

# Bookstore\_Experiment\_03

## 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	73.33	101.39	20.89	30.5	9.88	10.1	6.93	15.33	0.12	2.68
DWB	waypoints_1	93.33	169.14	22.41	32.7	10.08	10.2	1.60	38.49	0.12	3.96
DWB	circle_2	100.0	38.04	19.38	25.6	10.03	10.1	0.13	7.31	0.14	0.71
DWB	square_3	73.33	88.49	20.20	28.3	10.08	10.2	4.07	13.51	0.12	4.05
RPP	single_goal_0	93.33	85.27	20.08	29.3	10.10	10.2	6.53	15.64	0.12	1.62
RPP	waypoints_1	86.67	166.62	20.94	29.4	10.30	10.4	4.47	37.84	0.12	3.33
RPP	circle_2	100.0	36.29	18.19	25.4	10.30	10.3	0.80	7.43	0.23	0.81
RPP	square_3	100.0	33.27	18.66	23.9	10.30	10.3	0.00	6.38	0.56	0.93
DWB_RSC	single_goal_0	73.33	81.00	21.89	30.7	10.34	10.4	6.60	14.51	0.12	1.95
DWB_RSC	waypoints_1	93.33	169.27	22.87	32.5	10.40	10.5	2.07	37.91	0.12	3.76
DWB_RSC	circle_2	100.0	39.24	20.60	30.5	10.20	10.3	0.33	7.33	0.13	0.71
DWB_RSC	square_3	73.33	98.59	20.88	29.9	10.27	10.3	5.53	8.77	0.12	2.7
RPP_RSC	single_goal_0	93.33	85.53	20.57	29.7	10.25	10.3	6.67	15.64	0.12	1.43
RPP_RSC	waypoints_1	100.0	168.11	21.72	31.6	10.31	10.4	2.93	38.92	0.12	3.37
RPP_RSC	circle_2	100.0	36.57	19.42	28.7	10.28	10.3	1.00	7.44	0.22	0.81
RPP_RSC	square_3	100.0	33.36	19.37	24.5	10.28	10.3	0.00	6.40	0.53	0.92
MPPI	single_goal_0	86.67	113.24	23.02	31.2	10.36	10.5	5.73	16.29	0.12	2.25
MPPI	waypoints_1	86.67	175.49	24.23	32.4	10.47	10.6	3.60	39.33	0.12	4.25
MPPI	circle_2	100.0	38.58	21.66	29.5	10.42	10.5	0.73	7.18	0.12	0.76
MPPI	square_3	100.0	50.67	22.17	29.6	10.44	10.5	0.80	8.86	0.12	0.96
Graceful	single_goal_0	93.33	98.83	22.16	32.3	10.48	10.6	2.53	16.78	0.12	1.67
Graceful	waypoints_1	93.33	188.97	22.82	33.4	10.53	10.6	1.87	38.30	0.12	3.28
Graceful	circle_2	100.0	44.69	20.39	27.5	10.48	10.5	0.13	7.76	0.12	1.27
Graceful	square_3	100.0	42.96	19.94	27.7	10.48	10.5	0.40	6.64	0.12	0.9

### -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	80.0	83.80	22.72	38.4	10.52	10.9	8.07	13.83	0.12	2.53
DWB	waypoints_1	93.33	164.36	23.39	36.0	10.55	10.8	2.40	36.95	0.12	3.52
DWB	circle_2	100.0	41.89	22.02	28.3	10.50	10.6	0.67	7.47	0.13	0.73
DWB	square_3	46.67	137.21	22.40	31.9	10.57	10.7	7.87	18.73	0.12	7.8
RPP	single_goal_0	60.0	70.50	21.46	29.9	10.59	10.7	10.13	12.10	0.12	2.08
RPP	waypoints_1	100.0	158.38	22.21	30.4	10.62	10.7	3.47	37.32	0.12	3.5
RPP	circle_2	100.0	34.84	21.17	28.7	10.60	10.6	0.07	7.44	0.26	0.63
RPP	square_3	100.0	32.98	20.99	25.7	10.60	10.7	0.00	6.36	0.56	0.91
DWB_RSC	single_goal_0	93.33	83.41	23.70	31.1	10.61	10.7	3.80	15.29	0.12	1.93
DWB_RSC	waypoints_1	93.33	170.56	23.93	43.8	10.69	10.8	3.00	37.46	0.12	3.86
DWB_RSC	circle_2	100.0	37.39	22.57	29.8	10.67	10.7	0.07	7.28	0.35	0.57
DWB_RSC	square_3	46.67	120.96	23.47	31.5	10.70	10.8	7.73	8.84	0.12	3.46
RPP_RSC	single_goal_0	93.33	77.24	22.82	42.4	10.70	10.8	3.87	15.57	0.12	1.57
RPP_RSC	waypoints_1	100.0	159.70	22.84	30.8	10.76	10.9	2.80	37.40	0.12	3.55
RPP_RSC	circle_2	100.0	35.08	22.42	29.4	10.70	10.8	0.47	7.44	0.22	0.65
RPP_RSC	square_3	100.0	33.09	22.15	30.2	10.70	10.7	0.00	6.35	0.57	0.91
MPPI	single_goal_0	86.67	91.68	25.25	34.2	10.73	10.8	5.87	15.25	0.12	1.91
MPPI	waypoints_1	100.0	159.43	25.58	32.8	10.79	10.9	1.00	37.88	0.12	3.23
MPPI	circle_2	100.0	34.43	24.73	31.7	10.75	10.8	0.33	7.13	0.13	0.71
MPPI	square_3	86.67	68.91	24.19	31.4	10.77	10.8	2.87	8.15	0.13	1.35
Graceful	single_goal_0	93.33	101.48	24.60	37.4	10.80	10.8	3.07	16.32	0.12	1.35
Graceful	waypoints_1	100.0	186.27	23.90	34.9	10.84	11.0	0.87	37.82	0.12	3.11
Graceful	circle_2	100.0	40.77	23.57	41.9	10.80	10.9	0.00	7.60	0.13	1.05
Graceful	square_3	100.0	38.72	22.66	28.1	10.80	10.8	0.00	6.50	0.14	0.75

### -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	80.0	81.27	25.20	33.1	10.81	10.9	6.87	14.47	0.12	2.29
DWB	waypoints_1	100.0	162.90	25.00	31.8	10.88	11.0	0.87	37.19	0.12	3.11
DWB	circle_2	100.0	37.77	24.57	32.6	10.84	10.9	0.13	7.31	0.16	0.51
DWB	square_3	86.67	61.06	25.19	32.4	10.87	10.9	2.00	10.53	0.12	2.54
RPP	single_goal_0	73.33	74.74	24.14	31.7	10.89	10.9	7.07	13.35	0.12	1.54
RPP	waypoints_1	86.67	144.91	23.72	30.7	10.92	11.0	5.47	33.55	0.12	3.57

RPP	circle_2	100.0	34.71	23.47	30.9	10.90	10.9	0.07	7.44	0.27	0.58
RPP	square_3	100.0	32.47	23.10	29.2	10.90	10.9	0.00	6.35	0.56	0.85
DWB_RSC	single_goal_0	80.0	79.81	25.46	34.3	10.91	11.0	5.87	13.53	0.12	1.91
DWB_RSC	waypoints_1	100.0	165.66	25.25	32.8	10.98	11.1	1.73	37.09	0.12	3.04
DWB_RSC	circle_2	100.0	39.90	24.46	32.8	10.94	11.0	0.53	7.44	0.12	0.6
DWB_RSC	square_3	86.67	52.67	24.62	33.1	10.95	11.0	1.93	6.79	0.12	1.27
RPP_RSC	single_goal_0	80.0	73.27	23.94	31.2	10.99	11.0	5.33	14.42	0.12	2.07
RPP_RSC	waypoints_1	86.67	147.97	23.45	32.2	11.04	11.1	5.13	33.59	0.12	3.88
RPP_RSC	circle_2	100.0	36.31	22.08	30.4	11.00	11.1	0.60	7.49	0.14	0.63
RPP_RSC	square_3	100.0	32.56	23.14	30.9	11.00	11.1	0.00	6.34	0.5	0.87
MPPI	single_goal_0	93.33	121.60	26.26	34.5	11.05	11.1	7.53	15.74	0.12	1.94
MPPI	waypoints_1	100.0	150.50	26.17	33.1	11.07	11.2	0.40	36.50	0.12	2.45
MPPI	circle_2	100.0	68.10	24.84	33.1	11.01	11.1	3.60	7.39	0.14	1.16
MPPI	square_3	100.0	61.99	25.50	32.5	11.02	11.1	2.13	9.28	0.12	1.36
Graceful	single_goal_0	80.0	92.39	25.32	43.5	11.05	11.1	5.07	15.54	0.12	1.79
Graceful	waypoints_1	100.0	184.02	24.69	42.2	11.10	11.5	1.47	37.43	0.12	2.88
Graceful	circle_2	100.0	40.71	23.70	30.7	11.08	11.1	0.00	7.59	0.13	0.92
Graceful	square_3	100.0	41.23	23.41	30.2	11.08	11.1	0.13	6.64	0.15	0.71

### -Global planner: Lattice

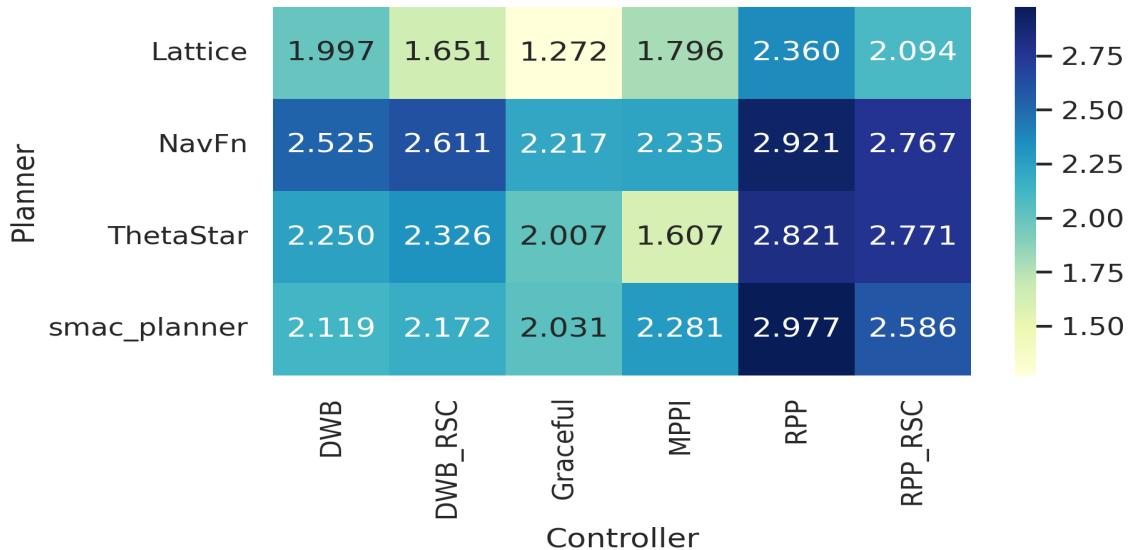
Controller type	Trajectory type	Success rate (%)	Average execution time (sec)	CPU(%)		Memory usage(%)		Average number of recoveries	Average path length(m)	Min distance to obstacles(m)	Average Path Deviation
				Mean	Max	Mean	Max				
DWB	single_goal_0	86.67	73.69	26.43	34.6	11.11	11.2	4.20	14.12	0.12	1.76
DWB	waypoints_1	86.67	158.56	26.22	33.9	11.19	11.3	2.93	36.25	0.12	4.28
DWB	circle_2	100.0	38.68	25.66	42.9	11.16	11.2	0.20	7.14	0.27	0.75
DWB	square_3	66.67	97.67	25.78	35.0	11.18	11.3	4.87	14.95	0.12	4.77
RPP	single_goal_0	80.0	74.60	25.16	38.5	11.20	11.3	7.60	13.80	0.12	2.05
RPP	waypoints_1	86.67	156.44	24.66	42.8	11.27	11.4	7.27	34.73	0.12	3.91
RPP	circle_2	100.0	38.68	24.47	31.8	11.21	11.3	0.13	7.73	0.12	0.76
RPP	square_3	100.0	34.71	24.12	29.1	11.21	11.3	0.07	6.63	0.54	0.9
DWB_RSC	single_goal_0	86.67	76.51	31.30	100.0	11.43	14.3	3.40	14.60	0.12	1.42
DWB_RSC	waypoints_1	93.33	169.77	26.10	34.2	11.40	11.5	3.73	37.74	0.12	4.09
DWB_RSC	circle_2	100.0	38.18	25.19	33.1	11.38	11.5	0.60	7.11	0.18	0.76
DWB_RSC	square_3	33.33	143.17	25.63	40.1	11.39	11.5	9.80	11.25	0.12	4.37
RPP_RSC	single_goal_0	93.33	80.98	25.45	34.9	11.40	11.5	7.73	15.42	0.12	1.71
RPP_RSC	waypoints_1	86.67	160.57	24.71	33.8	11.47	11.6	5.33	36.06	0.12	3.59
RPP_RSC	circle_2	100.0	36.87	24.62	31.3	11.42	11.5	0.07	7.68	0.13	0.75

RPP_RSC	square_3	100.0	34.03	24.18	29.3	11.40	11.5	0.00	6.54	0.57	0.92
MPPI	single_goal_0	86.67	93.90	27.87	35.5	11.47	11.5	4.13	16.12	0.12	2.05
MPPI	waypoints_1	100.0	164.83	26.83	35.2	11.52	11.6	1.87	38.20	0.12	3.51
MPPI	circle_2	100.0	31.62	26.15	31.9	11.50	11.5	0.00	7.14	0.39	0.71
MPPI	square_3	100.0	41.75	26.54	34.7	11.50	11.6	1.13	7.53	0.14	0.94
Graceful	single_goal_0	93.33	99.98	26.25	35.5	11.52	11.6	4.00	15.97	0.12	1.72
Graceful	waypoints_1	93.33	202.61	25.14	38.2	11.63	11.9	2.47	38.64	0.12	3.94
Graceful	circle_2	100.0	51.18	24.73	32.2	11.70	11.8	0.20	7.89	0.15	1.18
Graceful	square_3	100.0	49.35	24.51	30.9	11.70	11.8	0.00	6.78	0.13	1.2

## 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: 90.53%

Planner: ThetaStar, Success Rate: 93.06%

Planner: smac\_planner, Success Rate: 90.56%

Planner: NavFn, Success Rate: 92.22%

**Controllers' success rate are:**

Controller: Graceful, Success Rate: 96.67%

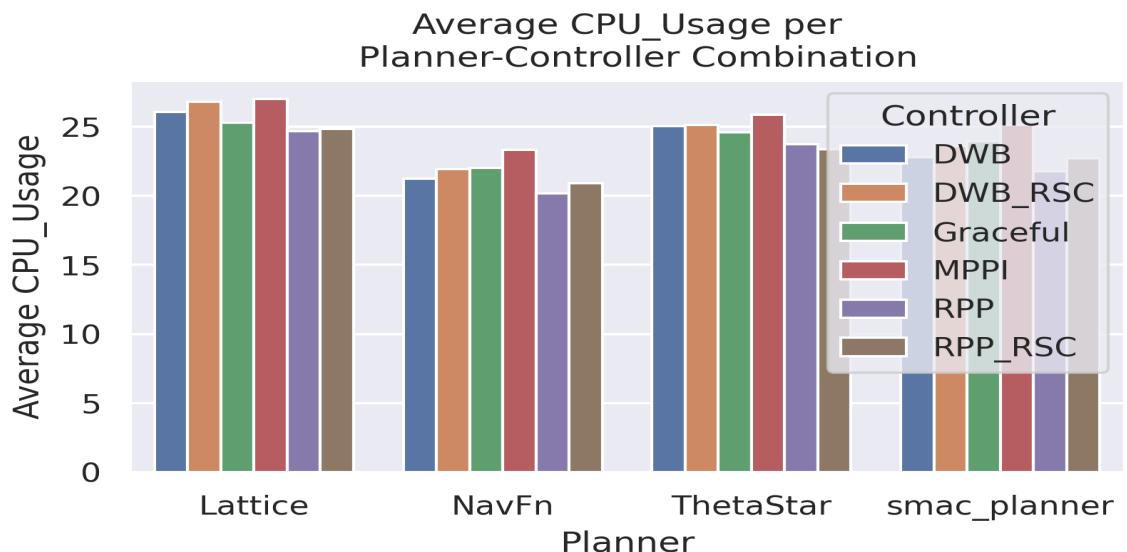
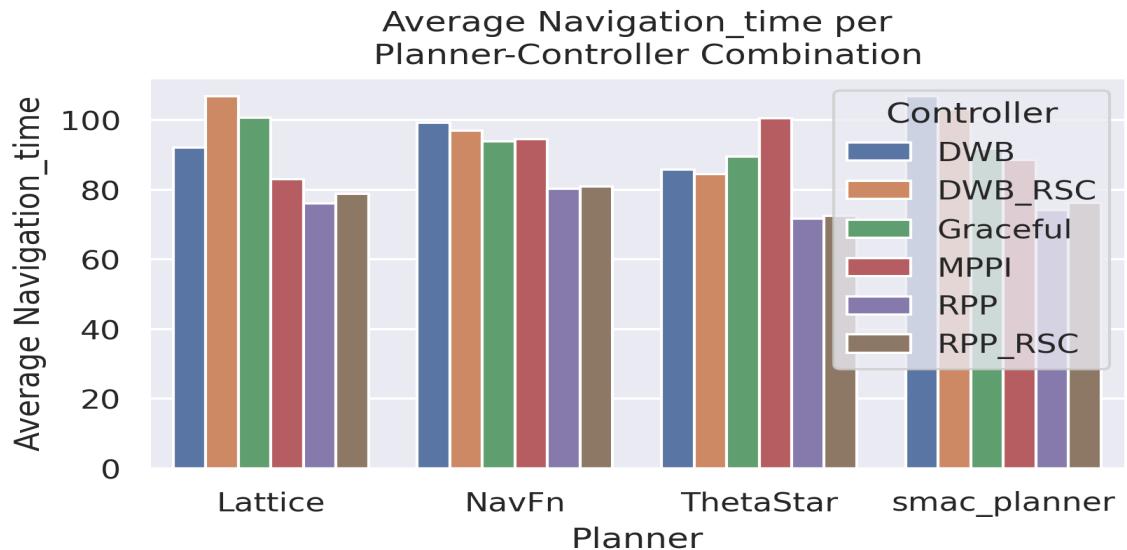
Controller: MPPI, Success Rate: 95.42%

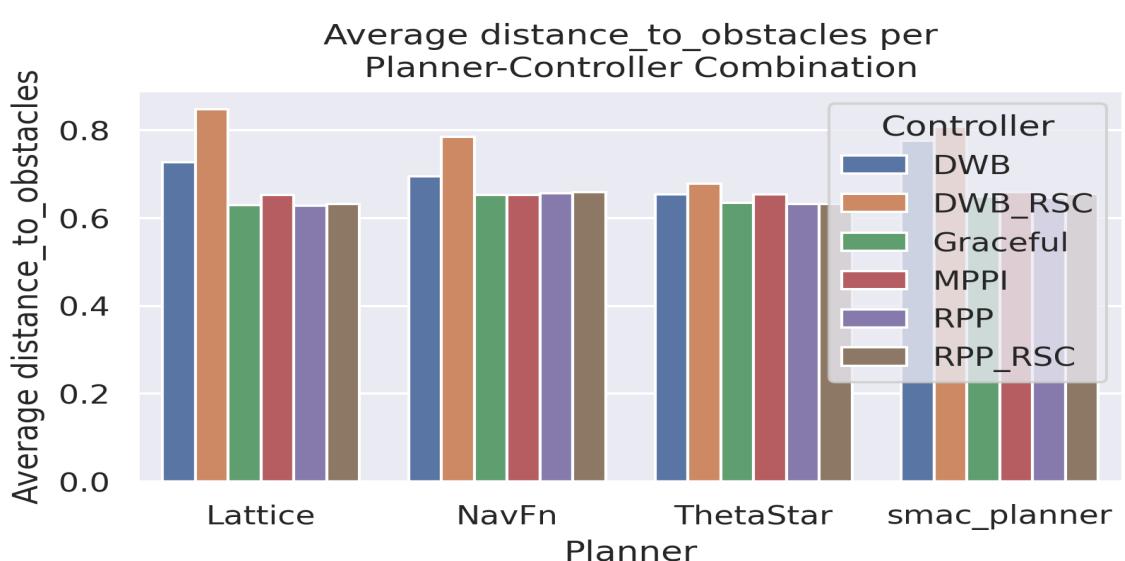
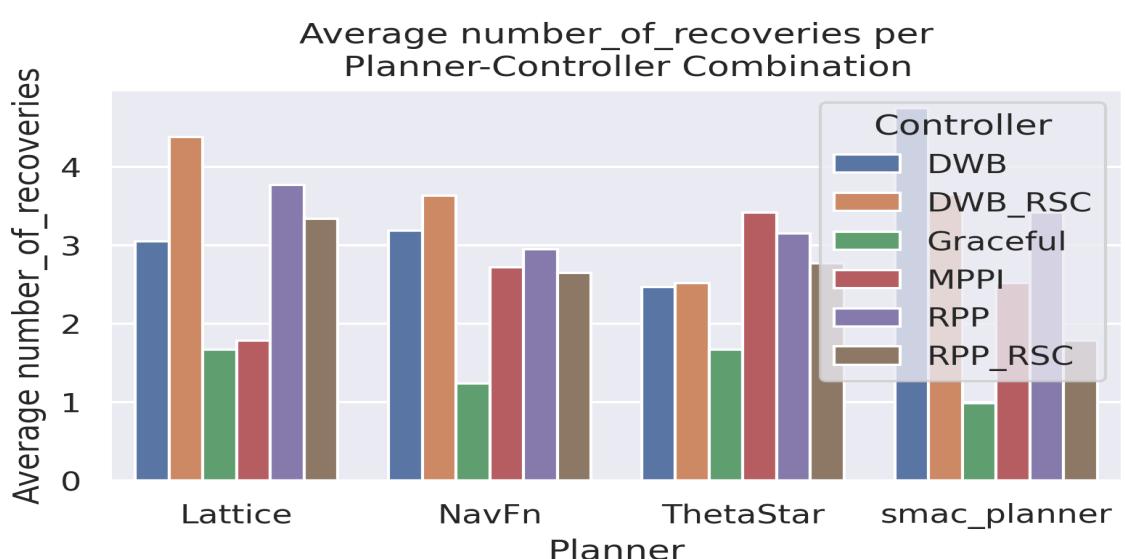
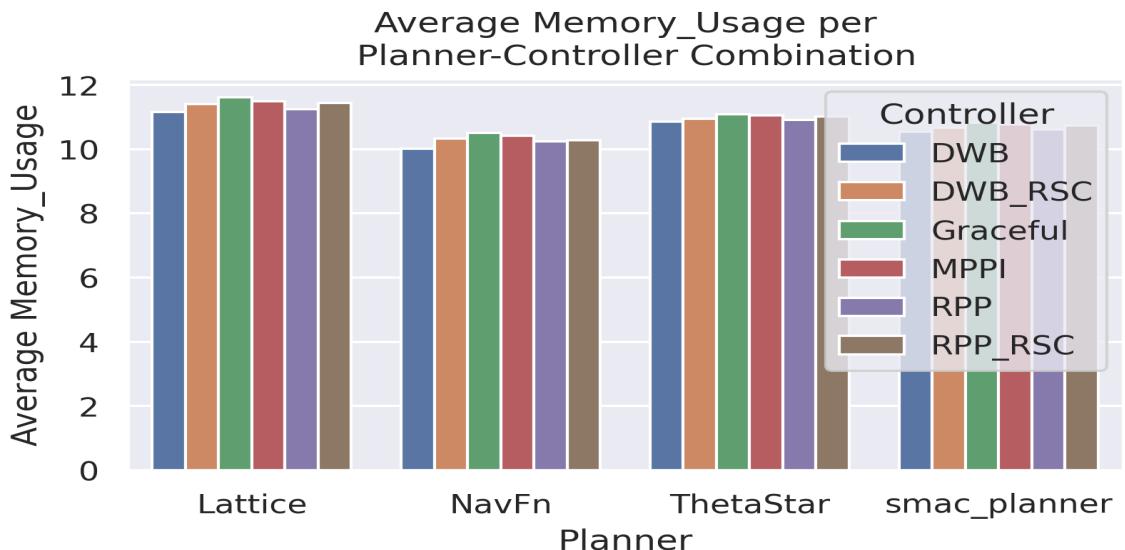
Controller: RPP\_RSC, Success Rate: 95.82%

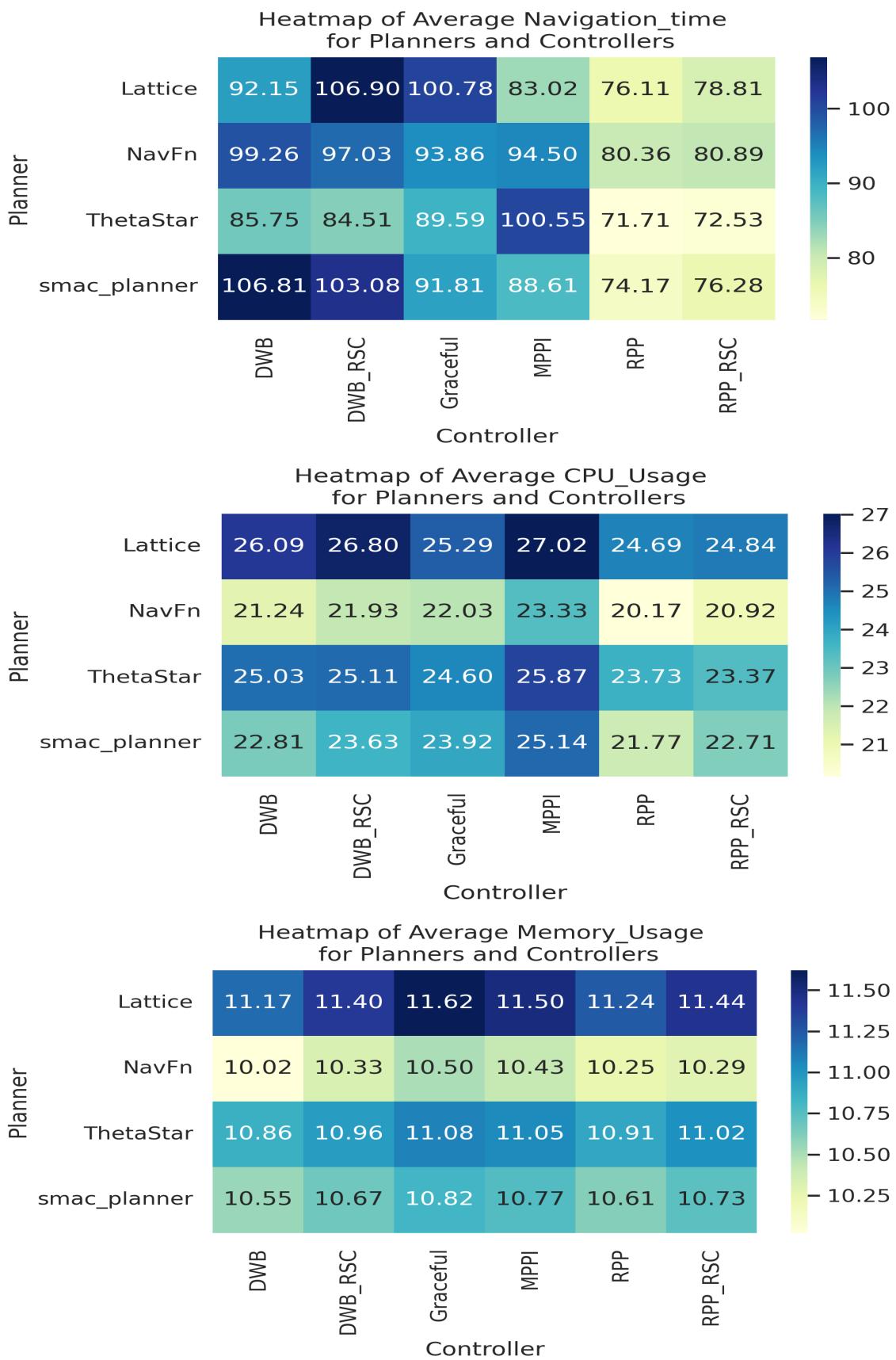
Controller: DWB\_RSC, Success Rate: 84.58%

Controller: RPP, Success Rate: 91.67%

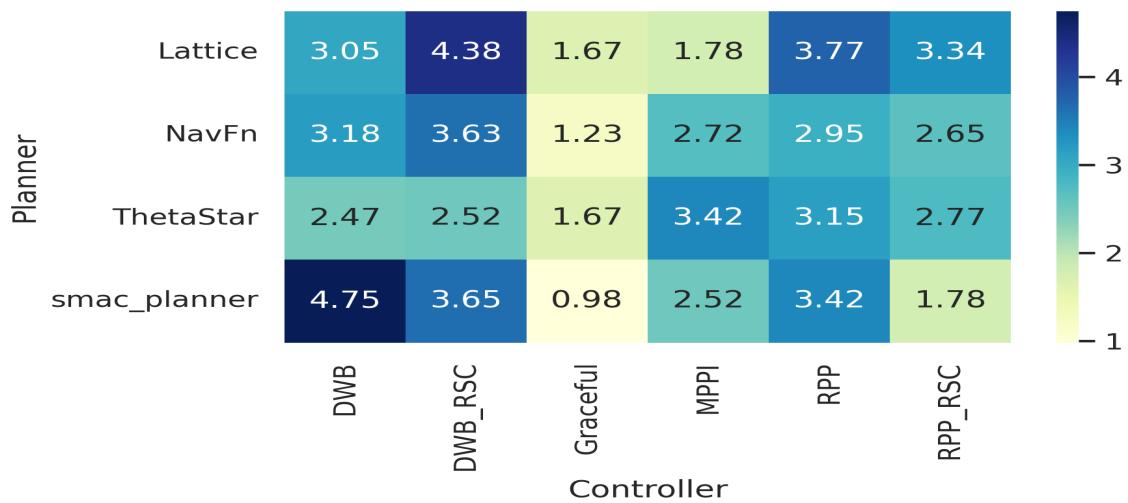
Controller: DWB, Success Rate: 85.42%



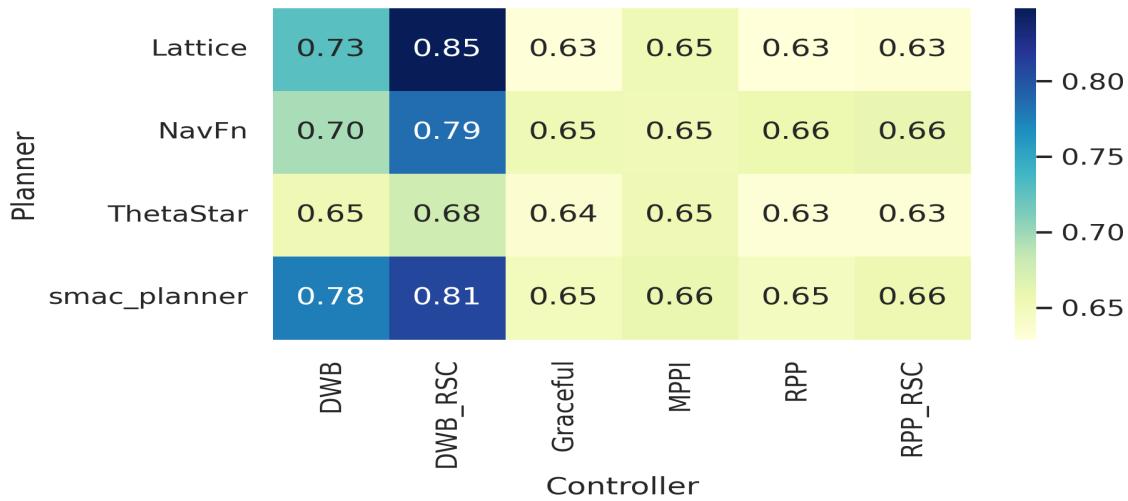




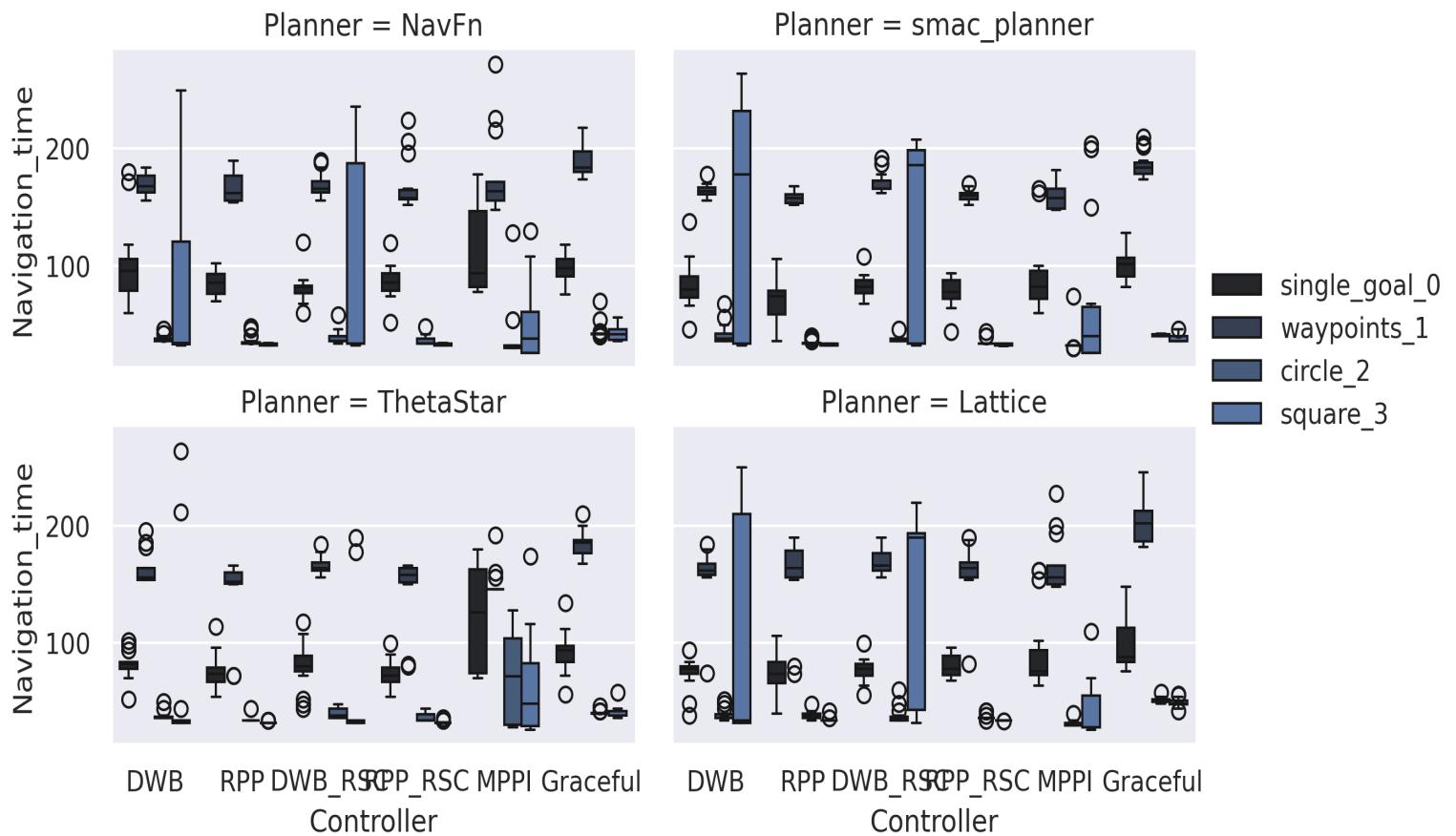
Heatmap of Average number\_of\_recoveries  
for Planners and Controllers



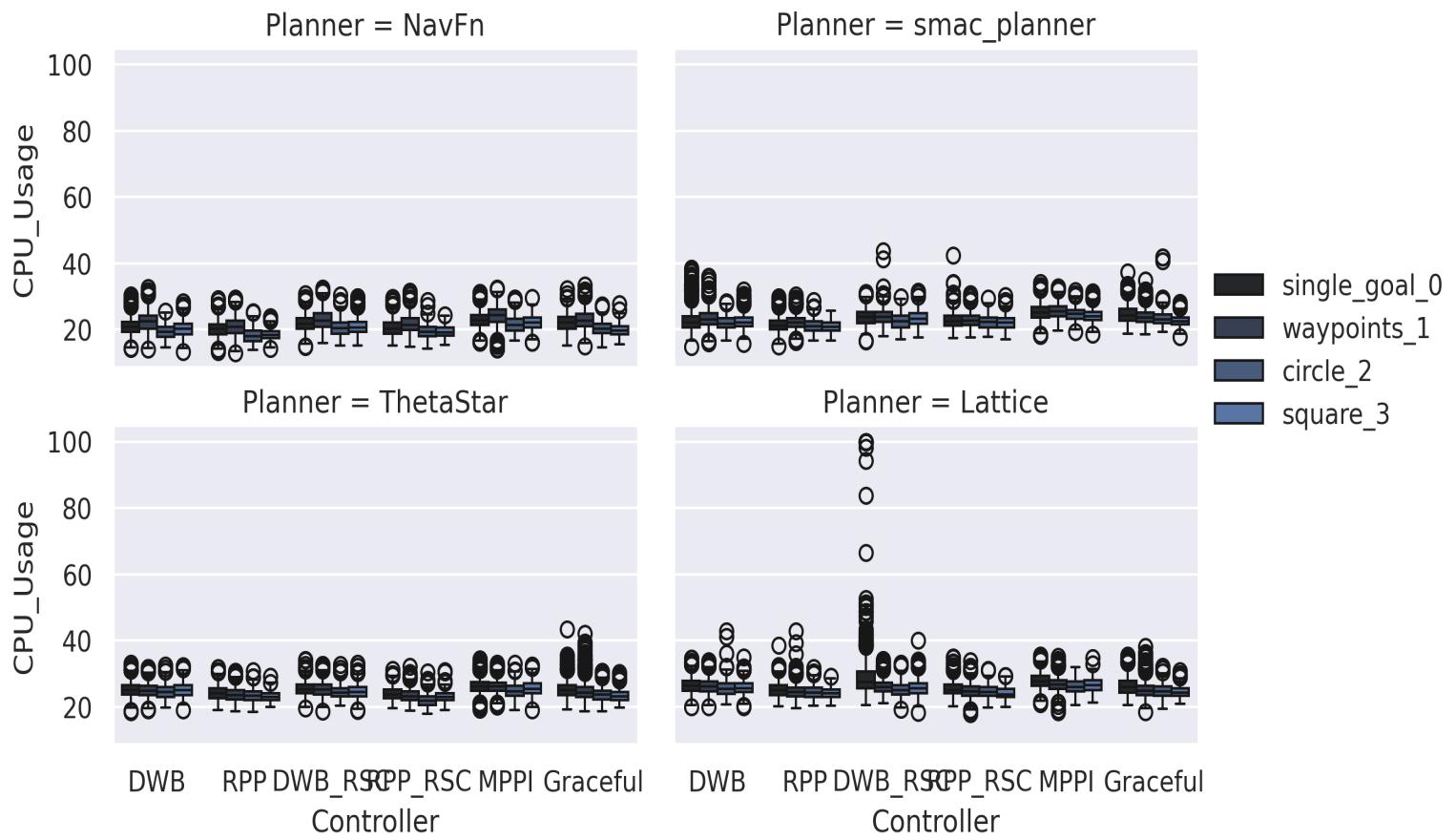
Heatmap of Average distance\_to\_obstacles  
for Planners and Controllers



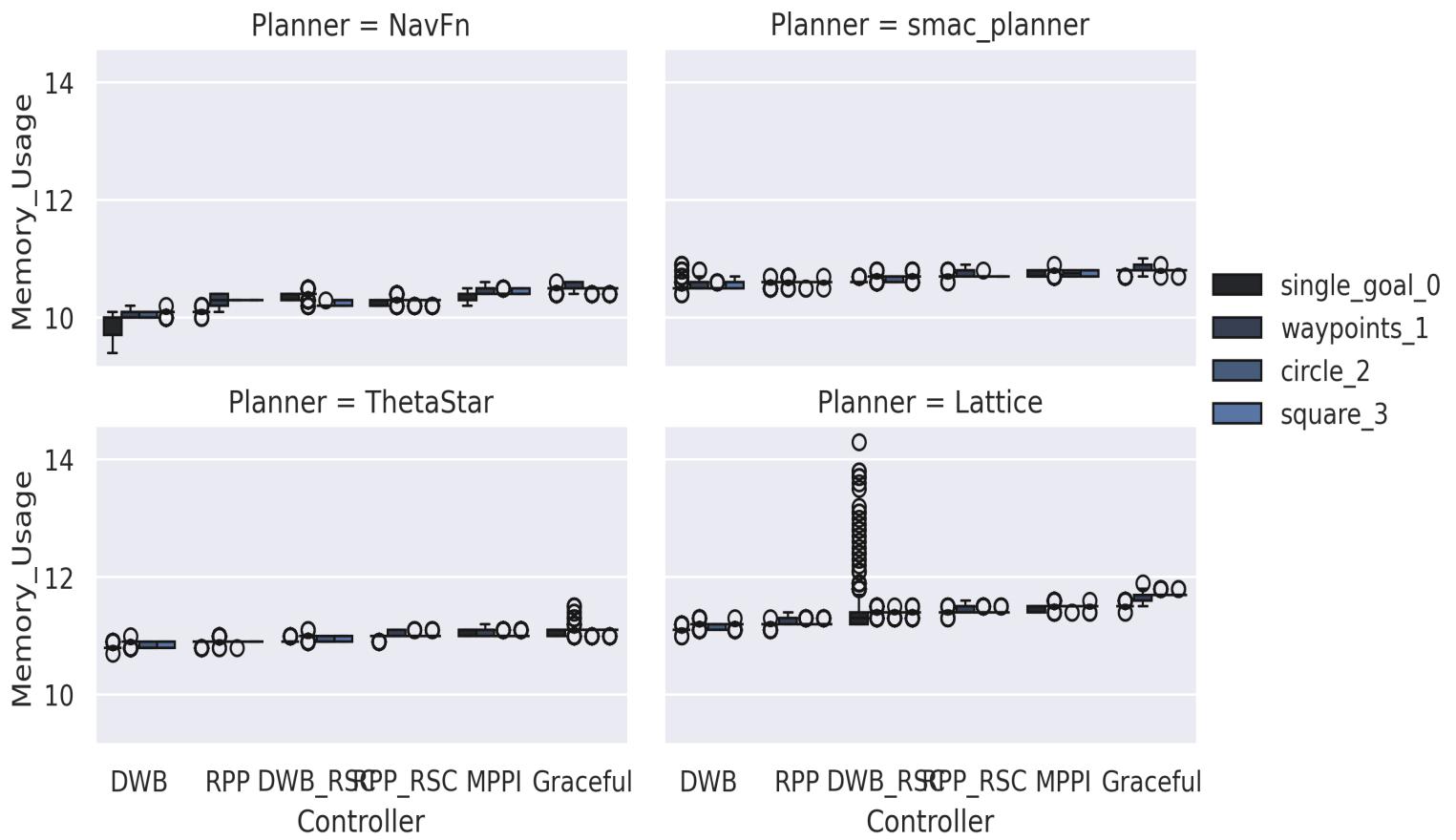
## Complex Distribution of Navigation\_time by Planner, Controller, and Trajectory Type



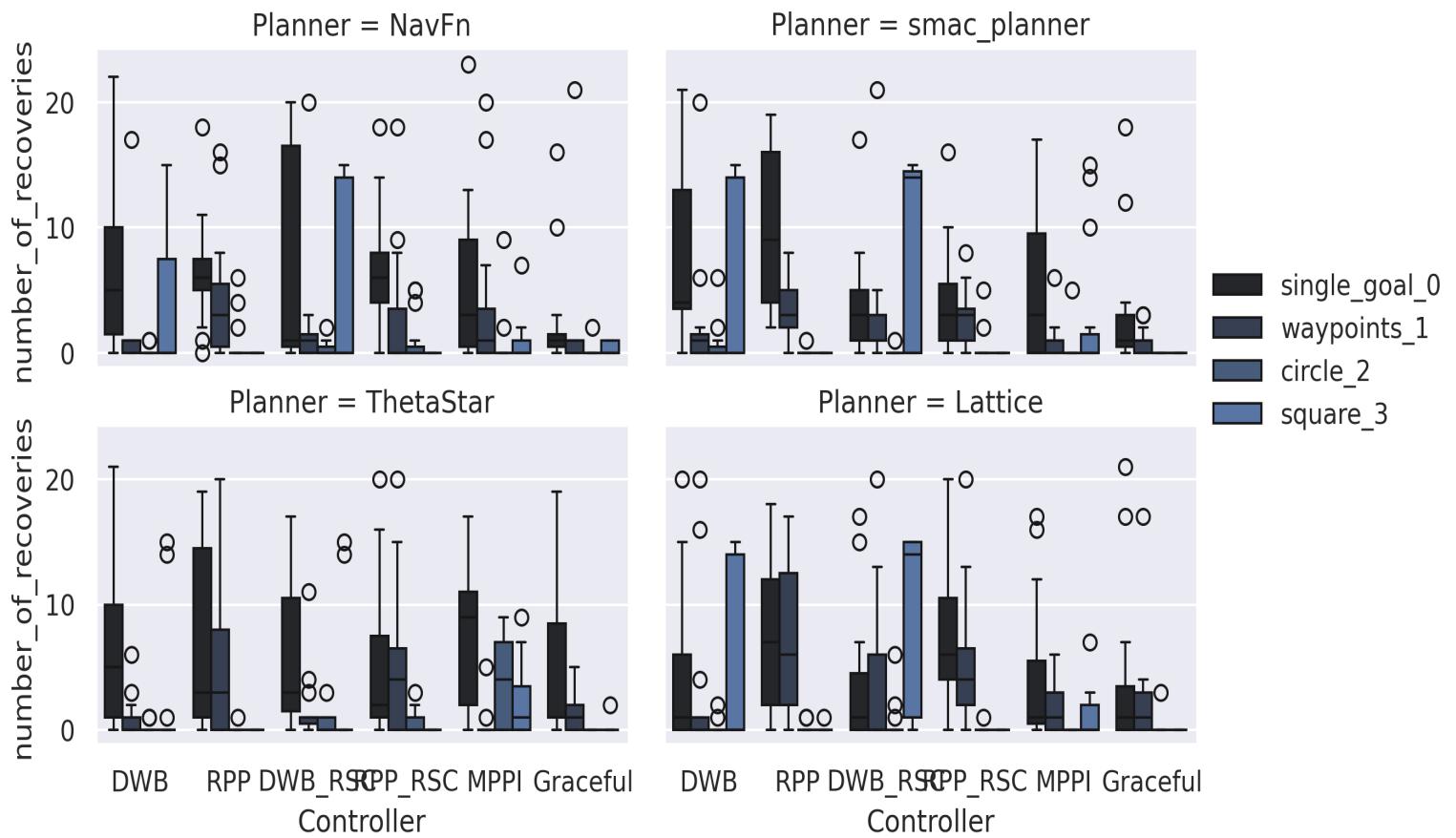
## Complex Distribution of CPU\_Usage by Planner, Controller, and Trajectory Type



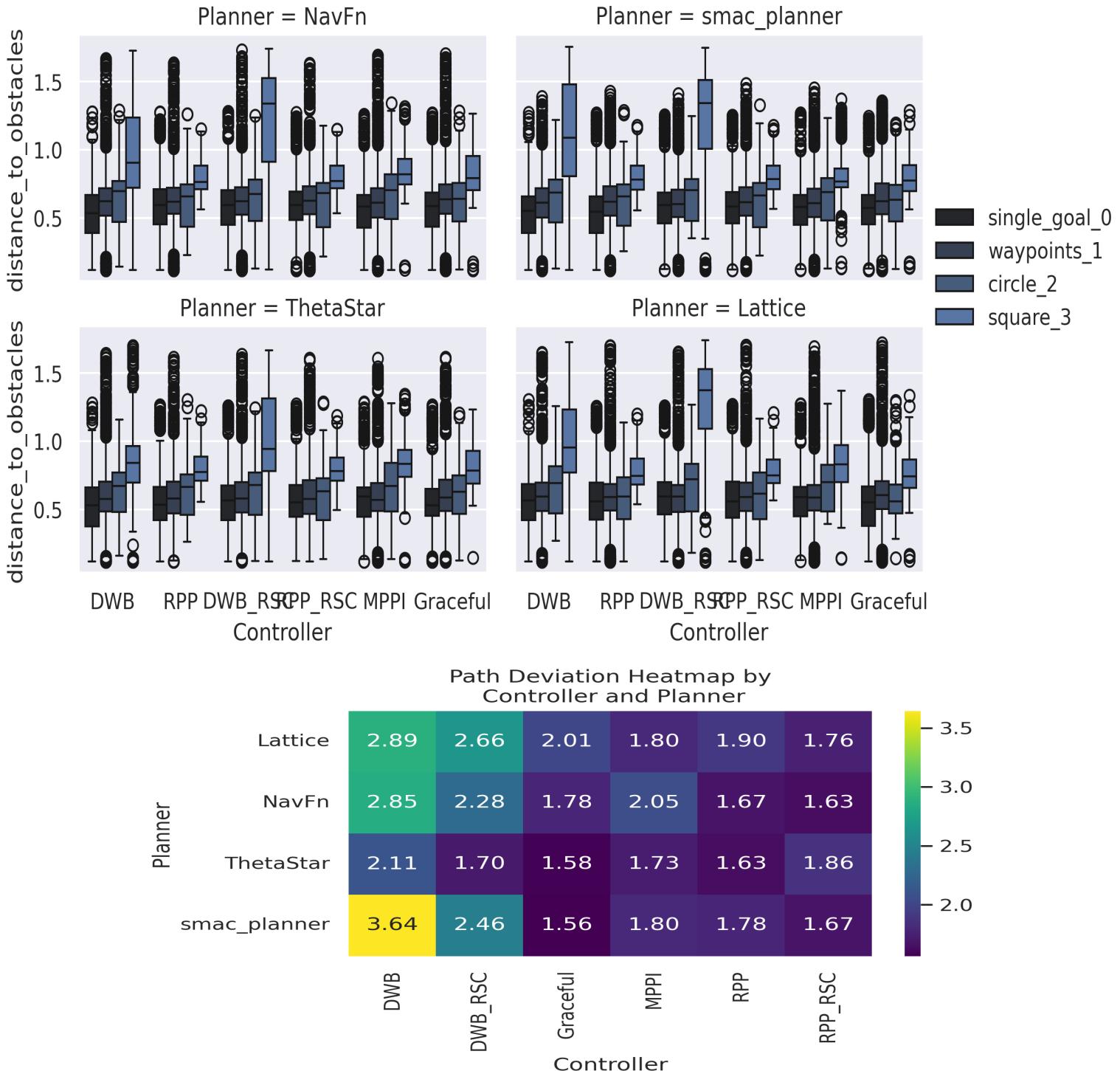
## Complex Distribution of Memory\_Usage by Planner, Controller, and Trajectory Type

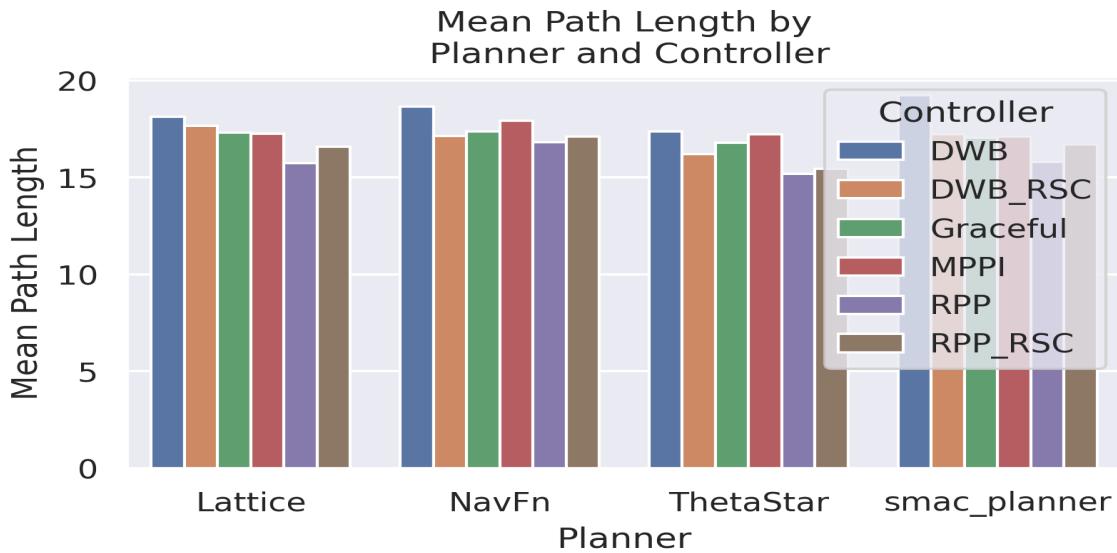


## Complex Distribution of number\_of\_recoveries by Planner, Controller, and Trajectory Type



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



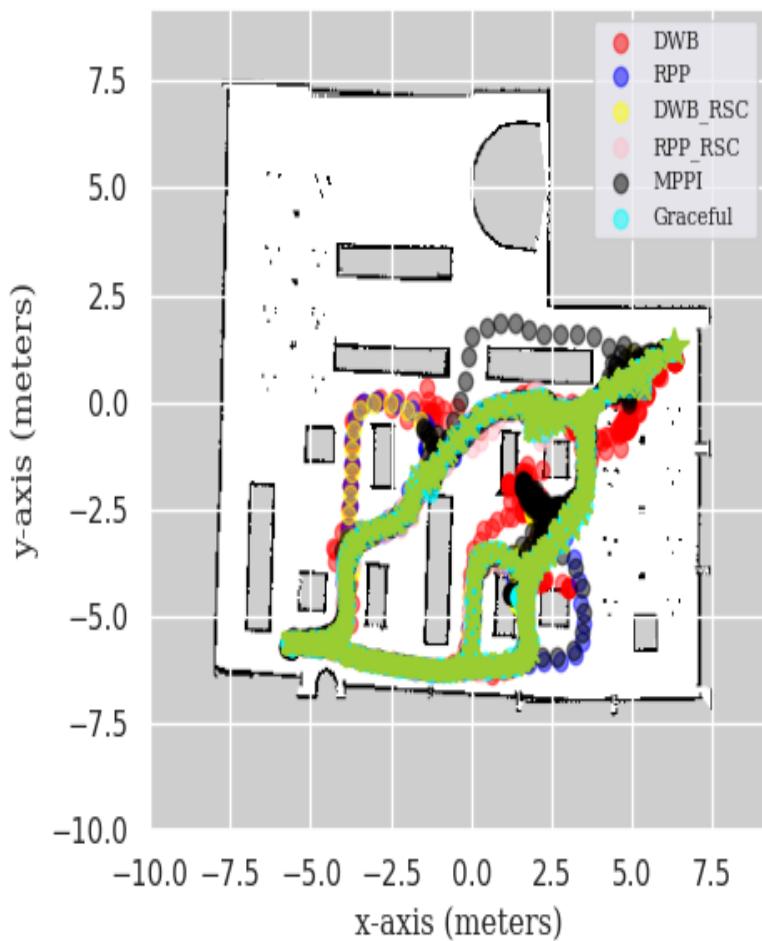


**-Global planner: NavFn**

Traveled path

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

■ Global planner path   \* Waypoints   ★ Initial pose



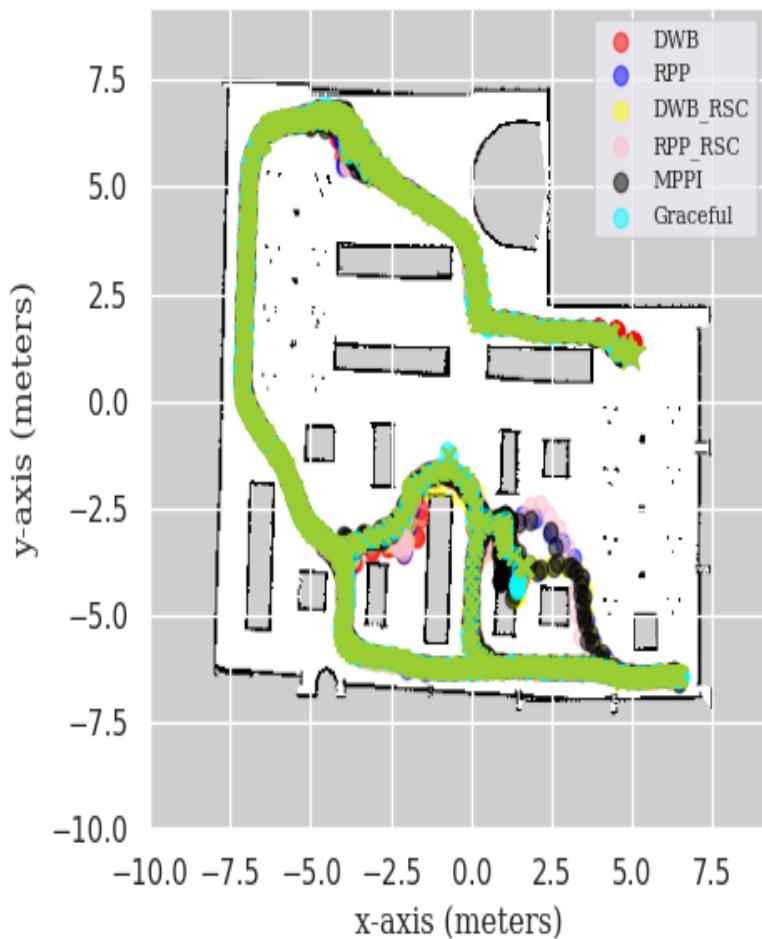
**-Global planner: NavFn**

Traveled path

**-Trajectory type: waypoints\_1**

 Global planner path  Waypoints

 Initial pose



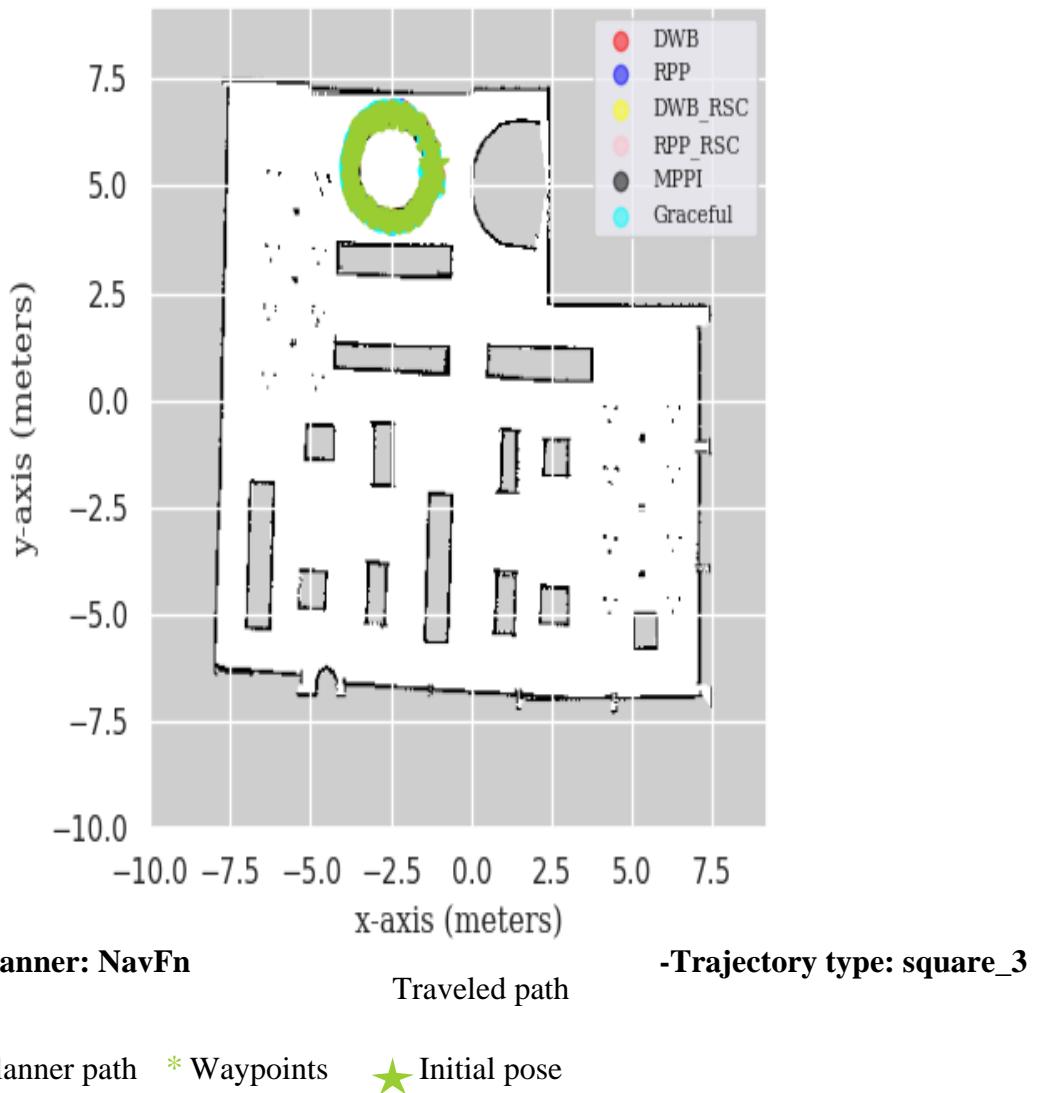
**-Global planner: NavFn**

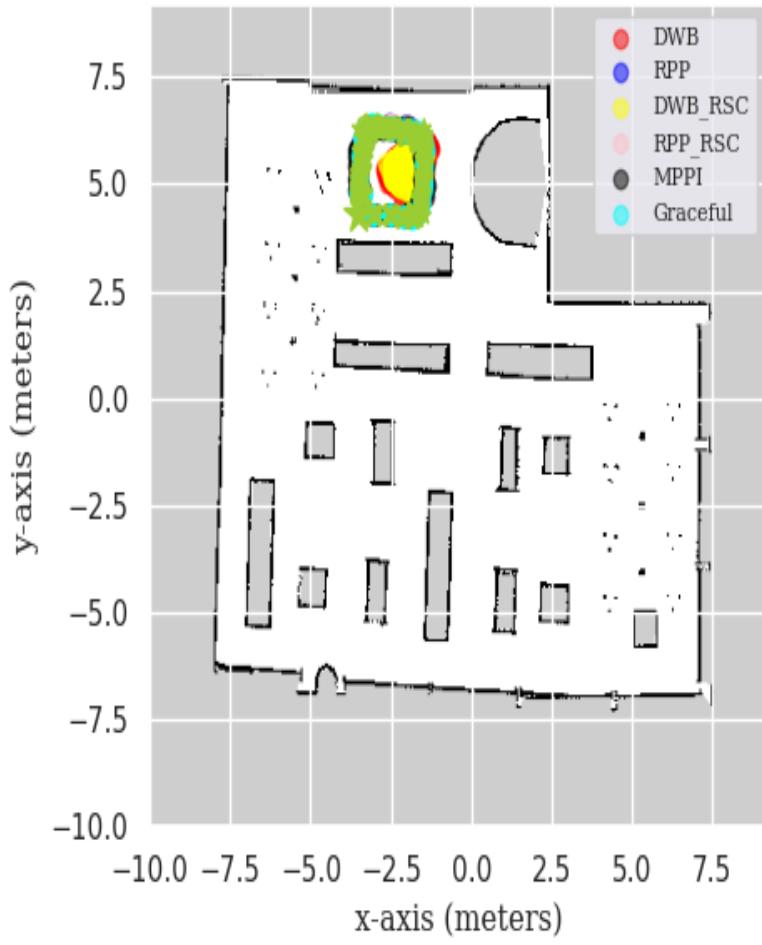
Traveled path

**-Trajectory type: circle\_2**

 Global planner path  Waypoints

 Initial pose





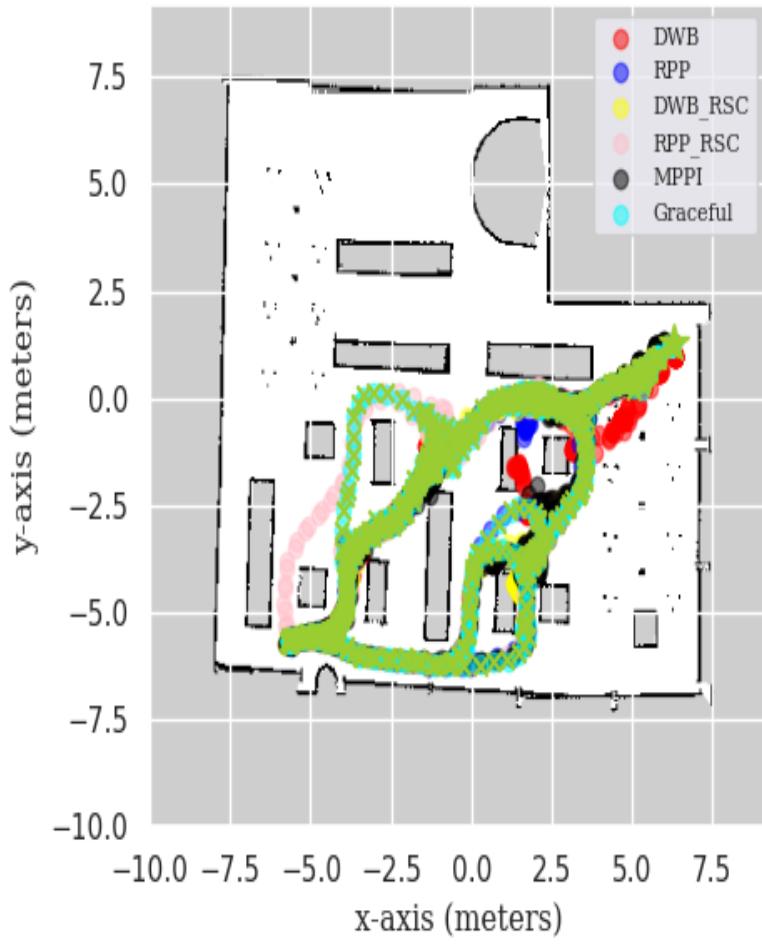
-Global planner: smac\_planner

Traveled path

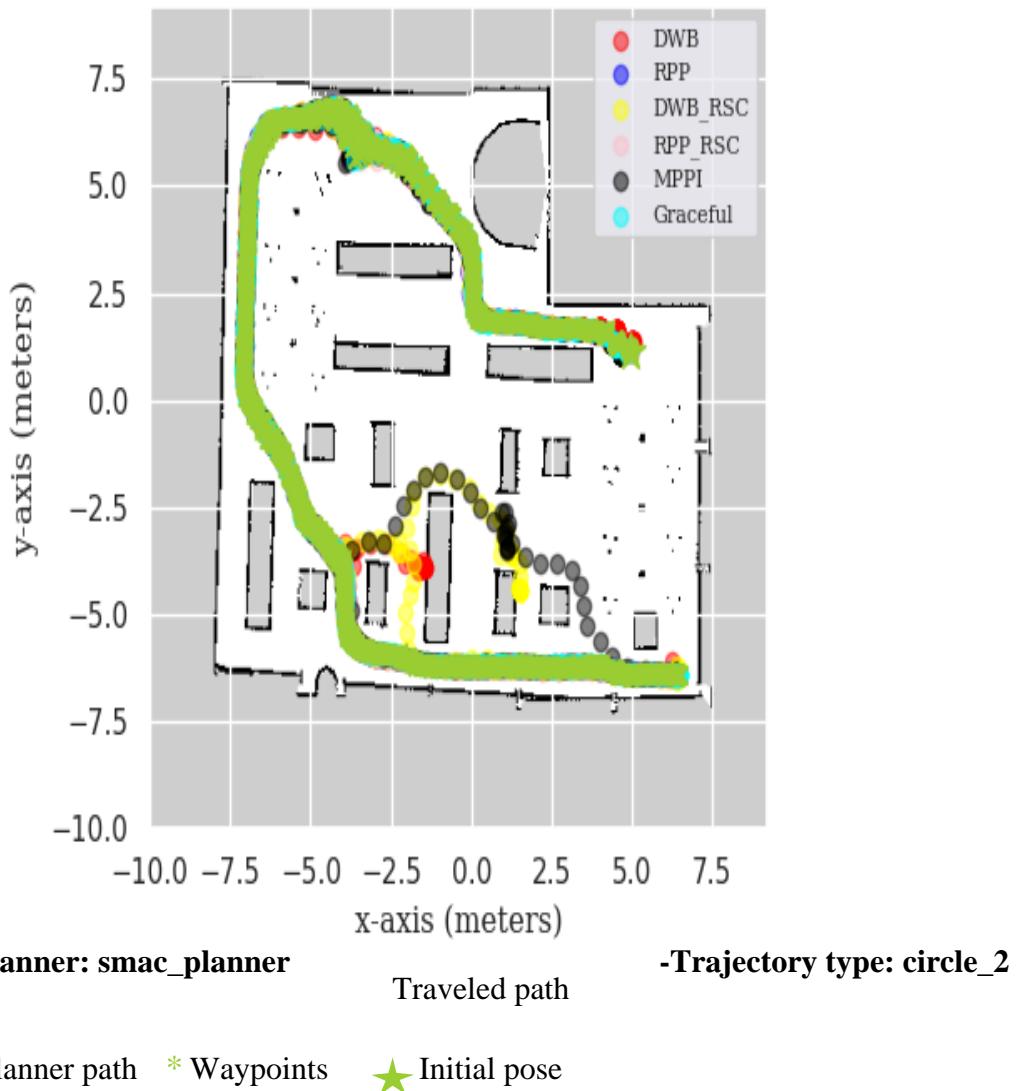
-Trajectory type: single\_goal\_0

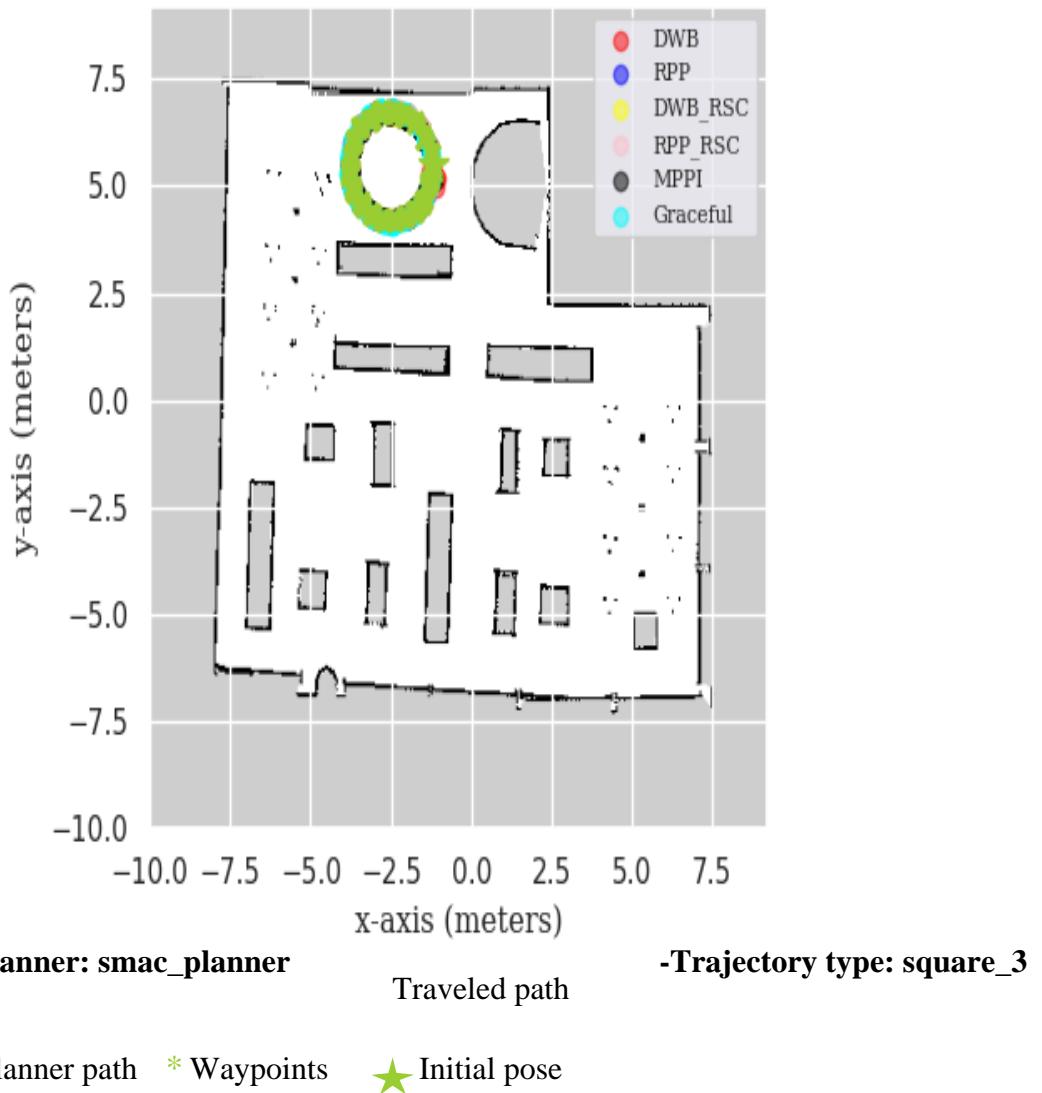
✖ Global planner path    \* Waypoints

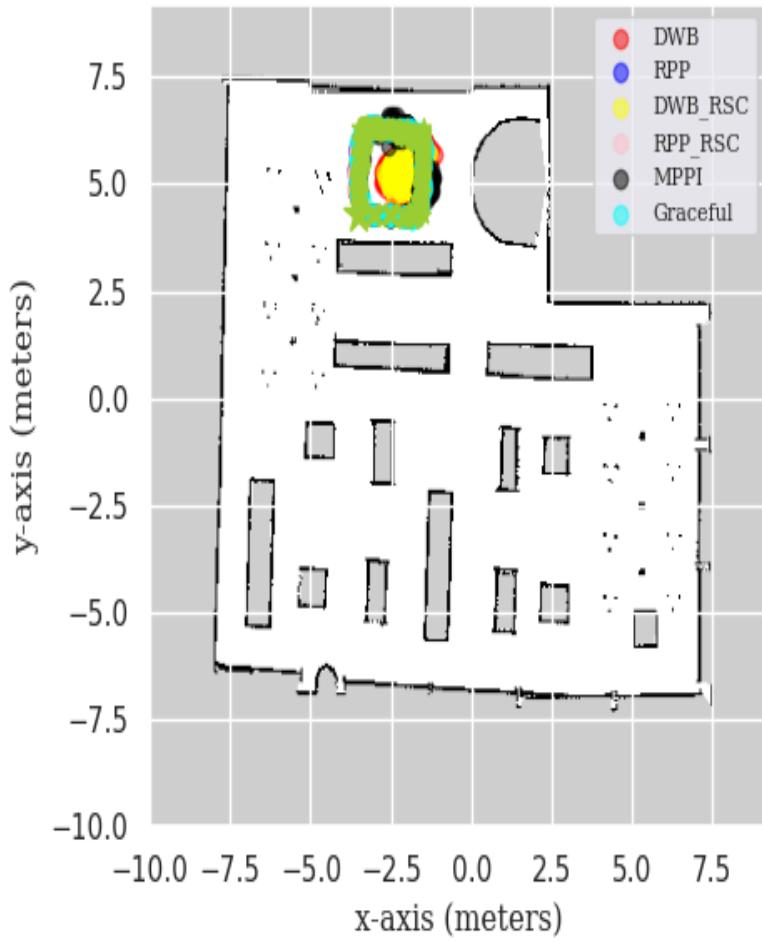
★ Initial pose



■ Global planner path   \* Waypoints   ★ Initial pose





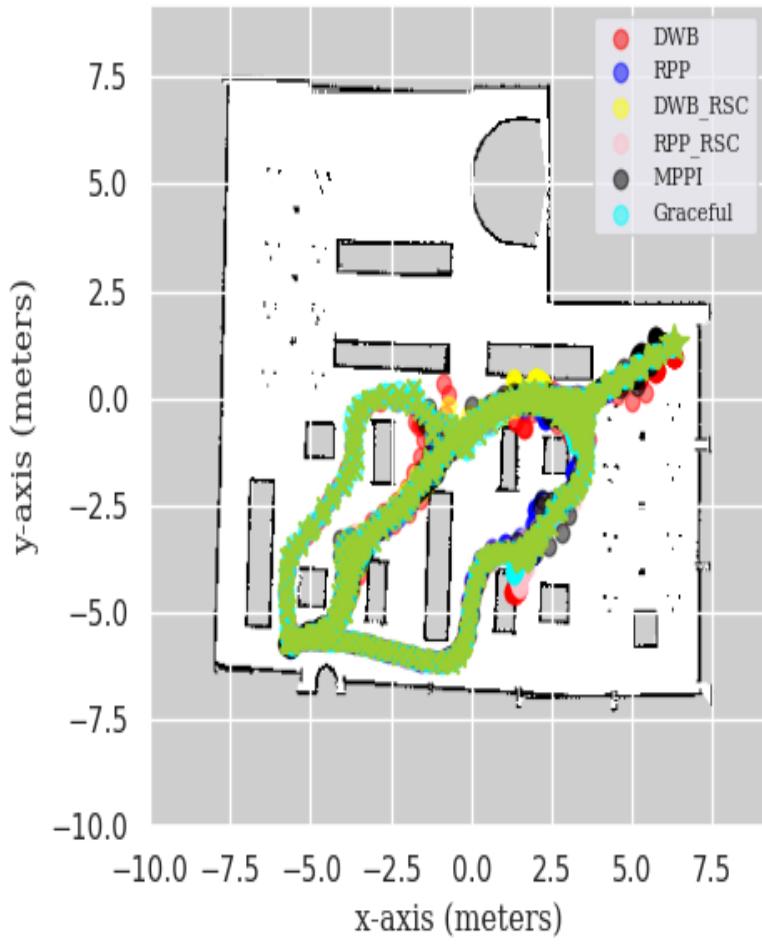


-Global planner: ThetaStar

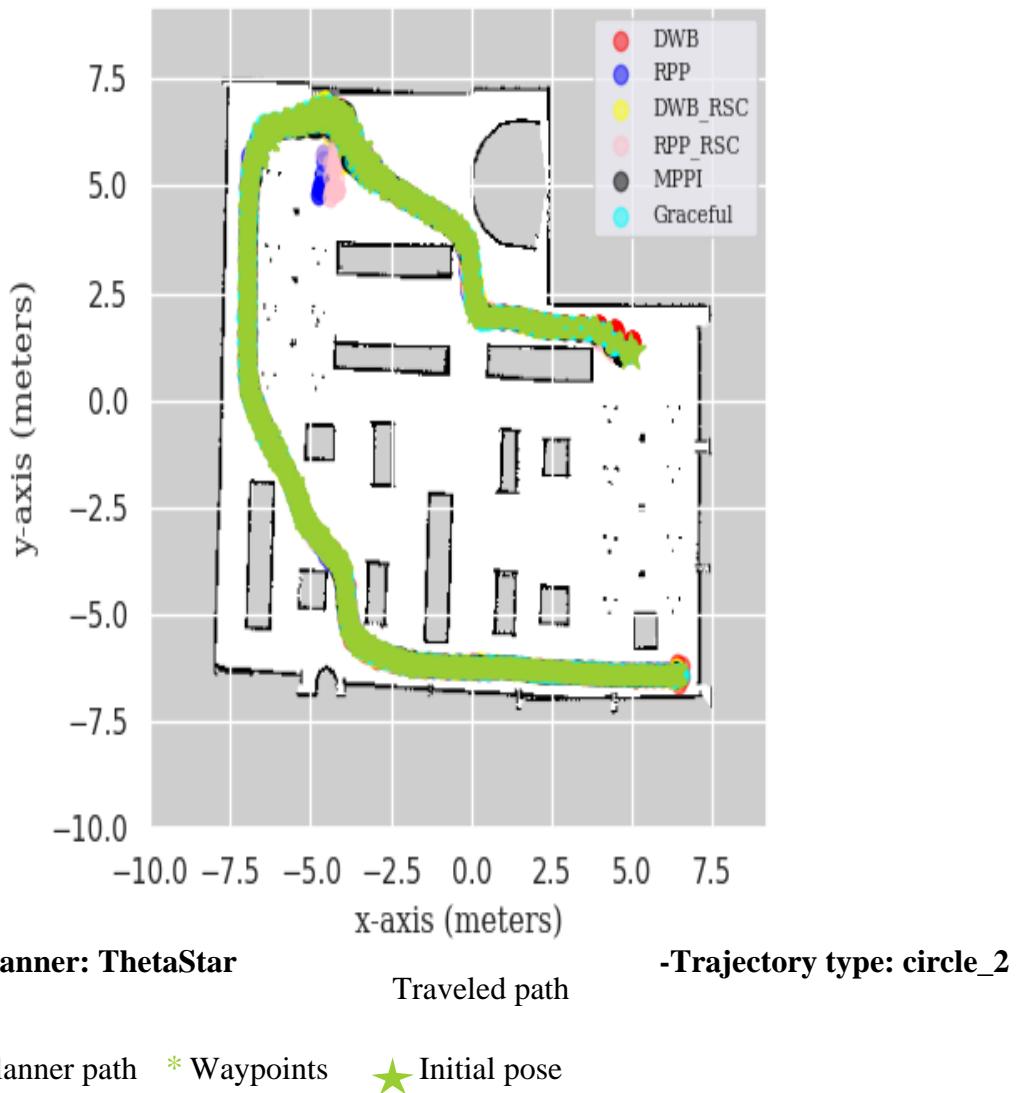
Traveled path

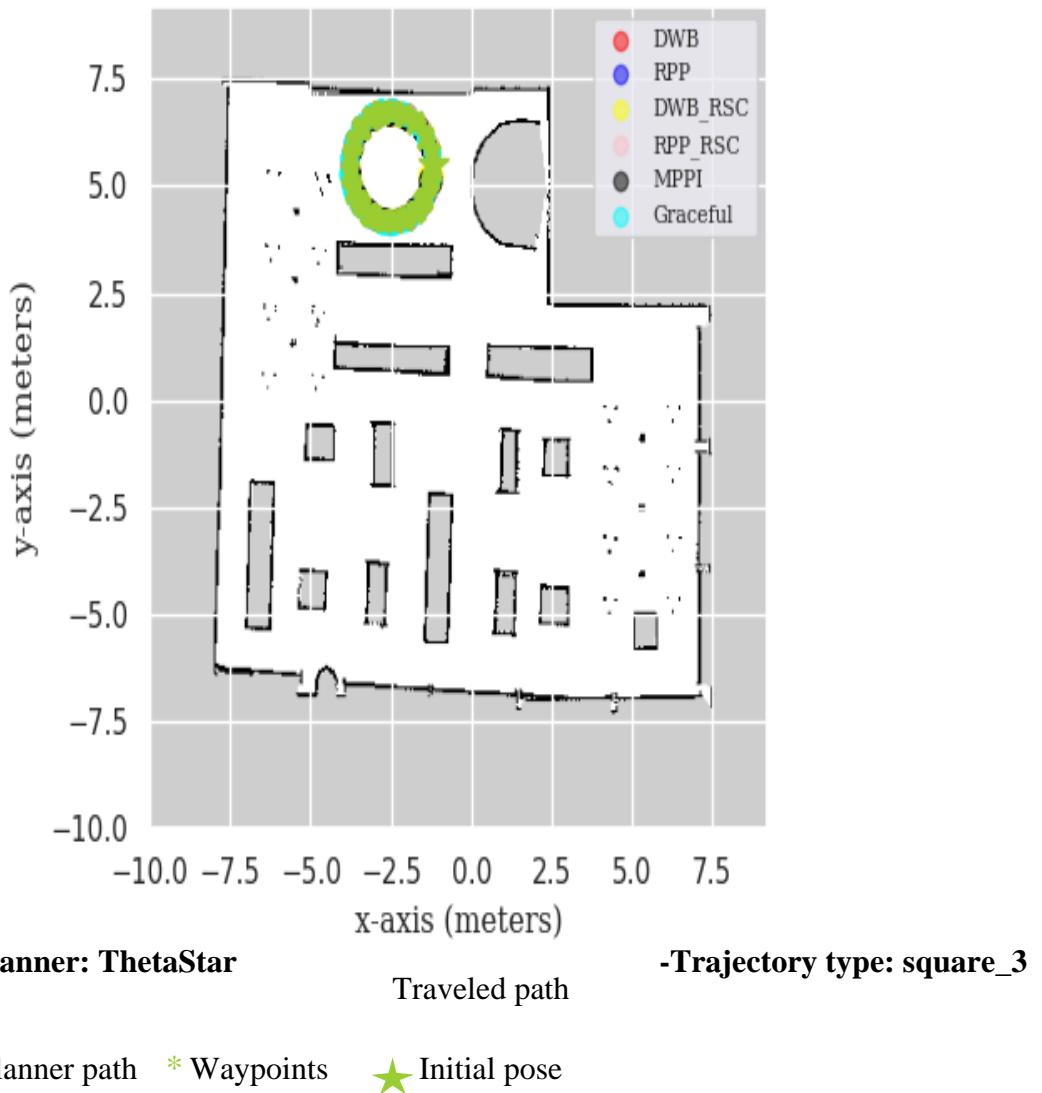
-Trajectory type: single\_goal\_0

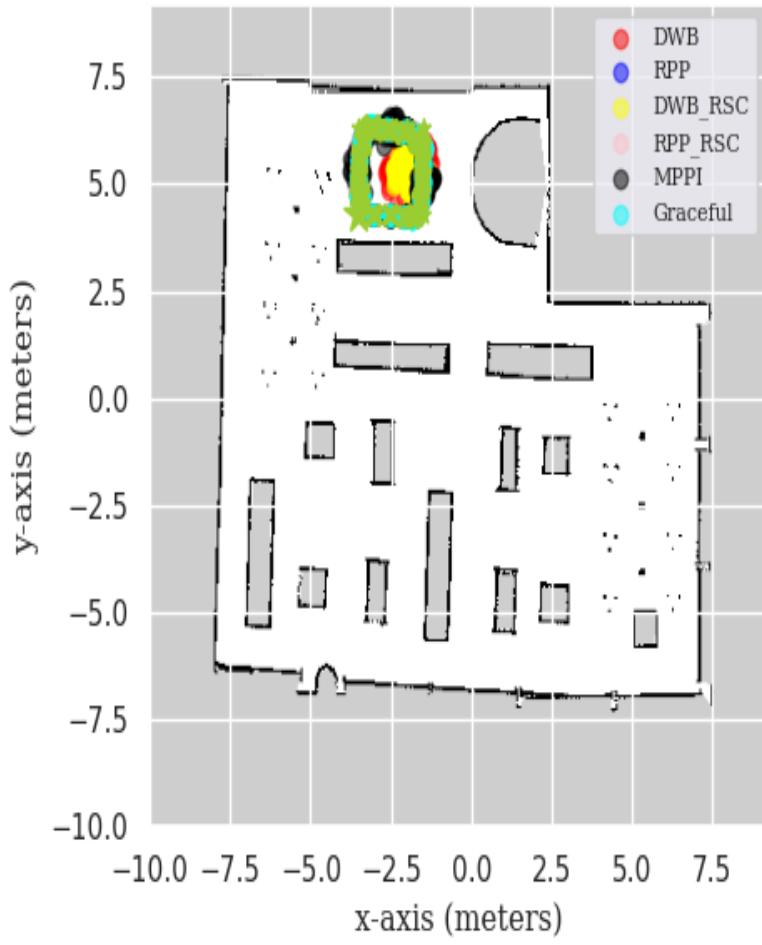
■ Global planner path   \* Waypoints   ★ Initial pose



■ Global planner path   \* Waypoints   ★ Initial pose



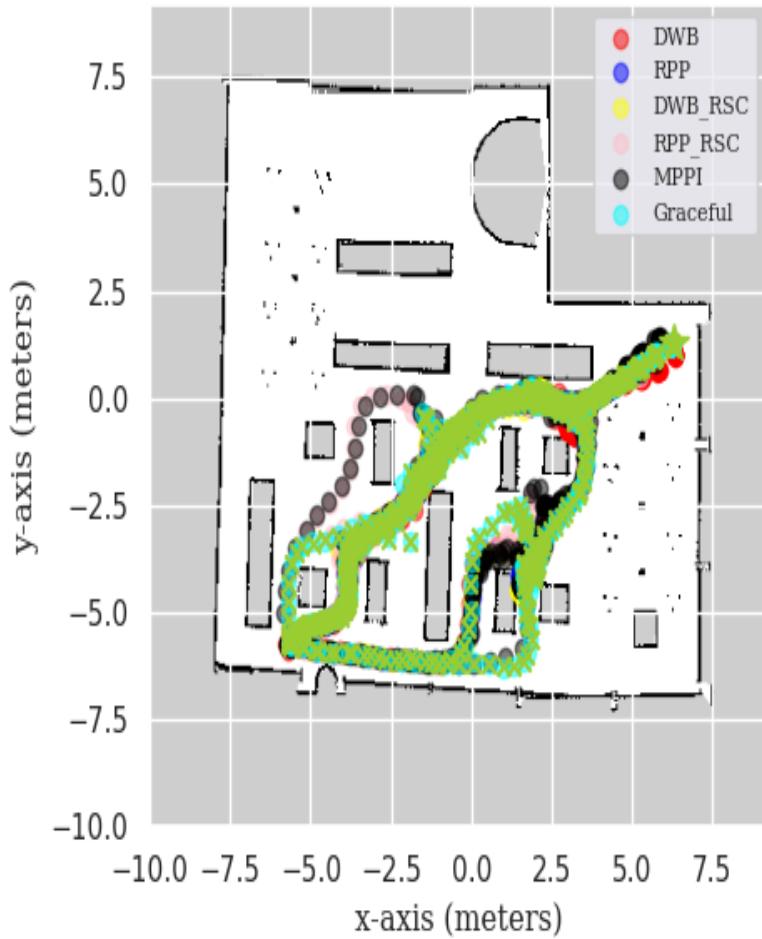




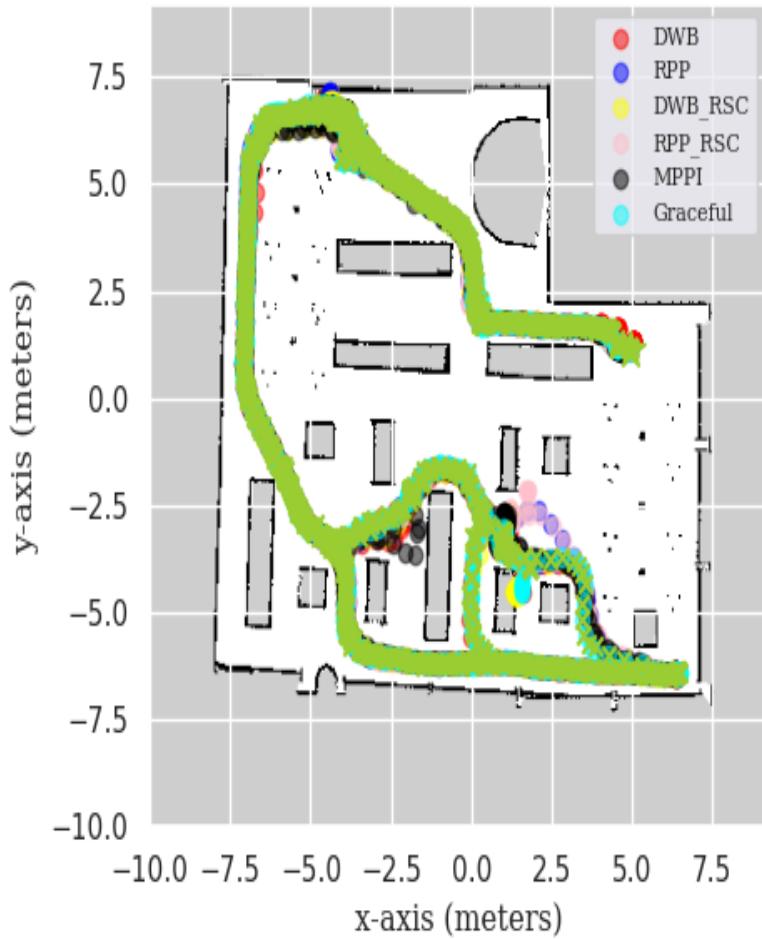
-Global planner: Lattice

-Trajectory type: single\_goal\_0

■ Global planner path   \* Waypoints   ★ Initial pose



Traveled path



-Global planner: Lattice

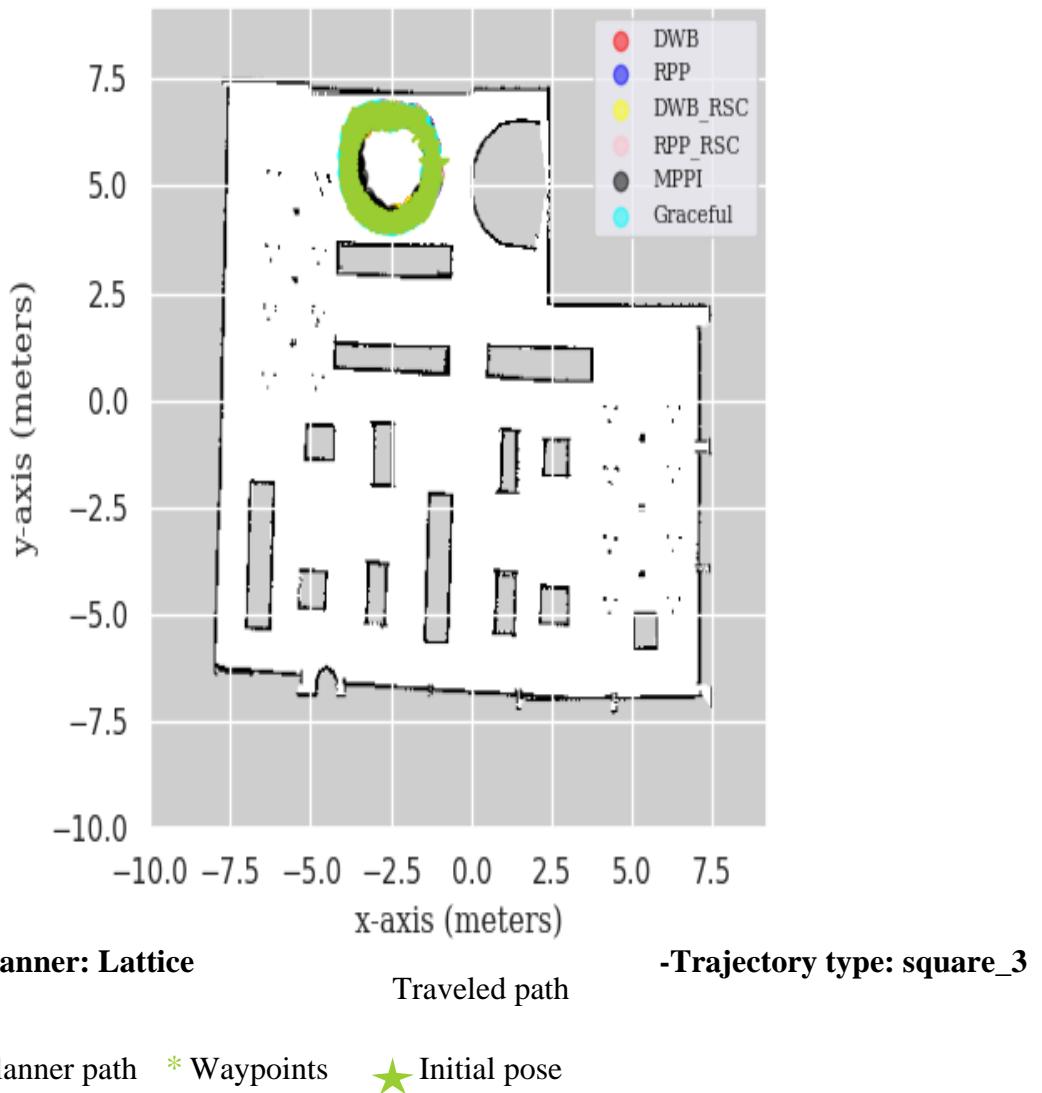
Traveled path

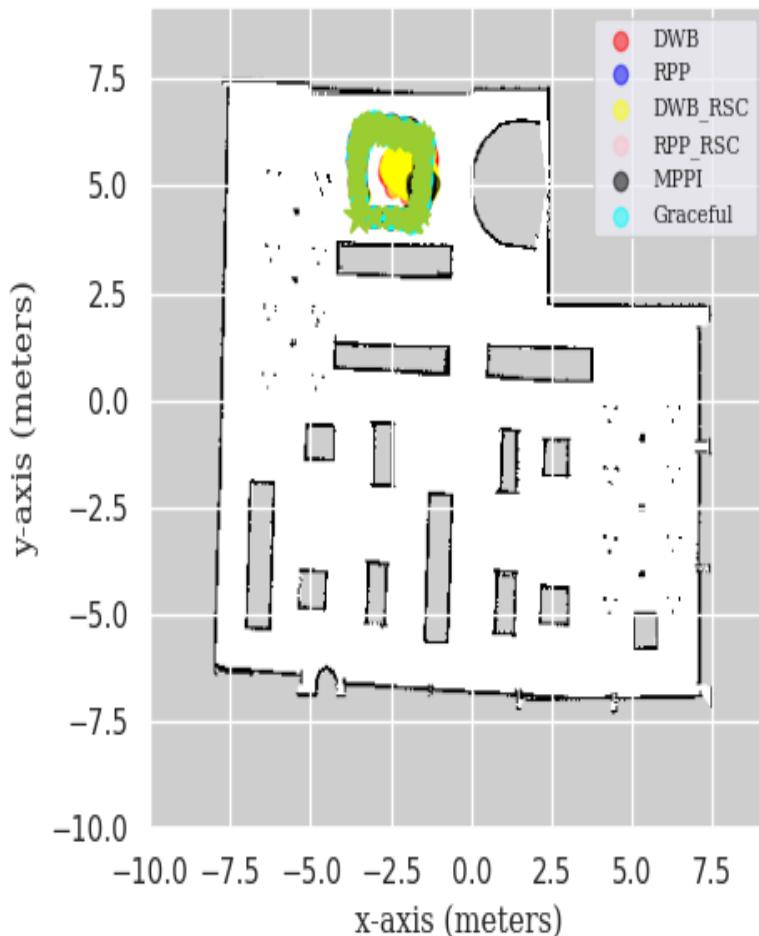
-Trajectory type: circle\_2

x Global planner path

\* Waypoints

★ Initial pose





## Failure report

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

Global planner: smac_planner		
Controller: Graceful experiment#:45 iteration#:9		
Logger_name	Level	Message
controller_server	ERROR	Invalid path, Path is empty.