

Total Ownership with Life-Cycle Cost Model under Uncertainty for Surface Ships' Electro-Optical-Infrared-Sensors



NAVAL
POSTGRADUATE
SCHOOL

Abstract

This thesis examines the basics of total ownership cost (TOC) modeling over the life cycle of electro-optic/infrared sensors, including the inception phase of Acquisition Costs, followed by annual Operations and Maintenance (O&M) expenses, and a final set of Disposition Costs at the end of life of the sensor. This model allows cost analysts to have better decision analytics of the costs for use in cost comparisons across sensor platforms, return on investment analysis, portfolio allocation of resources, and analysis of alternatives. The findings show that the developed model is functional and could be used in the Department of Defense total ownership cost estimation process to facilitate decisions among sensor platform

| System B | | Discount Rate: 3.00% | | Economic Life: 20 Years | | | | | | | | | | |
|--|---|----------------------------|-------------------------|-----------------------------------|-----------------------------|-----------------------------|------------------------|------------------|------|-------------|-------|----------------|-------|----------------|
| Unit Range: [Use Small +/- 5% Range] | Notes: Annual Growth or Decline Rate: 1.50% | Number of Units per System | Acquisition Cost (Unit) | Operational Costs (Unit) Per Year | Maintenance (Unit) Per Year | Replacement (Unit) Per Year | Total Acquisition Cost | Total Annual O&M | | | | | | |
| Minimum Field of View (MFOV) Sensors | | 43 | \$935 | \$7,229.00 | 0.2% | \$135.00 | 0.0% | \$578.00 | 0.6% | \$5,663.00 | 5.5% | \$1,004,795.00 | 2.3% | \$925,760.00 |
| TV Director | | 2 | \$5 | \$500.00 | 0.0% | \$7.00 | 0.0% | \$20.00 | 0.0% | \$400.00 | 0.4% | \$55,000.00 | 0.1% | \$46,970.00 |
| Thermal Imaging Sensor - TG #1 | | 1 | \$5 | \$430.00 | 0.0% | \$6.00 | 0.0% | \$23.00 | 0.0% | \$200.00 | 0.2% | \$70,350.00 | 0.2% | \$37,785.00 |
| Thermal Imaging Sensor - TG #2 | | 4 | \$5 | \$324.00 | 0.0% | \$5.00 | 0.0% | \$43.00 | 0.0% | \$300.00 | 0.3% | \$71,280.00 | 0.2% | \$76,560.00 |
| Electro-Optic Sensor - EOS #1 | | 1 | \$5 | \$450.00 | 0.0% | \$6.00 | 0.0% | \$6.00 | 0.1% | \$230.00 | 0.2% | \$24,750.00 | 0.1% | \$16,060.00 |
| Electro-Optic Sensor - EOS #2 | | 3 | \$5 | \$549.00 | 0.0% | \$4.00 | 0.0% | \$54.00 | 0.1% | \$400.00 | 0.4% | \$89,395.00 | 0.2% | \$75,370.00 |
| Electro-Optic Sensor - EOS #3 | | 4 | \$5 | \$520.00 | 0.0% | \$3.00 | 0.0% | \$43.00 | 0.0% | \$320.00 | 0.3% | \$114,400.00 | 0.3% | \$80,520.00 |
| Search Range Finder | | 1 | \$5 | \$200.00 | 0.0% | \$4.00 | 0.0% | \$23.00 | 0.0% | \$420.00 | 0.4% | \$33,000.00 | 0.1% | \$73,755.00 |
| Search Designator/Range Finder | | 2 | \$5 | \$192.00 | 0.0% | \$5.00 | 0.0% | \$21.00 | 0.0% | \$432.00 | 0.4% | \$61,320.00 | 0.1% | \$50,380.00 |
| Laser Designator/Range Finder/Illuminator | | 1 | \$5 | \$300.00 | 0.0% | \$6.00 | 0.0% | \$23.00 | 0.0% | \$320.00 | 0.3% | \$16,500.00 | 0.0% | \$18,040.00 |
| Search Point | | 1 | \$5 | \$600.00 | 0.0% | \$1.00 | 0.0% | \$33.00 | 0.0% | \$200.00 | 0.2% | \$33,000.00 | 0.1% | \$12,870.00 |
| Search Optical/Ocular Interrupter | | 2 | \$5 | \$400.00 | 0.0% | \$4.00 | 0.0% | \$43.00 | 0.0% | \$400.00 | 0.4% | \$44,000.00 | 0.1% | \$52,180.00 |
| Illuminator | | 1 | \$5 | \$200.00 | 0.0% | \$3.00 | 0.0% | \$55.00 | 0.1% | \$321.00 | 0.3% | \$11,000.00 | 0.0% | \$20,845.00 |
| Artificial Reference Unit | | 4 | \$5 | \$340.00 | 0.0% | \$2.00 | 0.0% | \$43.00 | 0.0% | \$430.00 | 0.4% | \$74,800.00 | 0.2% | \$104,500.00 |
| Weight Module | | 3 | \$5 | \$450.00 | 0.0% | \$3.00 | 0.0% | \$43.00 | 0.0% | \$330.00 | 0.3% | \$74,230.00 | 0.3% | \$60,235.00 |
| Electronics Unit | | 2 | \$5 | \$540.00 | 0.0% | \$4.00 | 0.0% | \$32.00 | 0.0% | \$210.00 | 0.2% | \$59,400.00 | 0.1% | \$27,060.00 |
| Material (cabling, mounting hardware, etc.) | | 3 | \$5 | \$310.00 | 0.0% | \$5.00 | 0.0% | \$21.00 | 0.0% | \$230.00 | 0.2% | \$51,130.00 | 0.1% | \$42,240.00 |
| if View (WFOV) Sensors | | 20 | \$85 | \$38,400.00 | 0.7% | \$41.00 | 0.0% | \$34.00 | 0.0% | \$24,100.00 | 23.6% | \$4,532,000.00 | 10.2% | \$3,581,830.00 |
| Director | | 3 | \$5 | \$6,000.00 | 0.1% | \$5.00 | 0.0% | \$4.00 | 0.0% | \$3,000.00 | 2.9% | \$990,000.00 | 2.2% | \$496,485.00 |
| Thermal Imaging Sensor | | 2 | \$5 | \$2,300.00 | 0.1% | \$6.00 | 0.0% | \$5.00 | 0.0% | \$5,000.00 | 4.9% | \$253,000.00 | 0.6% | \$55,210.00 |
| Electro-Optic Sensor | | 1 | \$5 | \$4,300.00 | 0.1% | \$7.00 | 0.0% | \$3.00 | 0.0% | \$3,200.00 | 3.1% | \$236,500.00 | 0.5% | \$178,550.00 |
| Artificial Reference Unit | | 2 | \$5 | \$4,500.00 | 0.1% | \$8.00 | 0.0% | \$6.00 | 0.0% | \$3,200.00 | 3.1% | \$495,000.00 | 1.1% | \$353,540.00 |
| Electronics Unit | | 3 | \$5 | \$2,300.00 | 0.1% | \$6.00 | 0.0% | \$7.00 | 0.0% | \$4,300.00 | 4.2% | \$379,500.00 | 0.9% | \$711,645.00 |
| Material (cabling, mounting hardware, etc.) | | 4 | \$5 | \$3,600.00 | 0.1% | \$5.00 | 0.0% | \$3.00 | 0.0% | \$3,600.00 | 3.3% | \$1,188,000.00 | 2.7% | \$790,200.00 |
| if Manager (ISM) | | 20 | \$30 | \$2,328.00 | 0.1% | \$26.00 | 0.0% | \$135.00 | 0.1% | \$2,865.00 | 2.6% | \$419,815.00 | 0.9% | \$407,110.00 |
| Equipment | | 3 | \$5 | \$540.00 | 0.0% | \$5.00 | 0.0% | \$12.00 | 0.0% | \$500.00 | 0.5% | \$89,100.00 | 0.2% | \$85,305.00 |
| Software | | 4 | \$5 | \$324.00 | 0.0% | \$4.00 | 0.0% | \$21.00 | 0.0% | \$340.00 | 0.3% | \$71,280.00 | 0.2% | \$80,300.00 |
| Equipment | | 3 | \$5 | \$564.00 | 0.0% | \$6.00 | 0.0% | \$43.00 | 0.0% | \$230.00 | 0.2% | \$92,895.00 | 0.2% | \$46,035.00 |
| Station Equipment | | 3 | \$5 | \$264.00 | 0.0% | \$6.00 | 0.0% | \$12.00 | 0.0% | \$345.00 | 0.3% | \$43,500.00 | 0.1% | \$59,895.00 |
| Material (video converters, encoders, ethernet switches, etc.) | | 4 | \$5 | \$324.00 | 0.0% | \$4.00 | 0.0% | \$22.00 | 0.0% | \$390.00 | 0.3% | \$71,500.00 | 0.2% | \$78,330.00 |
| | | 3 | \$5 | \$312.00 | 0.0% | \$1.00 | 0.0% | \$25.00 | 0.0% | \$321.00 | 0.3% | \$51,480.00 | 0.1% | \$57,255.00 |

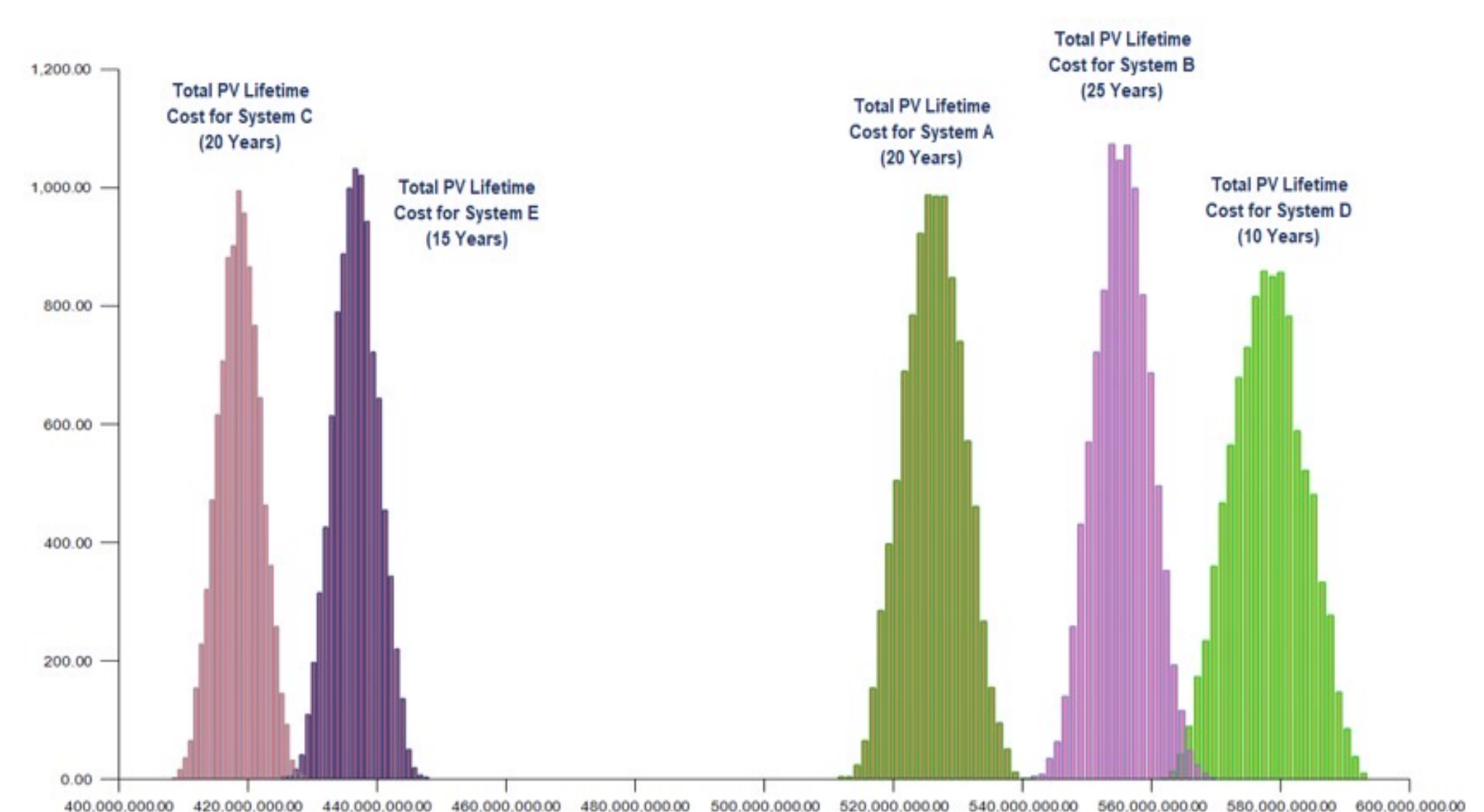
The Model input interface

Methods

- TOC's are modeled with predictive modeling and Monte Carlo risk simulation to determine the probabilistic of each cost element
- Multiple EO/IR capabilities are compared side by side with costs and risk element directly comparable in present values

Results

- TOC modeling over the life cycle of EO/IR sensors develop a useful model for TOC estimations. Monte Carlo risk simulation allows this model to account for risk and uncertainty when producing cost estimates.
- This model provides analysts with a realistic estimate by factoring in economic theory, such as economic growth, annual discount rate, and inflation allowing better decision analytics of the costs of EO/IR surface sensors. These analytics can be used in subsequent cost comparisons between different sensor platforms, Analysis of Alternatives, and portfolio allocation of resources.



Probability Distribution Cost Overlay of the Five Systems

Recommendations

- Use empirical cost data from a current EO/IR program to compare the results produced by the model.
- Executing this study would determine whether the TOC model developed in this thesis is a superior method of cost estimation for the DoD.
- PEO IWS and NAVSEA can utilize this model in future program cost estimation development. Since the model is tailorable to different sensor configurations, it can provide clarity in analyzing different and complex alternative sensor systems to develop and outfit the fleet.

Acquisition Research Program
Graduate School of Defense Management

www.acquisitionresearch.net

George, Katelyn, LT, USN
Ledbetter, Eliah, LT, USN

Advisors: Dr. Johnathan Mun
Dr. Robert Mortlock