

# Bookstore\_Experiment\_2

## Comparsion of controllers

### -Global planner: NavFn

Controller type	Trajectory type	Success rate (%)	Average execution time (sec)	CPU(%)		Memory usage(%)		Average number of recoveries	Average path length(m)	Min distance to obstacles(m)	Average Path Deviation
				Mean	Max	Mean	Max				
DWB	single_goal_0	86.67	125.34	19.21	27.3	9.88	10.1	3.13	21.54	0.12	2.23
DWB	waypoints_1	100.0	176.61	20.28	30.0	10.11	10.2	0.13	41.78	0.12	3.87
DWB	circle_2	100.0	40.46	17.85	25.5	10.06	10.1	0.47	7.34	0.12	0.84
DWB	square_3	40.0	218.99	19.23	27.3	10.11	10.2	10.00	34.58	0.12	13.58
RPP	single_goal_0	93.33	116.60	18.79	27.3	10.13	10.2	2.27	23.73	0.12	1.74
RPP	waypoints_1	100.0	171.43	19.75	27.4	10.19	10.3	0.00	40.88	0.12	3.25
RPP	circle_2	100.0	40.95	16.96	21.8	10.10	10.2	3.00	7.47	0.12	1.11
RPP	square_3	100.0	33.95	17.06	22.1	10.10	10.2	0.00	6.37	0.37	0.99
DWB_RSC	single_goal_0	100.0	128.67	20.43	29.0	10.19	10.3	1.73	25.42	0.12	1.74
DWB_RSC	waypoints_1	100.0	177.03	21.66	29.6	10.27	10.4	0.07	41.61	0.12	3.3
DWB_RSC	circle_2	100.0	39.93	19.06	26.2	10.20	10.3	0.33	7.38	0.12	0.86
DWB_RSC	square_3	73.33	85.43	20.15	29.0	10.24	10.4	4.20	8.47	0.12	2.27
RPP_RSC	single_goal_0	100.0	117.46	19.88	44.7	10.28	10.3	1.40	24.81	0.12	1.63
RPP_RSC	waypoints_1	100.0	173.69	20.31	27.3	10.35	10.4	0.00	41.52	0.12	3.41
RPP_RSC	circle_2	100.0	37.40	18.34	23.9	10.30	10.4	1.07	7.45	0.24	0.87
RPP_RSC	square_3	100.0	33.13	18.33	23.1	10.30	10.4	0.00	6.34	0.43	0.96
MPPI	single_goal_0	100.0	165.72	22.34	30.7	10.37	10.5	5.07	24.70	0.12	2.32
MPPI	waypoints_1	100.0	171.43	22.97	29.5	10.45	10.6	0.33	40.59	0.12	3.05
MPPI	circle_2	100.0	36.58	20.66	28.2	10.40	10.5	0.60	7.09	0.12	0.77
MPPI	square_3	100.0	62.91	21.61	30.0	10.40	10.5	2.33	9.26	0.12	1.43
Graceful	single_goal_0	100.0	133.87	21.07	29.2	10.43	10.6	0.53	24.23	0.13	1.52
Graceful	waypoints_1	100.0	205.40	21.60	35.0	10.73	10.9	0.00	41.80	0.12	3.01
Graceful	circle_2	100.0	44.97	19.31	26.3	10.70	10.7	0.27	7.67	0.15	1.31
Graceful	square_3	100.0	43.25	19.43	25.1	10.70	10.7	0.27	6.56	0.12	1.04

### -Global planner: smac\_planner

Controller type	Trajectory type	Success rate (%)	Average execution time (sec)	CPU(%)		Memory usage(%)		Average number of recoveries	Average path length(m)	Min distance to obstacles(m)	Average Path Deviation
				Mean	Max	Mean	Max				
DWB	single_goal_0	60.0	107.25	21.56	29.1	10.72	10.8	9.40	17.23	0.12	2.41
DWB	waypoints_1	100.0	181.41	21.78	29.1	10.78	10.9	0.27	42.81	0.12	3.89
DWB	circle_2	100.0	37.93	21.00	29.1	10.72	10.8	0.07	7.31	0.12	0.61
DWB	square_3	66.67	95.43	21.30	27.6	10.76	10.8	4.87	13.33	0.12	5.1
RPP	single_goal_0	86.67	112.28	20.97	28.1	10.80	10.9	4.33	22.18	0.12	1.61
RPP	waypoints_1	100.0	175.27	20.99	28.1	10.84	10.9	0.00	41.91	0.12	3.77
RPP	circle_2	100.0	36.18	20.22	27.0	10.80	10.9	0.67	7.43	0.24	0.71
RPP	square_3	100.0	33.35	20.33	44.8	10.80	10.8	0.00	6.36	0.43	0.9
DWB_RSC	single_goal_0	93.33	121.49	22.77	29.9	10.84	11.0	2.93	23.74	0.12	1.75
DWB_RSC	waypoints_1	100.0	178.50	22.84	30.1	10.89	11.0	0.20	42.11	0.13	3.35
DWB_RSC	circle_2	100.0	38.16	21.82	27.9	10.83	10.9	0.27	7.31	0.3	0.62
DWB_RSC	square_3	80.0	65.73	22.46	29.4	10.87	10.9	2.87	6.94	0.12	1.72
RPP_RSC	single_goal_0	93.33	126.54	21.44	27.3	10.90	11.0	4.40	24.89	0.12	1.87
RPP_RSC	waypoints_1	100.0	177.44	21.85	28.0	10.96	11.0	0.07	42.36	0.12	3.74
RPP_RSC	circle_2	100.0	35.49	21.09	28.6	10.90	11.0	0.40	7.43	0.14	0.67
RPP_RSC	square_3	100.0	32.83	20.92	26.2	10.90	11.0	0.00	6.35	0.44	0.91
MPPI	single_goal_0	100.0	124.27	24.68	33.8	10.98	11.1	1.80	24.55	0.12	1.84
MPPI	waypoints_1	100.0	167.98	24.17	30.9	11.03	11.1	0.00	41.40	0.12	3.43
MPPI	circle_2	100.0	34.84	23.65	29.8	11.00	11.0	0.33	7.14	0.12	0.77
MPPI	square_3	86.67	65.47	23.54	30.6	11.01	11.1	2.80	8.14	0.12	1.31
Graceful	single_goal_0	93.33	145.05	22.61	29.5	11.02	11.1	4.33	25.18	0.12	2.61
Graceful	waypoints_1	100.0	209.78	22.28	28.7	11.08	11.2	0.13	42.55	0.12	3.68
Graceful	circle_2	100.0	40.85	21.93	28.6	11.02	11.1	0.00	7.62	0.13	1.03
Graceful	square_3	100.0	37.80	21.76	27.2	11.04	11.1	0.00	6.47	0.12	0.7

### -Global planner: ThetaStar

Controller type	Trajectory type	Success rate (%)	Average execution time (sec)	CPU(%)		Memory usage(%)		Average number of recoveries	Average path length(m)	Min distance to obstacles(m)	Average Path Deviation
				Mean	Max	Mean	Max				
DWB	single_goal_0	53.33	102.05	23.74	31.2	11.08	11.2	14.47	17.79	0.12	2.64
DWB	waypoints_1	100.0	175.69	23.39	30.1	11.10	11.2	0.53	41.54	0.12	3.41
DWB	circle_2	100.0	38.69	23.10	31.8	11.09	11.1	0.27	7.35	0.12	0.54
DWB	square_3	93.33	44.98	23.13	28.4	11.10	11.2	1.07	8.02	0.13	1.43
RPP	single_goal_0	66.67	98.99	22.84	29.3	11.10	11.2	7.00	18.15	0.12	1.49
RPP	waypoints_1	100.0	177.43	22.22	28.0	11.15	11.2	1.73	41.67	0.12	3.59

RPP	circle_2	100.0	37.64	21.82	28.3	11.10	11.1	1.07	7.46	0.12	0.7
RPP	square_3	100.0	32.72	21.53	27.3	11.10	11.2	0.00	6.33	0.43	0.8
DWB_RSC	single_goal_0	100.0	129.08	23.95	30.9	11.16	11.2	2.73	24.60	0.12	1.84
DWB_RSC	waypoints_1	100.0	176.20	24.03	36.9	11.20	11.6	0.20	41.37	0.12	3.22
DWB_RSC	circle_2	100.0	39.51	23.20	30.7	11.19	11.2	0.40	7.35	0.12	0.56
DWB_RSC	square_3	73.33	90.48	23.10	29.6	11.20	11.3	4.80	8.73	0.12	2.44
RPP_RSC	single_goal_0	60.0	97.51	22.52	28.4	11.21	11.3	6.13	17.44	0.12	1.54
RPP_RSC	waypoints_1	100.0	175.91	22.68	35.0	11.29	11.8	1.07	41.55	0.12	3.54
RPP_RSC	circle_2	100.0	35.65	21.81	26.3	11.28	11.3	0.33	7.44	0.18	0.61
RPP_RSC	square_3	100.0	33.90	22.20	27.0	11.28	11.3	0.07	6.36	0.43	0.87
MPPI	single_goal_0	100.0	179.54	24.85	31.2	11.30	11.4	8.33	24.37	0.12	2.28
MPPI	waypoints_1	100.0	168.76	24.83	31.8	11.34	11.5	0.33	41.12	0.12	2.95
MPPI	circle_2	100.0	36.56	23.79	30.7	11.30	11.4	0.60	7.11	0.12	0.72
MPPI	square_3	100.0	35.09	23.88	31.8	11.31	11.4	0.33	6.83	0.13	0.76
Graceful	single_goal_0	80.0	129.76	23.08	30.6	11.39	11.4	5.13	21.85	0.12	1.97
Graceful	waypoints_1	100.0	201.60	22.93	40.2	11.41	11.5	0.40	41.50	0.12	3.23
Graceful	circle_2	100.0	41.51	22.08	29.3	11.40	11.4	0.13	7.60	0.13	0.96
Graceful	square_3	100.0	40.84	22.03	27.2	11.39	11.4	0.13	6.60	0.13	0.72

### -Global planner: Lattice

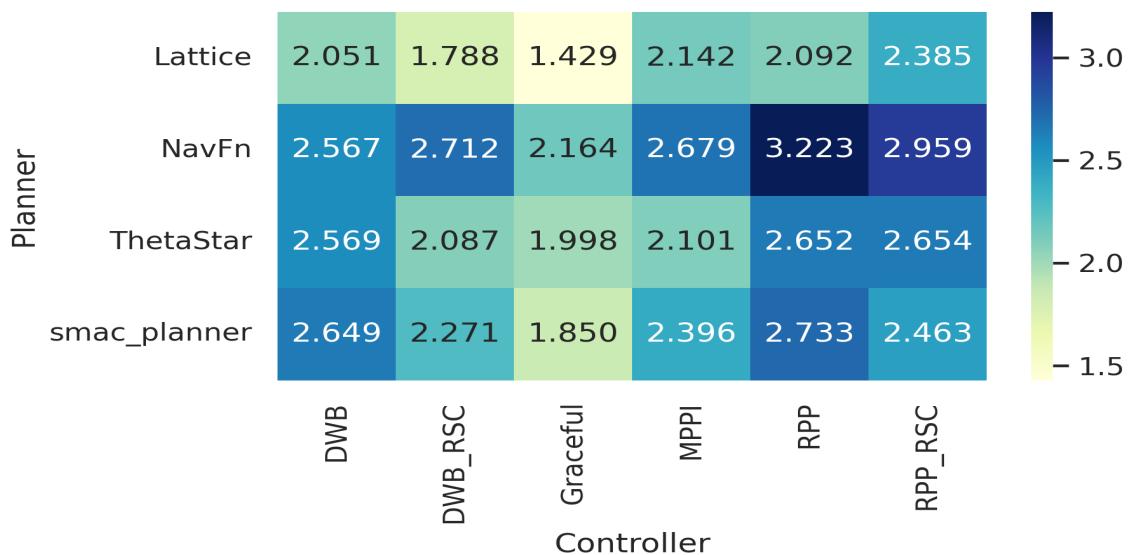
Controller type	Trajectory type	Success rate (%)	Average execution time (sec)	CPU(%)		Memory usage(%)		Average number of recoveries	Average path length(m)	Min distance to obstacles(m)	Average Path Deviation
				Mean	Max	Mean	Max				
DWB	single_goal_0	66.67	95.52	24.61	31.3	11.45	11.5	6.47	18.34	0.13	2.27
DWB	waypoints_1	93.33	186.85	24.29	31.7	11.50	11.6	1.27	42.99	0.12	4.41
DWB	circle_2	100.0	36.45	24.15	31.7	11.44	11.5	0.07	7.06	0.12	0.74
DWB	square_3	60.0	106.49	23.73	31.6	11.44	11.5	5.80	16.21	0.12	6.2
RPP	single_goal_0	86.67	124.83	23.34	29.5	11.51	11.6	5.00	23.81	0.12	2.05
RPP	waypoints_1	100.0	177.79	22.88	28.8	11.58	11.6	1.20	41.75	0.12	3.85
RPP	circle_2	100.0	36.85	22.21	26.7	11.50	11.6	0.53	7.66	0.12	0.74
RPP	square_3	100.0	34.17	22.21	28.8	11.50	11.6	0.00	6.62	0.47	0.89
DWB_RSC	single_goal_0	100.0	126.26	24.88	34.2	11.56	11.6	1.93	24.92	0.12	1.88
DWB_RSC	waypoints_1	86.67	189.35	24.08	31.3	11.64	11.7	2.87	40.74	0.12	4.38
DWB_RSC	circle_2	100.0	37.50	24.18	30.9	11.60	11.6	0.13	7.10	0.14	0.73
DWB_RSC	square_3	20.0	172.63	23.55	31.6	11.59	11.6	11.87	12.64	0.12	5.58
RPP_RSC	single_goal_0	100.0	105.23	23.39	30.3	11.62	11.7	1.07	22.95	0.12	1.58
RPP_RSC	waypoints_1	93.33	174.47	22.58	31.3	11.70	11.8	3.87	39.85	0.12	3.85
RPP_RSC	circle_2	100.0	35.65	22.06	26.4	11.69	11.7	0.00	7.61	0.13	0.72

RPP_RSC	square_3	100.0	34.05	22.49	28.5	11.69	11.7	0.00	6.58	0.47	0.94
MPPI	single_goal_0	100.0	142.67	25.69	33.5	11.71	11.8	4.20	23.38	0.12	2.19
MPPI	waypoints_1	100.0	167.17	24.89	31.0	11.76	11.8	0.07	40.81	0.12	3.53
MPPI	circle_2	100.0	37.61	23.81	32.1	11.72	11.8	0.80	7.13	0.12	0.72
MPPI	square_3	100.0	28.17	24.31	29.2	11.70	11.8	0.00	6.46	0.12	0.54
Graceful	single_goal_0	100.0	126.66	23.63	29.4	11.77	11.8	2.00	23.27	0.12	1.73
Graceful	waypoints_1	100.0	208.59	22.90	31.7	11.81	12.0	0.00	41.90	0.12	3.74
Graceful	circle_2	100.0	50.80	22.73	30.4	11.78	11.9	0.00	7.80	0.13	1.15
Graceful	square_3	100.0	47.49	22.63	43.6	11.77	11.8	0.00	6.74	0.13	1.19

## Performance analysis

Based on the criteria: Time, path\_length, CPU, Memory, Safety

The score of each controller and planner combinations are:



## Success rate

Planners' success rate are:

Planner: Lattice, Success Rate: 91.94%

Planner: ThetaStar, Success Rate: 92.78%

Planner: smac\_planner, Success Rate: 94.17%

Planner: NavFn, Success Rate: 95.56%

**Controllers' success rate are:**

Controller: Graceful, Success Rate: 98.33%

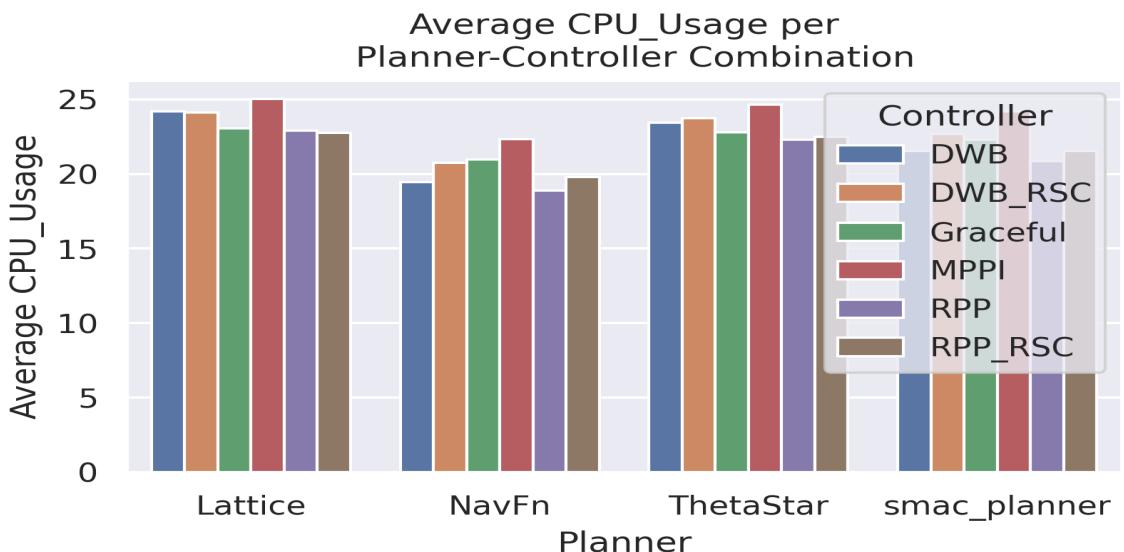
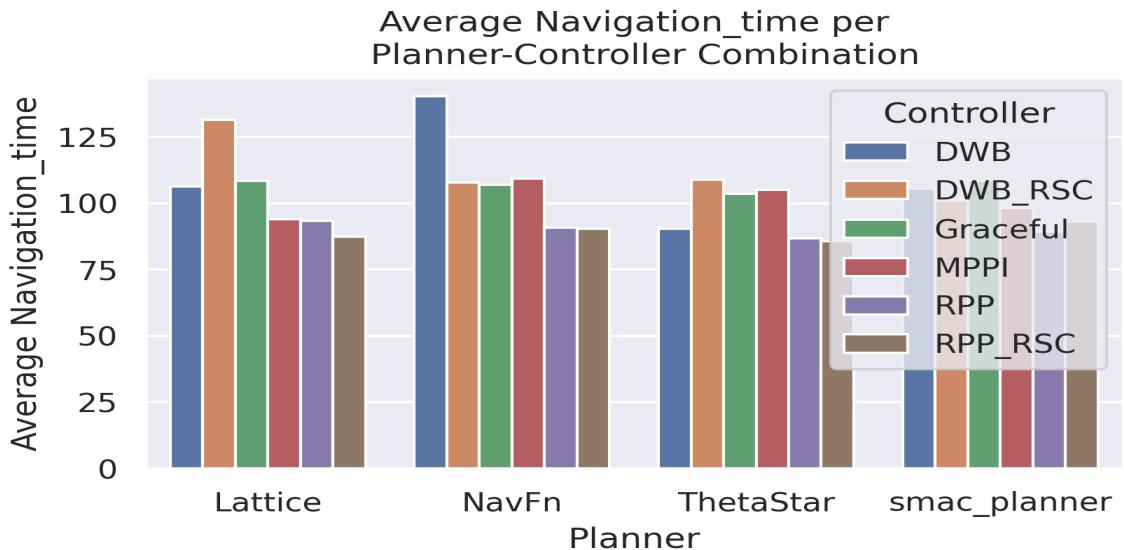
Controller: MPPI, Success Rate: 99.17%

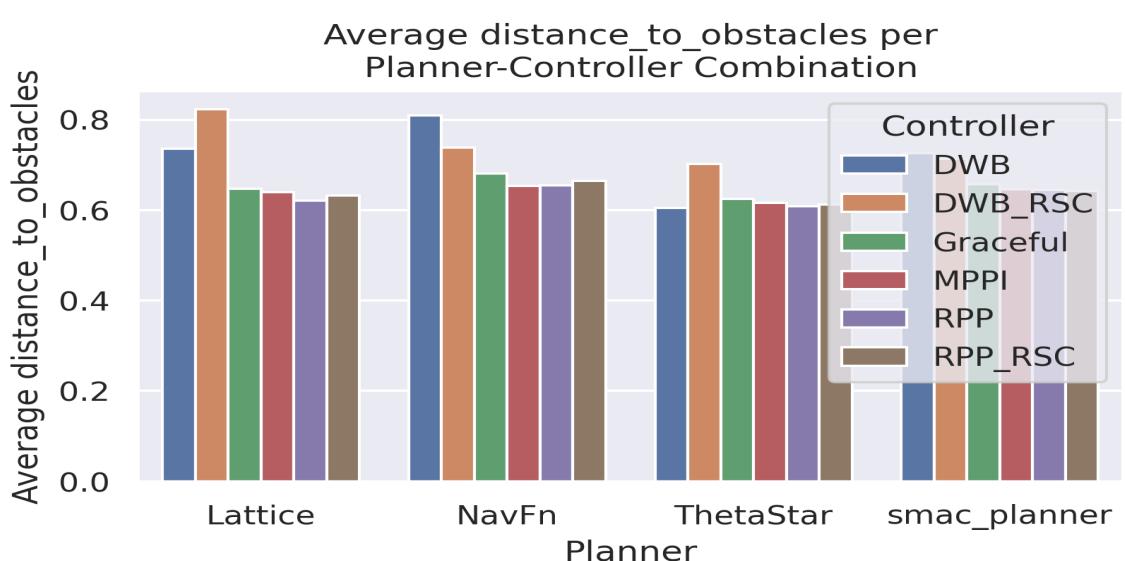
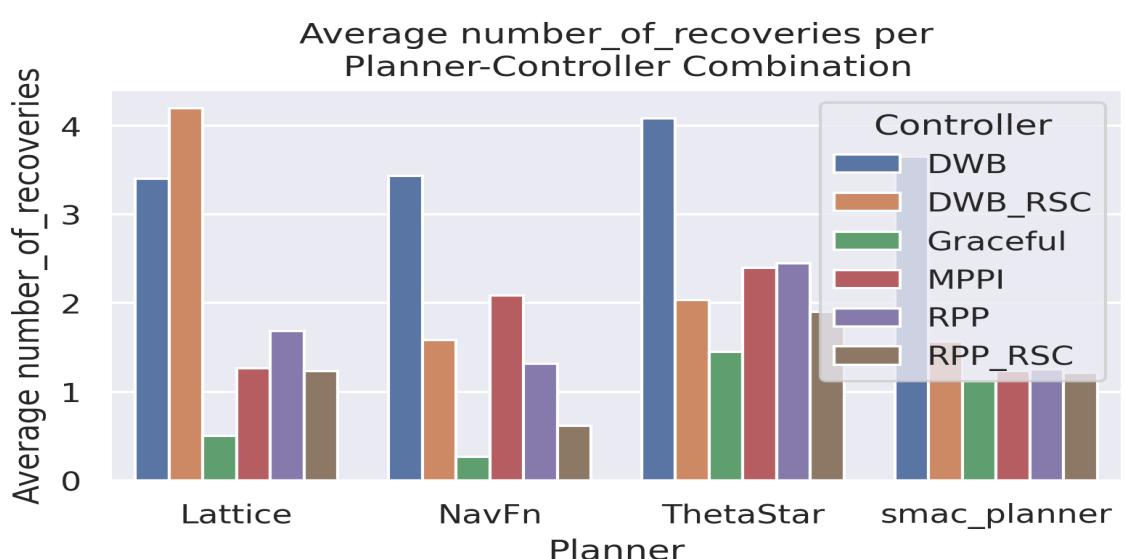
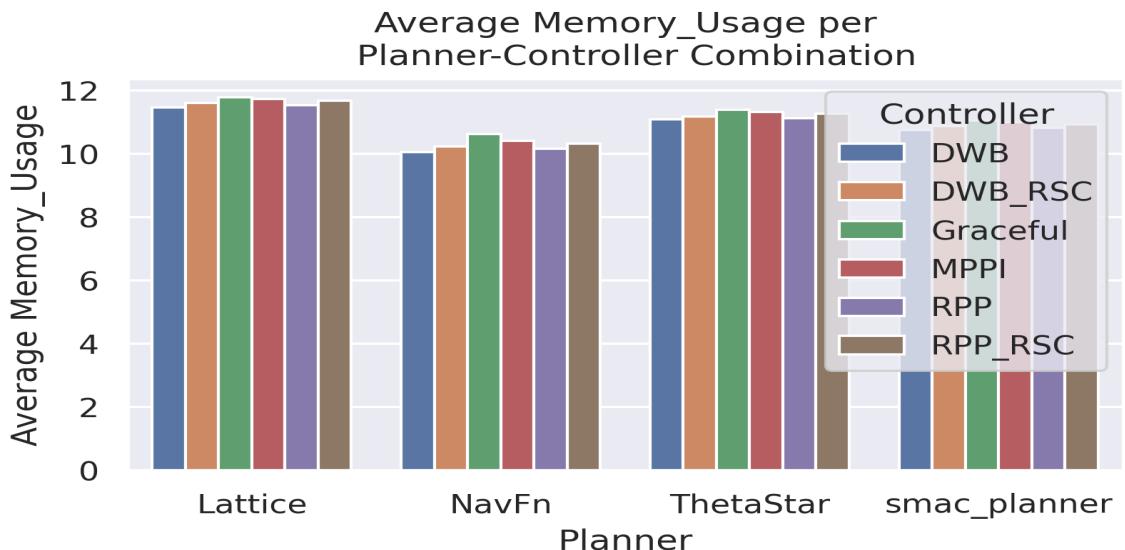
Controller: RPP\_RSC, Success Rate: 96.67%

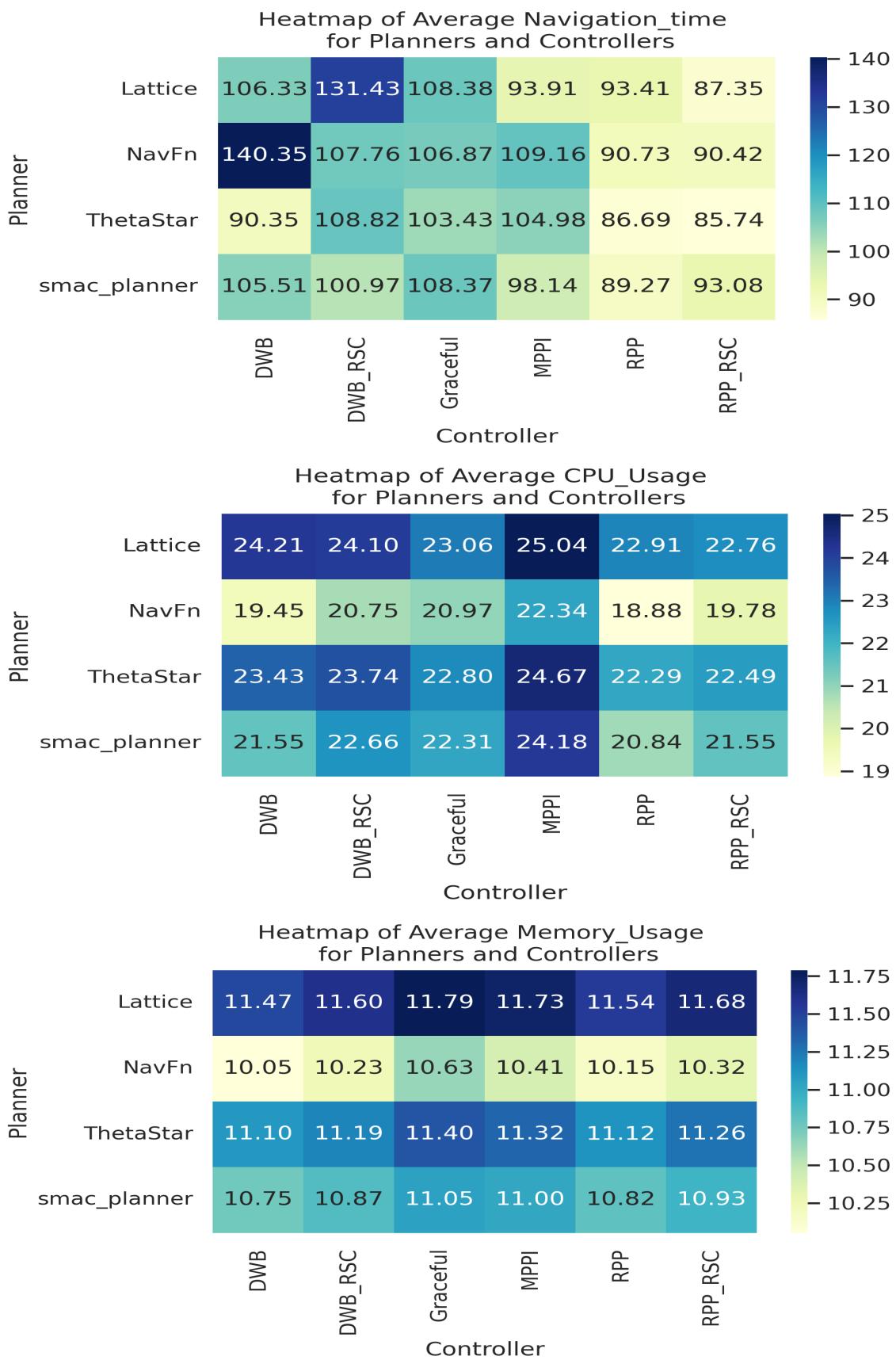
Controller: DWB\_RSC, Success Rate: 89.17%

Controller: RPP, Success Rate: 95.83%

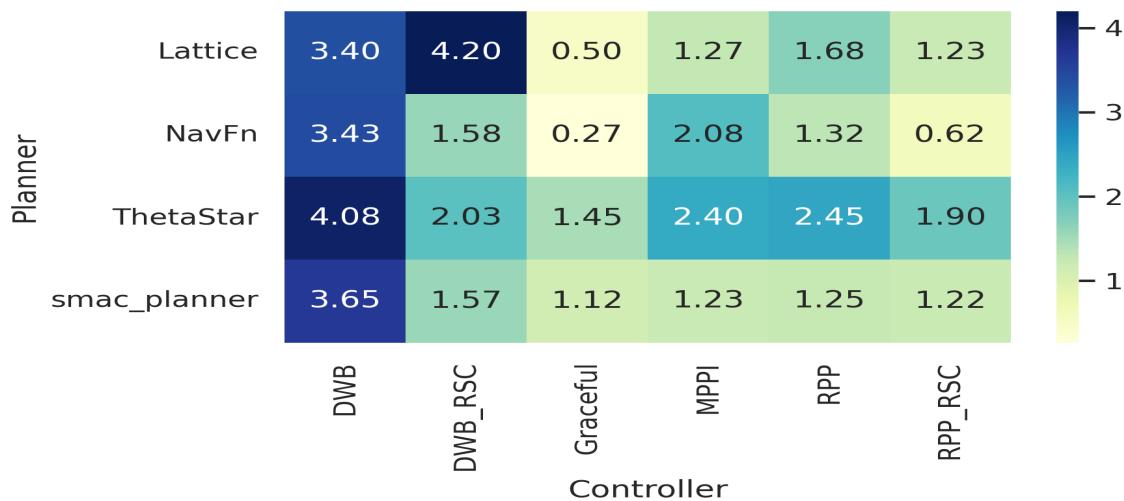
Controller: DWB, Success Rate: 82.50%



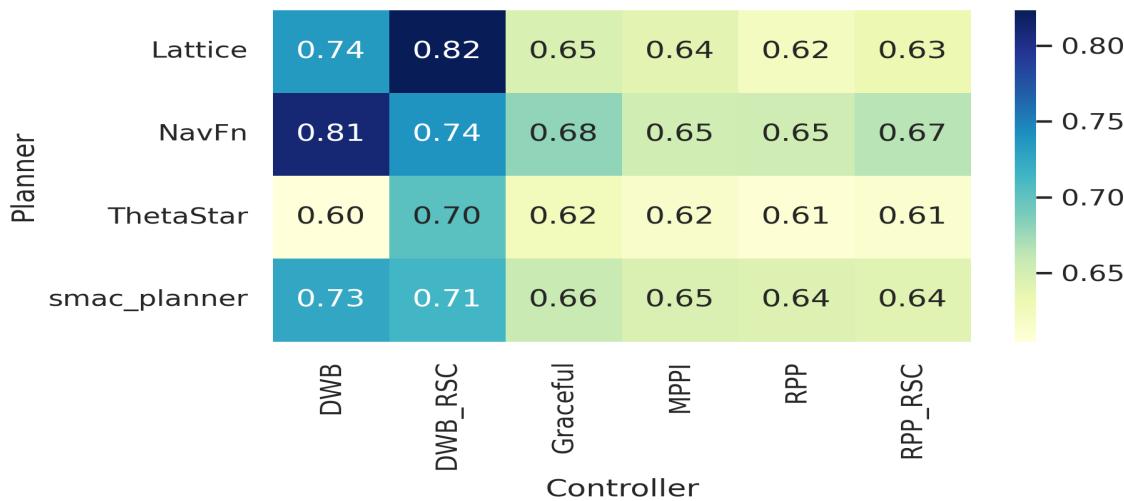




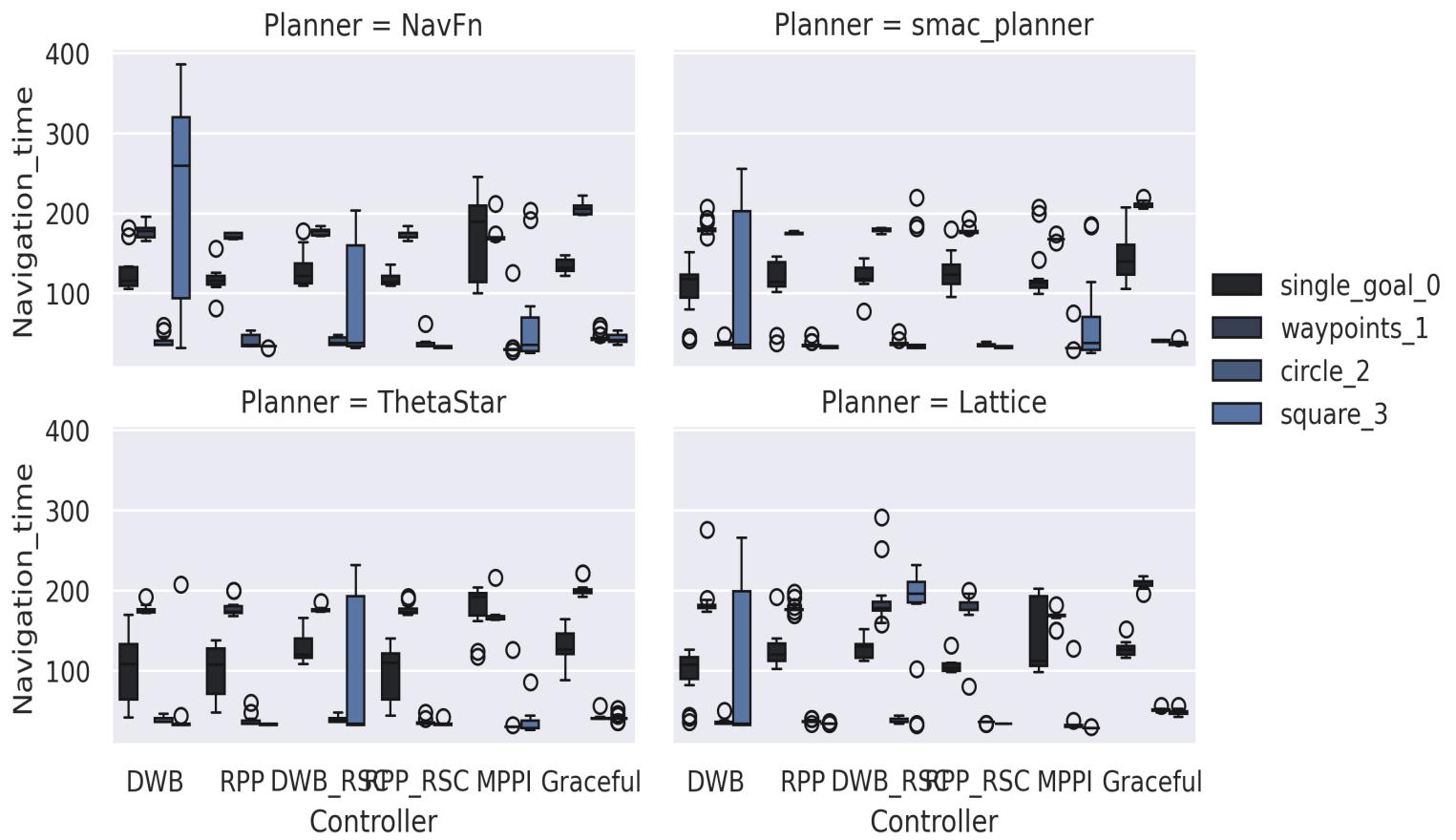
**Heatmap of Average number\_of\_recoveries  
for Planners and Controllers**



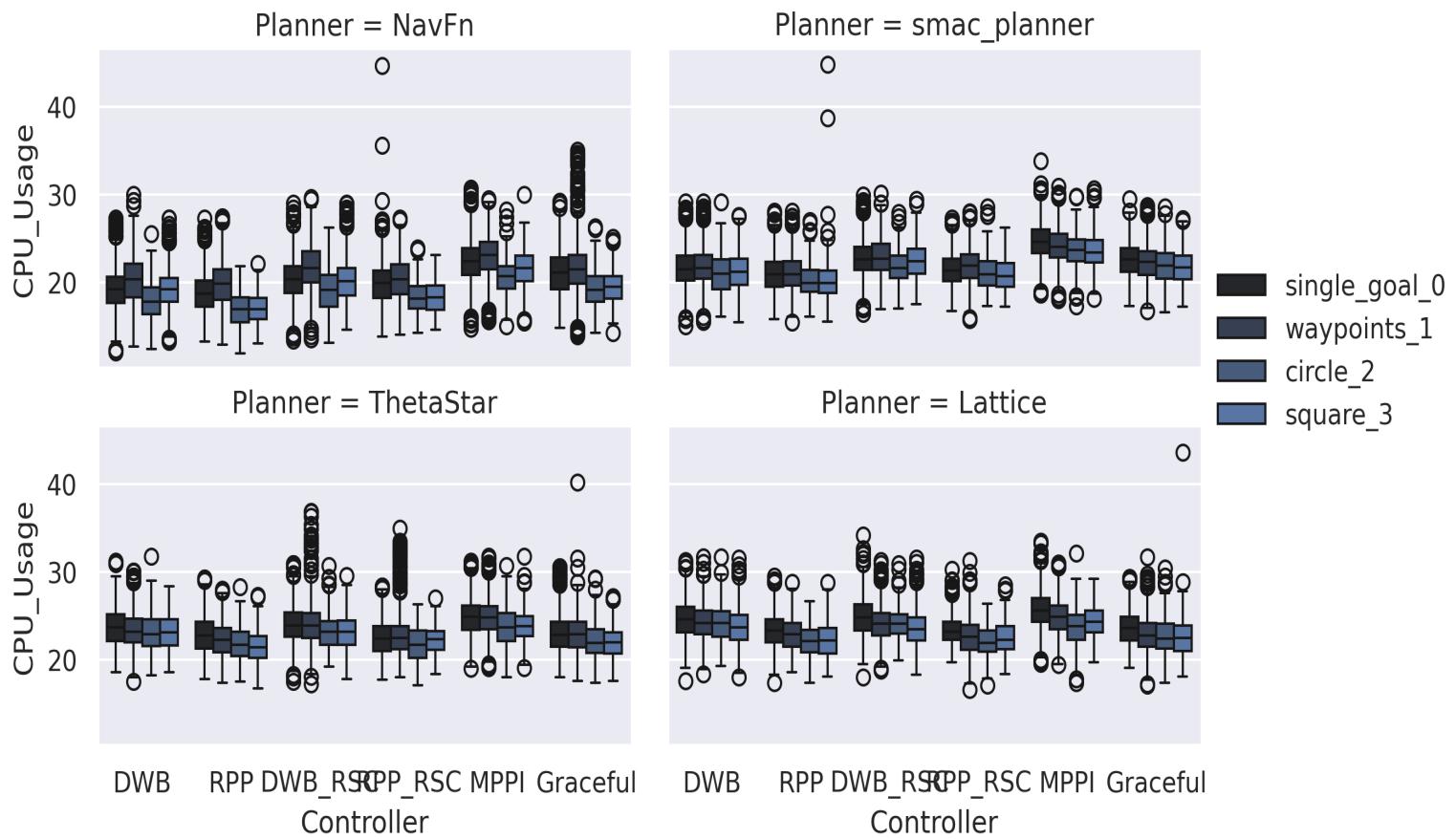
**Heatmap of Average distance\_to\_obstacles  
for Planners and Controllers**



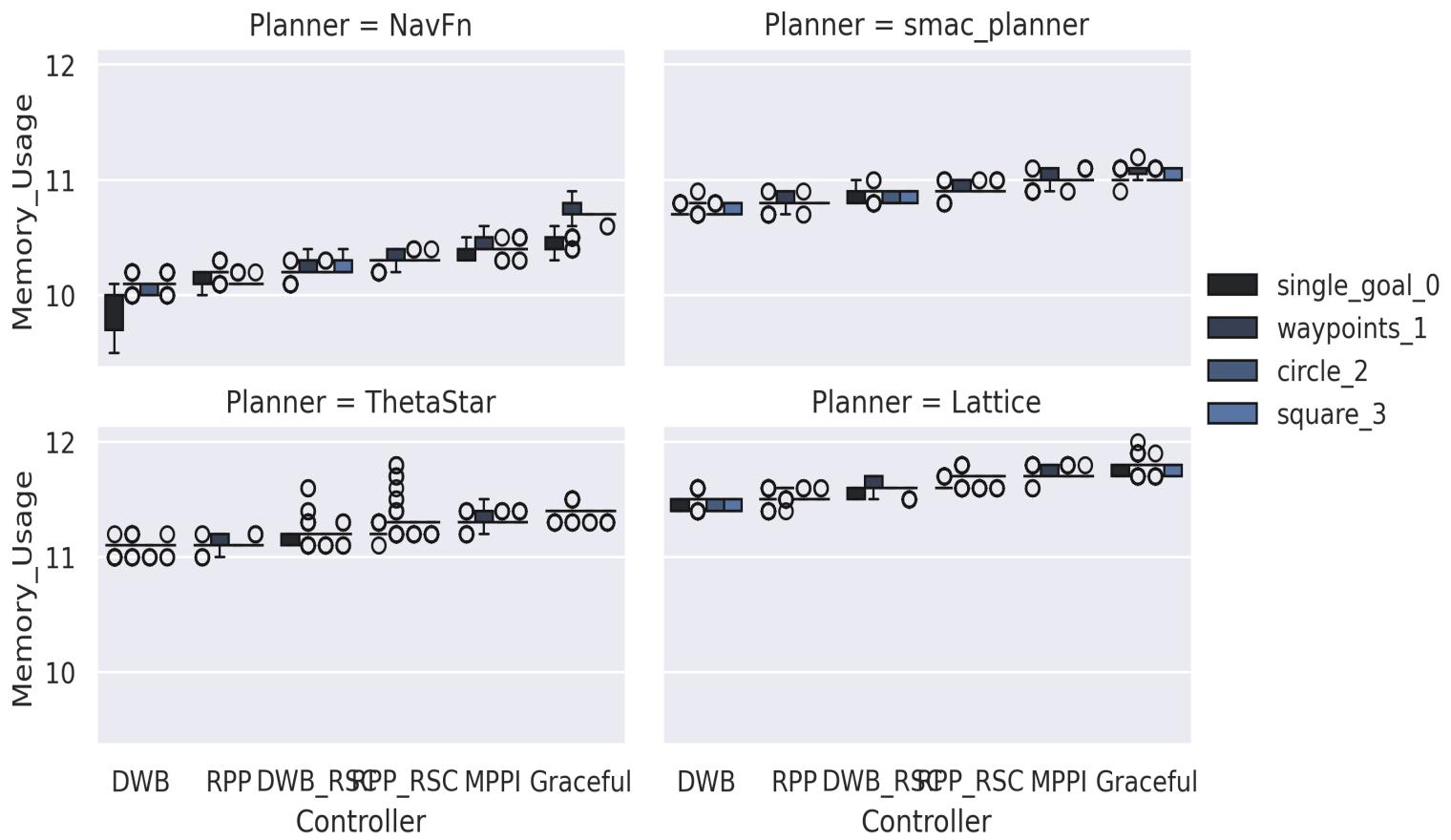
## Complex Distribution of Navigation\_time by Planner, Controller, and Trajectory Type



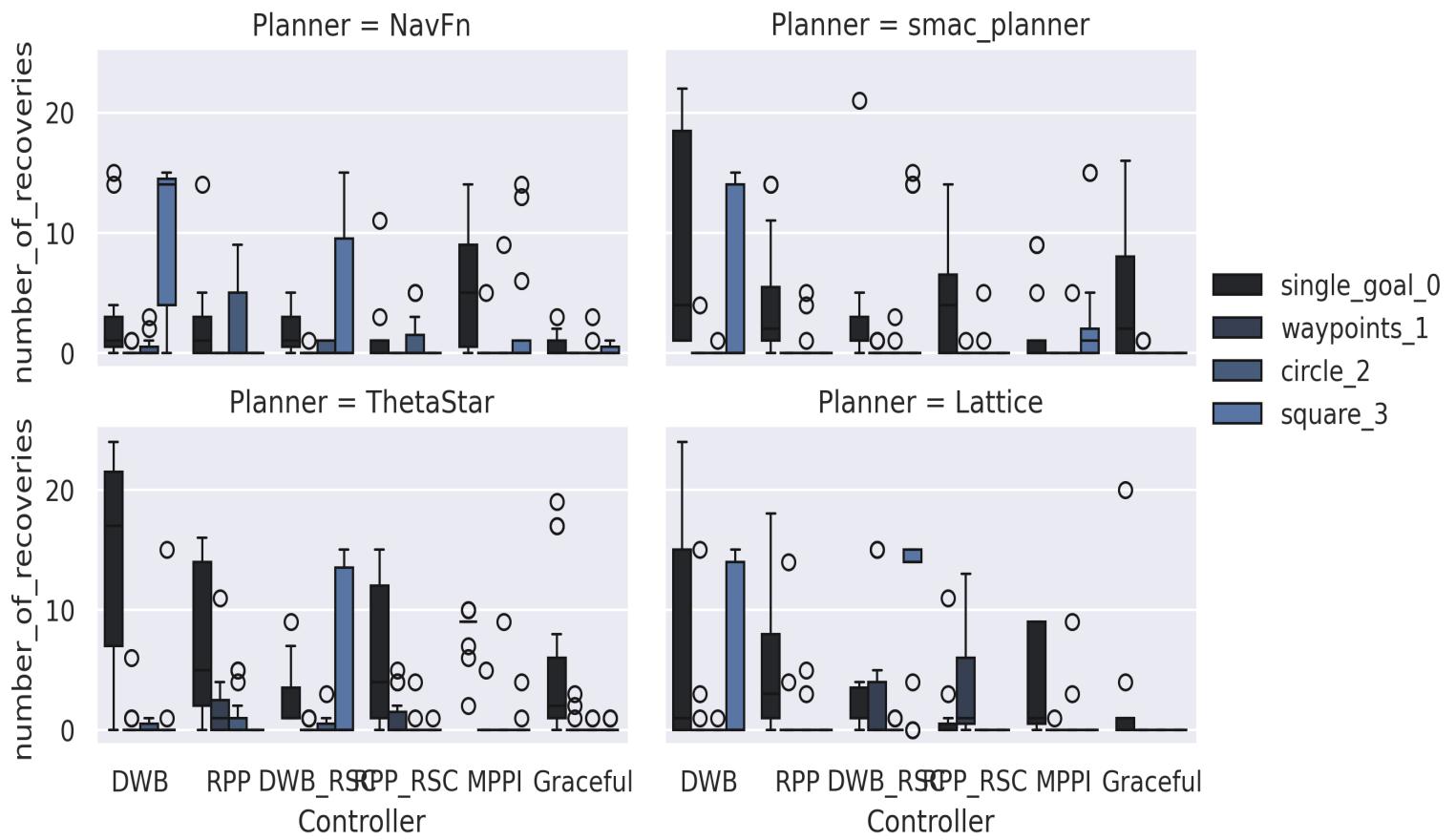
## Complex Distribution of CPU\_Usage by Planner, Controller, and Trajectory Type



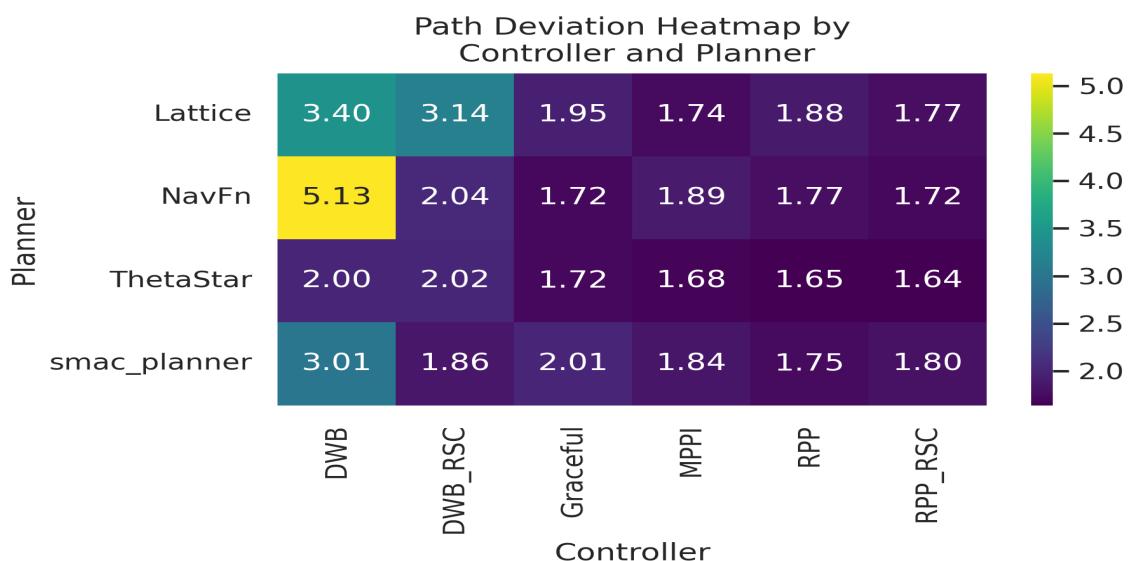
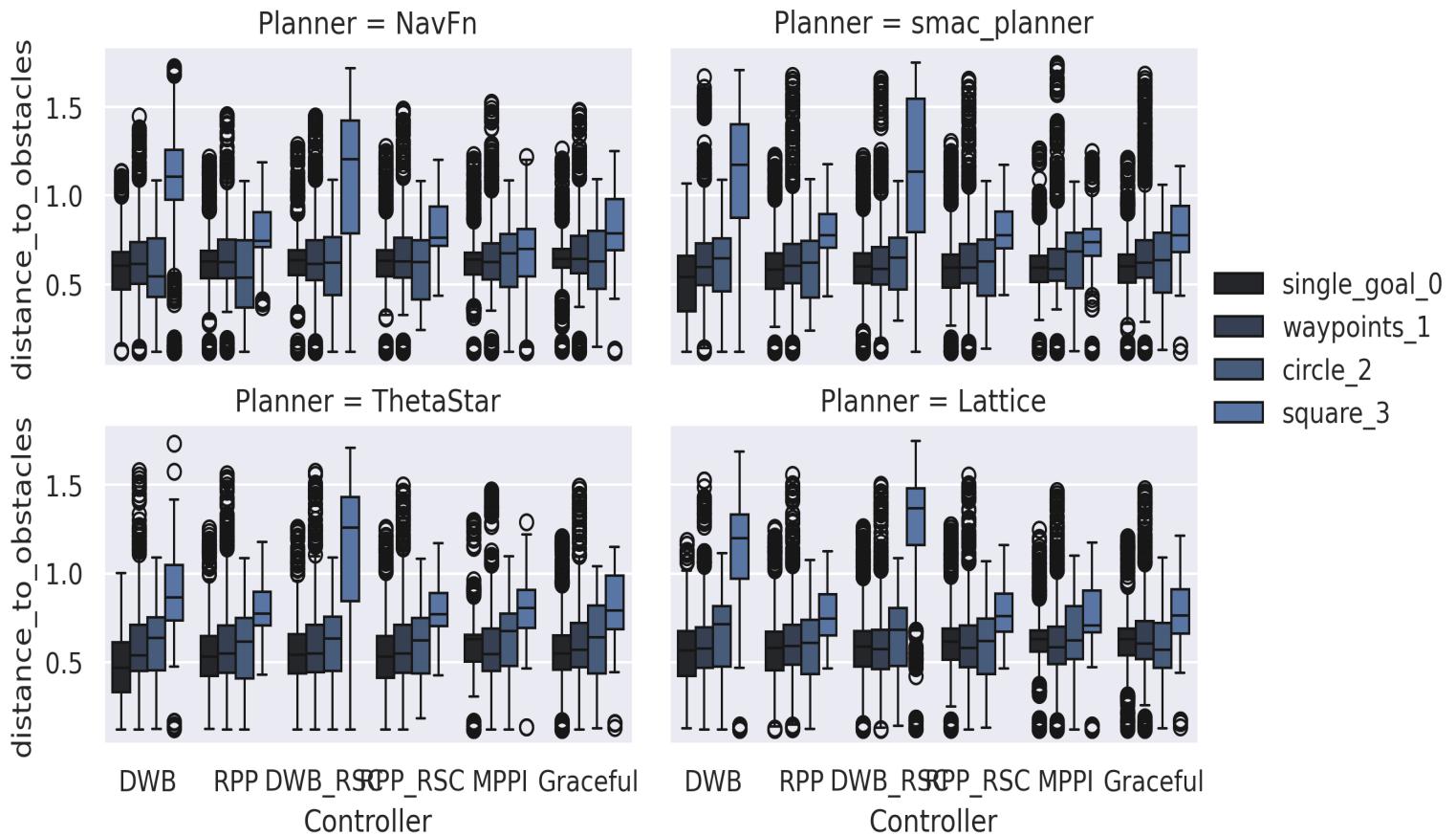
## Complex Distribution of Memory\_Usage by Planner, Controller, and Trajectory Type

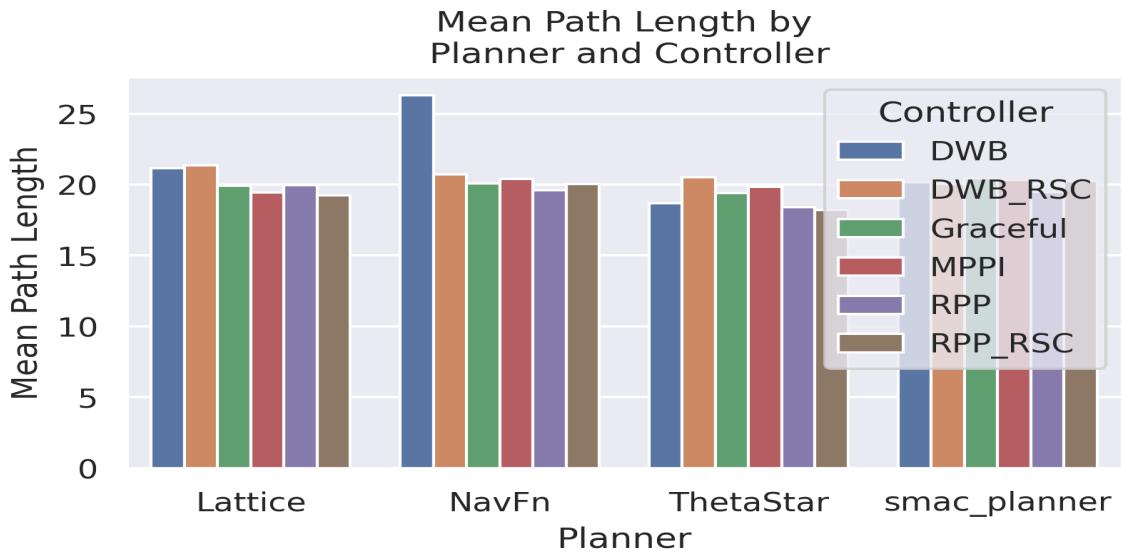


## Complex Distribution of number\_of\_recoveries by Planner, Controller, and Trajectory Type



## Complex Distribution of distance\_to\_obstacles by Planner, Controller, and Trajectory Type





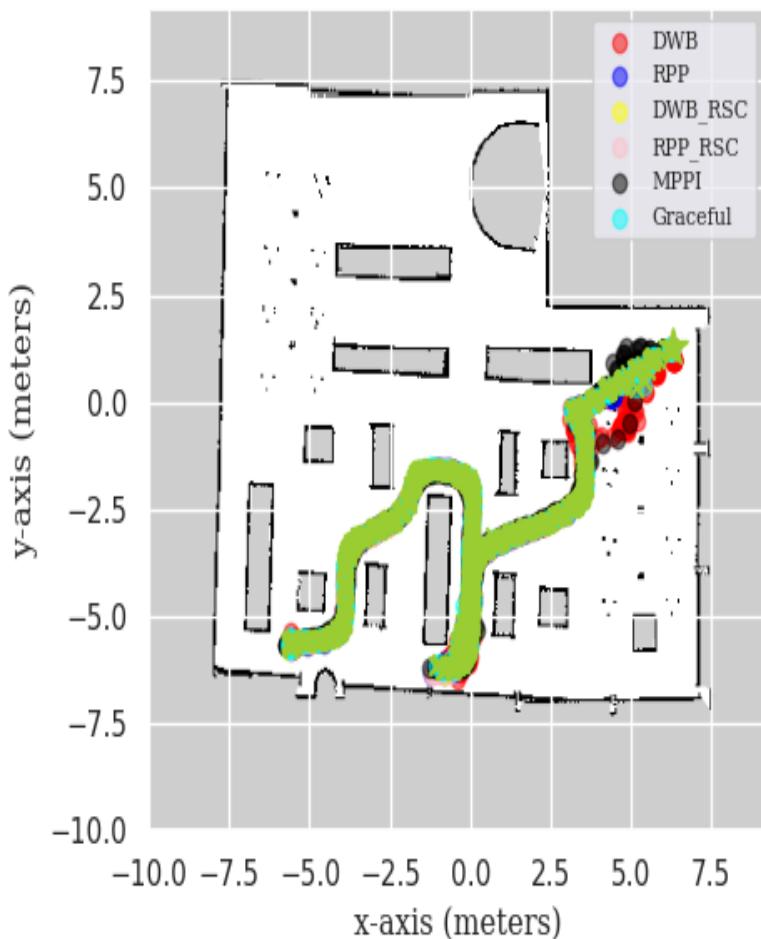
**-Global planner: NavFn**

Traveled path

**-Trajectory type: single\_goal\_0**

✖ Global planner path   \* Waypoints

★ Initial pose



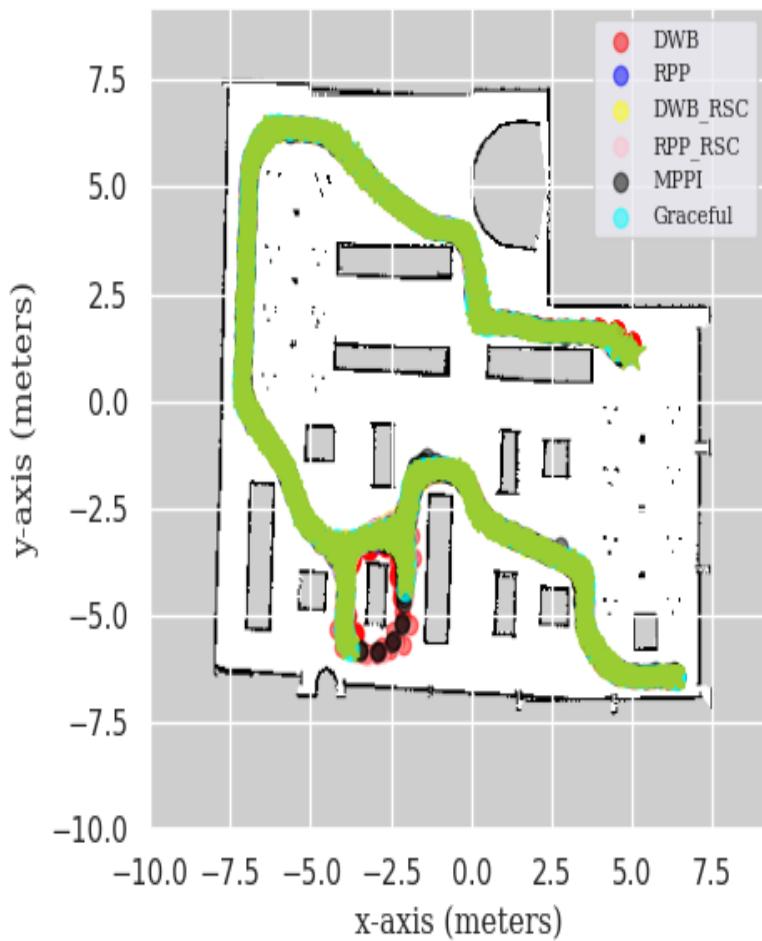
**-Global planner: NavFn**

Traveled path

**-Trajectory type: waypoints\_1**

 Global planner path  Waypoints

 Initial pose



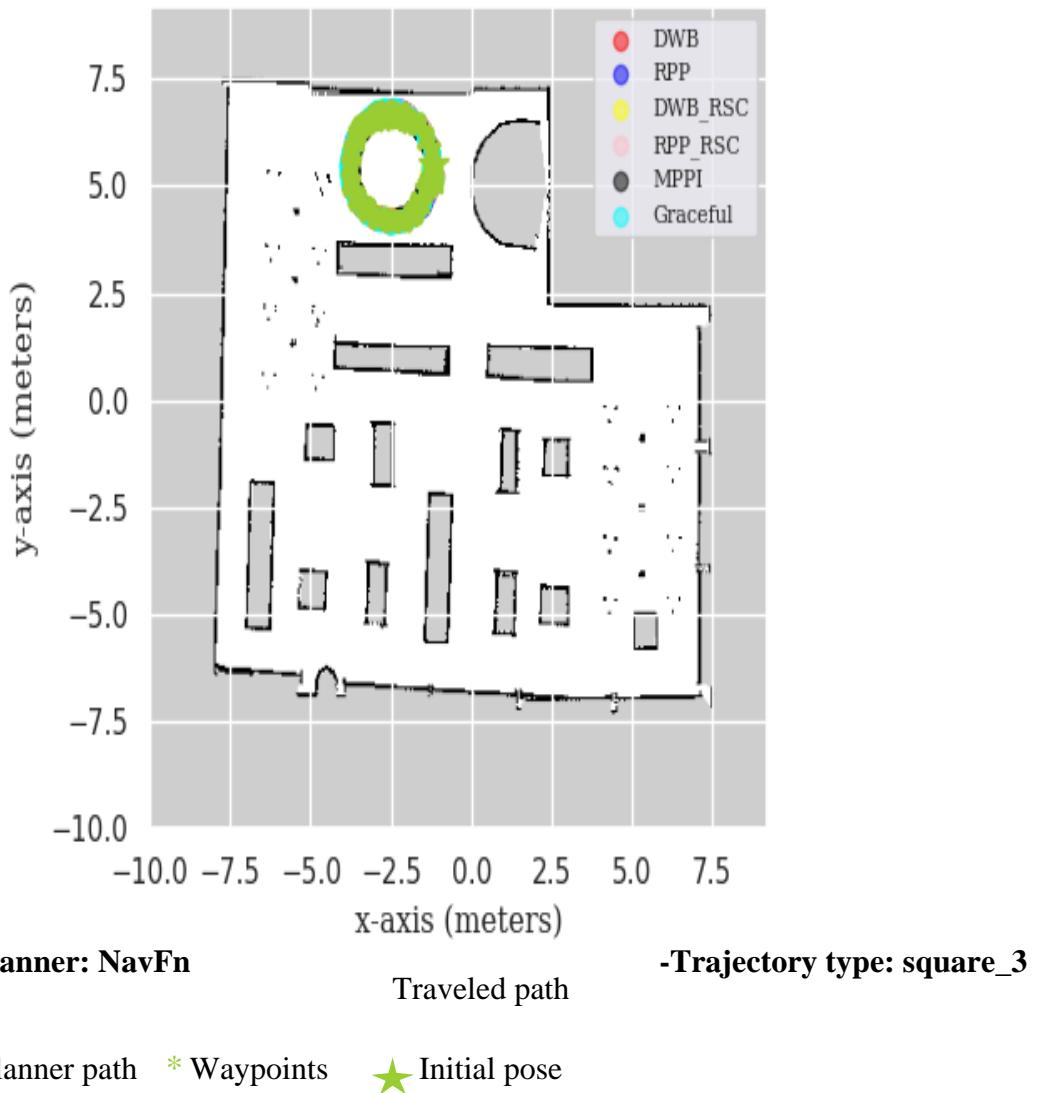
**-Global planner: NavFn**

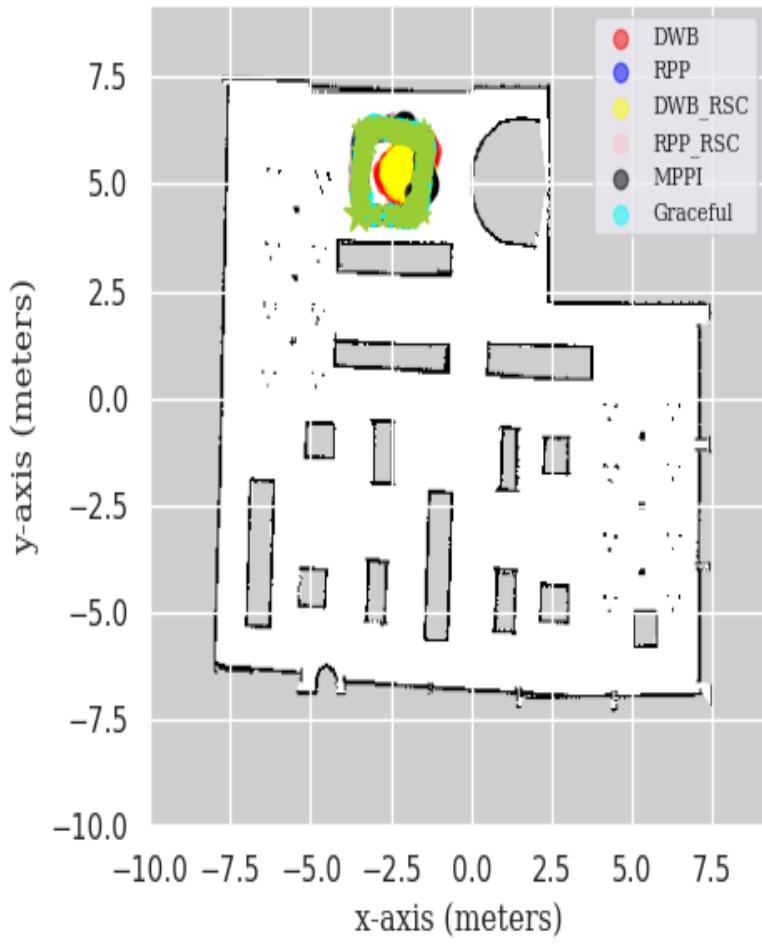
Traveled path

**-Trajectory type: circle\_2**

 Global planner path  Waypoints

 Initial pose





-Global planner: smac\_planner

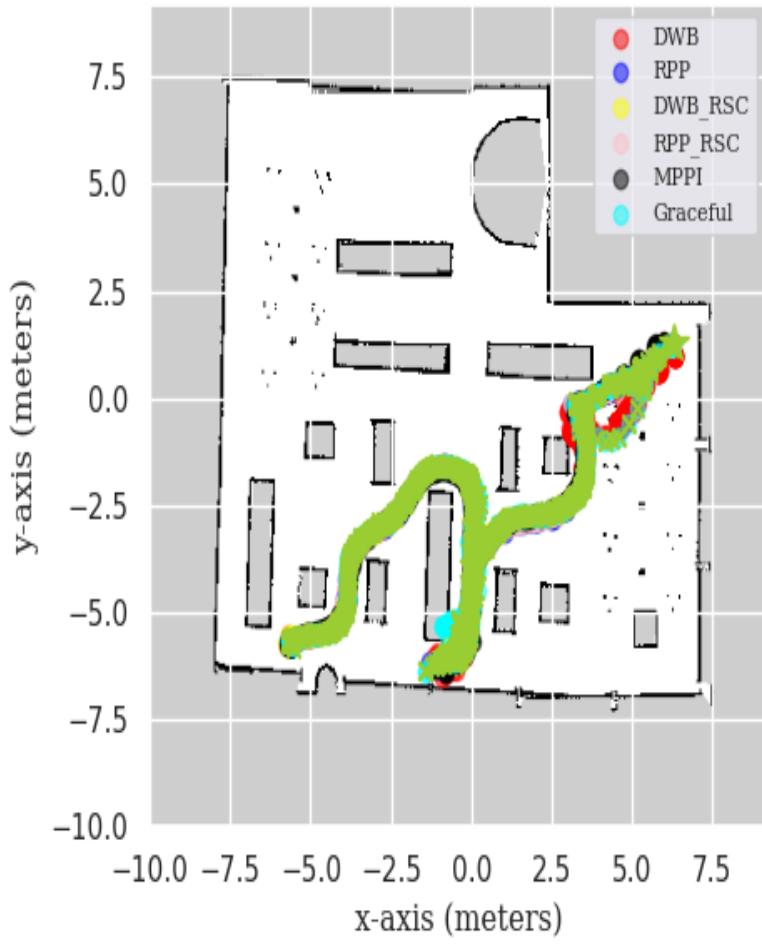
Traveled path

-Trajectory type: single\_goal\_0

x Global planner path

\* Waypoints

★ Initial pose



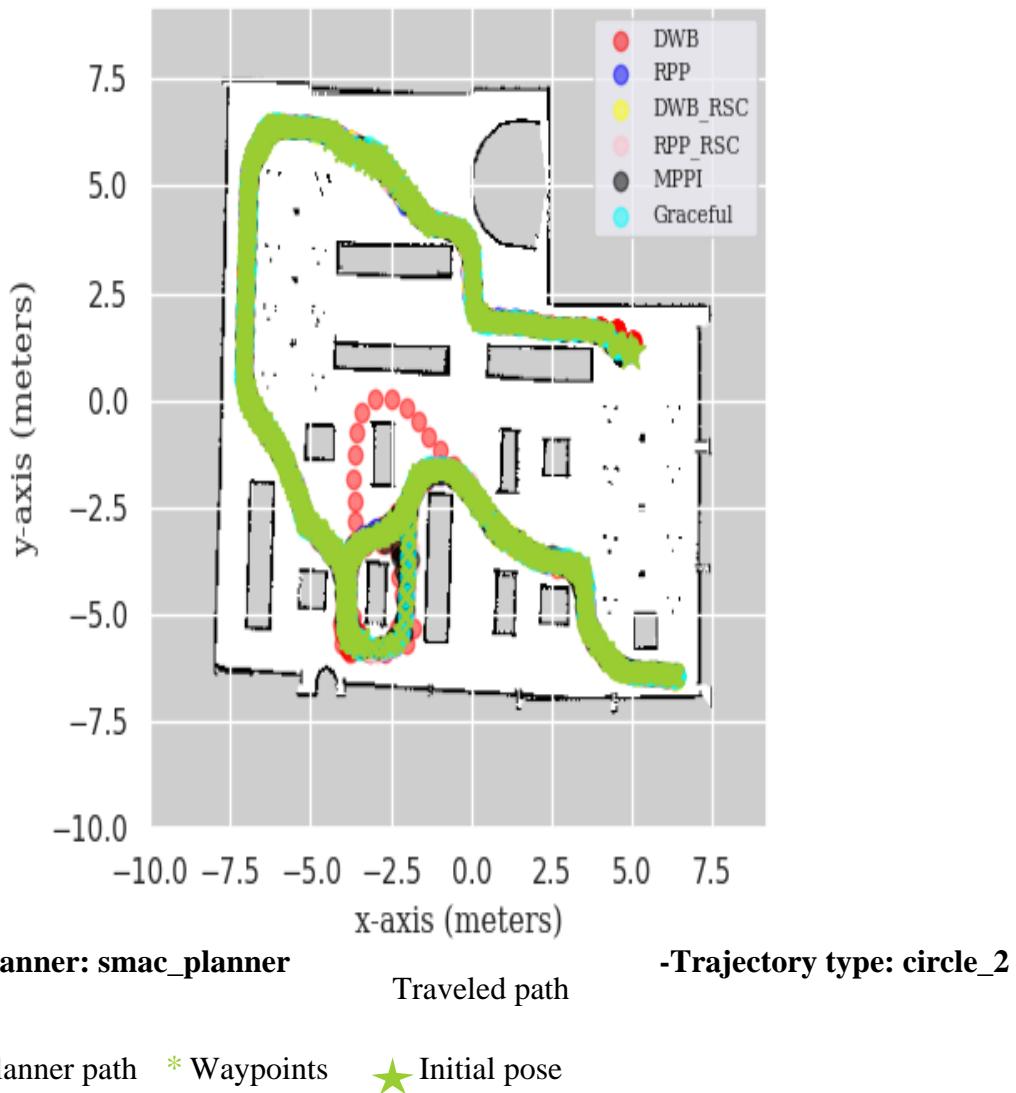
-Global planner: smac\_planner

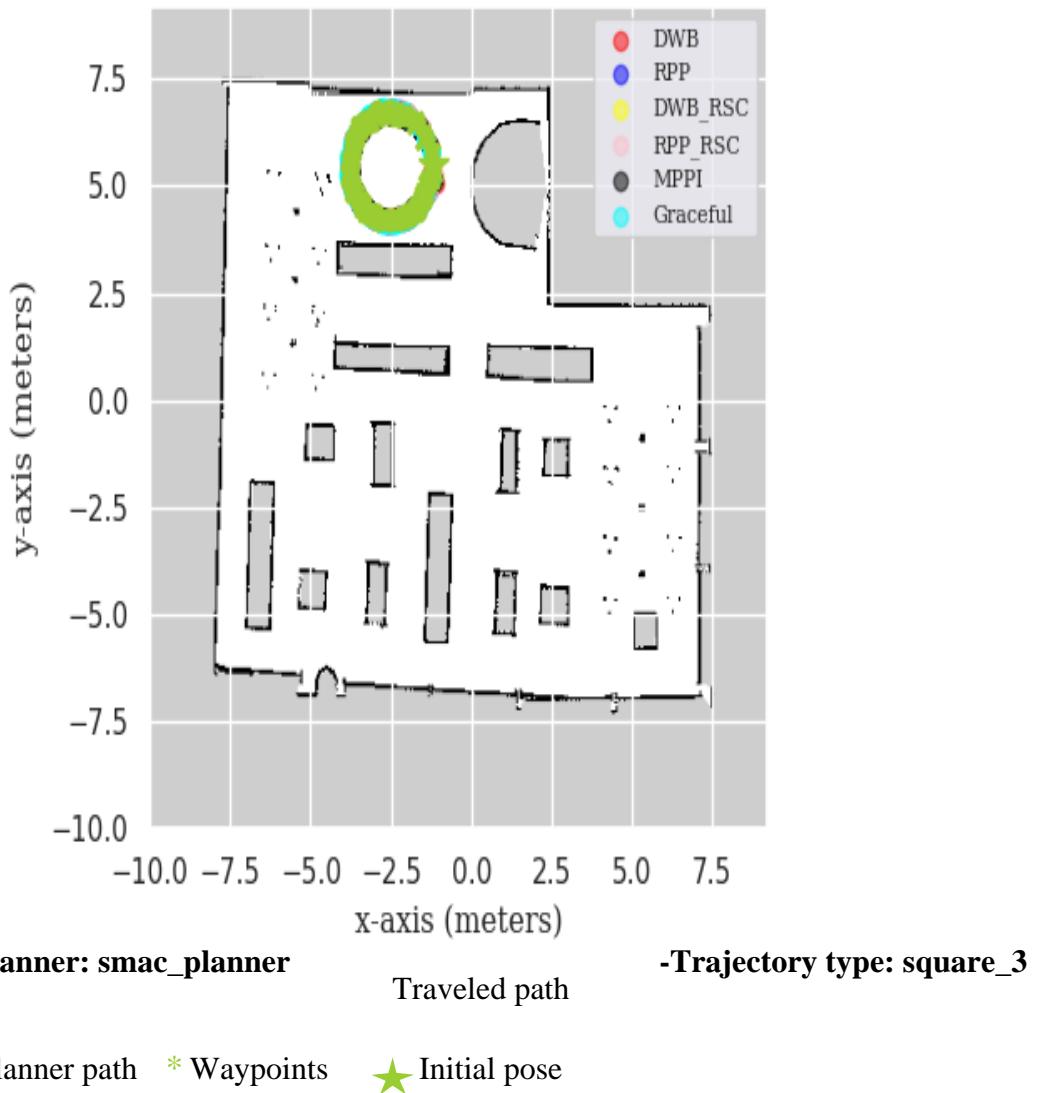
Traveled path

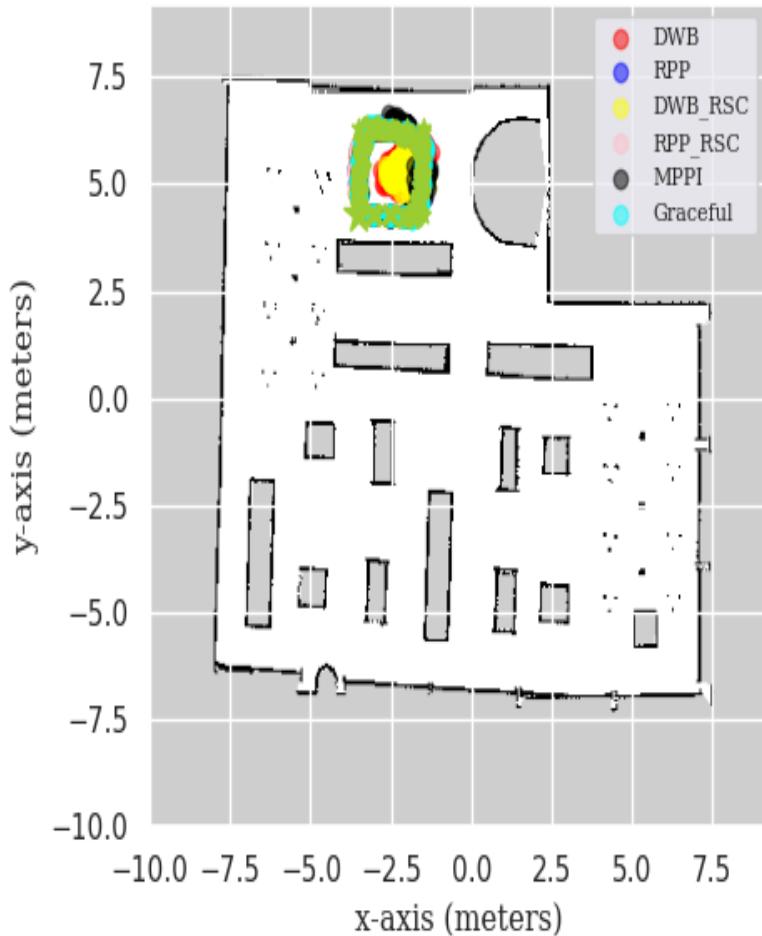
-Trajectory type: waypoints\_1

✖ Global planner path    \* Waypoints

★ Initial pose





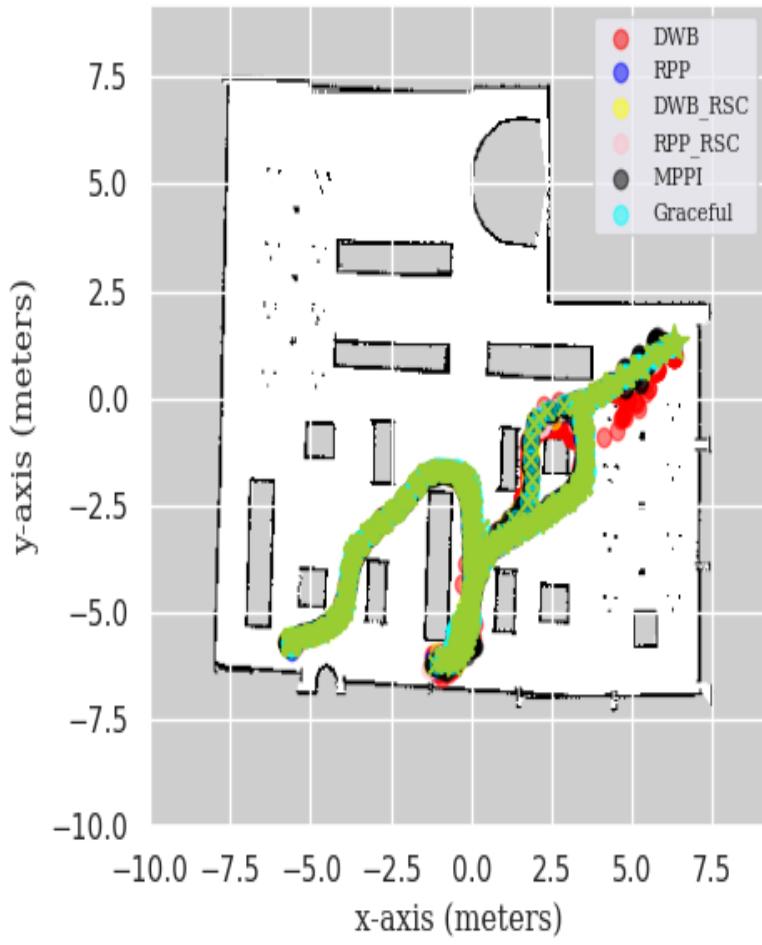


-Global planner: ThetaStar

-Trajectory type: single\_goal\_0

Traveled path

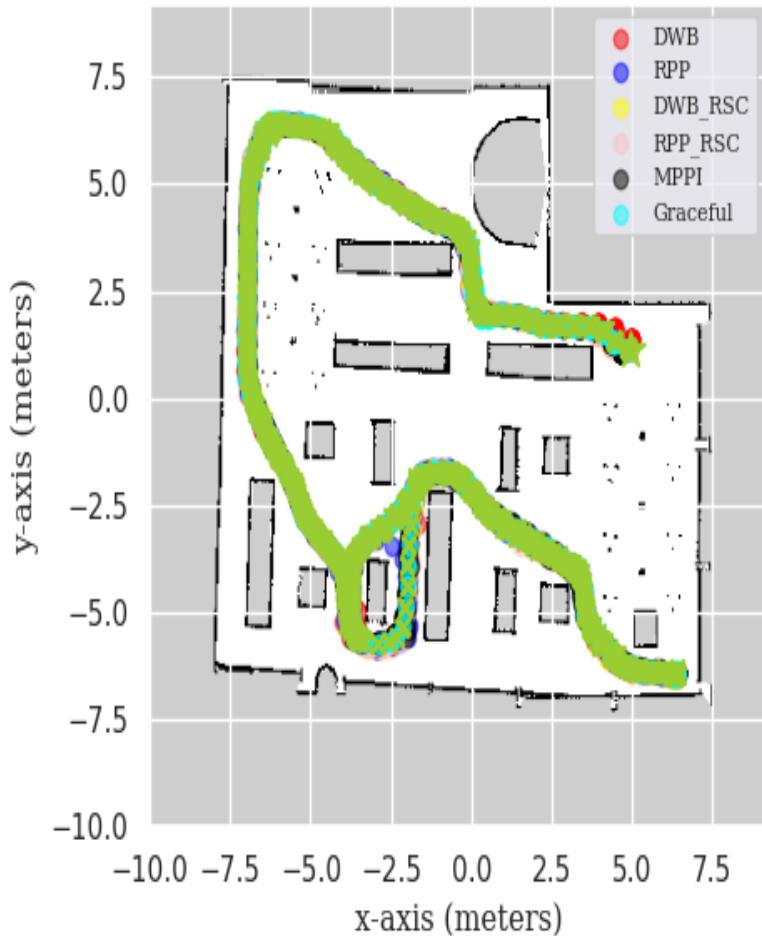
Global planner path   Waypoints   Initial pose



-Global planner: ThetaStar

-Trajectory type: waypoints\_1

■ Global planner path   \* Waypoints   ★ Initial pose



-Global planner: ThetaStar

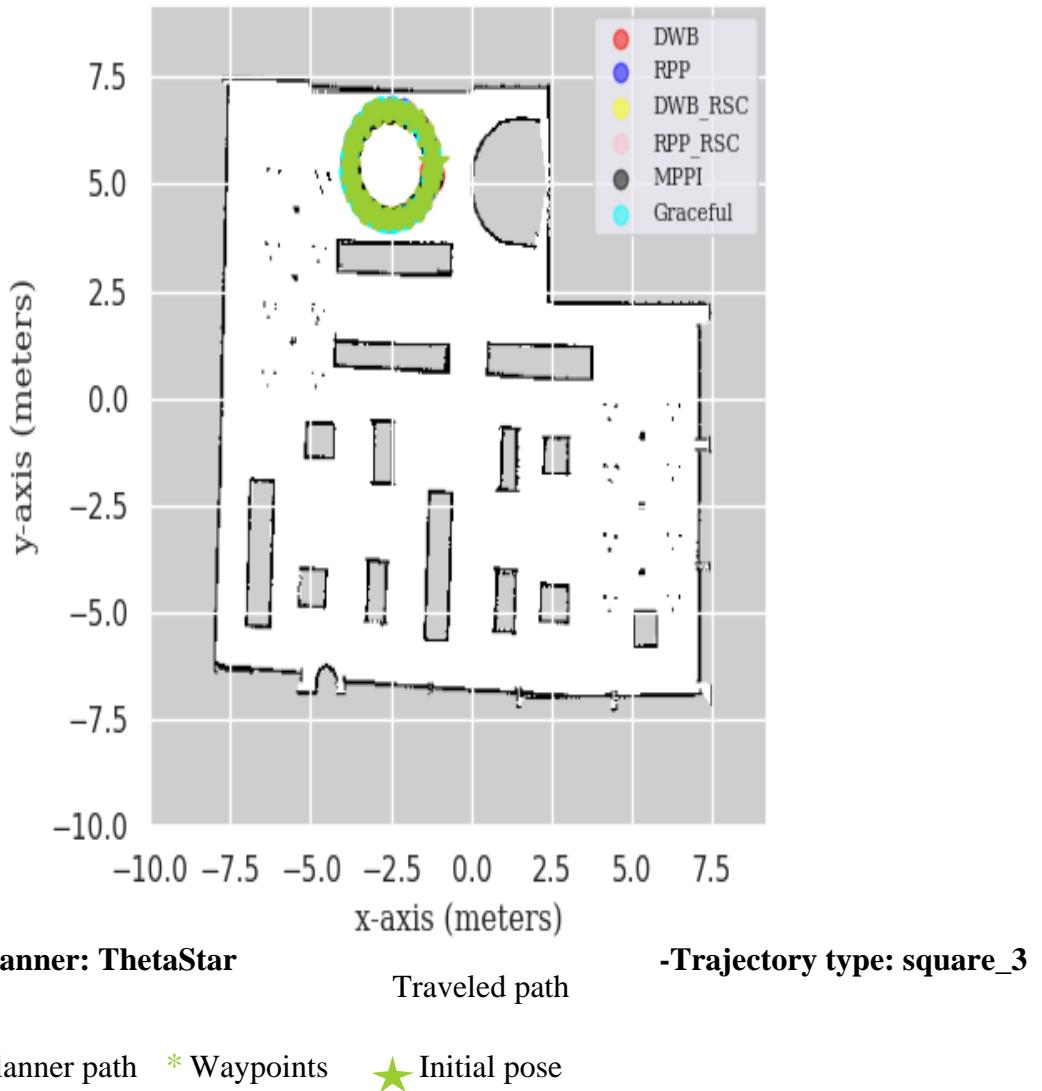
-Trajectory type: circle\_2

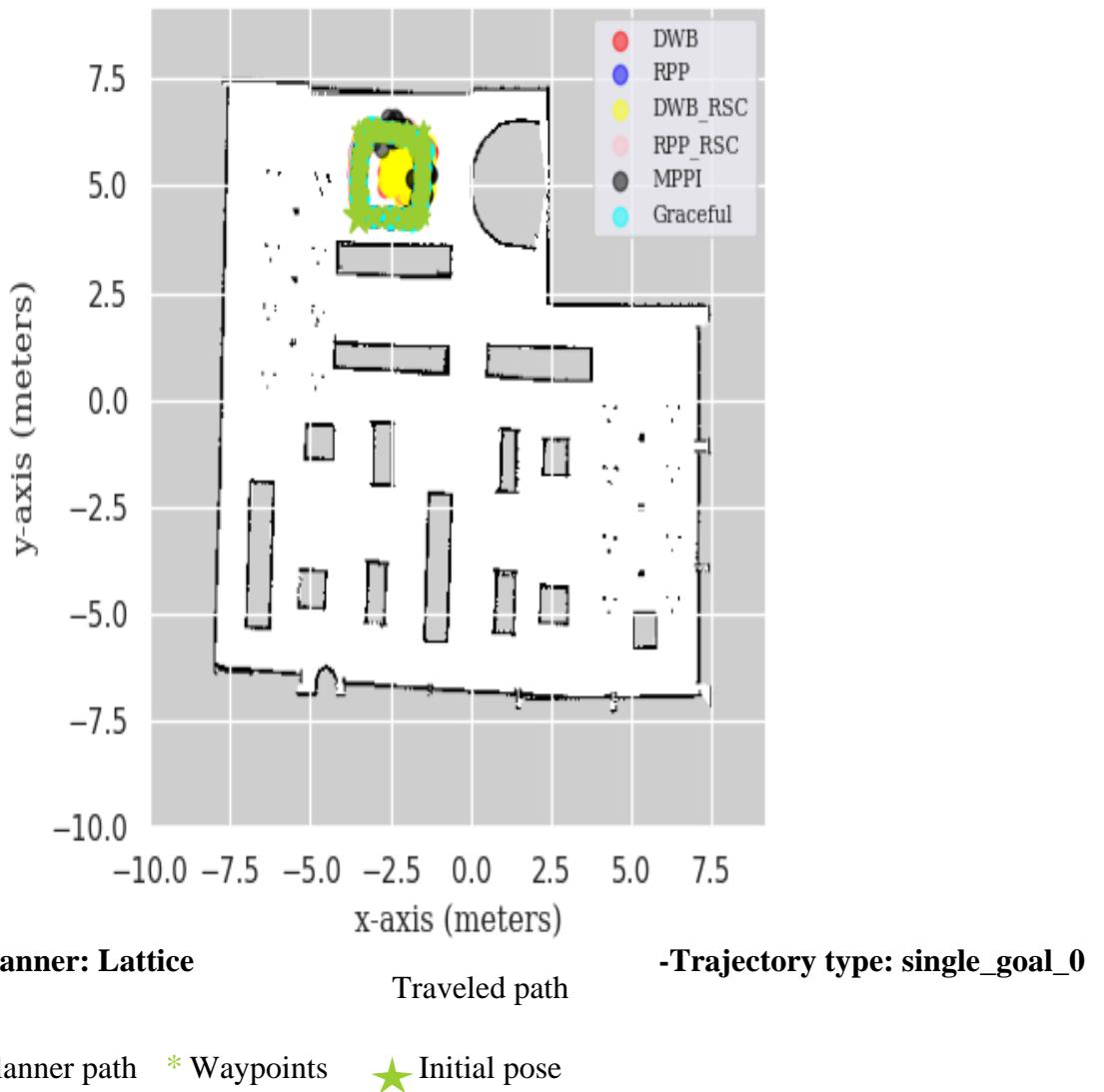
Traveled path

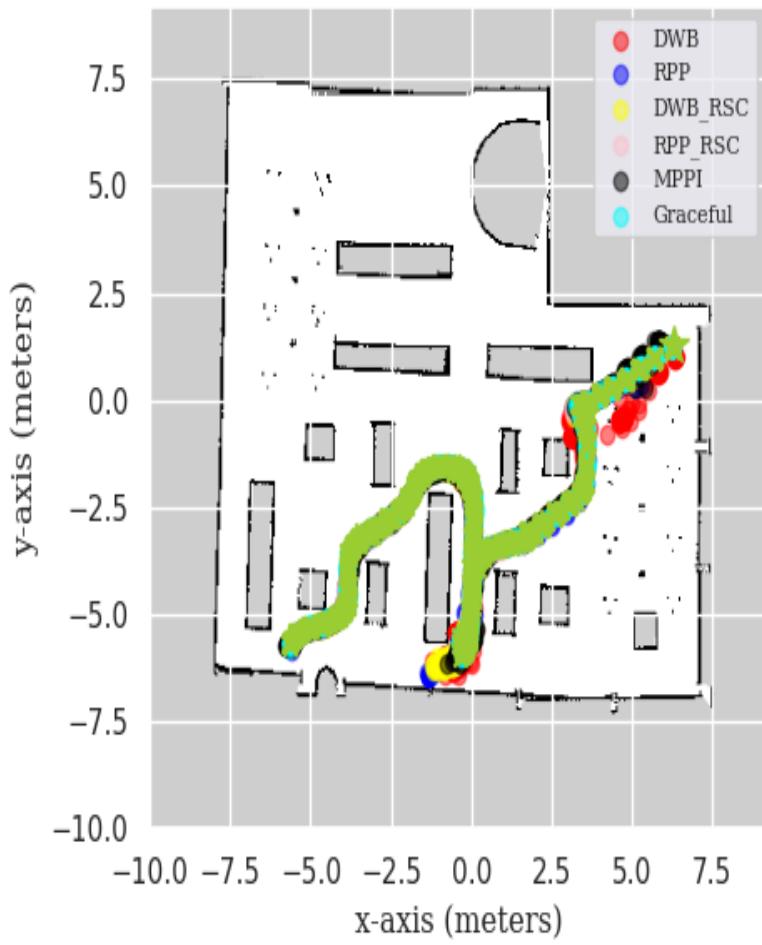
x Global planner path

\* Waypoints

★ Initial pose





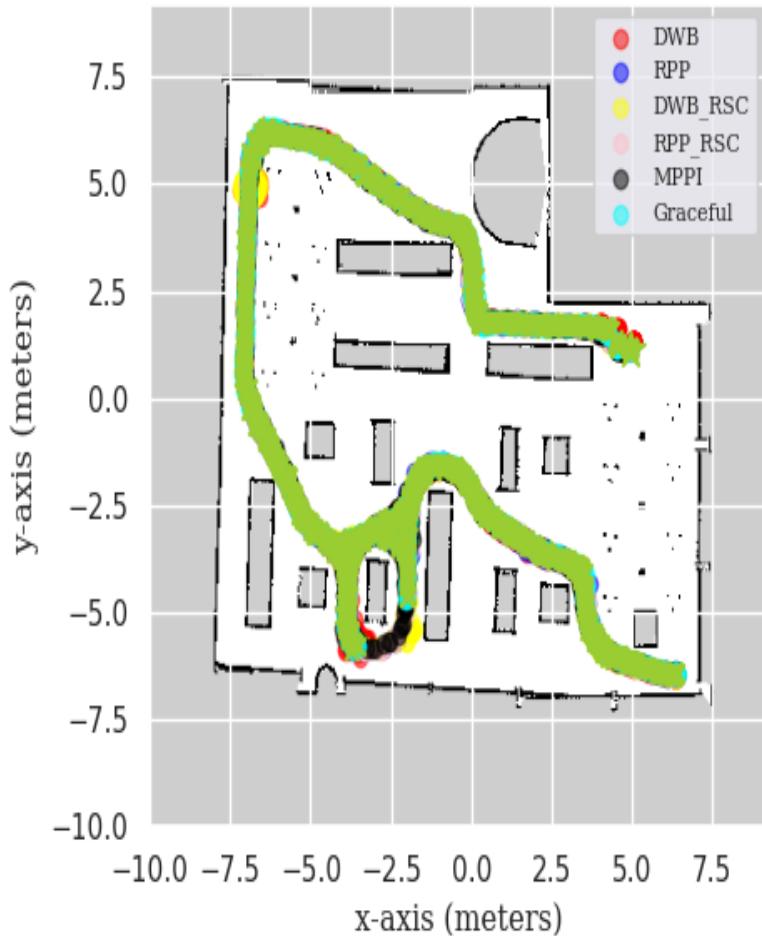


-Global planner: Lattice

Traveled path

-Trajectory type: waypoints\_1

✖ Global planner path   \* Waypoints   ★ Initial pose



-Global planner: Lattice

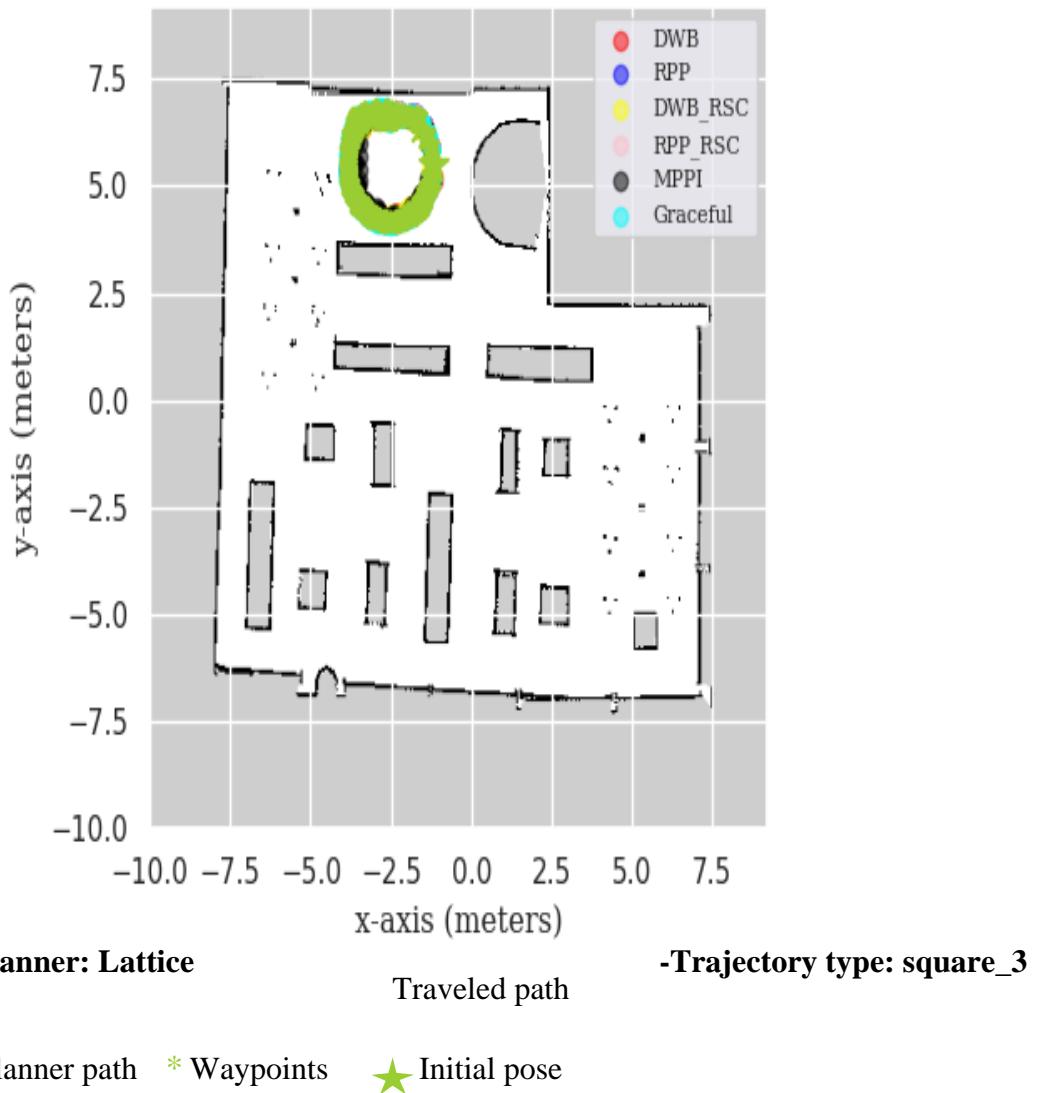
-Trajectory type: circle\_2

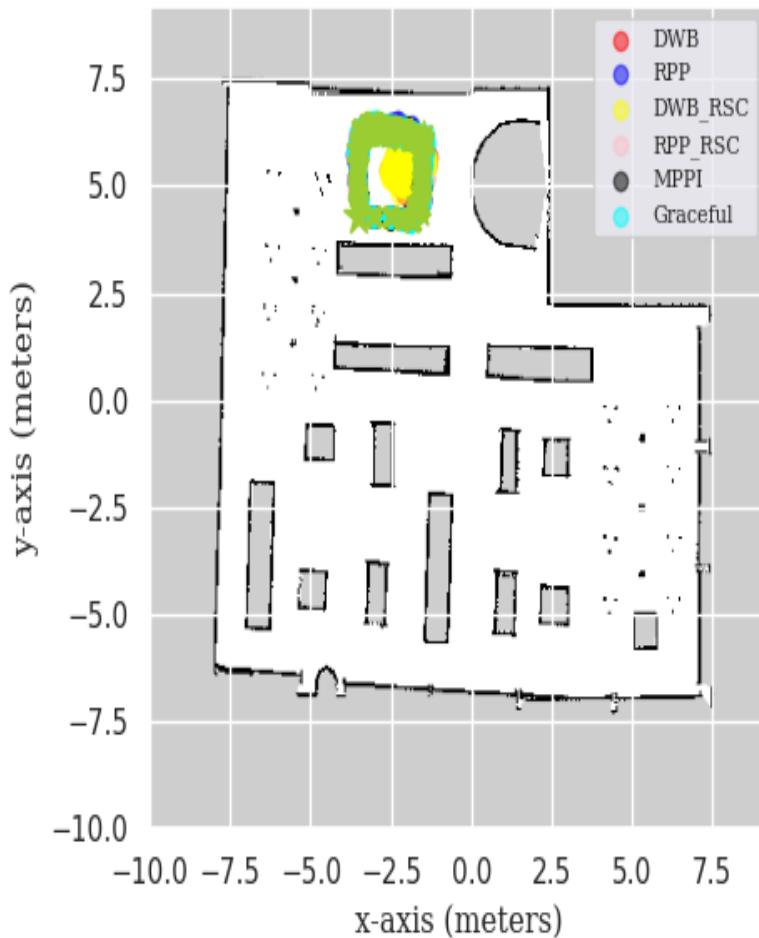
Traveled path

x Global planner path

\* Waypoints

★ Initial pose





## Failure report

Recorded log messages of navigation nodes, if any message is recorded