Design of a Marine Debris Removal System

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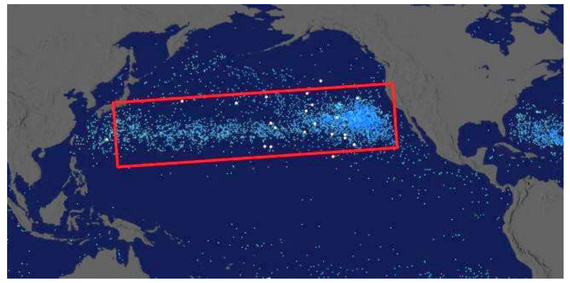
Context

Marine Debris – any persistent solid material that is directly or indirectly disposed of in the marine environment.



The **Subtropical Convergence Zone** is estimated to contain 8 million tons of debris, and is approximately the size of 3.8 billion football fields side by side.

The amount of marine debris that enters the ocean rises by 10% each year, and approximately 80% of the debris is plastic.

This effects everyone and is destroying the marine environment.

Need and Design Alternatives

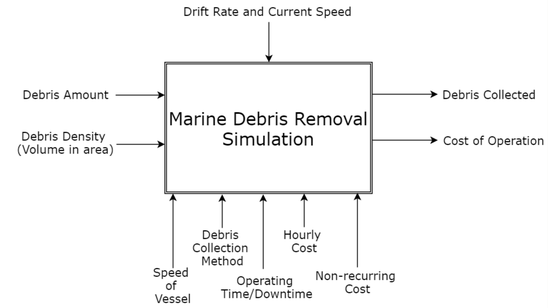
Need Statement – To mitigate the harmful effects of marine debris on the marine environment, the debris must be removed from the ocean before irreversible damage is done to the planet. There is a need for a removal system that can traverse the ocean collecting the marine debris efficiently and safely.

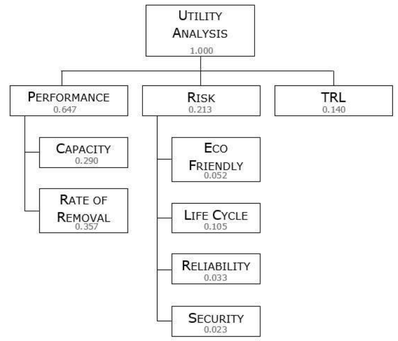
Design Alternative Technologies

Alternative	Propulsion	Collection	Storage	Disposal
B-ASV	Solar powered motor	Vacuum	Barge	Landfill, recycling, incinerator
B-UAV	Solar powered motor	UAV with net	Barge	Landfill, recycling, incinerator
VN	Fossil fuel powered ship	Net	Ship	Landfill, recycling, incinerator
AV	Solar and wind powered motor	Vacuum	AV	Landfill, recycling, incinerator
AFI	Current driven	Conveyor belts	AFI	Landfill, recycling, incinerator
AFI-S	Current driven and wind powered motor	Conveyor belts	AFI-S	Landfill, recycling, incinerator
AFI-M	Current driven and electric powered motor	Conveyor belts	AFI-M	Landfill, recycling, incinerator

Method of Analysis

Simulate each alternative given the same inputs.



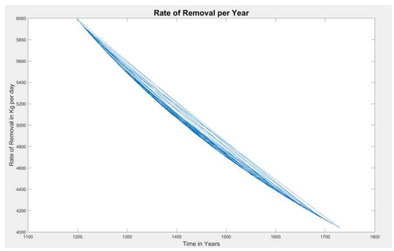


Utility analysis to determine which alternative to implement and the weights associated with each breakdown.

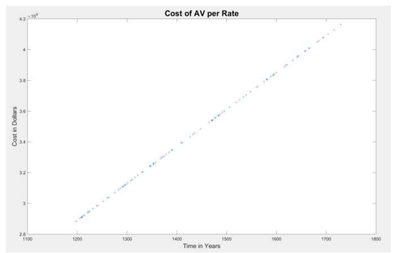
Simulation Results

Simulation Outputs for the AV:

This graph shows the total clean up time for the AV at different rates of removal.



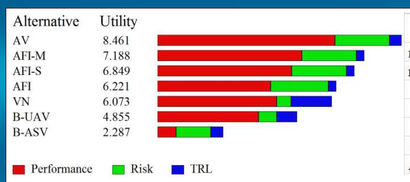
This graph shows the total cost of the AV over time to clean up the amount of debris.



Mean Rate of Removal: 5004 kg/day, std 590 kg/day

Mean Cost Based on Rate of Removal: $\$3.54\times10^{9}$, std $\$3.78\times10^{8}$

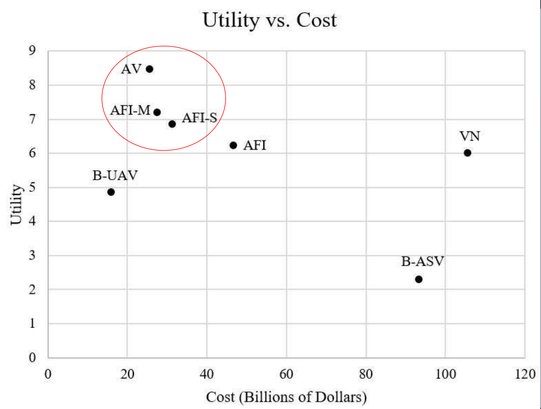
Utility vs. Cost



	Capacity	Eco Friendly	Lifecycle	Rate of Removal	Reliability	Security	TRL	Total
B-ASV	1	6	6	1	6	3	3	2.287
B-UAV	1	5	2	9	3	3	5	4.855
VN	7	1	1	6	6	3	10	6.004
AV	9	8	10	10	7	8	3	8.461
AFI	10	10	10	3	6	10	2	6.221
AFI-S	10	9	10	5	5	10	2	6.849
AFI-M	10	8	10	6	6	10	2	7.188

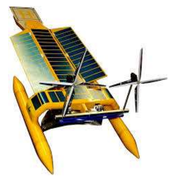
Top Three Alternatives:
AV
AFI-M
AFI-S

High performance and low risk values determined the top alternatives. Compared to the other alternatives, the cost is relatively low and utility values are high making them viable options.



Recommendations

Based on the results, the design alternative that is the best option for cleaning up marine debris is the AV.



Due to the proximity of the top three alternatives in the utility analysis, a single one cannot be definitively selected. The AV, AFI-M, and AFI-S each are feasible options to be considered when looking for a solution to this problem.

A recommendation to expand the efficiency of marine debris removal system would be to combine the unique design alternatives to get the best coverage, since the different alternatives have different methods of removal.