3					
EOY	**BEFORE TAX CF**	**CCA**	**TAXABLE INCOME**	**INCOME TAX**	**AFTER TAX CF**
0	-$21.25	$0.00			-$21.25
1	$3.13	$0.64	$2.49	$0.95	$2.18
2	$3.13	$1.24	$1.89	$0.72	$2.41
3	$3.13	$1.16	$1.97	$0.75	$2.38
4	$3.13	$1.09	$2.04	$0.77	$2.36
5	$3.13	$1.03	$2.10	$0.80	$2.33
6	$3.13	$0.97	$2.17	$0.82	$2.31
7	-$4.77	$0.91	-$5.68	-$2.16	-$2.61
8	$1.94	$0.85	$1.09	$0.41	$1.53
9	$3.13	$0.80	$2.33	$0.88	$2.25
10	$3.13	$0.75	$2.38	$0.90	$2.23
11	$3.13	$0.71	$2.42	$0.92	$2.21
12	$3.13	$0.67	$2.46	$0.94	$2.19
13	$3.13	$0.63	$2.50	$0.95	$2.18
14	$3.13	$0.59	$2.54	$0.97	$2.16
15	$3.13	$0.55	$2.58	$0.98	$2.15
16	$1.94	$0.52	$1.42	$0.54	$1.40
17	$3.13	$0.49	$2.64	$1.00	$2.13
18	$3.13	$0.46	$2.67	$1.02	$2.12
19	$3.13	$0.43	$2.70	$1.03	$2.11
20	$0.47	$0.41	$0.06	$0.02	$0.44
				NPV	$3.10

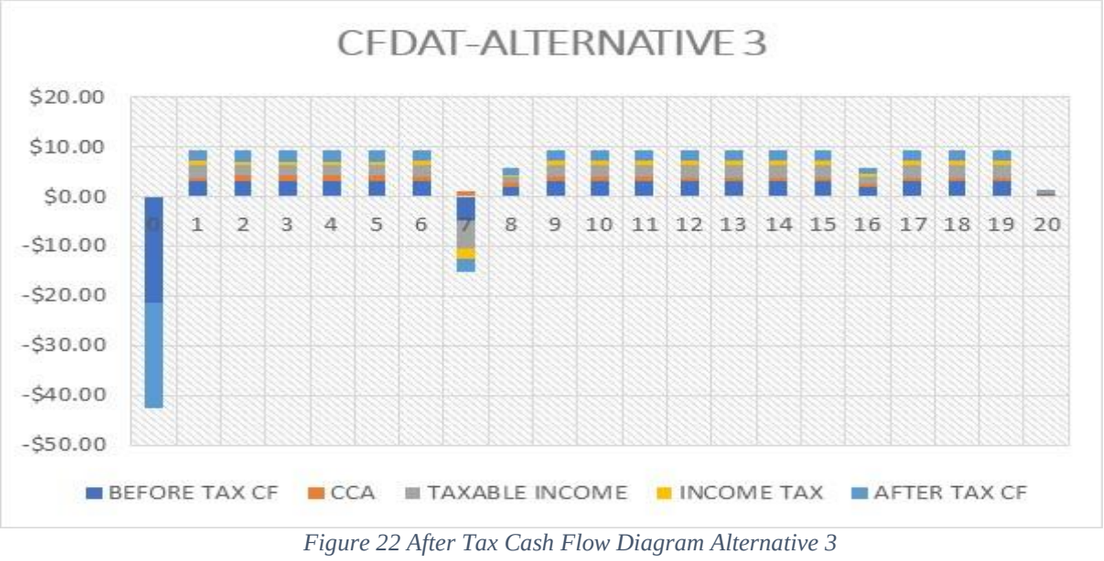

Figure 22 After Tax Cash Flow Diagram Alternative 3

Table 14 After Tax Cash Flow Diagram Alternative 4

A-4					
EOY	**BEFORE TAX CF**	**CCA**	**TAXABLE INCOME**	**INCOME TAX**	**AFTER TAX CF**
0	-$18.50	$0.00			-$18.50
1	$2.45	$0.56	$1.90	$0.72	$1.73
2	$2.45	$1.08	$1.38	$0.52	$1.93
3	$2.45	$1.01	$1.44	$0.55	$1.91
4	$2.45	$0.95	$1.50	$0.57	$1.88
5	$2.45	$0.89	$1.56	$0.59	$1.86
6	$2.45	$0.84	$1.61	$0.61	$1.84
7	-$1.97	$0.79	-$2.76	-$1.05	-$0.92
8	$2.14	$0.74	$1.39	$0.53	$1.61
9	$2.45	$0.70	$1.75	$0.67	$1.79
10	$2.45	$0.66	$1.80	$0.68	$1.77
11	$2.45	$0.62	$1.84	$0.70	$1.76
12	$2.45	$0.58	$1.87	$0.71	$1.74
13	$2.45	$0.55	$1.91	$0.72	$1.73
14	$2.45	$0.51	$1.94	$0.74	$1.72
15	$2.45	$0.48	$1.97	$0.75	$1.70
16	$2.14	$0.45	$1.69	$0.64	$1.50
17	$2.45	$0.43	$2.03	$0.77	$1.68
18	$2.45	$0.40	$2.05	$0.78	$1.67
19	$2.45	$0.38	$2.08	$0.79	$1.66
20	-$0.24	$0.35	-$0.60	-$0.23	-$0.02
				NPV	$2.04

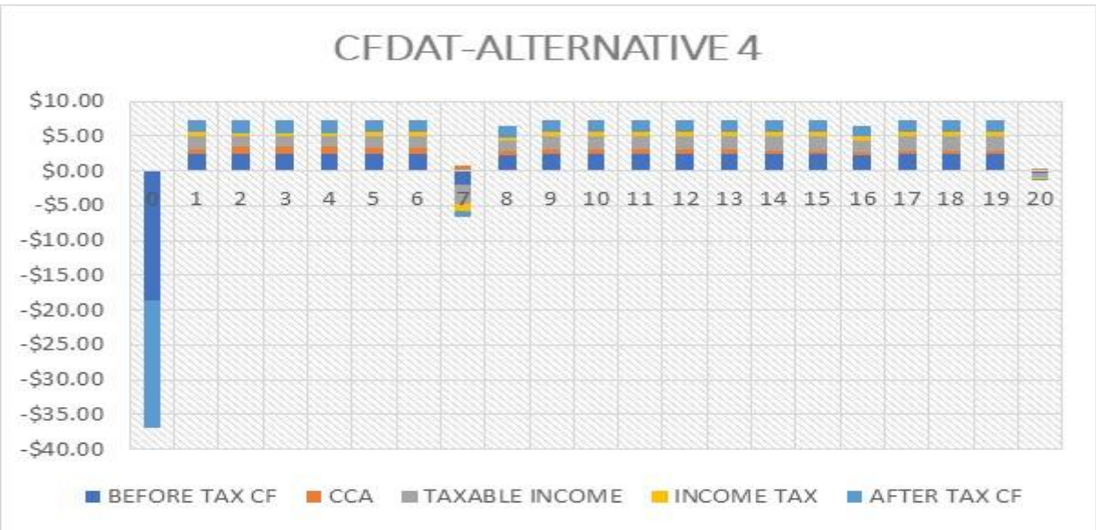

Figure 23 After Tax Cash Flow Diagram Alternative 4

APPENDIX- C

Sensitivity Analysis for all the alternatives and their corresponding Spider Graphs and Tornado Graphs are shown;

1. The Spider graph for the first alternative is attached.

Table 15 Uncertain Parameters for Alternative 1

Alternative 1				
Uncertain Parametres				
Revenue ($ M)	$4.51		NPW ($ M)	$4.42
O&M Cost ($ M)	$1.05			
Overhaul Cost ($ M)	$0.90			
MARR	7.0%			
Salvage value ($ M)	$0.36			
Inflation Rate	1.79%			

Table 16 Sensitivity Analysis for Alternative 1

Alternative 1					
NPW					
	Revenue (± 10%)	O&M Cost (± 8%)	Overhaul Cost (± 5%)	MARR (± 30%)	Salvage value (± 15%)
-50%	-$19.44	$9.99	$5.06	$13.56	$4.38
-40%	-$14.67	$8.88	$4.93	$11.38	$4.39
-30%	-$9.89	$7.77	$4.80	$9.40	$4.40
-20%	-$5.12	$6.65	$4.68	$7.59	$4.41
-15%	-$2.74	$6.10	$4.61	$6.74	$4.41
-10%	-$0.35	$5.54	$4.55	$5.94	$4.42
-8%	$0.61	$5.32	$4.53	$5.62	$4.42
-5%	$2.04	$4.98	$4.49	$5.16	$4.42
-2%	$3.47	$4.65	$4.45	$4.72	$4.42
-1%	$3.95	$4.54	$4.44	$4.57	$4.42
0%	$4.42	$4.42	$4.42	$4.42	$4.42
1%	$4.90	$4.31	$4.41	$4.28	$4.43
2%	$5.38	$4.20	$4.40	$4.14	$4.43
5%	$6.81	$3.87	$4.36	$3.72	$4.43
8%	$8.24	$3.53	$4.32	$3.31	$4.43
10%	$9.20	$3.31	$4.30	$3.04	$4.43
15%	$11.58	$2.75	$4.23	$2.39	$4.44
20%	$13.97	$2.20	$4.17	$1.77	$4.44
30%	$18.74	$1.08	$4.04	$0.60	$4.45
40%	$23.52	-$0.03	$3.92	-$0.47	$4.46
50%	$28.29	-$1.14	$3.79	-$1.47	$4.47

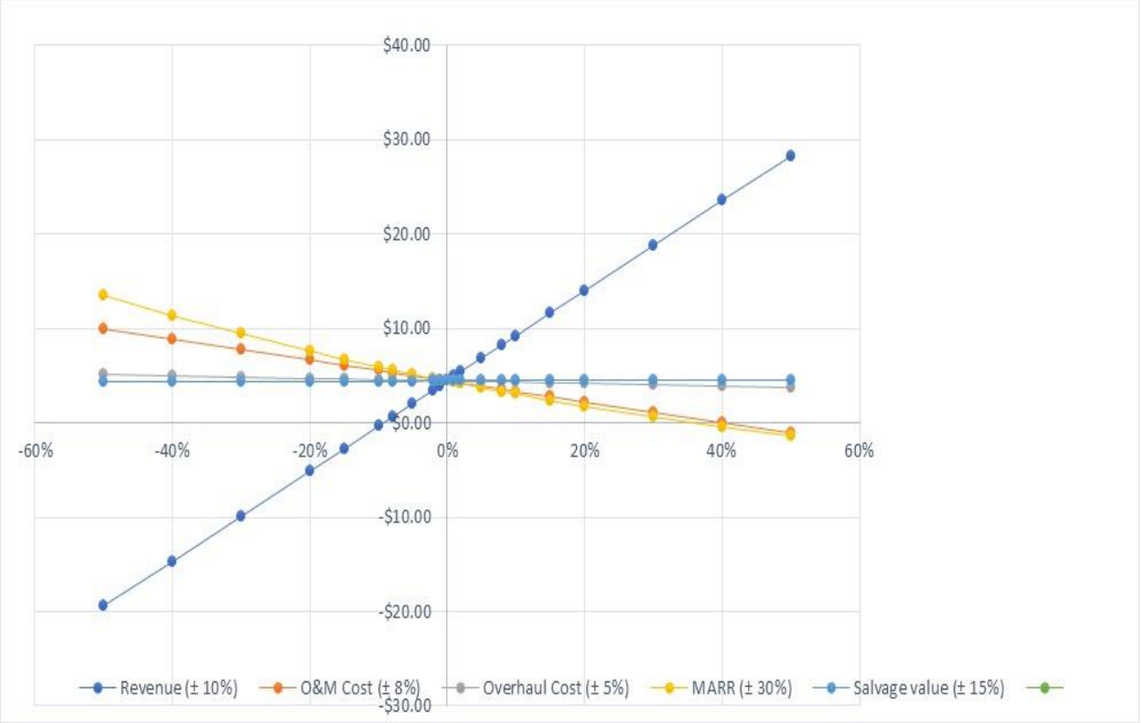

Figure 24 Spider graph of A1

2. The Spider and Graphs for the second alternative is attached below.

Table 17 Uncertain Parameters for Alternative 2

Alternative 2				
Uncertain Parametres				
Revenue ($ M)	$3.56		NPW ($ M)	$4.73
O&M Cost ($ M)	$1.07			
Overhaul Cost ($ M)	$1.04			
MARR	7.0%			
Salvage value ($ M)	$0.29			
Inflation Rate	1.79%			

Table 18 Sensitivity Analysis for Alternative 2

Alternative 1					
NPW					
	Revenue (± 10%)	O&M Cost (± 8%)	Overhaul Cost (± 5%)	MARR (± 30%)	Salvage value (± 15%)
-50%	-$14.14	$10.42	$5.47	$11.53	$4.70
-40%	-$10.37	$9.28	$5.32	$9.92	$4.70
-30%	-$6.59	$8.14	$5.17	$8.46	$4.71
-20%	-$2.82	$7.01	$5.03	$7.11	$4.72
-15%	-$0.93	$6.44	$4.95	$6.48	$4.72
-10%	$0.96	$5.87	$4.88	$5.87	$4.73
-8%	$1.71	$5.64	$4.85	$5.64	$4.73
-5%	$2.85	$5.30	$4.81	$5.29	$4.73
-2%	$3.98	$4.96	$4.76	$4.95	$4.73
-1%	$4.36	$4.85	$4.75	$4.84	$4.73
0%	$4.73	$4.73	$4.73	$4.73	$4.73
1%	$5.11	$4.62	$4.72	$4.63	$4.73
2%	$5.49	$4.51	$4.71	$4.52	$4.74
5%	$6.62	$4.17	$4.66	$4.20	$4.74
8%	$7.75	$3.83	$4.62	$3.89	$4.74
10%	$8.51	$3.60	$4.59	$3.69	$4.74
15%	$10.40	$3.03	$4.51	$3.19	$4.75
20%	$12.29	$2.46	$4.44	$2.72	$4.75
30%	$16.06	$1.33	$4.30	$1.82	$4.76
40%	$19.84	$0.19	$4.15	$1.00	$4.76
50%	$23.61	-$0.95	$4.00	$0.23	$4.77

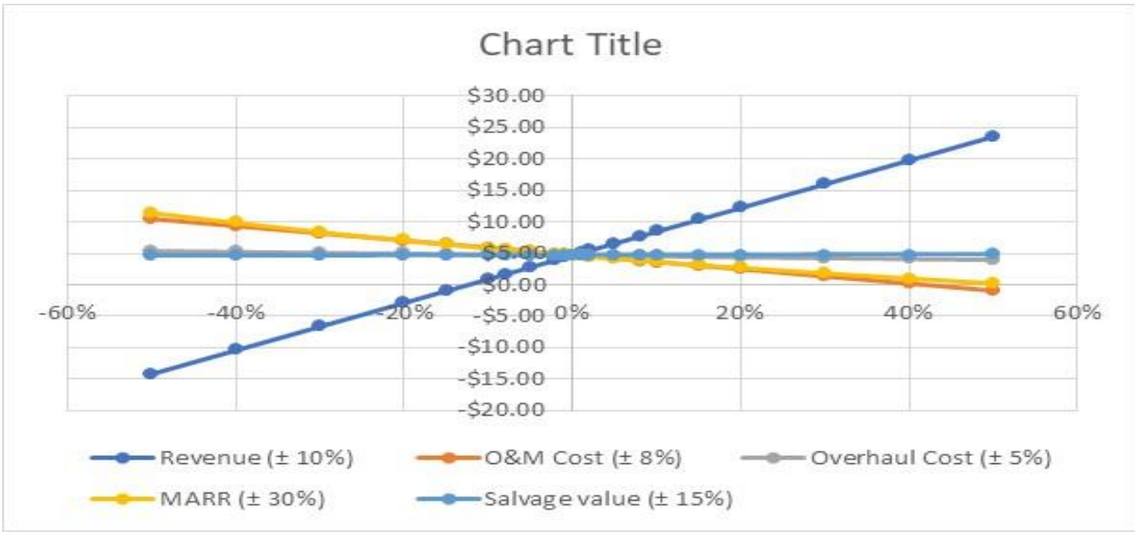

Figure 25 Spider Graph- Alternative 2

3. The Spider and Tornado Graphs for the third alternative are attached below.

Table 18 Uncertain Parameters for Alternative 3

Alternative 3				
Uncertain Parametres				
Revenue ($ M)	$4.53		NPW ($ M)	$5.21
O&M Cost ($ M)	$1.23			
Overhaul Cost ($ M)	$1.19			
MARR	7.0%			
Salvage value ($ M)	$0.33			
Inflation Rate	1.79%			

Table 179 Sensitivity Analysis for Alternative 3

Alternative 3					
NPW					
	Revenue (± 10%)	O&M Cost (± 8%)	Overhaul Cost (± 5%)	MARR (± 30%)	Salvage value (± 15%)
-50%	-$18.77	$11.71	$5.76	$14.60	$5.17
-40%	-$13.98	$10.41	$5.65	$12.37	$5.18
-30%	-$9.18	$9.11	$5.54	$10.33	$5.19
-20%	-$4.38	$7.81	$5.43	$8.47	$5.20
-15%	-$1.98	$7.16	$5.38	$7.60	$5.20
-10%	$0.42	$6.51	$5.32	$6.77	$5.21
-8%	$1.38	$6.25	$5.30	$6.45	$5.21
-5%	$2.82	$5.86	$5.27	$5.98	$5.21
-2%	$4.26	$5.47	$5.24	$5.52	$5.21
-1%	$4.74	$5.34	$5.23	$5.36	$5.21
0%	$5.21	$5.21	$5.21	$5.21	$5.21
1%	$5.69	$5.09	$5.20	$5.07	$5.22
2%	$6.17	$4.96	$5.19	$4.92	$5.22
5%	$7.61	$4.57	$5.16	$4.49	$5.22
8%	$9.05	$4.18	$5.13	$4.06	$5.22
10%	$10.01	$3.92	$5.11	$3.79	$5.22
15%	$12.41	$3.27	$5.05	$3.12	$5.23
20%	$14.81	$2.62	$5.00	$2.48	$5.23
30%	$19.61	$1.32	$4.89	$1.27	$5.24
40%	$24.41	$0.02	$4.78	$0.16	$5.25
50%	$29.20	-$1.28	$4.67	-$0.86	$5.26

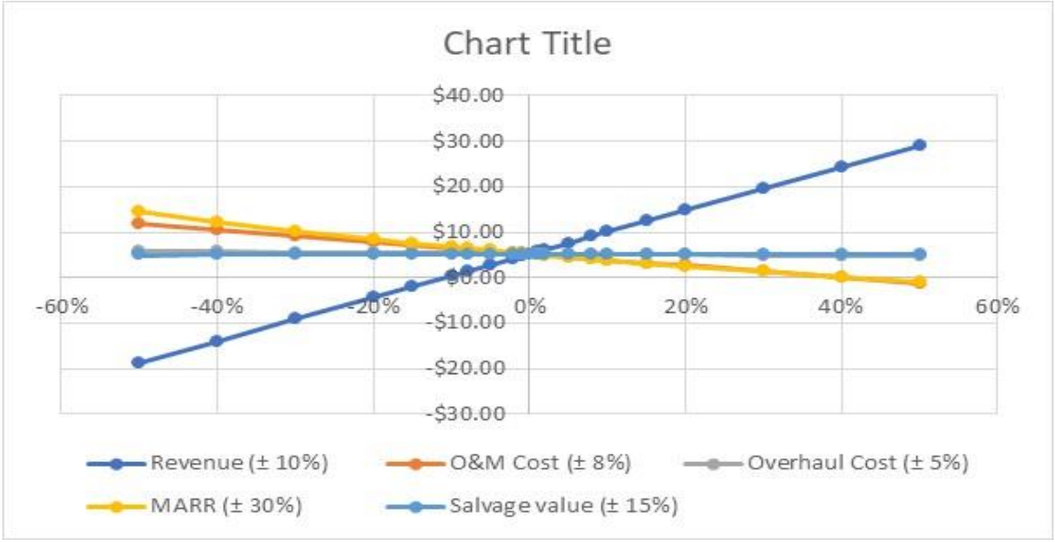

Figure 26 Spider Graph- Alternative 3

4. The Spider and Tornado Graphs for the third alternative are attached below.

Table 20 Uncertain Parameters for Alternative 4

Alternative 4					
Uncertain Parametres					
Revenue ($ M)		$3.15		NPW ($ M)	$3.74
O&M Cost ($ M)		$0.52			
Overhaul Cost ($ M)		$0.31			
MARR		7.0%			
Salvage value ($ M)		$0.30			
Inflation Rate		1.79%			

Table 21 Sensitivity Analysis for Alternative 4

Alternative 1					
NPW					
	Revenue (± 10%)	O&M Cost (± 8%)	Overhaul Cost (± 5%)	MARR (± 30%)	Salvage value (± 15%)
-50%	-$12.94	$6.52	$3.89	$11.23	$3.70
-40%	-$9.60	$5.96	$3.86	$9.46	$3.71
-30%	-$6.27	$5.41	$3.83	$7.83	$3.72
-20%	-$2.93	$4.85	$3.80	$6.35	$3.72
-15%	-$1.26	$4.57	$3.78	$5.65	$3.73
-10%	$0.40	$4.30	$3.77	$4.99	$3.73
-8%	$1.07	$4.19	$3.76	$4.73	$3.73
-5%	$2.07	$4.02	$3.76	$4.35	$3.74
-2%	$3.07	$3.85	$3.75	$3.98	$3.74
-1%	$3.41	$3.80	$3.74	$3.86	$3.74
0%	$3.74	$3.74	$3.74	$3.74	$3.74
1%	$4.07	$3.68	$3.74	$3.62	$3.74
2%	$4.41	$3.63	$3.73	$3.50	$3.74
5%	$5.41	$3.46	$3.73	$3.15	$3.74
8%	$6.41	$3.30	$3.72	$2.81	$3.75
10%	$7.08	$3.18	$3.71	$2.59	$3.75
15%	$8.74	$2.91	$3.70	$2.05	$3.75
20%	$10.41	$2.63	$3.68	$1.54	$3.76
30%	$13.75	$2.07	$3.65	$0.56	$3.76
40%	$17.09	$1.52	$3.62	-$0.34	$3.77
50%	$20.42	$0.96	$3.60	-$1.17	$3.78

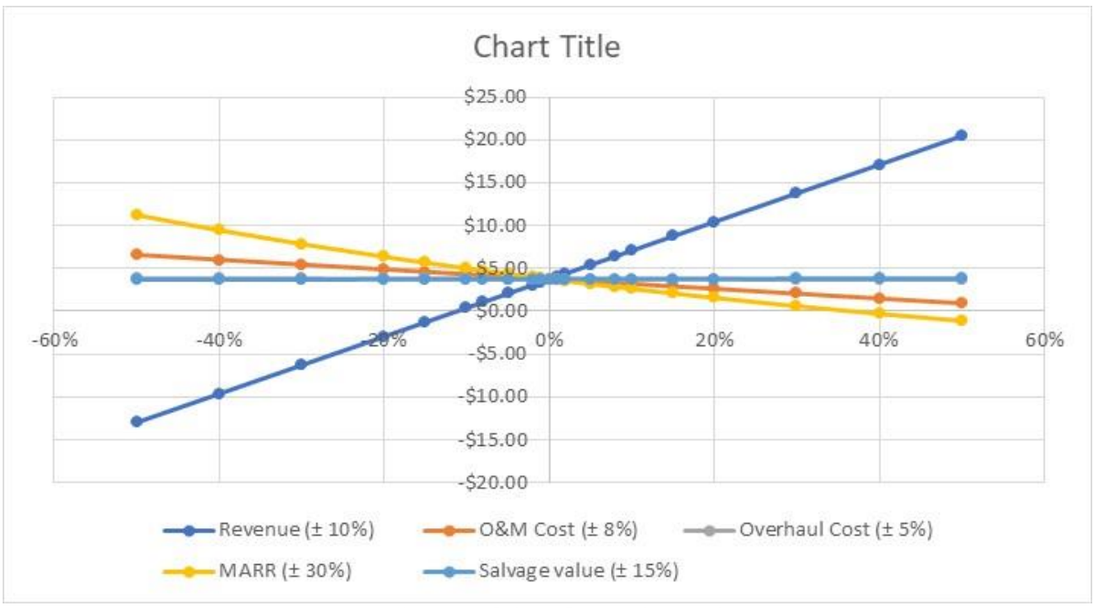

Figure 27 Spider Graph- Alternative 4

APPENDIX D

Risk Analysis of alternatives have been calculated and corresponding graphs are drawn

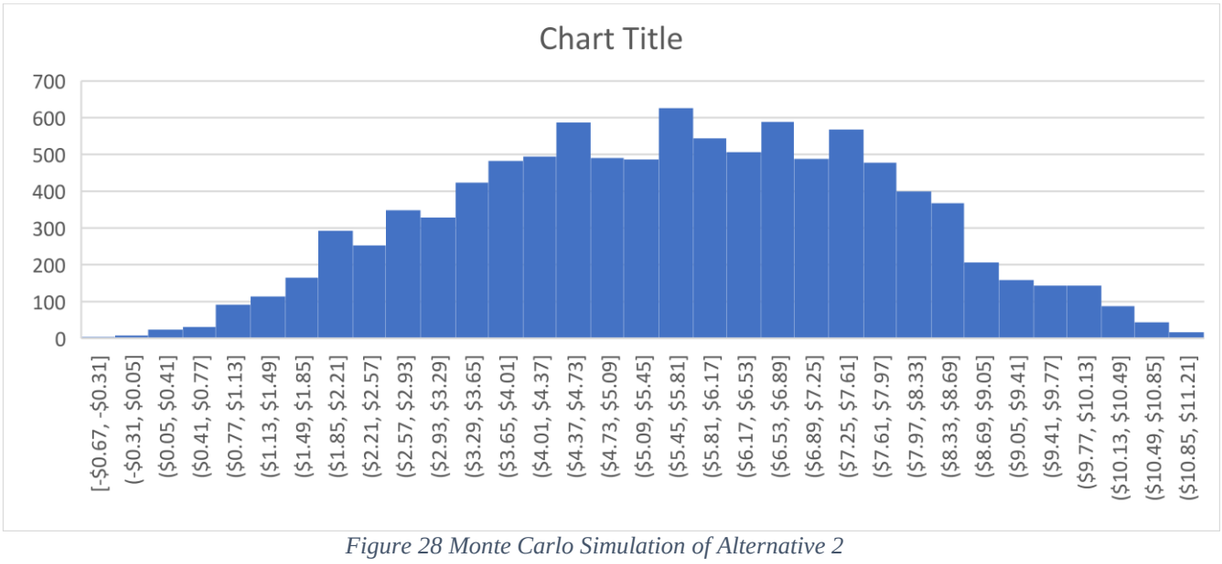

Figure 28 Monte Carlo Simulation of Alternative 2

EV = 5.64, SD=2.2143; EV>2SD = True

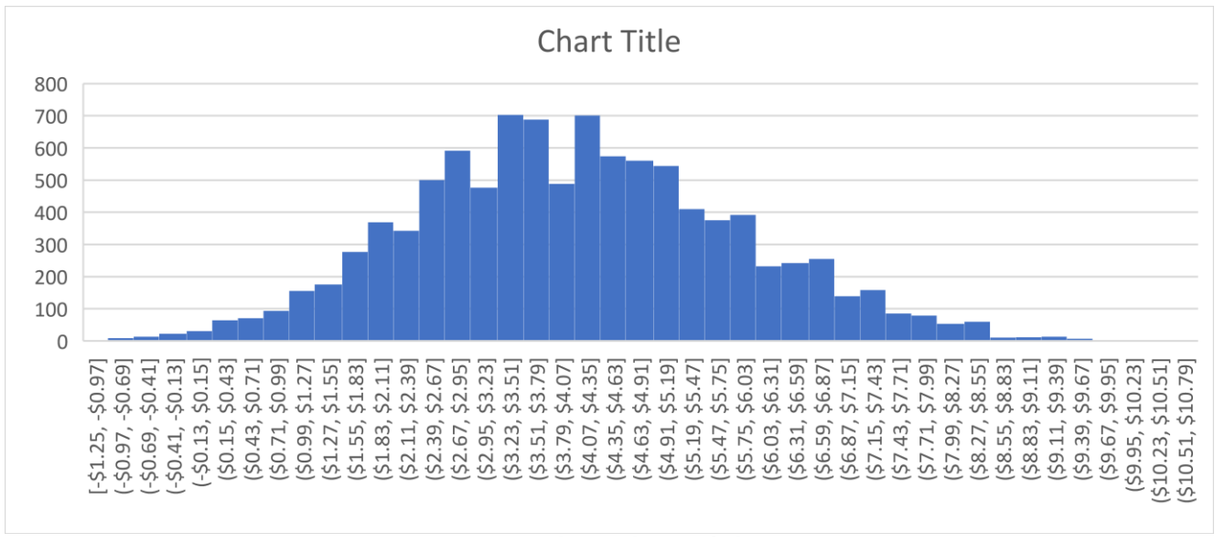

Figure 26 Monte Carlo Simulation of Alternative 3

EV = 4.09, SD=1.777; EV>2SD = True

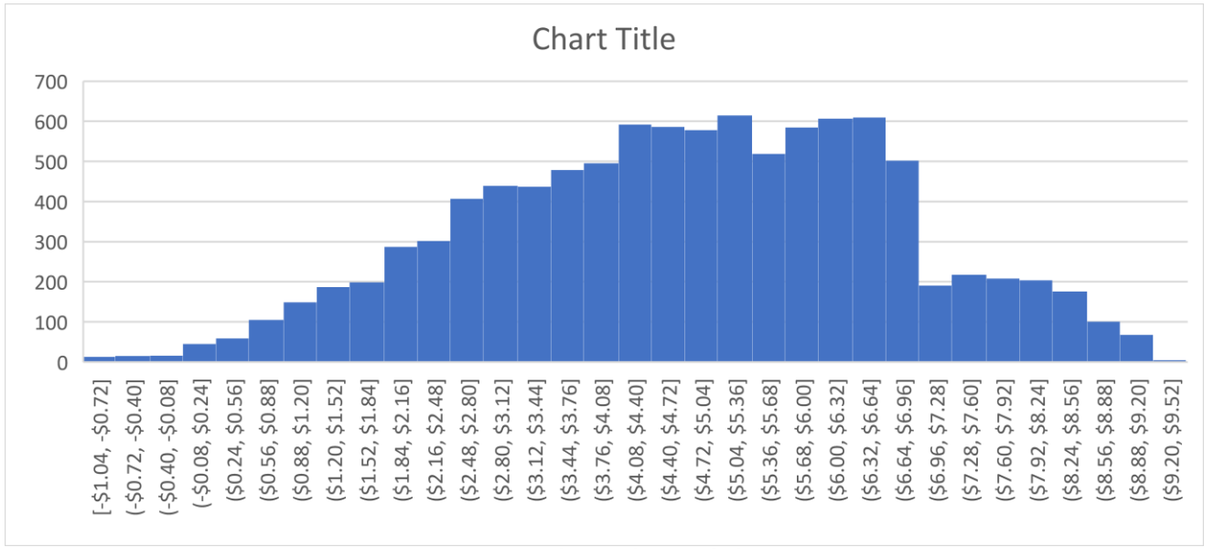

Figure 30 Monte Carlo Simulation of Alternative 4

EV = 4.692, SD=1.965; EV>2SD = True

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