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Next Generation Logistics Ship (NGLS) Automation and Uncrewed Underway Replenishment (UNREP):

Enhancing Efficiency and Effectiveness in Naval Operations

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Agenda

- Research Objectives and Background
- Literature Review & Gap
- Methodology
- Key Findings and Analysis of Alternatives (AOA)
- Proposed Technological Paths
- Conclusion and Future Research
- References
- Questions

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Research Objectives

- Propose adaptive modeling processes for NGLS automation.
- Assist in calculating, valuing, and optimizing UNREP equipment and operations.
- Explore technology development, investment costs, and benefits.

Literature Review & Gap

- Koteskey (2020): Highlighted the significant portion of refueling time taken by in-port refueling for U.S. Naval surface combatants. Emphasized the strategic need for underway replenishment (UNREP) in operational scenarios where conventional supply ports are inaccessible.
- Miller et al. (1987): Described the evolution of the US Navy's Underway Replenishment Fleet from small cargo ships to technologically advanced vessels capable of day and night operations in varying weather conditions.
- Hewgley & Yakimenko (2009): Investigated precision-guided airdrops as innovative UNREP techniques, presenting autonomous cargo packages as a potential future direction.
- Curtin (2001): Developed a conceptual model merging UNREP processes with operational scenarios, suggesting enhancements in helicopter lift capacity could significantly reduce UNREP cycle times.

- Technology Gap Identified: Despite advancements, the need for automated and uncrewed UNREP solutions remains largely unaddressed, especially in the context of distributed maritime operations and advanced technology integration.

Methodological Approach

Advanced Analytical Techniques:

- Monte Carlo Simulation: Utilized to perform stochastic forecasting and uncertainty modeling, crucial for evaluating the viability of automated and uncrewed UNREP systems under various scenarios.
- Stochastic Forecasting: Applied to predict technology development durations, investment costs, and potential benefits, ensuring comprehensive planning and risk assessment.

Strategic Real Options:

- Incorporated to quantify and hedge against prototyping uncertainty, allowing for flexible decision-making in the face of technological and operational risks.

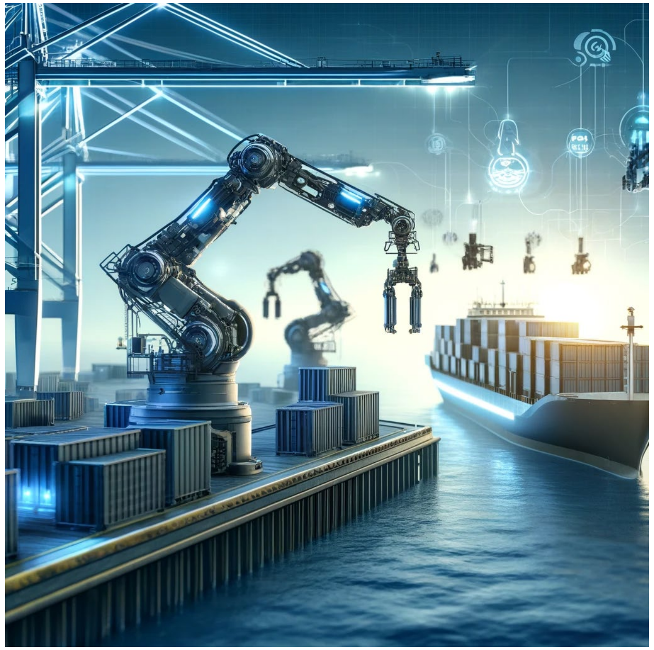
Integrated Risk Management (IRM):

- Knowledge Value Add (KVA) Analysis: Adopted to assess the return on knowledge (ROK) and return on investment (ROI) across different UNREP subprocesses, facilitating a quantifiable measure of potential improvements.
- Portfolio Optimization: Enabled the selection of optimal technology development paths based on cost, benefit, and risk profiles, ensuring efficient allocation of resources.

Key Findings and AoA

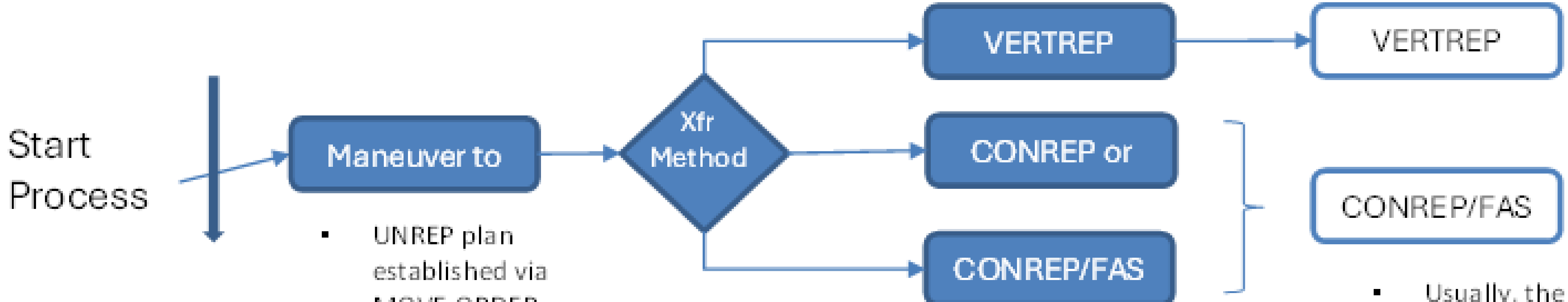
- Enhanced Operational Efficiency
- Strategic Advantages of Uncrewed Operations
- Resilience and Adaptability
- Future Readiness
- Cost-Benefit Analysis
- Risk Management and Forecasting

- Automated UNREP Systems
- Uncrewed Surface Vessels (USVs) for UNREP
- Hybrid Crewed-Uncrewed Systems



Current “Analog” UNREP Process

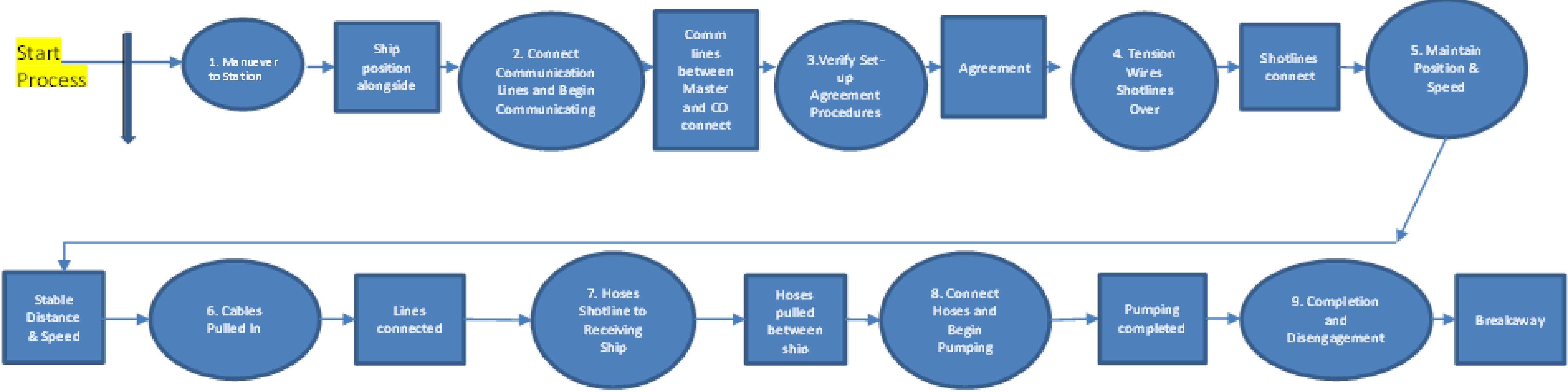
- If VERTREP only, the overall formation guide will remain with the senior CO.
- Ships are usually 5-12 miles apart for VERTREP but sometimes further.
- Winds will determine potential courses to steer for safe helicopter operations.



- UNREP plan established via MOVE ORDER.
- Logistics demand

- Usually, the transfer ship will be the formation Guide and fly the “GOLF” flag.

As-Is Optimization



Process	TLT	Total K	Expenses	Revenues	Denominator	Numerator	ROK	ROI
1. Maneuvering to Station	26400.00	26400.00	$ 60,930	$ 242,789	$ 60,930	$ 242,789	398%	298%
2. Comm lines connected	5280.00	5280.00	$ 10,508	$ 48,558	$ 10,508	$ 48,558	462%	362%
3.Set-up Agreement Procedures	35200.00	35200.00	$ 23,654	$ 323,719	$ 23,654	$ 323,719	1369%	1269%
4.Tension lines received	17600.00	17600.00	$ 8,326	$ 161,859	$ 8,326	$ 161,859	1944%	1844%
5. Maintain Distance and Speed	35200.00	35200.00	$ 49,378	$ 323,719	$ 49,378	$ 323,719	656%	556%
6. Cable Pulled In	8800.00	8800.00	$ 9,433	$ 80,930	$ 9,433	$ 80,930	858%	758%
7. Hose Shotline Over	8800.00	8800.00	$ 26,940	$ 80,930	$ 26,940	$ 80,930	300%	200%
8. Connect Hoses	3520.00	3520.00	$ 8,478	$ 32,372	$ 8,478	$ 32,372	382%	282%
9. Completion and Disengagement (Breakaway)	32160.00	32160.00	$ 8,055	$ 295,761	$ 8,055	$ 295,761	3672%	3572%
Total	140800.00	172960.00	$197,647	$ 1,294,875	$ 197,647	$ 1,294,875	655%	555%

To-Be Optimization

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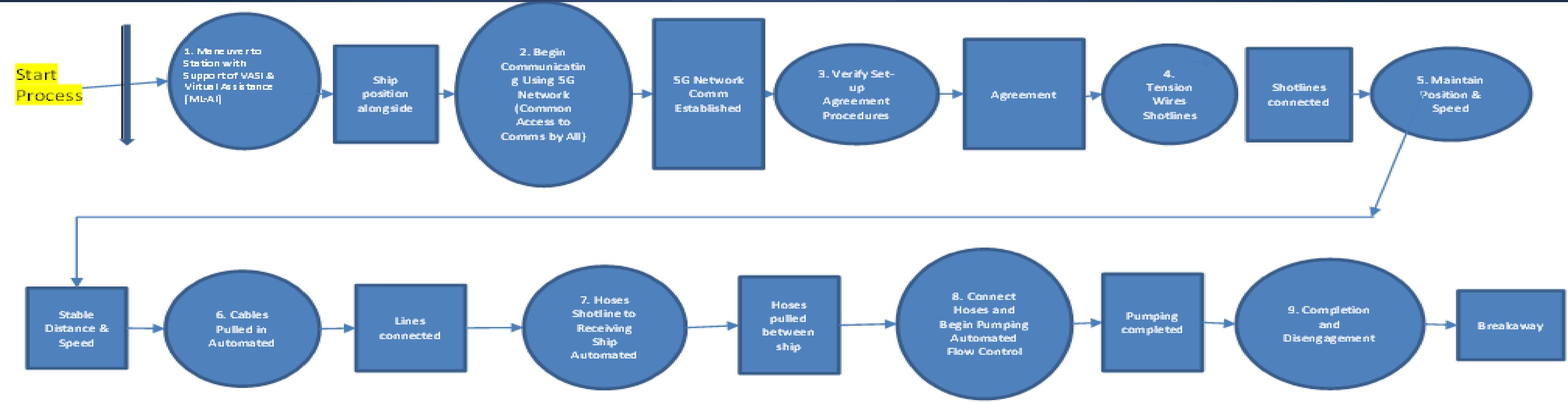

Process	TLT	Total K	Expenses	Revenues	Denomiator	Numerator	ROK	ROI
1. Manuevering to Station	36000	36000	$ 16,489	$ 331,200	$ 16,489	$ 331,200	2009%	1909%
2. Comm lines connected	5280	5280	$ 8,631	$ 48,576	$ 8,631	$ 48,576	563%	463%
3.Set-up Agreement Procedures	35200	35200	$ 21,263	$ 323,840	$ 21,263	$ 323,840	1523%	1423%
4.Tension lines received	28800	28800	$ 311	$ 264,960	$ 311	$ 264,960	85236%	85136%
5. Maintain Distance and Speed	35200	35200	$ 16,459	$ 323,840	$ 16,459	$ 323,840	1968%	1868%
6. Cable Pulled In	8800	8800	$ 311	$ 80,960	$ 311	$ 80,960	26044%	25944%
7. Hose Shotline Over	8800	8800	$ 9,090	$ 80,960	$ 9,090	$ 80,960	891%	791%
8. Connect Hoses	6080	6080	$ 544	$ 55,936	$ 544	$ 55,936	10287%	10187%
9. Completion and Disengagement (Breakaway)	32160	32160	$ 5,155	$ 295,872	$ 5,155	$ 295,872	5739%	5639%
Total	164160	196320	$ 73,098	$ 1,510,272	$ 73,098	$ 1,510,272	2066%	1966%

Simulations

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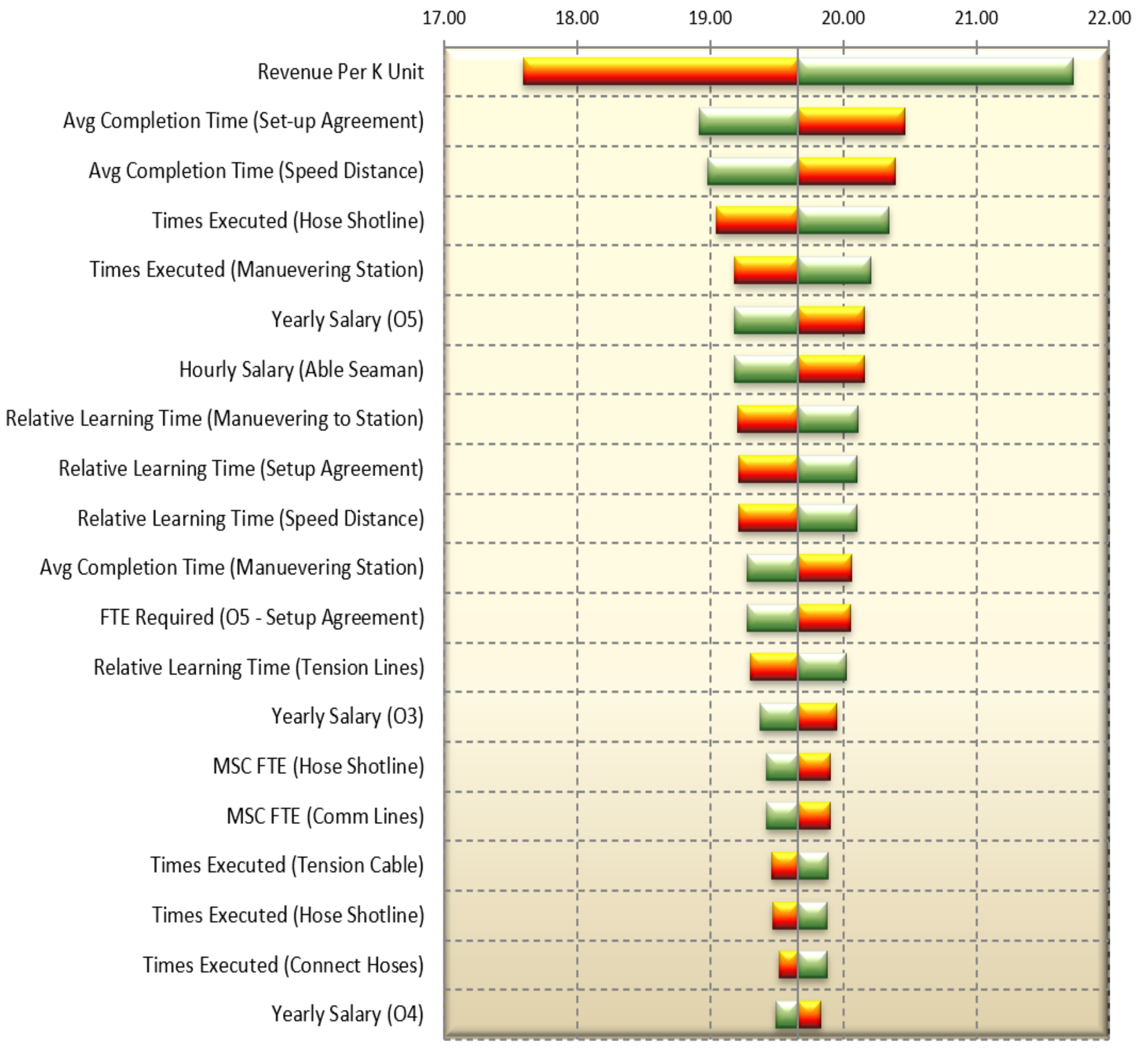
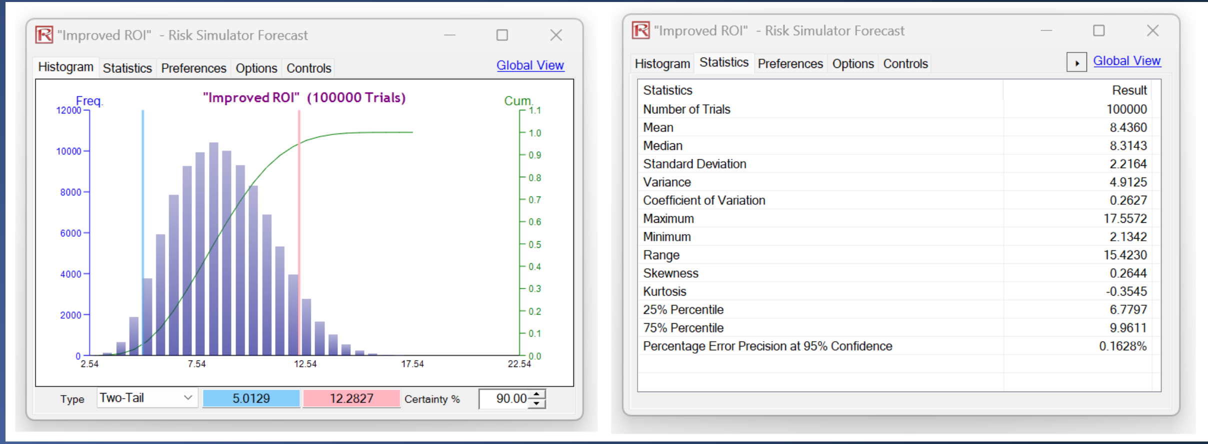
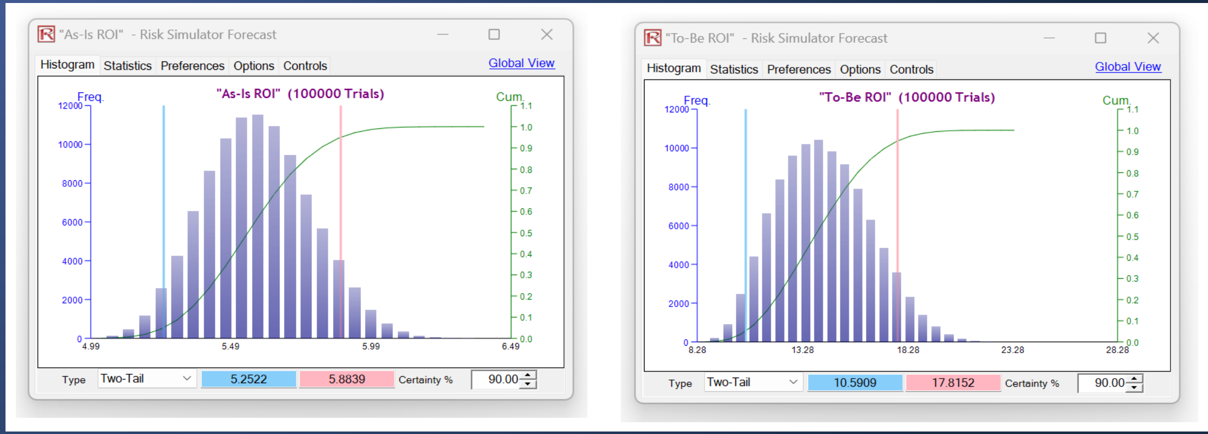


Tornado Static Sensitivity



Simulated Option Return on Investment for As-Is and To-Be



Simulated Option Return on Investment Increment

Conclusions and Pathways for Future Research

- Demonstrated the feasibility and strategic benefits of integrating advanced automation, AI, and uncrewed technologies in naval logistics operations.
- Identified significant potential for operational efficiency gains, cost reductions, and enhanced safety through the proposed technological paths.
- Applied sophisticated analytical methods, including Monte Carlo simulations and risk management techniques such as KVA, to model and optimize logistics scenarios.

- **Technology Development**: Continued innovation in AI, robotics, and autonomous vessel technologies to further enhance capability and reliability.
- **Operational Integration**: Studies on the seamless integration of automated and uncrewed systems into existing naval logistics frameworks, focusing on interoperability and human-machine teaming.
- **Strategic Impact Assessment**: Evaluation of the long-term strategic implications of advanced logistics automation on global naval operations and maritime security.
- **Resilience and Adaptability**: Research into enhancing the resilience of automated logistics systems against cyber and physical threats, ensuring operational continuity under adverse conditions.

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