

Creating the benchmark job list...  
75 total simulation jobs created.  
Parallel pool already running.

Starting parallel execution of all jobs...

Starting: [Scenario\_1\_Low\_Complexity] - [GA\_BOA] - Run 1  
Starting: [Scenario\_1\_Low\_Complexity] - [GA\_BOA] - Run 5  
Starting: [Scenario\_1\_Low\_Complexity] - [GA\_BOA] - Run 2  
Starting: [Scenario\_1\_Low\_Complexity] - [GA\_PSO] - Run 2  
Starting: [Scenario\_1\_Low\_Complexity] - [ACO\_BSO] - Run 2  
Starting: [Scenario\_1\_Low\_Complexity] - [GA\_BOA] - Run 3  
Starting: [Scenario\_1\_Low\_Complexity] - [GA\_PSO] - Run 4  
Starting: [Scenario\_1\_Low\_Complexity] - [ACO\_BSO] - Run 1  
Starting: [Scenario\_1\_Low\_Complexity] - [GA\_BOA] - Run 4  
Starting: [Scenario\_1\_Low\_Complexity] - [GA\_PSO] - Run 1  
Starting: [Scenario\_1\_Low\_Complexity] - [GA\_PSO] - Run 3  
Starting: [Scenario\_1\_Low\_Complexity] - [GA\_PSO] - Run 5  
Finished: [Scenario\_1\_Low\_Complexity] - [ACO\_BSO] - Run 1 | Cost: 1074.17  
Starting: [Scenario\_2\_Medium\_Complexity] - [ACO\_CMAES] - Run 3  
Finished: [Scenario\_1\_Low\_Complexity] - [ACO\_BSO] - Run 2 | Cost: 68.88  
Starting: [Scenario\_2\_Medium\_Complexity] - [ALNS\_PSO] - Run 5  
Finished: [Scenario\_1\_Low\_Complexity] - [GA\_BOA] - Run 3 | Cost: 72.16  
Starting: [Scenario\_1\_Low\_Complexity] - [ACO\_CMAES] - Run 1  
Finished: [Scenario\_2\_Medium\_Complexity] - [ALNS\_PSO] - Run 5 | Cost: 77.66  
Starting: [Scenario\_2\_Medium\_Complexity] - [ALNS\_PSO] - Run 4  
Finished: [Scenario\_1\_Low\_Complexity] - [GA\_PSO] - Run 3 | Cost: 71.66  
Starting: [Scenario\_2\_Medium\_Complexity] - [ACO\_BSO] - Run 1  
Finished: [Scenario\_1\_Low\_Complexity] - [GA\_PSO] - Run 5 | Cost: 65.12  
Starting: [Scenario\_2\_Medium\_Complexity] - [ALNS\_PSO] - Run 2  
Finished: [Scenario\_1\_Low\_Complexity] - [GA\_BOA] - Run 5 | Cost: 66.37  
Starting: [Scenario\_2\_Medium\_Complexity] - [GA\_BOA] - Run 2  
Finished: [Scenario\_1\_Low\_Complexity] - [GA\_BOA] - Run 4 | Cost: 71.91  
Starting: [Scenario\_1\_Low\_Complexity] - [ACO\_CMAES] - Run 4  
Finished: [Scenario\_1\_Low\_Complexity] - [GA\_PSO] - Run 1 | Cost: 2077.48  
Starting: [Scenario\_2\_Medium\_Complexity] - [GA\_BOA] - Run 5  
Finished: [Scenario\_1\_Low\_Complexity] - [GA\_PSO] - Run 4 | Cost: 70.23  
Starting: [Scenario\_2\_Medium\_Complexity] - [ACO\_BSO] - Run 4  
Finished: [Scenario\_1\_Low\_Complexity] - [GA\_BOA] - Run 1 | Cost: 1073.76  
Starting: [Scenario\_1\_Low\_Complexity] - [ACO\_BSO] - Run 5  
Finished: [Scenario\_2\_Medium\_Complexity] - [ACO\_CMAES] - Run 3 | Cost: 1069.62  
Starting: [Scenario\_2\_Medium\_Complexity] - [ACO\_CMAES] - Run 2  
Finished: [Scenario\_1\_Low\_Complexity] - [GA\_BOA] - Run 2 | Cost: 68.38  
Starting: [Scenario\_1\_Low\_Complexity] - [ALNS\_PSO] - Run 3  
Finished: [Scenario\_2\_Medium\_Complexity] - [ALNS\_PSO] - Run 4 | Cost: 66.09  
Starting: [Scenario\_2\_Medium\_Complexity] - [ALNS\_PSO] - Run 3  
Finished: [Scenario\_2\_Medium\_Complexity] - [ALNS\_PSO] - Run 2 | Cost: 70.40  
Starting: [Scenario\_2\_Medium\_Complexity] - [ALNS\_PSO] - Run 1  
Finished: [Scenario\_1\_Low\_Complexity] - [GA\_PSO] - Run 2 | Cost: 77.93  
Starting: [Scenario\_2\_Medium\_Complexity] - [GA\_PSO] - Run 3  
Finished: [Scenario\_1\_Low\_Complexity] - [ACO\_CMAES] - Run 4 | Cost: 67.89  
Starting: [Scenario\_1\_Low\_Complexity] - [ACO\_CMAES] - Run 3  
Finished: [Scenario\_1\_Low\_Complexity] - [ACO\_CMAES] - Run 1 | Cost: 1074.96  
Starting: [Scenario\_1\_Low\_Complexity] - [ALNS\_PSO] - Run 5  
Finished: [Scenario\_1\_Low\_Complexity] - [ALNS\_PSO] - Run 3 | Cost: 72.57  
Starting: [Scenario\_1\_Low\_Complexity] - [ALNS\_PSO] - Run 2

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Finished: [Scenario_2_Medium_Complexity] - [ACO_BSO] - Run 4 | Cost: 66.11
Starting: [Scenario_2_Medium_Complexity] - [ACO_BSO] - Run 3
Finished: [Scenario_2_Medium_Complexity] - [ALNS_PSO] - Run 3 | Cost: 82.64
Starting: [Scenario_2_Medium_Complexity] - [ACO_CMAES] - Run 5
Finished: [Scenario_2_Medium_Complexity] - [ALNS_PSO] - Run 1 | Cost: 90.94
Starting: [Scenario_2_Medium_Complexity] - [ACO_BSO] - Run 5
Finished: [Scenario_2_Medium_Complexity] - [ACO_BSO] - Run 1 | Cost: 86.24
Starting: [Scenario_2_Medium_Complexity] - [GA_PSO] - Run 5
Finished: [Scenario_1_Low_Complexity] - [ACO_BSO] - Run 5 | Cost: 69.13
Starting: [Scenario_1_Low_Complexity] - [ACO_BSO] - Run 4
Finished: [Scenario_2_Medium_Complexity] - [ACO_CMAES] - Run 2 | Cost: 61.75
Starting: [Scenario_2_Medium_Complexity] - [ACO_CMAES] - Run 1
Finished: [Scenario_1_Low_Complexity] - [ALNS_PSO] - Run 5 | Cost: 71.29
Starting: [Scenario_1_Low_Complexity] - [ALNS_PSO] - Run 4
Finished: [Scenario_1_Low_Complexity] - [ALNS_PSO] - Run 2 | Cost: 77.65
Starting: [Scenario_1_Low_Complexity] - [ALNS_PSO] - Run 1
Finished: [Scenario_1_Low_Complexity] - [ACO_CMAES] - Run 3 | Cost: 66.39
Starting: [Scenario_1_Low_Complexity] - [ACO_CMAES] - Run 2
Finished: [Scenario_1_Low_Complexity] - [ALNS_PSO] - Run 4 | Cost: 80.19
Starting: [Scenario_3_High_Complexity] - [GA_BOA] - Run 1
Finished: [Scenario_2_Medium_Complexity] - [GA_BOA] - Run 2 | Cost: 71.95
Starting: [Scenario_2_Medium_Complexity] - [GA_BOA] - Run 1
Finished: [Scenario_2_Medium_Complexity] - [GA_PSO] - Run 3 | Cost: 69.41
Starting: [Scenario_2_Medium_Complexity] - [GA_PSO] - Run 2
Finished: [Scenario_1_Low_Complexity] - [ALNS_PSO] - Run 1 | Cost: 1073.35
Starting: [Scenario_3_High_Complexity] - [GA_PSO] - Run 4
Finished: [Scenario_2_Medium_Complexity] - [ACO_BSO] - Run 3 | Cost: 1068.15
Starting: [Scenario_2_Medium_Complexity] - [ACO_BSO] - Run 2
WARNING: No viable solution found.
Finished: [Scenario_2_Medium_Complexity] - [ACO_CMAES] - Run 5 | Cost: Inf
Starting: [Scenario_3_High_Complexity] - [ACO_BSO] - Run 1
Finished: [Scenario_1_Low_Complexity] - [ACO_BSO] - Run 4 | Cost: 77.40
Starting: [Scenario_1_Low_Complexity] - [ACO_BSO] - Run 3
WARNING: No viable solution found.
Finished: [Scenario_2_Medium_Complexity] - [ACO_BSO] - Run 5 | Cost: Inf
Starting: [Scenario_3_High_Complexity] - [GA_BOA] - Run 3
Finished: [Scenario_2_Medium_Complexity] - [ACO_CMAES] - Run 1 | Cost: 82.77
Starting: [Scenario_2_Medium_Complexity] - [ACO_CMAES] - Run 4
WARNING: No viable solution found.
Finished: [Scenario_2_Medium_Complexity] - [GA_BOA] - Run 5 | Cost: Inf
Starting: [Scenario_2_Medium_Complexity] - [GA_BOA] - Run 4
Finished: [Scenario_1_Low_Complexity] - [ACO_CMAES] - Run 2 | Cost: 1065.03
Starting: [Scenario_3_High_Complexity] - [GA_BOA] - Run 5
Finished: [Scenario_2_Medium_Complexity] - [ACO_BSO] - Run 2 | Cost: 61.01
Starting: [Scenario_3_High_Complexity] - [GA_PSO] - Run 2
Finished: [Scenario_1_Low_Complexity] - [ACO_BSO] - Run 3 | Cost: 68.60
Starting: [Scenario_3_High_Complexity] - [GA_PSO] - Run 3
Finished: [Scenario_2_Medium_Complexity] - [ACO_CMAES] - Run 4 | Cost: 65.20
Starting: [Scenario_3_High_Complexity] - [ALNS_PSO] - Run 1
Finished: [Scenario_3_High_Complexity] - [ACO_BSO] - Run 1 | Cost: 68.42
Starting: [Scenario_3_High_Complexity] - [ACO_BSO] - Run 4
Finished: [Scenario_3_High_Complexity] - [GA_BOA] - Run 1 | Cost: 81.12
Starting: [Scenario_3_High_Complexity] - [ACO_BSO] - Run 2
Finished: [Scenario_3_High_Complexity] - [ALNS_PSO] - Run 1 | Cost: 82.02
Starting: [Scenario_3_High_Complexity] - [ALNS_PSO] - Run 5
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Finished: [Scenario_3_High_Complexity] - [GA_BOA] - Run 3 | Cost: 1068.66
Starting: [Scenario_3_High_Complexity] - [ACO_BSO] - Run 5
WARNING: No viable solution found.
Finished: [Scenario_2_Medium_Complexity] - [GA_PSO] - Run 5 | Cost: Inf
Starting: [Scenario_2_Medium_Complexity] - [GA_PSO] - Run 4
Finished: [Scenario_2_Medium_Complexity] - [GA_PSO] - Run 2 | Cost: 77.34
Starting: [Scenario_2_Medium_Complexity] - [GA_PSO] - Run 1
WARNING: No viable solution found.
Finished: [Scenario_3_High_Complexity] - [ACO_BSO] - Run 4 | Cost: Inf
Starting: [Scenario_3_High_Complexity] - [ACO_CMAES] - Run 1
Finished: [Scenario_3_High_Complexity] - [ALNS_PSO] - Run 5 | Cost: 1067.46
Starting: [Scenario_3_High_Complexity] - [ACO_CMAES] - Run 3
Finished: [Scenario_2_Medium_Complexity] - [GA_BOA] - Run 4 | Cost: 62.25
Starting: [Scenario_2_Medium_Complexity] - [GA_BOA] - Run 3
Finished: [Scenario_2_Medium_Complexity] - [GA_BOA] - Run 1 | Cost: 73.32
Starting: [Scenario_1_Low_Complexity] - [ACO_CMAES] - Run 5
Finished: [Scenario_3_High_Complexity] - [GA_BOA] - Run 5 | Cost: 61.80
Starting: [Scenario_3_High_Complexity] - [ALNS_PSO] - Run 2
Finished: [Scenario_3_High_Complexity] - [ACO_BSO] - Run 2 | Cost: 74.96
Starting: [Scenario_3_High_Complexity] - [ACO_CMAES] - Run 2
Finished: [Scenario_3_High_Complexity] - [GA_PSO] - Run 2 | Cost: 66.08
Starting: [Scenario_3_High_Complexity] - [ALNS_PSO] - Run 3
WARNING: No viable solution found.
Finished: [Scenario_3_High_Complexity] - [GA_PSO] - Run 4 | Cost: Inf
Starting: [Scenario_3_High_Complexity] - [ACO_BSO] - Run 3
Finished: [Scenario_3_High_Complexity] - [GA_PSO] - Run 3 | Cost: 4069.97
Starting: [Scenario_3_High_Complexity] - [ALNS_PSO] - Run 4
Finished: [Scenario_3_High_Complexity] - [ACO_BSO] - Run 5 | Cost: 1064.04
Starting: [Scenario_3_High_Complexity] - [ACO_CMAES] - Run 4
Finished: [Scenario_3_High_Complexity] - [ALNS_PSO] - Run 2 | Cost: 74.23
Finished: [Scenario_3_High_Complexity] - [ALNS_PSO] - Run 4 | Cost: Inf
Finished: [Scenario_3_High_Complexity] - [ACO_CMAES] - Run 1 | Cost: 69.91
Starting: [Scenario_3_High_Complexity] - [ACO_CMAES] - Run 5
Finished: [Scenario_3_High_Complexity] - [ALNS_PSO] - Run 3 | Cost: 1070.46
Finished: [Scenario_3_High_Complexity] - [ACO_CMAES] - Run 3 | Cost: 2058.34
Finished: [Scenario_2_Medium_Complexity] - [GA_PSO] - Run 4 | Cost: 65.34
Starting: [Scenario_3_High_Complexity] - [GA_BOA] - Run 2
Finished: [Scenario_3_High_Complexity] - [ACO_CMAES] - Run 2 | Cost: 68.44
Finished: [Scenario_1_Low_Complexity] - [ACO_CMAES] - Run 5 | Cost: 71.24
Starting: [Scenario_3_High_Complexity] - [GA_BOA] - Run 4
Finished: [Scenario_3_High_Complexity] - [ACO_BSO] - Run 3 | Cost: 5074.31
WARNING: No viable solution found.
Finished: [Scenario_3_High_Complexity] - [ACO_CMAES] - Run 4 | Cost: Inf
Finished: [Scenario_2_Medium_Complexity] - [GA_BOA] - Run 3 | Cost: 1064.14
Starting: [Scenario_3_High_Complexity] - [GA_PSO] - Run 1
Finished: [Scenario_3_High_Complexity] - [ACO_CMAES] - Run 5 | Cost: 1068.57
Finished: [Scenario_2_Medium_Complexity] - [GA_PSO] - Run 1 | Cost: 73.78
Starting: [Scenario_3_High_Complexity] - [GA_PSO] - Run 5
Finished: [Scenario_3_High_Complexity] - [GA_BOA] - Run 2 | Cost: 76.73
Finished: [Scenario_3_High_Complexity] - [GA_PSO] - Run 1 | Cost: 67.12
Finished: [Scenario_3_High_Complexity] - [GA_PSO] - Run 5 | Cost: 57.75
WARNING: No viable solution found.
Finished: [Scenario_3_High_Complexity] - [GA_BOA] - Run 4 | Cost: Inf

All parallel jobs complete.
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Generating final report...

Benchmark Summary Table

			Algorithm	Mean_Cost_USD	Std_Dev_Cost
Min_Cost_USD	Max_Cost_USD	Mean_Time_sec			
{'Scenario_1_Low_Complexity'}			{'GA_BOA'}	270.51	449.03
66.371	1073.8	6086.2			
{'Scenario_1_Low_Complexity'}			{'GA_PSO'}	472.49	897.23
65.124	2077.5	6171.1			
{'Scenario_1_Low_Complexity'}			{'ACO_BSO'}	271.63	448.65
68.596	1074.2	3626.6			
{'Scenario_1_Low_Complexity'}			{'ALNS_PSO'}	275.01	446.3
71.294	1073.3	1913.7			
{'Scenario_1_Low_Complexity'}			{'ACO_CMAES'}	469.1	548.55
66.387	1075	3360.8			
{'Scenario_2_Medium_Complexity'}			{'GA_BOA'}	Inf	NaN
62.249	Inf	6951.8			
{'Scenario_2_Medium_Complexity'}			{'GA_PSO'}	Inf	NaN
65.345	Inf	6631.8			
{'Scenario_2_Medium_Complexity'}			{'ACO_BSO'}	Inf	NaN
61.013	Inf	3609.7			
{'Scenario_2_Medium_Complexity'}			{'ALNS_PSO'}	77.548	9.8444
66.09	90.94	1960.4			
{'Scenario_2_Medium_Complexity'}			{'ACO_CMAES'}	Inf	NaN
61.747	Inf	3339.6			
{'Scenario_3_High_Complexity'}			{'GA_BOA'}	Inf	NaN
61.805	Inf	5492.5			
{'Scenario_3_High_Complexity'}			{'GA_PSO'}	Inf	NaN
57.752	Inf	5563.1			
{'Scenario_3_High_Complexity'}			{'ACO_BSO'}	Inf	NaN
68.418	Inf	3370.6			
{'Scenario_3_High_Complexity'}			{'ALNS_PSO'}	Inf	NaN
74.233	Inf	1735.1			
{'Scenario_3_High_Complexity'}			{'ACO_CMAES'}	Inf	NaN
68.443	Inf	2920.2			

Writing main summary table to: Benchmark\_Results\_Final\benchmark\_summary.csv

Performing statistical analysis and appending to CSV...

--- Friedman Test ---

Scenario	Friedman_p_value
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{'Scenario_1_Low_Complexity'}	0.72105
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--- Wilcoxon Signed-Rank Test (p-values) ---

	GA_BOA	GA_PSO	ACO_BSO	ALNS_PSO	ACO_CMAES
GA_BOA	NaN	0.8125	0.4375	0.125	0.8125
GA_PSO	0.8125	NaN	0.625	0.8125	1

ACO_BSO	0.4375	0.625	NaN	0.125	1
ALNS_PSO	0.125	0.8125	0.125	NaN	1
ACO_CMAES	0.8125	1	1	1	NaN

--- Friedman Test ---

Scenario	Friedman_p_value
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{'Scenario_2_Medium_Complexity'}	0.88536
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--- Wilcoxon Signed-Rank Test (p-values) ---

	GA_BOA	GA_PSO	ACO_BSO	ALNS_PSO	ACO_CMAES
GA_BOA	NaN	0.875	0.625	0.625	0.875
GA_PSO	0.875	NaN	0.625	1	0.875
ACO_BSO	0.625	0.625	NaN	0.625	0.875
ALNS_PSO	0.625	1	0.625	NaN	0.8125
ACO_CMAES	0.875	0.875	0.875	0.8125	NaN

--- Friedman Test ---

Scenario	Friedman_p_value
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{'Scenario_3_High_Complexity'}	0.49325
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--- Wilcoxon Signed-Rank Test (p-values) ---

	GA_BOA	GA_PSO	ACO_BSO	ALNS_PSO	ACO_CMAES
GA_BOA	NaN	0.875	0.625	0.625	0.625
GA_PSO	0.875	NaN	0.125	0.875	0.875
ACO_BSO	0.625	0.125	NaN	1	0.625
ALNS_PSO	0.625	0.875	1	NaN	1
ACO_CMAES	0.625	0.875	0.625	1	NaN

Statistical analysis complete and appended to CSV.

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Total Benchmark Execution Time: 515.19 minutes.  
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Parallel pool using the 'LocalProfile1' profile is shutting down.

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