

An analysis of the repair and replacement cost assessment of ships

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Abstract. This passage will evaluate an old vessel in a project management manner to determine whether it should be repaired or replaced. The article will evaluate the project on five parts, we will solve two problems, which is problem a and b, and focus on solving the b problem, We will first conduct background research on the data, then bring the data into the formula for calculation, and finally make a chart, appendix and chart will be presented at the end of the passage.

Keywords: Capital Cost; Shrinkage factor; Net present value; Profitable.

1. Introduction

1.1 Decision background

As a new driving force of national development, how to ensure its high speed and height. This paper summarizes the main points of the current situation of Marine logistics, and puts forward "integration" "synergy", "wisdom" development strategy.

The NETCO is confronted with an economical choice about its old vessel, Vital Spark. NETCO's finance director and chief engineer have brought up several alternatives: to keep it in use after an overhaul, or to replace it with a new vessel from Cohn and Doyle.

1.2 Analysis Schema

The analysis will follow 7 steps. We will define problems, develop alternatives and cash flow spreadsheet, select criterion, make comparison and selection. Besides these, we also explore other relevant information for audit and risk assessment purposes.

1.3 Basic conclusions

For problem A, the choice of installation of a new engine and control was recommended.

For problem B, if we only consider cost, we should choose to overhaul the Vital Spark, but when we consider revenue as well, it is better to buy a new vessel.

Mr. Handy keep the old vessel running when they have a shrinkage factor of 0.85 or above and should not be replaced until there are more than 10 months left

2. General Assumptions

For this project's analysis, we have following assumptions:

The after-tax MARR is $MARR_a = \text{Capital Cost} * (1 - \text{tax rate})$;

Only actual dollar will be taken into consideration;

We don't know which month is at Year 0, the inflation base year will be treated as Year 1.

Sensitivity analysis will be conducted on 3 variables: tax rate, inflation rate and cost of capital. The tuning steps and ranges are as follow in Table 1:

Table 1. Parameters of baseline and sensitivity analysis

Variable	Tax rate	Inflation rate	Cost of capital
Baseline	35%	2.5%	11%
Sensitivity range	20%~50%	1.0%~4.0%	5%~25%
Step	1%	0.1%	1%

3. Part 1: sensitivity analysis and Solutions of problem A

3.1 Problem description

In order to keep life Spark in service for 25 years, we have two choices first is to undergo an overhaul (donated by OH), second is to install with brand-new engine and control system (donated by NE). Both alternatives will generate capital investment (for the overhaul and installation), and operating or maintenance expenditures through its useful life. Alternatives is as follow:

Alternative OH: Overhaul the vessel now at a total expenditure of \$820,000, and maintain a post overhaul operating cost of \$1,181,000 per year till the vessel scrapped.

Alternative NE: Install a brand-new engine and control system with extra cost of \$600,000, additionally with the \$820,000 overhaul cost. The maintenance cost is \$1,020,000 per year.

3.2 Assumptions

Based on our understandings of NETCO's situation at present, the following assumptions will be taken throughout the whole comparison analysis between OH vs. NE.

The depreciation base contains book value of vessel (\$100,000), the overhaul cost plus the extra cost of new engine (only for NE), excluding the value of spare parts.

The recovery period of depreciation follows 7-year MACRS class.

Annual cost will increase with a constant inflation rate from the 2nd year.

The useful life of Vital Spark is 10,11 or 12 years, which will be analyzed respectively.

3.3 Spreadsheets and Results

Our choice of comparison criterion is Net present value (NPV), we also consider indicators of ATCF, NOPAT and EVA. According to spreadsheet analysis, results are shown in the Table 2~7:

Table 2. The comparison results

	10 Useful life	11 Useful life	12 Useful life
OH (NPV) \$	430181.38	283151.12	336539.19
NE (NPV) \$	801764.08	548935.31	641572.15

Table 3. Spreadsheet for 10 Useful lives OH

		2	3	4	5						
Initial Outlay	-920000.00										
Revenue	1400000.00	1435000.00	1470875.00	1507646.88	1545338.05	1583971.50	1623570.79	1664160.06	1705764.06	1748408.16	
Operating Costs	-1181000.00	-1210525.00	-1240786.13	-1271807.83	-1303903.02	-1336933.02	-1369957.93	-1403037.86	-1436193.62	-1474907.17	
Depreciation	131468.00	225308.00	160908.00	114908.00	82156.00	82064.00	82156.00	41032.00	0.00	0.00	
Taxable Income	87532.00	-833.00	69178.87	120931.05	159579.02	165714.40	171816.86	219290.18	266830.23	273500.99	
Taxes	30636.20	-291.55	24212.61	42325.87	55852.66	58003.04	60135.90	76751.56	93390.58	95725.35	
ATCF	188363.00	224766.55	205874.27	193513.18	185882.36	189778.36	193636.96	183570.62	173439.65	177775.64	
NOPAT	56695.80	-541.45	44966.27	78605.18	103726.36	107714.36	111680.96	142539.62	173439.65	177775.64	
IRR (ATCF)	0.1674948										
Book Value	788532.00	563224.00	402316.00	287408.00	205252.00	123188.00	41032.00	0.00	0.00	0.00	
EVA		515.75	-48811.97	16200.67	58055.51	89050.85	88906.42	108747.17	142539.62	173439.65	177775.64
Present Value for Each year (11%)	-920000.00	175794.49	195770.54	167349.93	146805.34	131606.49	125398.07	119533.97	105649.09	93157.71	89114.94
NPV of the overhaul without brand-new engine and control system	430181.38										

Table 4. Spreadsheet for 10 Useful life NE

		2	3	4	5					
Initial Outlay	-920000.00									
Revenue	1400000.00	1435000.00	1470075.00	1507646.88	1545338.05	1583971.50	1623570.79	1664160.06	1705764.06	1748408.16
Operating Costs	1181300.00	1213625.00	1247088.13	1271807.83	1309003.02	1336194.20	1389997.93	1423837.88	1438933.62	1474807.17
Depreciation	121468.00	225308.20	162908.00	114908.00	82156.00	82064.00	82156.00	41032.00	0.00	0.00
Taxable Income	87532.00	-833.00	66178.87	12931.05	19579.02	165714.40	171818.86	219290.18	266830.23	273500.99
Taxes	30636.20	291.25	24212.61	42325.87	55852.66	58003.04	60135.99	76751.56	93390.58	95725.25
ATCF	188363.80	224786.55	205874.27	190513.18	185882.36	189778.36	193806.96	182570.62	173439.65	177775.64
NOPAT	56695.60	541.45	44966.27	70605.19	103726.26	107714.26	111680.96	142538.62	173439.65	177775.64
IRR (ATCF)	0.1674948									
Book Value	788532.00	563224.00	402316.00	287408.00	206752.00	173188.00	41032.00	0.00	0.00	0.00
EVA	515.76	-40811.61	16200.67	58065.51	89050.85	98906.42	108747.17	142538.62	173439.65	177775.64
Present Value for Each year (11%)	-920000.00	175794.48	195770.54	167349.93	146605.34	131606.49	125398.87	119533.97	105649.09	93157.71
NPV of the overhaul without brand-new engine and control system	430181.39									

Table 5. Spreadsheet for 11 Useful lifeOH

		2	3	4	5					
Initial Outlay	-1520000.00									
Revenue	1400000.00	1435000.00	1470075.00	1507646.88	1545338.05	1583971.50	1623570.79	1664160.06	1705764.06	1748408.16
Operating Costs	1000000.00	1049306.00	1073637.50	1098428.44	1125889.15	1154036.38	1182897.29	1212489.47	1242770.98	1273840.23
Depreciation	217208.00	372248.00	265648.00	189848.00	135736.00	135884.00	135736.00	87792.00	0.00	0.00
Taxable Income	162792.00	1752.00	133389.50	219370.44	283712.50	294351.12	304447.50	303908.59	462993.10	474567.93
Taxes	56377.20	6038.20	46686.32	76779.65	99299.51	103022.89	106731.62	134368.01	162047.58	166396.78
ATCF	323022.80	383481.80	352551.18	332438.78	320149.38	326912.23	333951.87	317332.58	300945.52	308169.15
NOPAT	106844.80	11213.60	86703.17	142590.78	184413.38	191329.23	198215.87	249458.58	300945.52	308169.15
IRR (ATCF)	0.1785485									
Book Value	1302792.00	930544.00	664596.00	474848.00	338112.00	203528.00	67792.00	0.00	0.00	0.00
EVA	12665.17	-55200.10	20177.41	108639.15	160166.88	176775.98	193368.75	249458.58	300945.52	308169.15
Present Value for Each year (11%)	-1520000.00	301467.85	333993.30	285789.84	252198.78	226668.83	210121.12	205009.03	182632.16	161843.52
NPV of the overhaul without brand-new engine and control system	801764.08									

Table 6. Spreadsheet for 11 Useful life NE

		1	2	3	4	5	6	7	8	9	10	11
Initial Outlay	-920000.00											
Revenue	1400000.00	1435000.00	1470075.00	1507646.88	1545338.05	1583971.50	1623570.79	1664160.06	1705764.06	1748408.16	1792118.25	
Operating Costs	1181300.00	1213625.00	1247088.13	1271807.83	1309003.02	1336194.20	1389997.93	1423837.88	1438933.62	1474807.17	1521778.65	
Depreciation	121468.00	225308.20	162908.00	114908.00	82156.00	82064.00	82156.00	41032.00	0.00	0.00	0.00	
Taxable Income	87532.00	-833.00	66178.87	12931.05	19579.02	165714.40	171818.86	219290.18	266830.23	273500.99	280238.52	
Taxes	30636.20	291.25	24212.61	42325.87	55852.66	58003.04	60135.99	76751.56	93390.58	95725.25	98118.48	
ATCF	188363.80	224786.55	205874.27	190513.18	185882.36	189778.36	193806.96	182570.62	173439.65	177775.64	182220.03	
NOPAT	56695.60	541.45	44966.27	70605.19	103726.26	107714.26	111680.96	142538.62	173439.65	177775.64	182220.03	
IRR (ATCF)	0.1703987											
Book Value	788532.00	563224.00	402316.00	287408.00	206752.00	173188.00	41032.00	0.00	0.00	0.00	0.00	
EVA	515.76	-40811.61	16200.67	58065.51	89050.85	98906.42	108747.17	142538.62	173439.65	177775.64	182220.03	
Present Value for Each year (11%)	-920000.00	209697.12	282425.57	190533.49	127473.13	110312.14	101463.26	93363.29	79656.10	67801.86	62639.82	57813.28
NPV of the overhaul without brand-new engine and control system	283151.12											

Table 7. Spreadsheet for 12 Useful lifeOH

		1	2	3	4	5	6	7	8	9	10	11	12
Initial Outlay	-3030000.00												
Revenue	1400000.00	1435000.00	1470075.00	1507646.88	1545338.05	1583971.50	1623570.79	1664160.06	1705764.06	1748408.16	1792118.25	1836887.32	
Operating Costs	1181300.00	1213625.00	1247088.13	1271807.83	1309003.02	1336194.20	1389997.93	1423837.88	1438933.62	1474807.17	1521778.65	1569743.54	
Depreciation	121468.00	225308.20	162908.00	114908.00	82156.00	82064.00	82156.00	41032.00	0.00	0.00	0.00	0.00	
Taxable Income	87532.00	-833.00	66178.87	12931.05	19579.02	165714.40	171818.86	219290.18	266830.23	273500.99	280238.52	287186.98	
Taxes	30636.20	291.25	24212.61	42325.87	55852.66	58003.04	60135.99	76751.56	93390.58	95725.25	98118.48	100571.44	
ATCF	188363.80	224786.55	205874.27	190513.18	185882.36	189778.36	193806.96	182570.62	173439.65	177775.64	182220.03	186725.54	
NOPAT	56695.60	541.45	44966.27	70605.19	103726.26	107714.26	111680.96	142538.62	173439.65	177775.64	182220.03	186725.54	
IRR (ATCF)	0.1684175												
Book Value	788532.00	563224.00	402316.00	287408.00	206752.00	173188.00	41032.00	0.00	0.00	0.00	0.00	0.00	
EVA	515.76	-40811.61	16200.67	58065.51	89050.85	98906.42	108747.17	142538.62	173439.65	177775.64	182220.03	186725.54	
Present Value for Each year (11%)	-3030000.00	106997.21	182425.57	190533.49	127473.13	110312.14	101463.26	93363.29	79656.10	67801.86	62639.82	57813.28	53088.07
NPV of the overhaul without brand-new engine and control system	336539.13												

The yearly cash flow, EVA and NOPAT are shown in Figure 1 below. Here we only take 10 Useful lives as an example, see diagrams of 11,12 useful life, Figure 2~3.

In conclusion, no matter the useful life of Vital Spark is 10, 11 or 12, on the criterion of NPV, NE is always better than OH. Additionally, when the vessel can be used 10 more years, the NE profit will be the most. However, although the breakeven points of NE and OH are the same (Year 7), from the cash flow diagram, we can see that EVA and NOPAT of NE for the first several years is lower than OH, which may be considered for the decision.

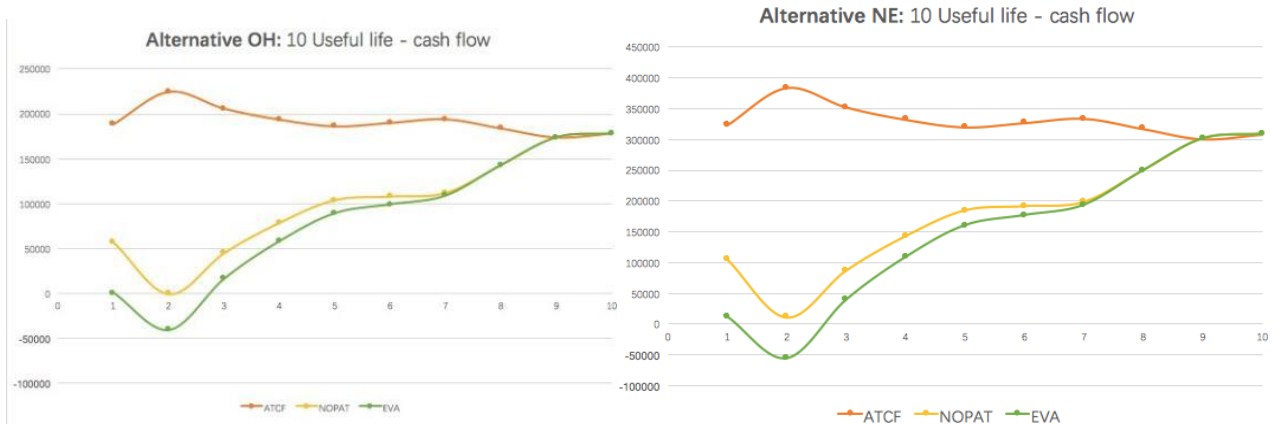


Figure 1. Cash flow diagram OH vs. NE (Useful life 10)

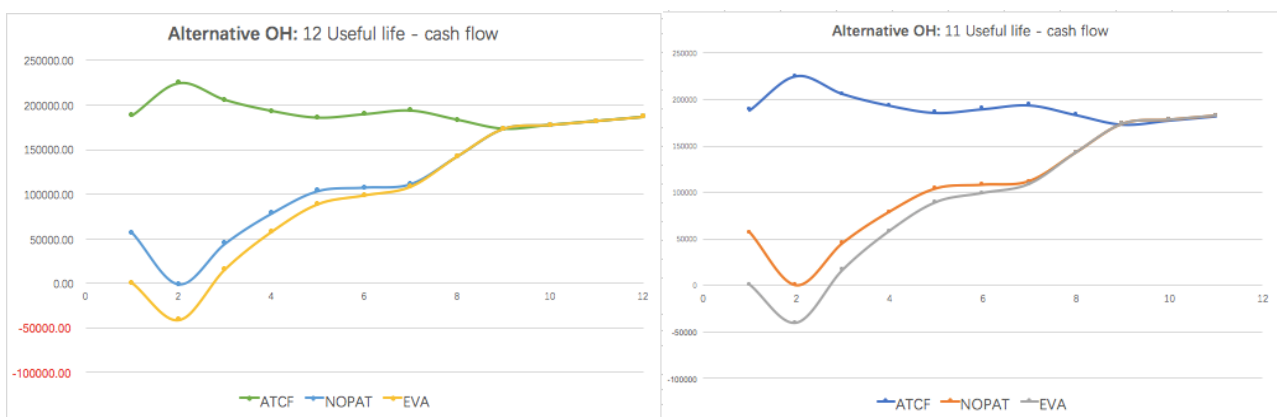


Figure 2. Cash flow diagram OH (useful life 11)

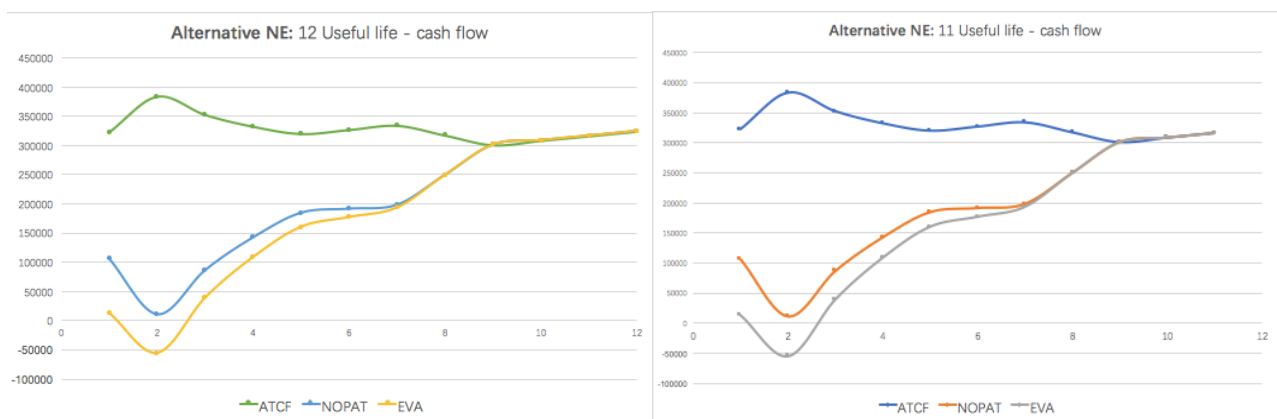


Figure 3. Cash flow diagram OH (useful life 12)

3.4 Sensitivity Analysis (adjustment to reality)

When the 3 variables (tax rate, inflation rate & cost of capital) varied in our pretended range, NE is always better than OH. One special situation happens when the cost of capital is higher than 28%, both NE and OH will change to be samely unprofitable, See Figure 4~6.

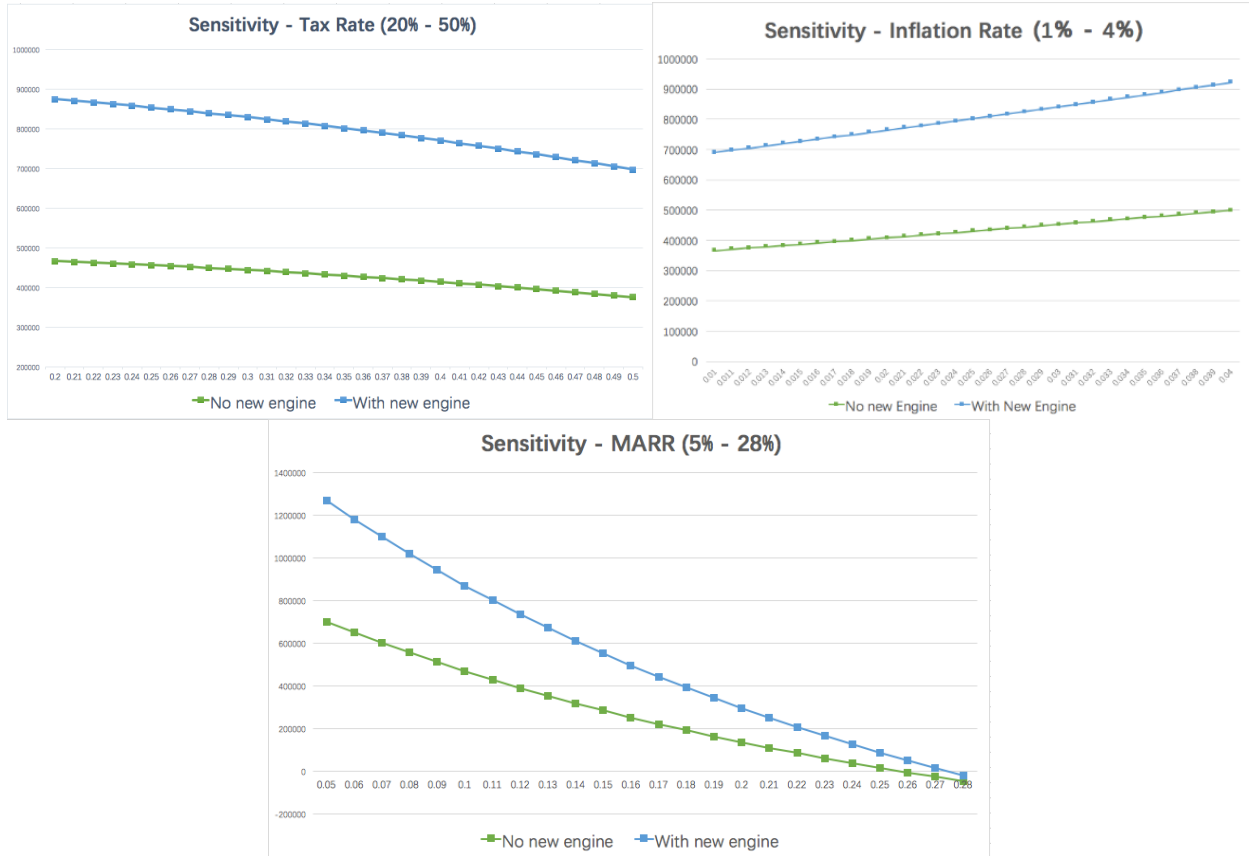


Figure 4. Sensitivity (useful life 10)

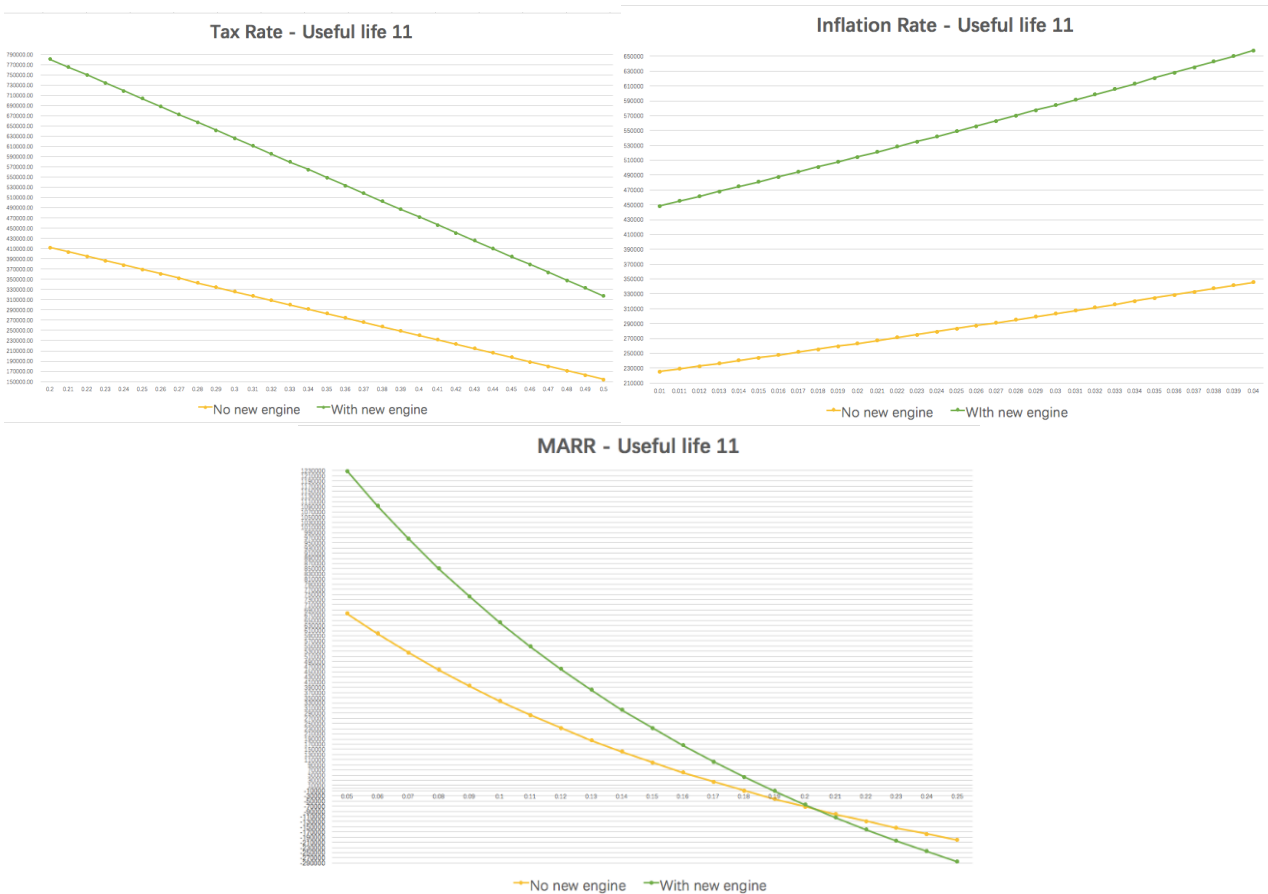


Figure 5. Sensitivity (useful life 11)

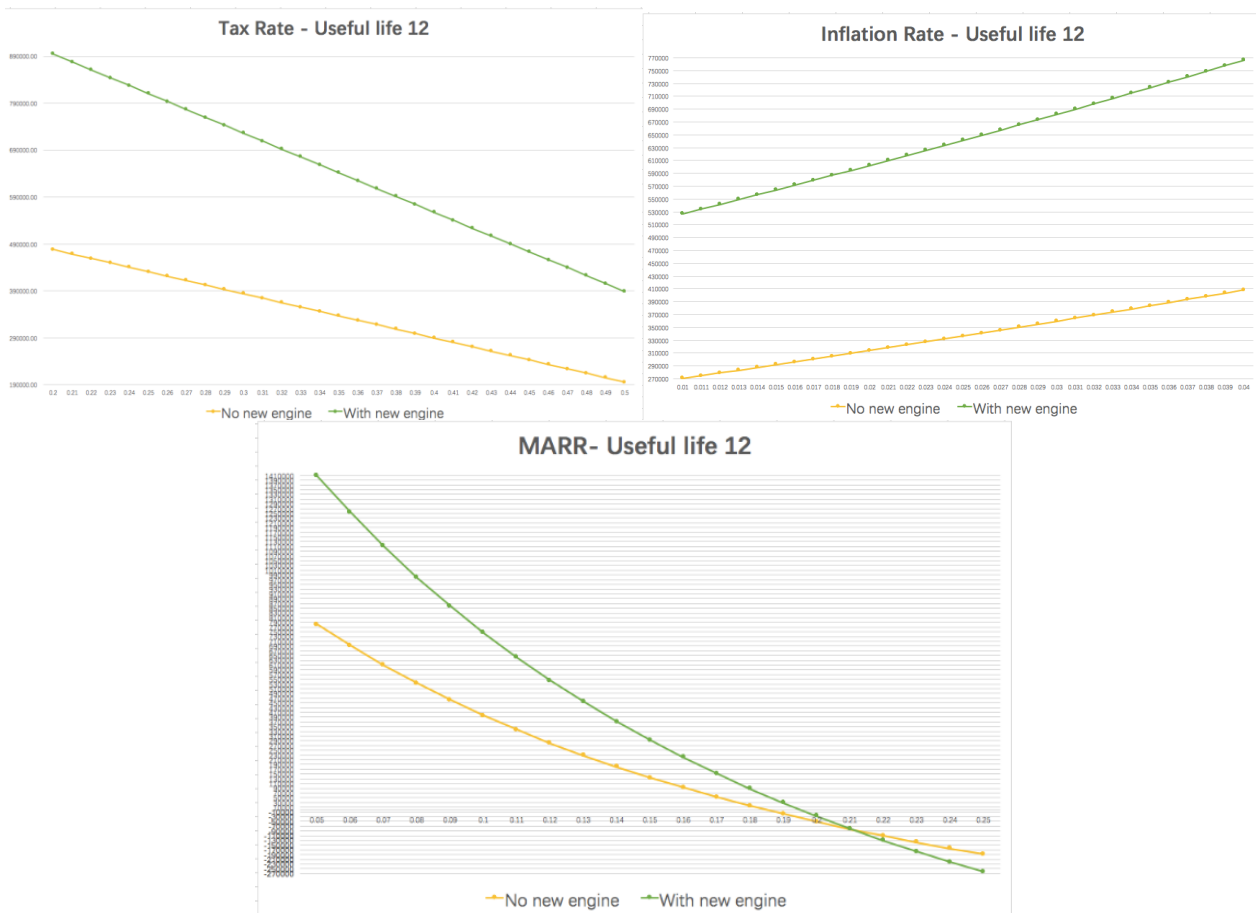


Figure 6. Sensitivity (useful life 12)

4. Part 2: Solutions and sensitivity analysis of problem B (cost only)

4.1 Problem description

In part b we will calculate the equivalent annual cost of (a) overhauling and operating the Vital Spark for 12 more years, and (b) buying and operating the proposed replacement vessel for 20 years or more and then compare those two plans, here we set the time period as 21 years.

Estimated annual operating cost of the new vessel is \$885000 in total. Besides, training is required and would cost \$50000 next year. The new vessel would generate additional annual revenue \$100000, so the annual revenue adds up to \$1500000, still increasing with inflation rate. The new vessel will cost \$3000000, which can be payable half immediately and half on delivery next year. The VitalSpark has a net worth of \$100,000, and has a book value of \$40,000 in spare parts, and it can be sold for \$200,000. Therefore, the sale of Vital Spark would generate an immediate tax liability of \$140000.

4.2 Assumptions

- Based on the current situation, the following Assumptions are taken in this problem:
- We use ten-year MACRS class for the new vessel to calculate the depreciation for tax purpose.
- All the cost would be calculated with tax and we treat the training fee as operating cost.
- We set the time period of the new vessel as 21 years; the time period of the old vessel is 11 years.
- We assume that the cost of repairment for the new vehicle is included in other cost.
- Taking the tax liability of \$140000 into the income calculation.

4.3 Spreadsheets and Results

Due to the fact that we only consider the cost, the EVA and NOPAT is not suitable for the evaluation, we only consider ATCF and annual cost in this part. Except for the first year, the ACTF

of changing a new ship for each year is always less than overhauling and operating the old ship, taking consideration of the selling price of the first year, the comparison is shown in Table 8 and Figure 7.

We simply analyze the cost of (a) and (b), due to their different time period, we calculate the total cost at year 0 and convert it into annual cost, then make the comparison. The results are shown in Table 9 below. The cost of buying a new vessel is higher than fix it. The computation process is shown in Table 10 and Table 11.

Table 8. ATCF comparison between (a) and (b) (cost only)

Years	1	2	3	4	5	6	7
ATCF in (a)	-820000	-738950	-735181	-765184	-793613	-820881	-847374
ATCF in (b)	-477750	-400631	-453172	-498521	-538158	-573458	-598339
Years	8	9	10	11	12	13	14
ATCF in (a)	-871440	-893696	-916480	-939891	-973243	NULL	NULL
ATCF in (b)	-615016	-632006	-649633	-701929	-754778	-773647	-792988
Years	15	16	17	18	19	20	21
ATCF in (a)	NULL	NULL	NULL	NULL	NULL	NULL	NULL
ATCF in (b)	-812813	-833134	-853962	-875311	-897194	-919624	-942614

Table 9. The comparison results (cost only)

Category	Total cost	Annual Cost
Overhauling the Vital Spark	-6985596.030	-1125526.268
Buying a new vessel	-9133008.757	-1471519.569

Table 10. The calculation process of (a) overhauling the Vital Spark

(a) overhauling the Vital Spark												
Year	0	1	2	3	4	5	6	7	8	9	10	11
Initial Outlay	-820000											
Revenue		0	0	0	0	0	0	0	0	0	0	0
Operating Costs		1181000	1210525	1240788.125	1271807.828	1303603.024	1336193.099	1369597.927	1403837.875	1438933.822	1474907.168	1511779.847
Depreciation		82000	147600	118080	94464	75604	60434	53710	53710	53792	53710	26896
Operating income before taxes		1263000	1358125	1358868.125	1366271.828	1379207.024	1396627.099	1423307.927	1457547.875	1492725.822	1528617.168	1538675.847
Taxes		442050	475343.75	475603.8438	478195.1398	482722.4583	488819.4848	498157.7744	510141.7563	522454.0377	535016.0086	538536.5463
Operating income after taxes (NOPAT)		820950	882781.25	883264.2813	888076.6883	896484.5655	907807.6146	925150.1525	947406.1188	970271.7843	993601.1589	1000139.3
Add:		82000	147600	118080	94464	75604	60434	53710	53710	53792	53710	26896

tax*depreciation																						
After tax operating cash flow		-738950	-735181.25	-765184.2813	-793612.6883	-820880.5655	-847373.6146	-871440.1525	-893696.1188	-916479.7843	-939891.1589	-973243.3004										
Total After tax operating cash flows (ACTF)	-820000	-738950	-735181.25	-765184.2813	-793612.6883	-820880.5655	-847373.6146	-871440.1525	-893696.1188	-916479.7843	-939891.1589	-973243.3004										
Cost of Capital	11%	1.0715	1.14811225	1.230202276	1.318161739	1.412410303	1.51339764	1.621605571	1.737550369	1.861785221	1.994902864	2.137538419										
Present Value @ 11% for Each year (NPV)	-820000	689640.6906	640339.1742	621998.7528	602060.176	581191.2897	559914.7194	537393.4132	514342.568	492258.599	471146.3279	455310.3195										

Table 11. The calculation process of (b) buying the new vessel

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Initial Outlay	-1500000																					
Revenue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operating Costs	885000	907125	929803.125	953048.2031	976087.4082	100129.6268	102632.8675	105102.6892	107107.8264	110524.2828	113287.4822	116119.6692	119022.0975	121998.2275	125048.1832	128174.3877	131174.3747	134134.6661	138029.6565	141480.5414	145017.555	
Depreciation	300000	540000	432000	345600	276600	221100	196500	196500	196800	196500	98400	0	0	0	0	0	0	0	0	0	0	0
Fixed Price	1500000																					
Training	50000																					
Operating income before taxes	-2735000	-1447125	136180.25	129864.03	125347.08	122239.68	122282.75	124848.92	127508.64	130174.28	123127.22	116119.92	119022.09	121998.75	125048.32	128174.77	131174.74	134134.61	138029.65	141480.54	145017.55	
Taxes (NO)	-957250	-506493	-476631	-454526	-438716	-427838	-427990	-436970	-446280	-455610	-430946	-406418	-416579	-426993	-437668	-448610	-459825	-471321	-483321	-495104	-507181	-507561

PAT)		.75	.09	.87	.04	.69	.03	.41	.29	.30	.18	.84	.31	.79	.64	.35	.61	.25	.28	.89	.44
		38	11	29	39	63	22	75	49	76	23	33	61	1	71	6	64	78	5	24	
Operating income after taxes	-177,775.00	-940,631.25	-885,172.03	-844,121.33	-814,758.36	-794,557.45	-794,838.63	-811,516.47	-828,806.26	-846,133.42	-800,328.63	-754,777.84	-773,647.29	-792,988.47	-812,813.19	-833,133.52	-853,961.85	-875,310.90	-897,193.67	-919,623.51	-942,614.10
Add: tax* depreciation	300,000.00	540,000.00	432,000.00	345,600.00	276,600.00	221,100.00	196,500.00	196,500.00	196,800.00	196,500.00	984.00	0	0	0	0	0	0	0	0	0	0
After tax operating cash flow (except the 1st year)	-147,775.00	-400,631.25	-453,172.03	-498,521.33	-538,158.36	-573,457.45	-598,338.63	-615,016.47	-632,006.26	-649,633.42	-701,928.63	-754,777.84	-773,647.29	-792,988.47	-812,813.19	-833,133.52	-853,961.85	-875,310.90	-897,193.67	-919,623.51	-942,614.10
Sale price by selling the vehicle and spare parts	200,000.00																				
Book value of vehicle and spare parts	140,000.00																				
Difference between the sale price and book	60,000.00																				

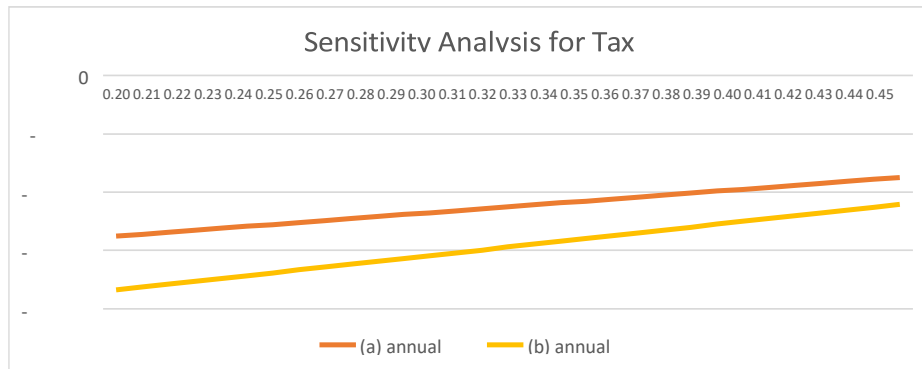


Figure 8. Sensitivity Analysis for tax rate (cost only)

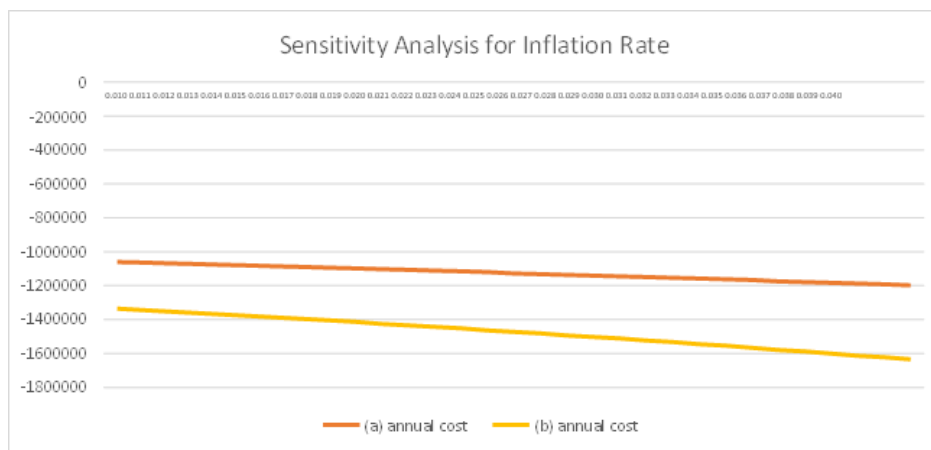


Figure 9. Sensitivity Analysis for inflation rate (cost only)

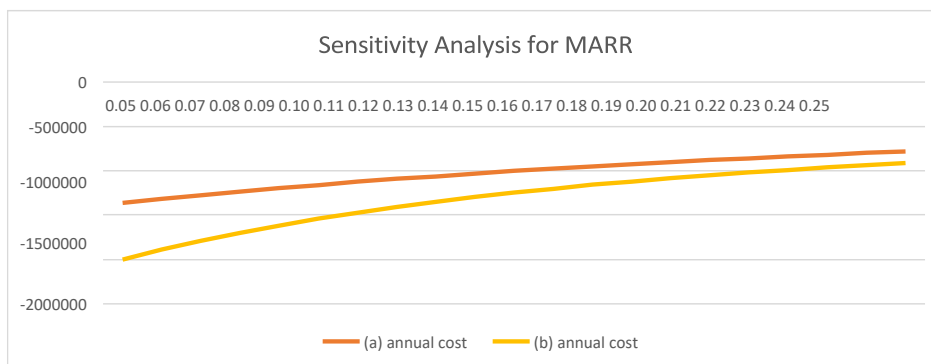


Figure 10. Sensitivity Analysis for MARR (cost only)

5. Part 3: Solutions and sensitivity analysis of problem B (considering 5revenue)

5.1 Spreadsheets and Results

Based on the information and assumptions in Part 2, analysis on equivalent annual cost has shown that ATCF of changing a new vessel is always less than overhauling the old ship. However, since the new vessel is more profitable, we cannot directly draw a conclusion. In this part, we add revenue into the calculation of equivalent annual ATCF and compare the defender and the challenger. The results are given in Table 12 below, Apparently, it’s a better choice to change a new vessel when revenue is considered. The process is shown in the Table 13 and 14 in appendix. Besides, the comparison of NOPAT, ATCF and EVA is shown in Figure 11 and 12.

Table 12. The comparison results (considering the revenue)

Operation	Annual ATCF
Defender (overhauling the Vital Spark)	80243
Challenger (buying a new vessel)	301936

Table 13. The calculation process of (a) overhauling the Vital Spark considering the revenue

(b) buying the new vessel												
Year	0	1	2	3	4	5	6	7	8	9	10	11
Initial Outlay	-820000											
Revenue	0	1400000	1435000	1470875	1507646.875	1545338.047	1583971.498	1623570.785	1664160.055	1705764.057	1748408.158	1792118.362
Operating Costs	0	1181000	1210525	1240788.125	1271807.828	1303603.024	1336193.099	1369597.927	1403837.875	1438933.822	1474907.168	1511779.847
Depreciation	0	92000	165600	132480	105984	84824	67804	60260	60260	60352	60260	30176
Book Value	920000	828000	662400	529920	423936	339112	271308	211048	150788	90436	30176	0
Training												
Taxable Income	0	127000	58875	97606.875	129855.0469	156911.023	179974.3986	193712.8586	200062.1801	206478.2346	213240.9904	250162.5152
Taxes	0	-44450	20606.25	34162.40625	45449.26641	54918.85807	62991.03952	67799.50051	70021.76302	72267.38209	74634.34665	87556.88031
ATCF	-820000	174550	203868.75	195924.4688	190389.7805	186816.165	184787.3591	186173.3581	190300.417	194562.8525	198866.6438	192781.6349
NOPAT		82550	38268.75	63444.46875	84405.78047	101992.165	116983.3591	125913.3581	130040.417	134210.8525	138606.6438	162605.6349
EVA		16770	20933.25	16082.86875	46516.50047	71680.74098	92736.8511	106514.8361	114950.485	123429.5105	132140.4698	160448.0509
P/F		1.0715	1.14811225	1.230202276	1.318161739	1.412410303	1.51339764	1.621605571	1.737550369	1.861785221	1.994902864	2.137538419
NPV ATCF	-820000	162902.4732	177568.6567	159261.995	144435.8267	132267.6312	122100.996	114808.0405	109522.2449	104503.3822	99687.38197	90188.61752

Table 14. The calculation process of (b) buying the new vessel

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Initial Outlay	-1500000	-1500000																				
Revenue	200000	1500000	1537500	1575937.5	1615335.9	1655719.3	1697112.3	1739540.1	1783028.6	1827604.3	1873294.4	1920126.8	1968129.9	2017333.2	2067766.5	2119460.7	2172447.2	2226753.1	2282429.2	2339487.7	2397978	2457924.6
Operating Costs	0	885000	907125	929803.12	953048.20	976874.40	1001296.2	1026328.6	1051989.2	1076328.6	1105242.8	1132872.2	1161199.2	1190220.9	1219987.5	1250483.2	1281747.7	1313787.4	1346636.1	1381386.5	1414807.9	1450175.5
Depreciation	0	300000	540000	432000	345600	276600	221100	196500	196500	196800	196500	98400										
Book Value	300000	270000	216000	172800	138240	110580	884700	688200	491700	294900	98400	0										
Training		-50000																				
Taxable Income	60000	265000	90375	214134	316687	402244	474716	516711	534541	552517	571550	688851	806933	827106	847784	868978	890703	912970	935795	959190	983169	100774
Taxes	-14400	-92750	-31631.25	-74947.03125	-110840.70	-140785.72	-166150.61	-180849.00	-187089.60	-193381.22	-200042.75	-241098.19	-282426.65	-289487.31	-296724.50	-304142.61	-311746.18	-319539.48	-327528.07	-335716.09	-344109.45	-352712.18
AC TF	-131440	-1027750	598743.75	571187.34	551447.02	538059.20	529665.43	532362.44	543952.13	555936.55	568007.97	546153.79	524506.64	537619.30	551059.79	564836.28	578957.19	593431.12	608266.89	623473.57	639060.41	655036.92
NO PAT		172250	58743.75	139187.34	205847.02	261459.20	308565.43	335862.44	347452.13	359136.55	371507.97	447753.79	524506.64	537619.30	551059.79	564836.28	578957.19	593431.12	608266.89	623473.57	639060.41	655036.92
EV A		-42250	-134306.25	-15252.656	95.02734	162617.603	229500.7331	272606.3939	298245.83	323980.0083	350422.6222	440718.1965	524506.6415	537619.3075	551059.7902	564836.2849	578957.1921	593431.1219	608266.8999	623473.5724	639060.4117	655036.922

				25																		
P/F		1.0	481	302	181	124	133	216	375	617	949	375	903	541	296	176	190	349	662	140	796	641
		715	122	022	617	103	976	055	503	852	028	384	724	340	046	213	812	455	442	806	374	815
			5	76	39	03	4	71	69	21	64	19	15	43	27	58	85	97	07	68	36	13
NP	-	-	521	464	418	380	349	328	313	298	284	255	229	219	209	200	191	183	175	167	160	153
V	13	959	502	303	345	951	984	293	056	604	729	505	004	066	559	465	766	443	482	867	582	613
AT	14	169	.79	.59	.49	.06	.31	.42	.89	.02	.63	.95	.95	.80	.94	.64	.01	.92	.99	.53	.57	.75
CF	40	.38	73	86	68	07	29	32	88	38	9	57	92	65	09	57	67	64	07	66	12	22

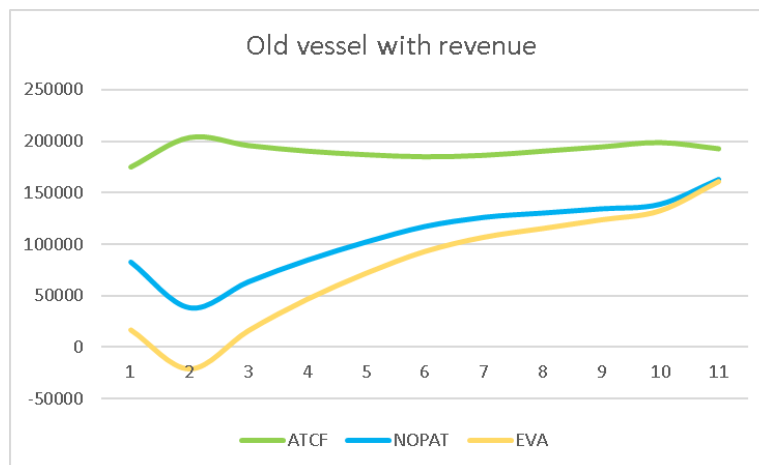


Figure 11. ATCF, NOPAT, EVA for overhauling the Vital Spark

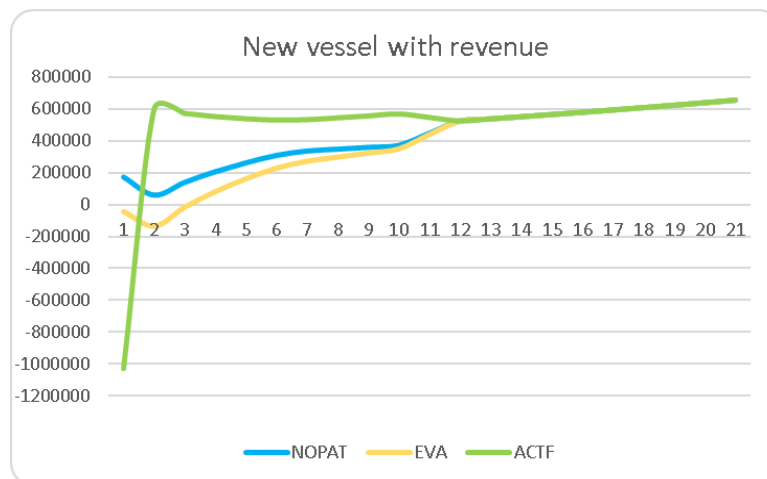


Figure 12. ATCF, NOPAT, EVA for buying the new vessel

5.2 Sensitivity Analysis

We also conduct sensitivity analysis in this part, based on the same parameters and same range of variation.

As is shown in Figure 13~15 in the appendix, the equivalent annual ATCF decreases as capital cost and tax rate increases, while increases as inflation rate increases. This is easy to explain, since the increase of revenue is only based on inflation rate and we only consider actual dollar. The plots also show that changing a new vessel is always a better choice when parameters vary in the given ranges.

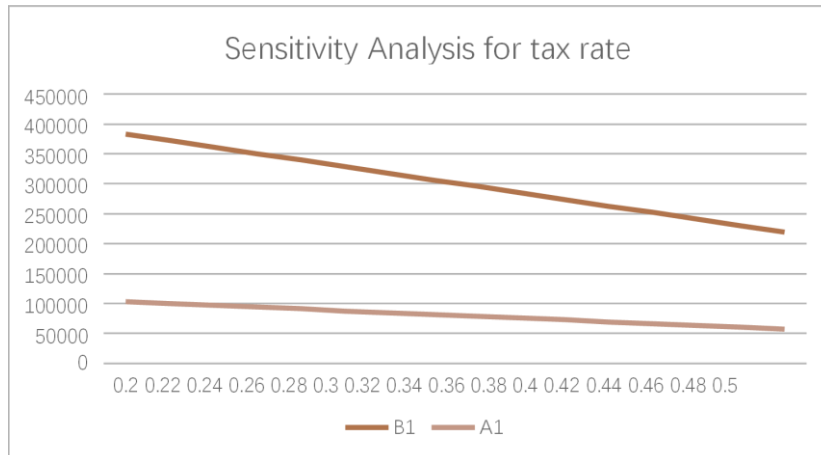


Figure 13. Sensitivity Analysis for tax rate (considering revenue)

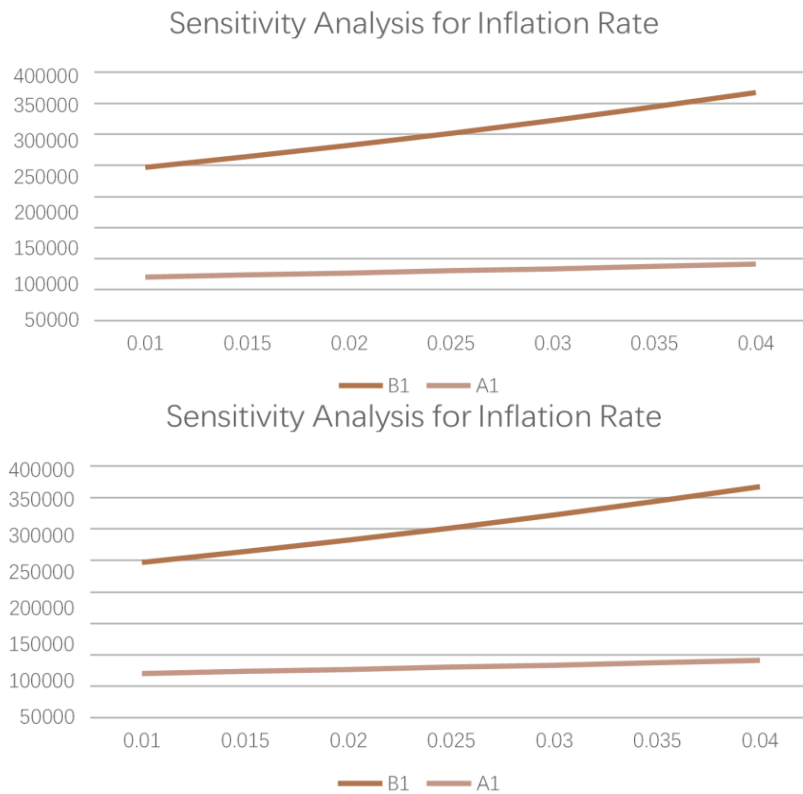


Figure 14. Sensitivity Analysis for inflation rate (considering revenue)

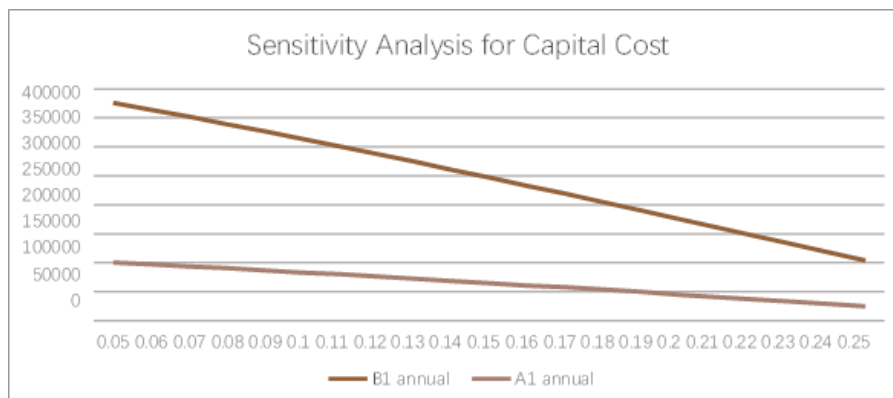


Figure 15. Sensitivity Analysis for MARR (considering revenue)

6. Part 4: Think twice and extension in problem B

6.1 Think twice: the appropriate time to make the replacement

In reality, the choices Mr. Handy faces are much more than what we have discussed above. For example, he can overhaul the old vessel, keep it running for 5 or 10 years and make the replacement. We compute the annual equivalent after tax cash flow for alternatives respectively and derive. $AW_{5\text{ years}} = 48125$, $AW_{10\text{ years}} = 74864$. Both are smaller than the annual worth of the challenger. So, it's advisable to place the order for replacement now.

6.2 Extension: sell the old vessel now or next year?

As above, it's more profitable to place the order for a new vessel right now. However, should he scrap the vessel right now or keep it running until the replacement is ready? There is a tradeoff here: keeping the old vessel running will yield revenues but its market value will decrease with time. The decision depends on the months left this year and the estimated revenue. Considering inflation, monthly expense of operating and revenue this year is:

$$R_m = 1,400,000 / (1.025 \times 12) = 113,821\$,$$

$$E_m = 1,181,000 / (1.025 \times 12) = 96,016\$.$$

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$$R_m = 1,400,000 / (1.025 \times 12) = 113,821\$, E_m = 1,181,000 / (1.025 \times 12) = 96,016\$$$

Also, we should estimate the monthly depreciation. The old vessel is 25 years old, but still has a book value of \$100,000. Suppose that the company uses SL method, the initial book value of the vessel is $B_0 = \frac{3,000,000}{1.025^{25}} = \$1,618,172$ and the monthly depreciation is $d = \frac{1.025 \times (1,618,172 - 100,000)}{(25 \times 12)} = \$5,061$. If Mr Handy scraps the old vessel now, ATCF is 179,000\$. Considering months left this year, the total after tax cash flow is shown in the Table 15.

Table 15. The total after tax cash flow

Months left	Total ATCF	Months left	Total ATCF
1	108,283.60	7	157,985.20
2	116,567.20	8	166,268.80
3	124,850.80	9	174,552.40
4	133,134.40	10	182,836
5	141,418	11	191,119.60
6	149,701.60	12	199,403.20

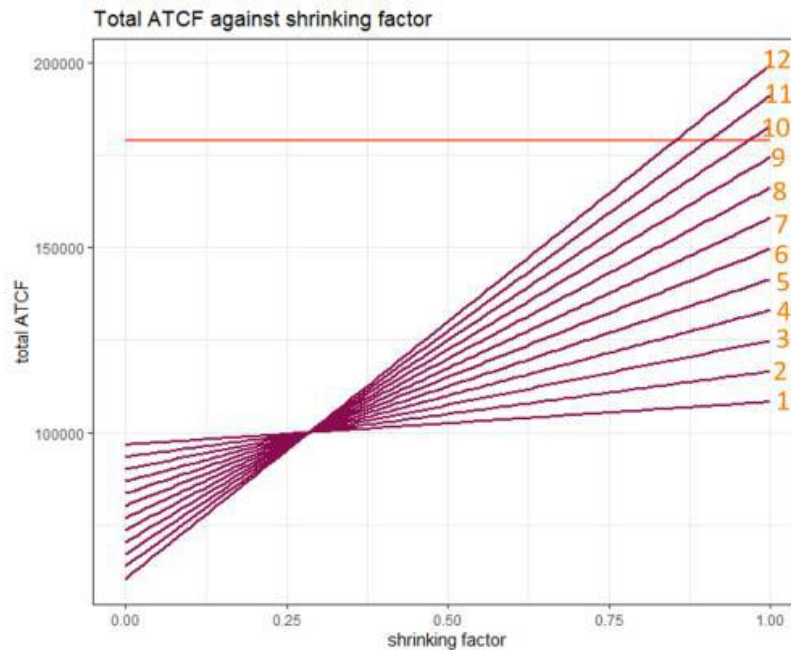


Figure 16. Total ATCF ~ shrinking factor

We can conclude that only when there is more than 10 months left this year is it wise to keep the old vessel running. However, the gross profit (revenue- expense) might not be as high as the profit after overhauling. Multiply it by a shrinking factor s between 0 and 1 and we derive the Figure 16 above. It can be concluded from the chart that only when there are more than 10 months left and the shrinking factor is no less than 0.85 should Mr. Handy consider keeping the old vessel running. The process is shown in Table 16.

Table 16. The calculation process of extension

Computation of total ATCF based on the months left													
Months left	Monthly revenue	Revenue	Monthly cost	Cost	Monthly depreciation	Depreciation Reduction	BTCF	Taxable income	Income taxes	ATCF	Initial BV	Income from scrap	Total cashflow
1	11382 1.00	11382 .00	96016 .00	96016. 00	5061.00	5061.00	17805. 00	12744. 00	4460. 40	13344. 60	10000 0.00	94939 .00	10828 3.60
2	11382 1.00	227642 .00	96016 .00	192032 .00	5061.00	10122.0 0	35610. 00	25488. 00	8920. 80	26689. 20	10000 0.00	89878 .00	11656 7.20
3	11382 1.00	341463 .00	96016 .00	288048 .00	5061.00	15183.0 0	53415. 00	38232. 00	13381 .20	40033. 80	10000 0.00	84817 .00	12485 0.80
4	11382 1.00	455284 .00	96016 .00	384064 .00	5061.00	20244.0 0	71220. 00	50976. 00	17841 .60	53378. 40	10000 0.00	79756 .00	13313 4.40
5	11382 1.00	569105 .00	96016 .00	480080 .00	5061.00	25305.0 0	89025. 00	63720. 00	22302 .00	66723. 00	10000 0.00	74695 .00	14141 8.00
6	11382 1.00	682926 .00	96016 .00	576096 .00	5061.00	30366.0 0	10683 0.00	76464. 00	26762 .40	80067. 60	10000 0.00	69634 .00	14970 1.60
7	11382 1.00	796747 .00	96016 .00	672112 .00	5061.00	35427.0 0	12463 5.00	89208. 00	31222 .80	93412. 20	10000 0.00	64573 .00	15798 5.20
8	11382 1.00	910568 .00	96016 .00	768128 .00	5061.00	40488.0 0	14244 0.00	10195 2.00	35683 .20	10675 6.80	10000 0.00	59512 .00	16626 8.80
9	11382 1.00	102438 9.00	96016 .00	864144 .00	5061.00	45549.0 0	16024 5.00	11469 6.00	40143 .60	12010 1.40	10000 0.00	54451 .00	17455 2.40

10	11382 1.00	113821 0.00	96016 .00	960160 .00	5061.00	50610.0 0	17805 0.00	12744 0.00	44604 .00	13344 6.00	10000 0.00	49390 .00	18283 6.00
11	11382 1.00	125203 1.00	96016 .00	105617 6.00	5061.00	55671.0 0	19585 5.00	14018 4.00	49064 .40	14679 0.60	10000 0.00	44329 .00	19111 9.60
12	11382 1.00	136585 2.00	96016 .00	115219 2.00	5061.00	60732.0 0	21366 0.00	15292 8.00	53524 .80	16013 5.20	10000 0.00	39268 .00	19940 3.20

7. Part 5: Additional Information

If the equivalent annual cost of the replacement is higher, we should collect some additional information as follows:

7.1 The payback period for investment replacements should be considered.

You need to gather information about the specific business value that the replacement can bring and figure out how many years it will take to recoup the initial investment. This examines the liquidity of capital and is important information for making choices.

7.2 Accounting rate of return (AAR) should be considered.

Information on the average annual net profit and the average annual book value needs to be collected.

7.3 The profitability of the replacement should be evaluated.

Future cash flows after production need to be collected and calculated. Focus on the increase in the value of money in the investment.

7.4 Possible risks should be considered.

Different from the original ship, there are different risks for the replacement, which may affect the cash flow and require information collection and specific assessment.

7.5 Other alternatives should be considered.

The opportunity cost of the currency may not be considered fully, and the substitution may not capture the maximum value of the transaction.

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