

# Bookstore\_Experiment\_1

## 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	93.33	85.64	19.21	28.7	9.71	9.9	1.93	14.33	0.12	1.2
DWB	waypoints_1	100.0	155.86	20.55	30.3	9.94	10.1	0.00	37.22	0.12	2.89
DWB	circle_2	100.0	39.13	18.26	23.4	9.90	9.9	0.40	7.29	0.15	0.74
DWB	square_3	46.67	143.60	18.91	27.1	9.94	10.1	7.73	21.85	0.12	8.9
RPP	single_goal_0	100.0	68.52	18.27	25.3	9.96	10.0	0.40	15.03	0.12	0.96
RPP	waypoints_1	100.0	152.64	19.51	28.4	10.07	10.2	0.00	37.03	0.12	2.93
RPP	circle_2	100.0	34.45	17.18	24.7	10.00	10.1	0.40	7.36	0.14	0.73
RPP	square_3	100.0	33.66	16.54	22.3	10.01	10.1	0.00	6.38	0.66	0.93
DWB_RSC	single_goal_0	100.0	71.29	19.87	30.3	10.07	10.1	0.60	15.06	0.12	0.96
DWB_RSC	waypoints_1	93.33	166.75	21.35	30.9	10.13	10.2	1.53	37.09	0.12	3.19
DWB_RSC	circle_2	100.0	38.06	18.55	25.1	10.09	10.1	0.13	7.27	0.14	0.66
DWB_RSC	square_3	60.0	106.87	19.49	28.2	10.10	10.2	6.60	9.00	0.12	3.15
RPP_RSC	single_goal_0	100.0	73.94	18.69	26.4	10.11	10.2	2.20	15.11	0.13	1.11
RPP_RSC	waypoints_1	100.0	153.59	20.03	26.8	10.19	10.3	0.00	37.11	0.12	2.86
RPP_RSC	circle_2	100.0	34.03	17.33	24.5	10.15	10.2	0.07	7.36	0.18	0.7
RPP_RSC	square_3	100.0	33.39	17.91	23.8	10.13	10.2	0.00	6.38	0.67	0.92
MPPI	single_goal_0	100.0	110.98	21.30	28.6	10.20	10.3	4.13	15.22	0.12	1.5
MPPI	waypoints_1	100.0	156.93	22.75	31.4	10.28	10.3	0.93	36.77	0.13	2.59
MPPI	circle_2	100.0	30.20	20.59	27.8	10.21	10.3	0.00	7.08	0.14	0.62
MPPI	square_3	100.0	44.84	20.76	27.4	10.21	10.3	0.60	8.48	0.12	0.83
Graceful	single_goal_0	100.0	78.64	19.68	26.6	10.25	10.3	0.07	15.29	0.12	0.89
Graceful	waypoints_1	100.0	175.16	20.95	29.0	10.32	10.4	0.00	37.64	0.12	2.65
Graceful	circle_2	100.0	43.37	19.13	24.4	10.27	10.3	0.07	7.58	0.12	1.18
Graceful	square_3	100.0	42.96	18.69	24.6	10.28	10.3	0.27	6.59	0.12	0.86

### -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	100.0	78.34	20.99	28.3	10.30	10.3	1.60	14.98	0.13	1.06
DWB	waypoints_1	100.0	154.54	21.71	28.8	10.33	10.4	0.00	36.90	0.12	3.06
DWB	circle_2	100.0	36.59	20.61	27.8	10.31	10.4	0.00	7.25	0.35	0.55
DWB	square_3	46.67	130.45	21.34	31.6	10.37	10.5	7.93	18.38	0.12	7.63
RPP	single_goal_0	100.0	68.74	19.81	27.9	10.39	10.4	1.07	14.78	0.12	1.03
RPP	waypoints_1	100.0	151.71	20.37	45.4	10.44	10.5	0.00	36.88	0.12	3.21
RPP	circle_2	100.0	35.53	19.26	25.0	10.40	10.5	0.67	7.43	0.23	0.65
RPP	square_3	100.0	32.86	19.19	25.2	10.40	10.4	0.00	6.35	0.14	0.87
DWB_RSC	single_goal_0	100.0	73.31	22.19	29.7	10.40	10.4	1.00	14.92	0.14	0.92
DWB_RSC	waypoints_1	80.0	174.09	22.41	29.4	10.47	10.6	3.00	36.38	0.12	4.24
DWB_RSC	circle_2	100.0	38.58	21.68	28.7	10.45	10.5	0.20	7.33	0.14	0.57
DWB_RSC	square_3	46.67	126.83	21.99	29.9	10.49	10.6	8.13	9.04	0.12	3.47
RPP_RSC	single_goal_0	86.67	68.25	21.07	27.8	10.50	10.6	4.47	13.23	0.13	1.05
RPP_RSC	waypoints_1	100.0	151.87	21.36	28.4	10.55	10.7	0.00	36.90	0.12	3.18
RPP_RSC	circle_2	100.0	36.97	20.48	26.3	10.50	10.5	1.20	7.44	0.23	0.69
RPP_RSC	square_3	100.0	32.86	19.99	26.7	10.50	10.6	0.00	6.33	0.68	0.92
MPPI	single_goal_0	100.0	86.46	23.38	29.7	10.51	10.6	2.27	14.84	0.12	1.19
MPPI	waypoints_1	100.0	153.62	23.38	31.1	10.57	10.7	0.40	37.22	0.12	3.0
MPPI	circle_2	100.0	31.13	22.50	29.1	10.52	10.6	0.00	7.11	0.12	0.65
MPPI	square_3	93.33	62.79	22.93	35.4	10.56	11.0	2.20	8.95	0.12	1.43
Graceful	single_goal_0	100.0	76.23	21.65	28.1	10.59	10.7	0.40	15.06	0.13	0.94
Graceful	waypoints_1	100.0	172.93	21.87	28.3	10.62	10.7	0.00	37.19	0.12	2.75
Graceful	circle_2	100.0	40.58	21.31	28.3	10.60	10.6	0.00	7.57	0.12	0.99
Graceful	square_3	100.0	38.19	20.83	26.6	10.60	10.6	0.07	6.48	0.14	0.72

### -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	100.0	74.77	23.56	29.9	10.60	10.7	1.07	14.87	0.12	1.03
DWB	waypoints_1	100.0	153.73	23.29	30.1	10.65	10.8	0.13	36.39	0.12	2.76
DWB	circle_2	100.0	38.32	22.51	29.2	10.61	10.7	0.20	7.30	0.35	0.5
DWB	square_3	66.67	106.64	23.17	41.5	10.66	10.7	5.67	16.37	0.12	5.94
RPP	single_goal_0	100.0	66.23	22.42	27.6	10.68	10.7	0.80	14.64	0.15	0.95
RPP	waypoints_1	100.0	149.33	21.78	28.9	10.71	10.8	0.00	36.29	0.12	2.72

RPP	circle_2	100.0	35.51	21.72	27.9	10.70	10.8	0.60	7.43	0.23	0.63
RPP	square_3	100.0	32.97	21.72	36.0	10.70	10.7	0.00	6.35	0.13	0.87
DWB_RSC	single_goal_0	100.0	73.72	24.08	31.8	10.70	10.8	0.93	14.77	0.12	0.95
DWB_RSC	waypoints_1	100.0	154.27	23.79	31.2	10.77	10.8	0.13	36.31	0.12	2.63
DWB_RSC	circle_2	100.0	38.19	22.96	29.1	10.71	10.8	0.13	7.29	0.13	0.54
DWB_RSC	square_3	66.67	100.33	23.00	30.5	10.76	10.8	5.80	9.22	0.13	3.02
RPP_RSC	single_goal_0	100.0	68.75	22.53	30.1	10.78	10.8	1.07	14.70	0.13	1.03
RPP_RSC	waypoints_1	100.0	149.06	22.20	28.4	10.81	11.0	0.27	36.25	0.12	2.84
RPP_RSC	circle_2	100.0	35.38	21.46	26.7	10.80	10.8	0.40	7.43	0.24	0.62
RPP_RSC	square_3	100.0	32.70	21.81	27.0	10.80	10.8	0.00	6.35	0.68	0.87
MPPI	single_goal_0	100.0	140.94	24.61	32.9	10.82	10.9	7.73	15.02	0.13	1.7
MPPI	waypoints_1	100.0	146.93	24.69	31.6	10.88	11.0	0.33	36.04	0.12	2.3
MPPI	circle_2	100.0	30.04	24.15	30.0	10.86	10.9	0.00	7.06	0.13	0.59
MPPI	square_3	86.67	61.20	23.64	30.0	10.87	10.9	2.33	8.21	0.14	1.16
Graceful	single_goal_0	100.0	73.03	23.00	30.3	10.88	10.9	0.60	14.83	0.14	0.88
Graceful	waypoints_1	100.0	164.65	22.99	28.4	10.91	11.0	0.00	36.64	0.12	2.53
Graceful	circle_2	100.0	41.49	22.69	29.5	10.90	10.9	0.07	7.65	0.13	0.98
Graceful	square_3	100.0	38.33	21.52	28.3	10.90	10.9	0.07	6.45	0.15	0.64

### -Global planner: Lattice

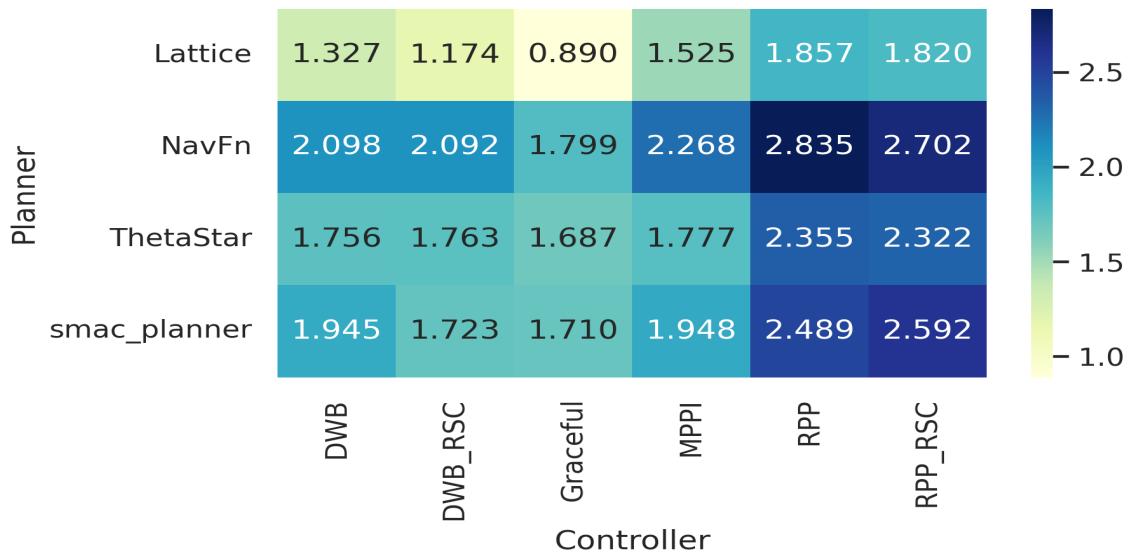
Controller type	Trajectory type	Success rate (%)	Average execution time (sec)	CPU(%)		Memory usage(%)		Average number of recoveries	Average path length(m)	Min distance to obstacles(m)	Average Path Deviation
				Mean	Max	Mean	Max				
DWB	single_goal_0	93.33	74.09	24.70	33.5	10.95	11.0	1.93	14.14	0.12	1.22
DWB	waypoints_1	100.0	155.35	23.90	30.9	11.02	11.1	0.07	36.98	0.12	2.97
DWB	circle_2	100.0	35.76	24.33	31.7	10.99	11.0	0.00	7.06	0.37	0.72
DWB	square_3	40.0	169.58	24.23	31.5	11.00	11.1	8.73	25.92	0.12	9.92
RPP	single_goal_0	86.67	66.34	23.27	29.6	11.02	11.1	2.67	14.53	0.12	1.05
RPP	waypoints_1	100.0	152.37	22.79	29.1	11.10	11.2	0.00	37.00	0.12	3.18
RPP	circle_2	100.0	36.45	22.92	30.0	11.08	11.1	0.07	7.64	0.12	0.7
RPP	square_3	100.0	34.17	21.92	27.5	11.08	11.2	0.00	6.61	0.56	0.86
DWB_RSC	single_goal_0	100.0	72.79	24.73	32.6	11.10	11.2	0.53	14.92	0.12	1.05
DWB_RSC	waypoints_1	93.33	164.00	24.16	30.6	11.17	11.3	1.13	37.06	0.13	3.45
DWB_RSC	circle_2	100.0	38.98	23.93	31.2	11.13	11.2	0.33	7.18	0.13	0.78
DWB_RSC	square_3	26.67	165.44	23.93	37.2	11.13	11.3	11.47	12.78	0.14	5.11
RPP_RSC	single_goal_0	93.33	65.85	23.88	30.8	11.18	11.3	1.40	14.62	0.14	1.09
RPP_RSC	waypoints_1	100.0	152.10	22.87	29.5	11.26	11.4	0.00	37.01	0.12	3.17
RPP_RSC	circle_2	100.0	36.03	22.70	29.5	11.20	11.3	0.00	7.63	0.12	0.68

RPP_RSC	square_3	100.0	34.06	22.74	28.5	11.20	11.3	0.00	6.59	0.58	0.91
MPPI	single_goal_0	100.0	62.50	25.93	33.3	11.23	11.3	0.27	14.67	0.14	1.03
MPPI	waypoints_1	100.0	158.25	25.43	31.8	11.30	11.4	0.87	37.76	0.12	3.22
MPPI	circle_2	100.0	30.31	25.32	31.2	11.26	11.3	0.00	7.09	0.14	0.67
MPPI	square_3	100.0	52.95	24.59	30.9	11.20	11.3	1.93	8.25	0.12	1.38
Graceful	single_goal_0	100.0	79.69	24.08	31.6	11.27	11.3	0.53	14.97	0.12	1.05
Graceful	waypoints_1	100.0	174.46	23.16	29.9	11.34	11.5	0.00	37.30	0.12	2.97
Graceful	circle_2	100.0	50.69	23.22	29.6	11.30	11.4	0.00	7.88	0.13	1.13
Graceful	square_3	100.0	47.76	23.16	29.3	11.27	11.3	0.00	6.71	0.14	1.15

## 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: 93.06%

Planner: ThetaStar, Success Rate: 96.67%

Planner: smac\_planner, Success Rate: 93.89%

Planner: NavFn, Success Rate: 95.56%

**Controllers' success rate are:**

Controller: Graceful, Success Rate: 100.00%

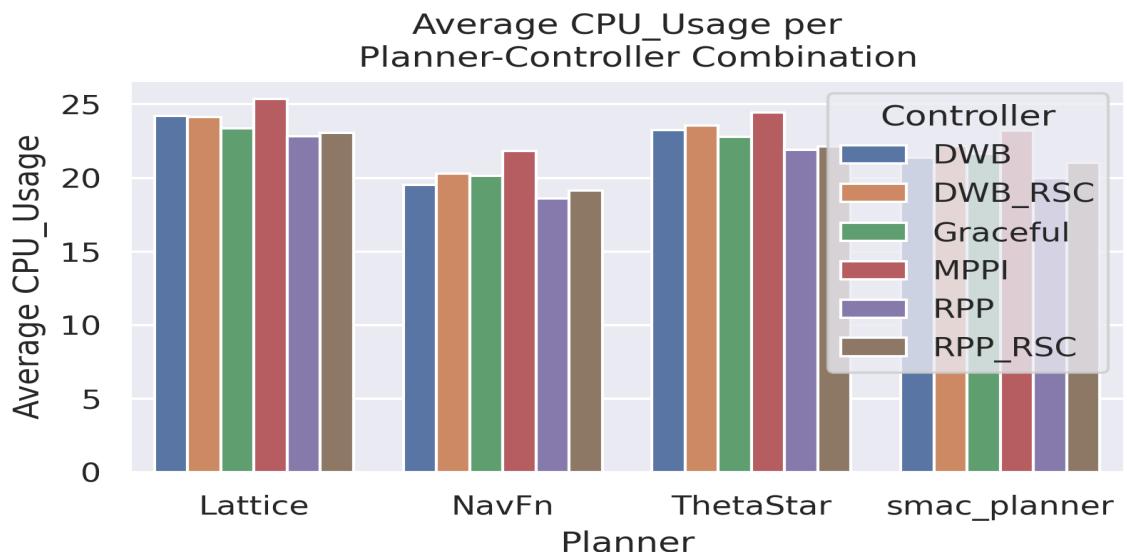
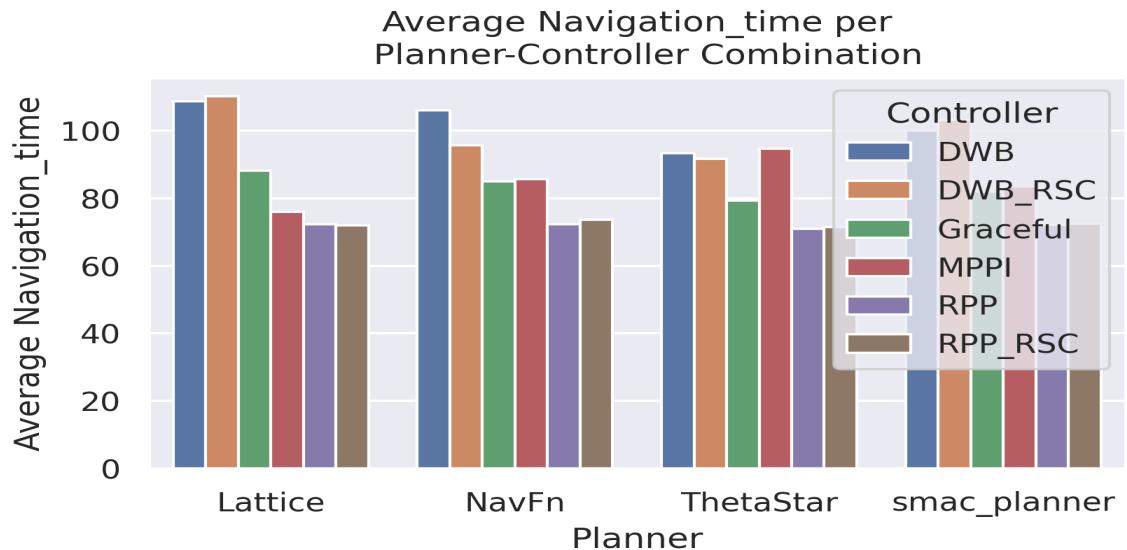
Controller: MPPI, Success Rate: 98.75%

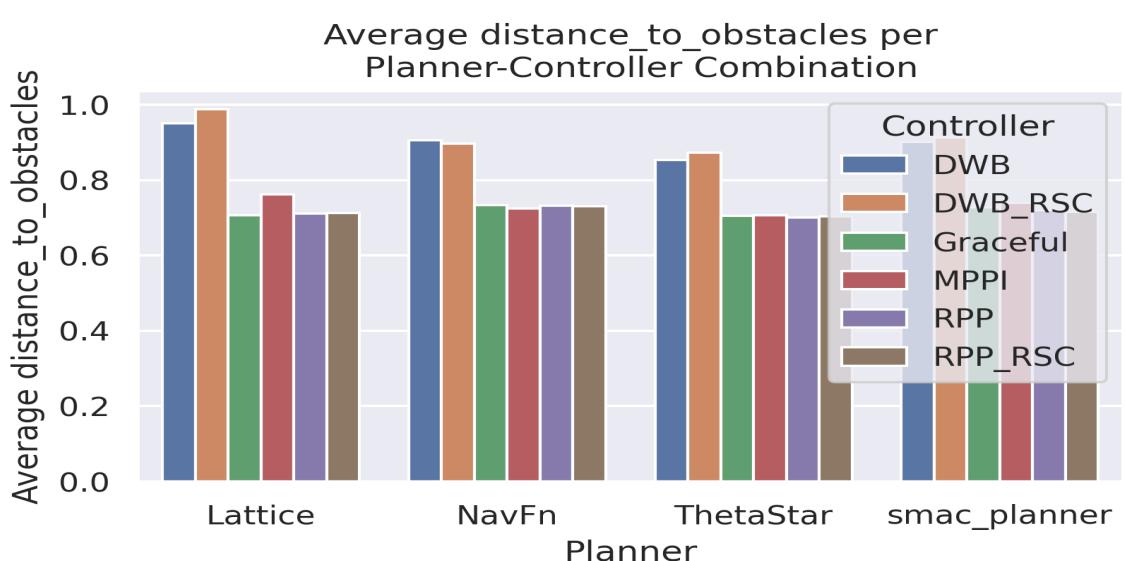
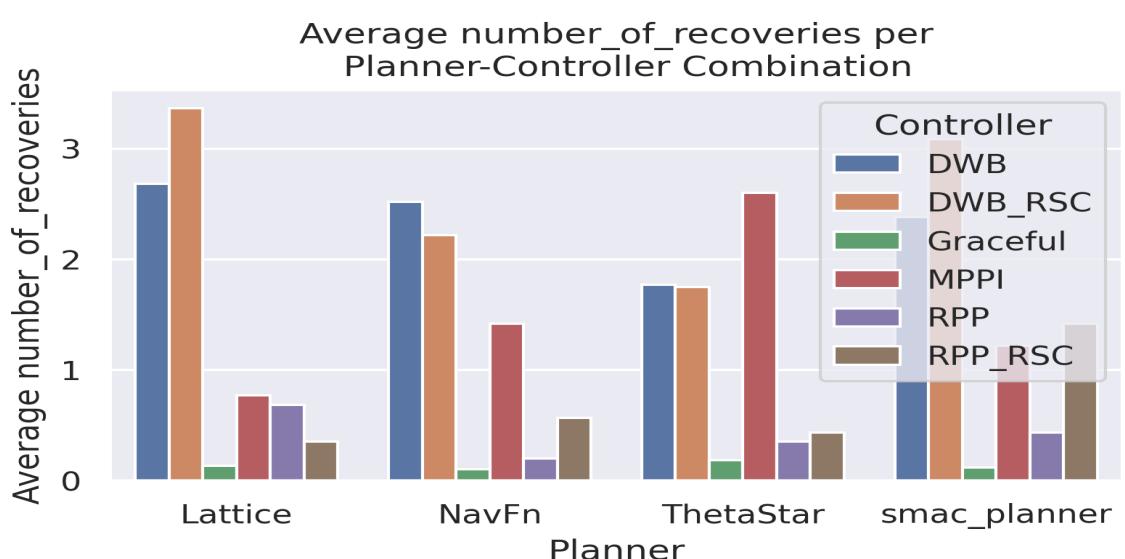
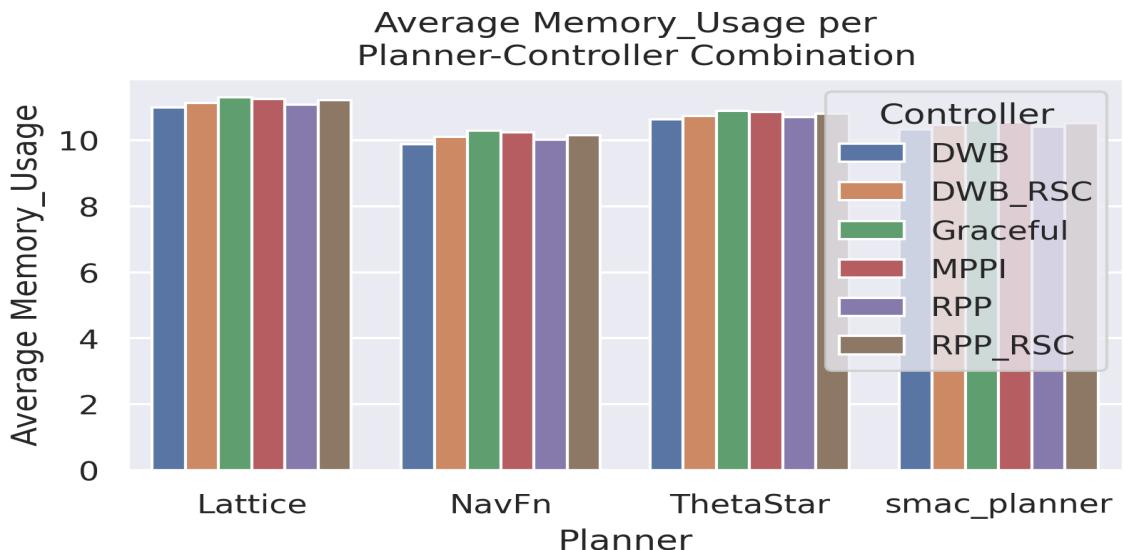
Controller: RPP\_RSC, Success Rate: 98.75%

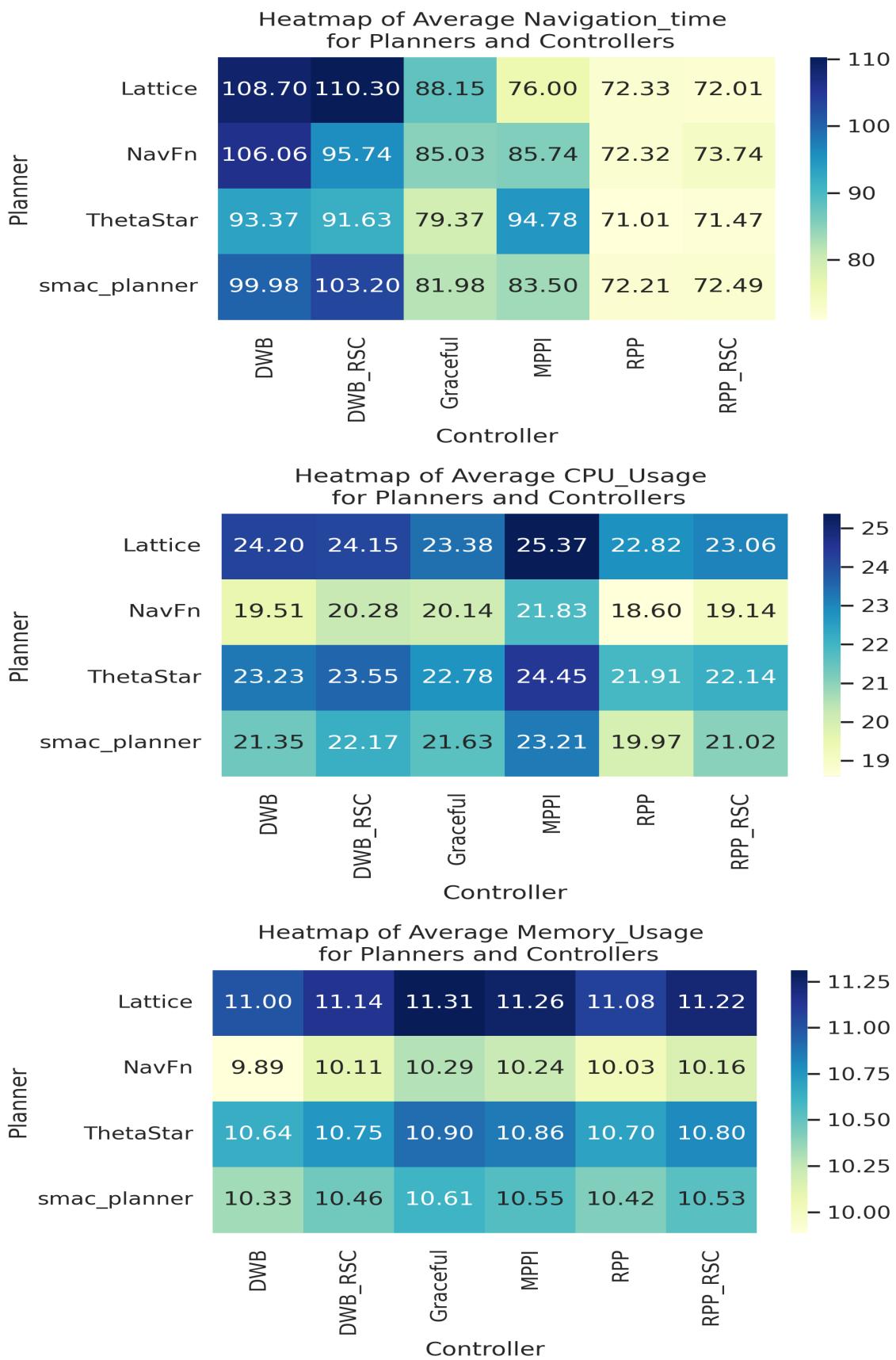
Controller: DWB\_RSC, Success Rate: 85.42%

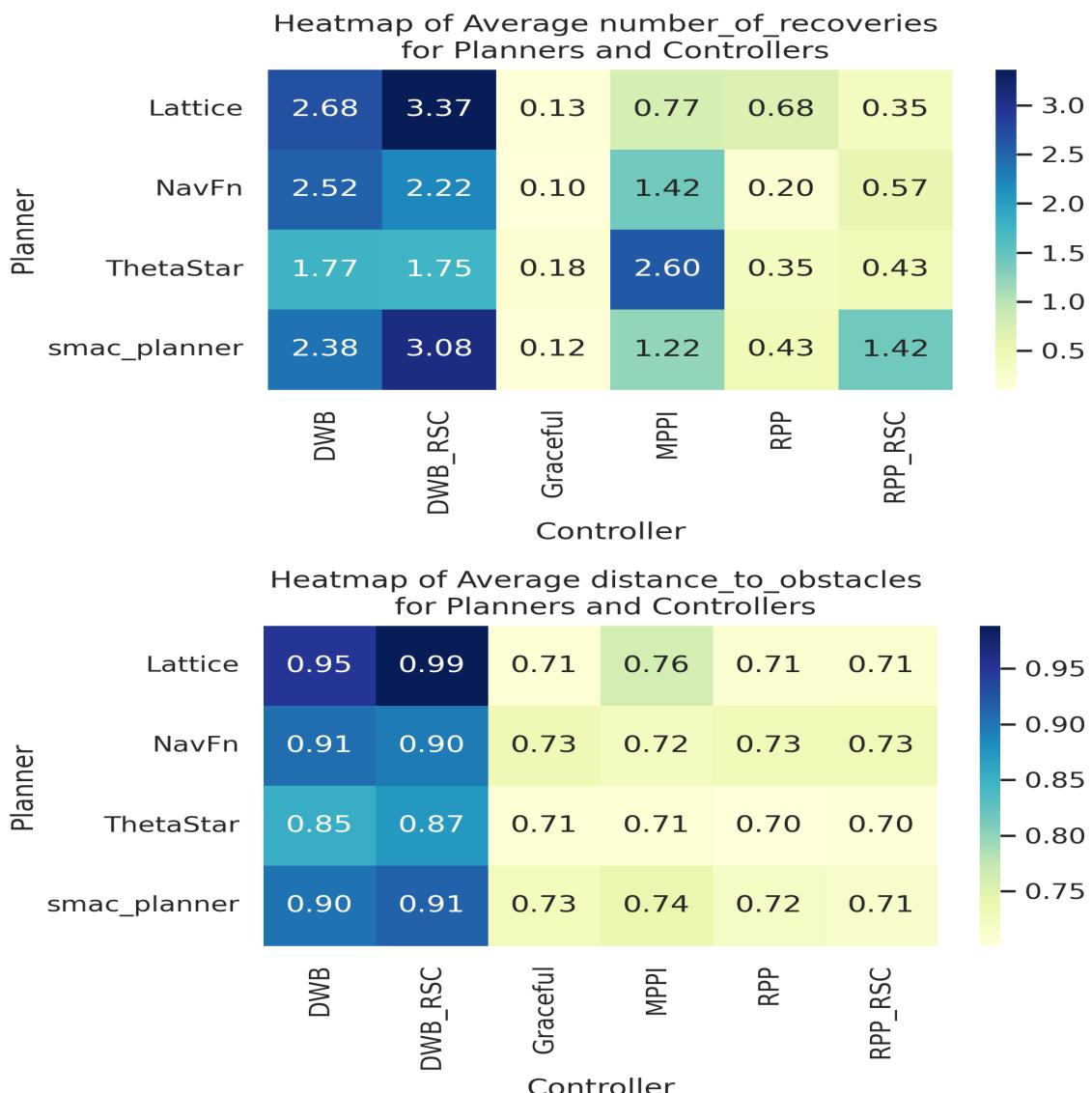
Controller: RPP, Success Rate: 99.17%

Controller: DWB, Success Rate: 86.67%

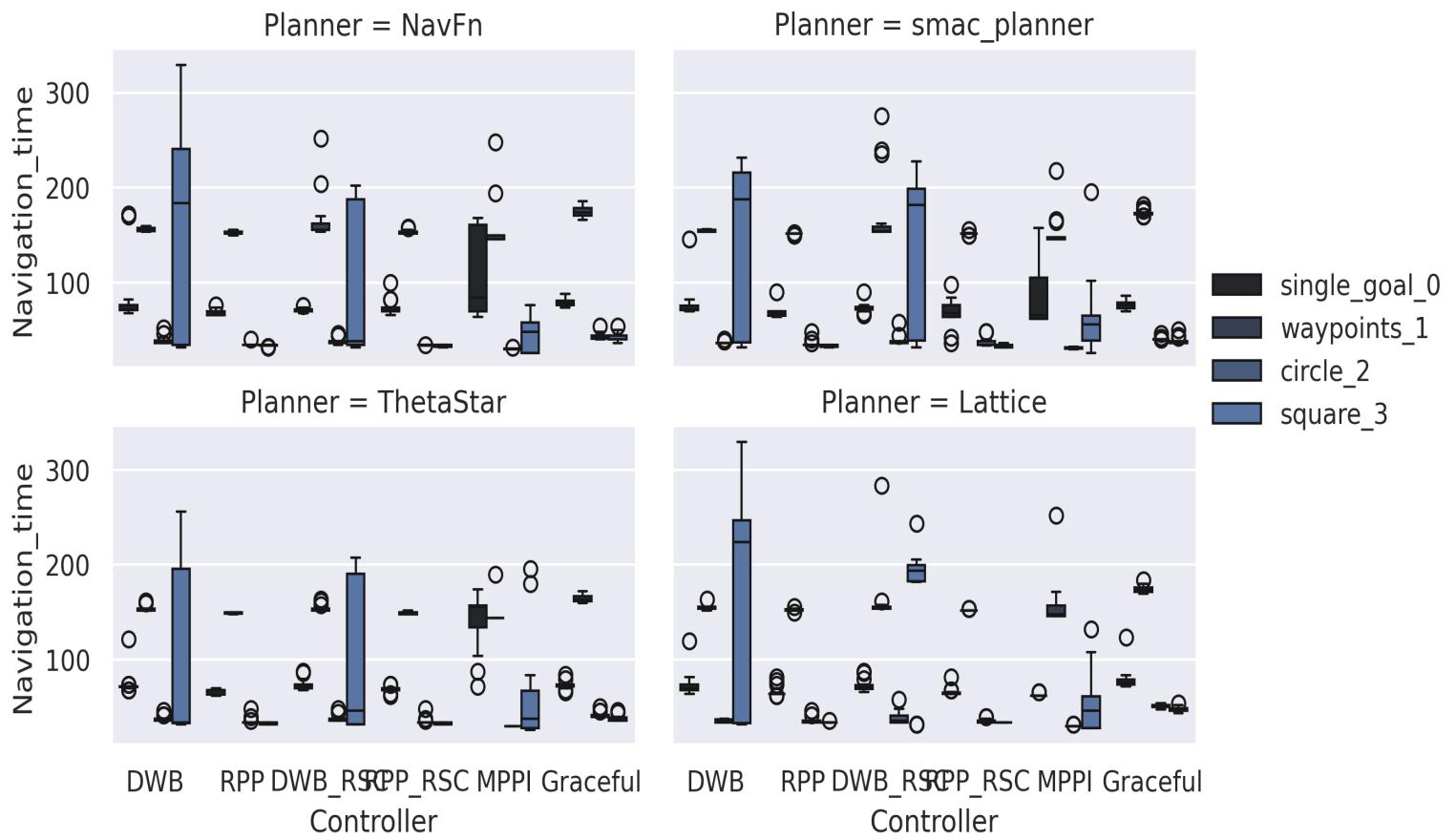




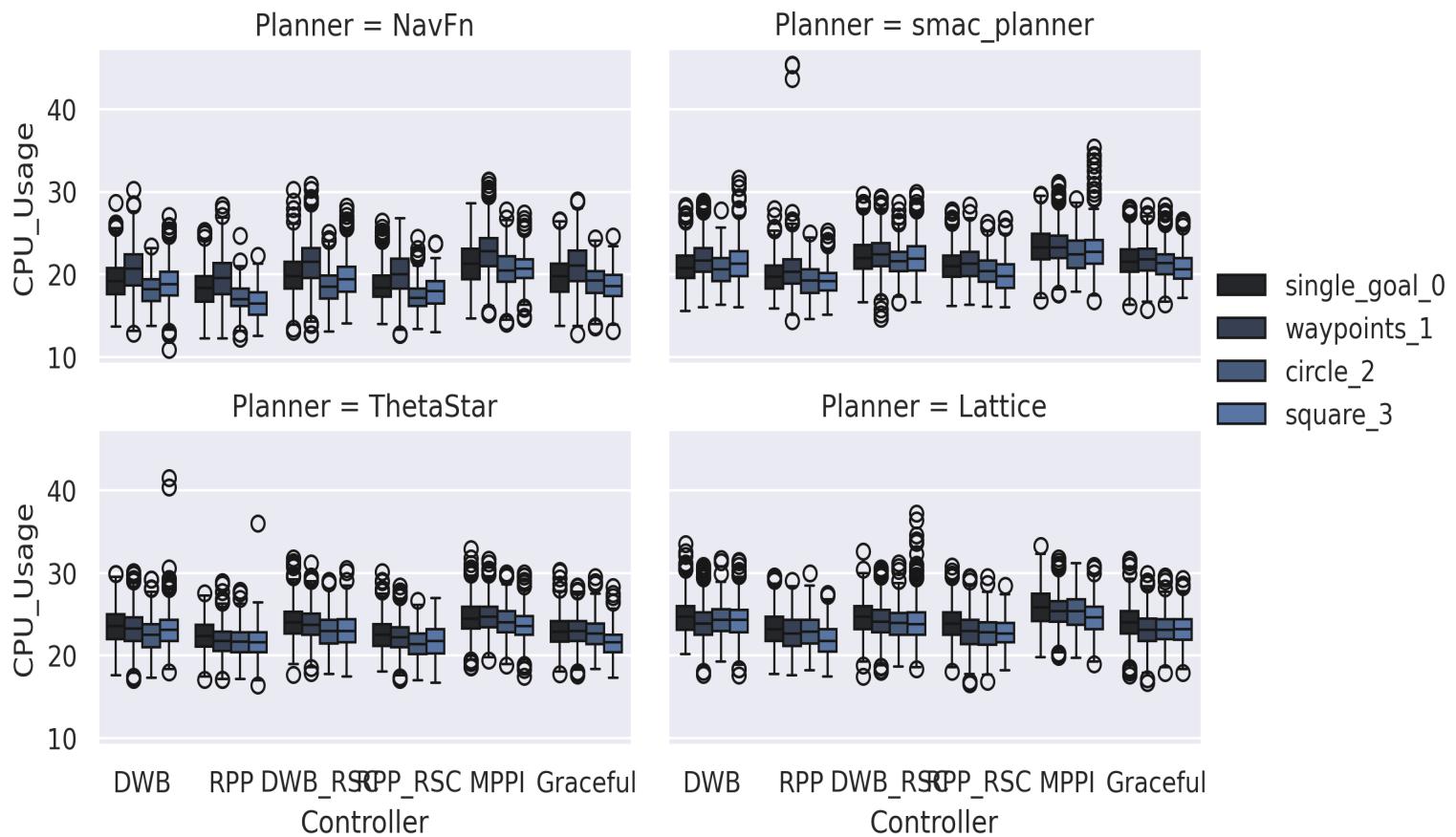




## Complex Distribution of Navigation\_time by Planner, Controller, and Trajectory Type



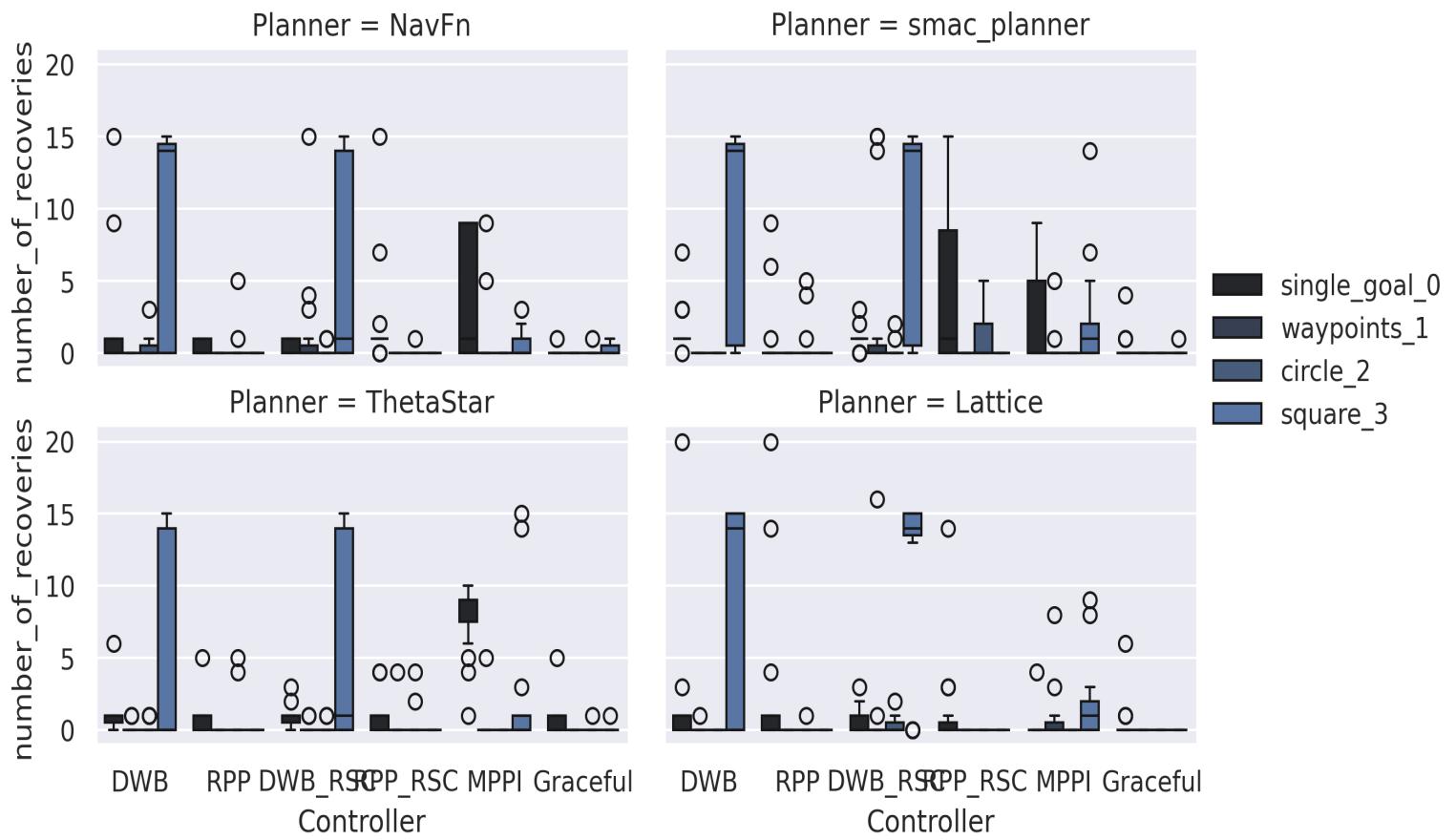
## Complex Distribution of CPU\_Usage by Planner, Controller, and Trajectory Type



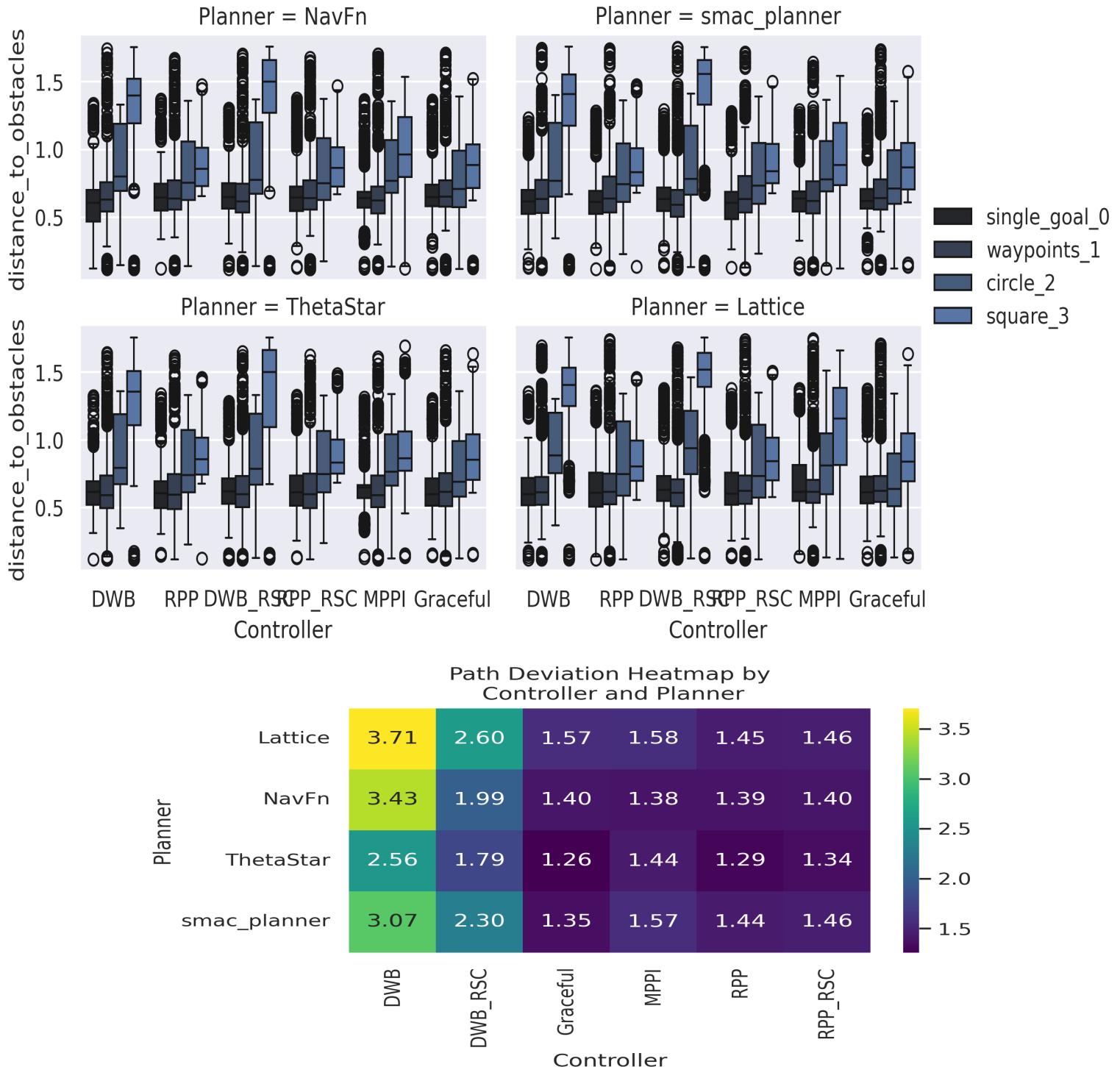
## Complex Distribution of Memory\_Usage by Planner, Controller, and Trajectory Type

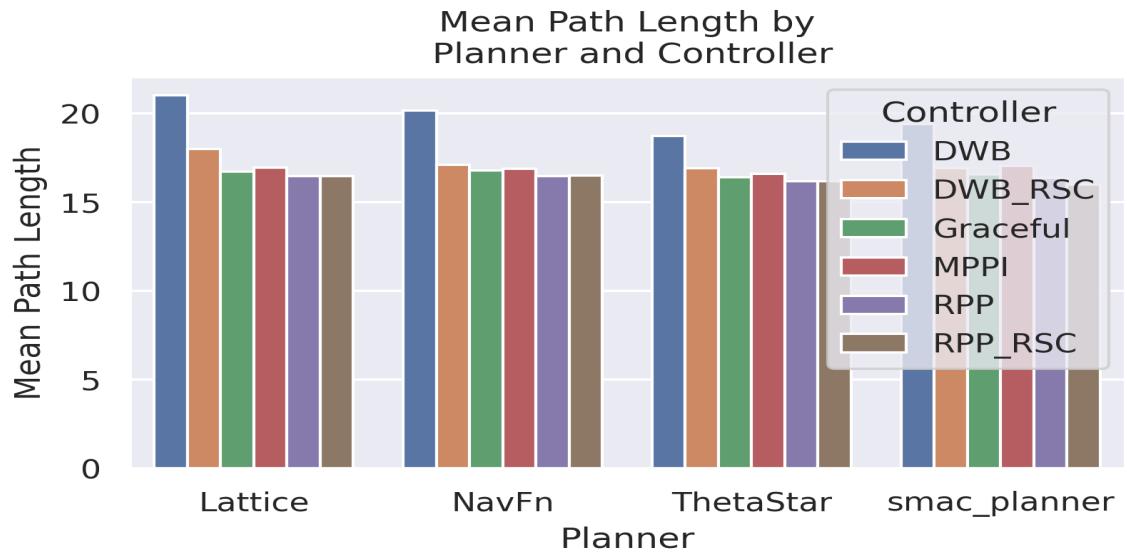


## Complex Distribution of number\_of\_recoveries by Planner, Controller, and Trajectory Type



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





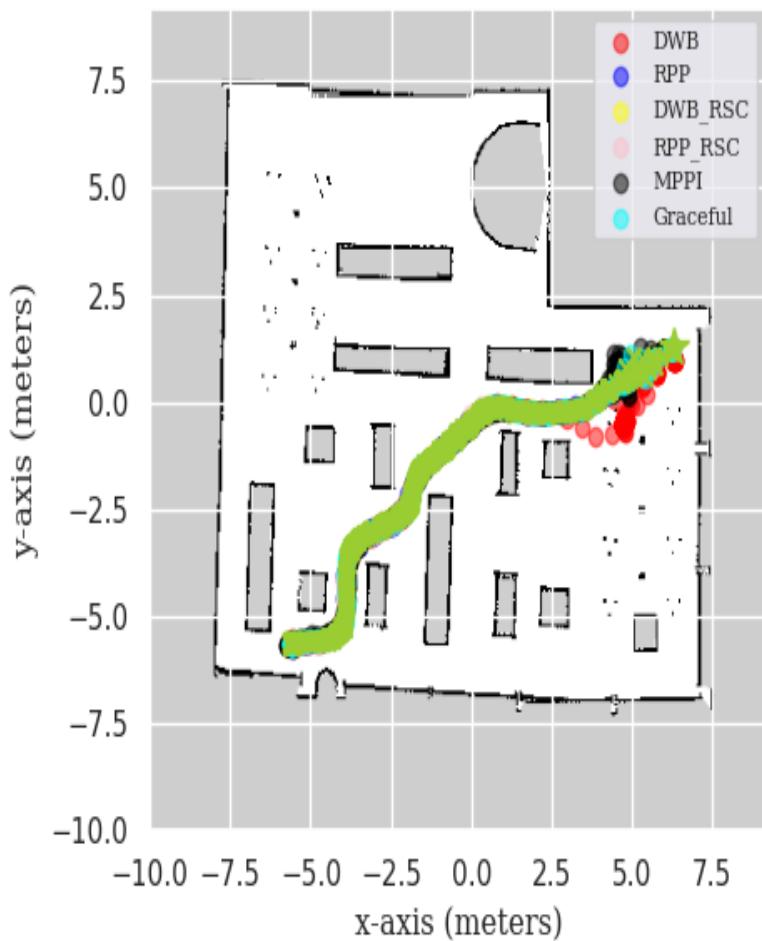
-Global planner: NavFn

Traveled path

-Trajectory type: single\_goal\_0

✖ Global planner path   \* Waypoints

★ Initial pose



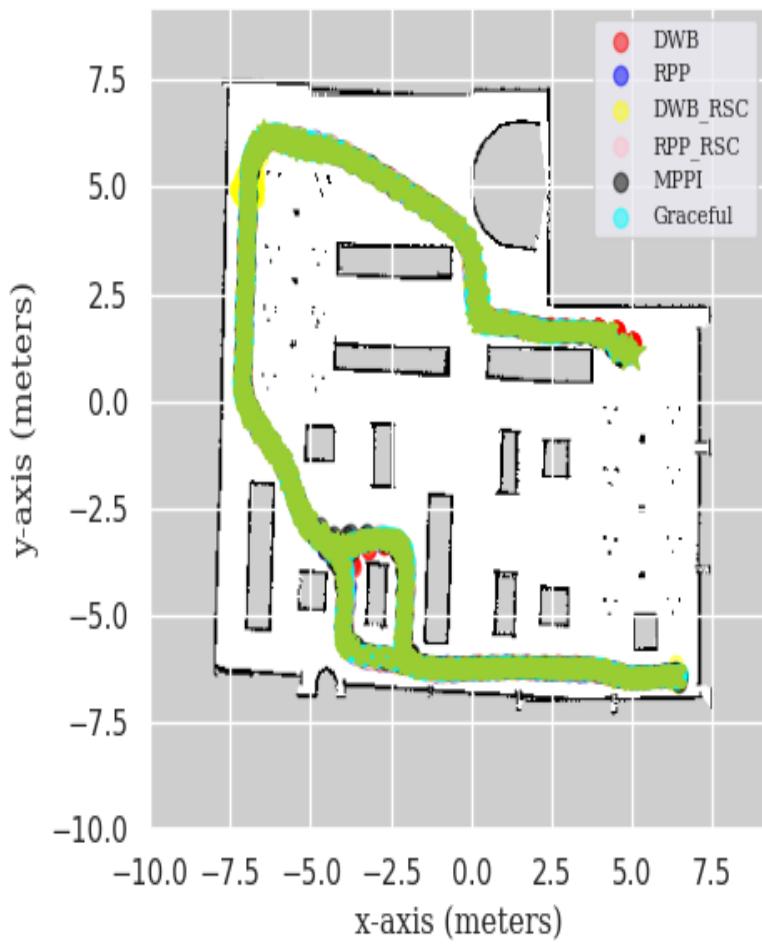
**-Global planner: NavFn**

Traveled path

**-Trajectory type: waypoints\_1**

 Global planner path  Waypoints

 Initial pose



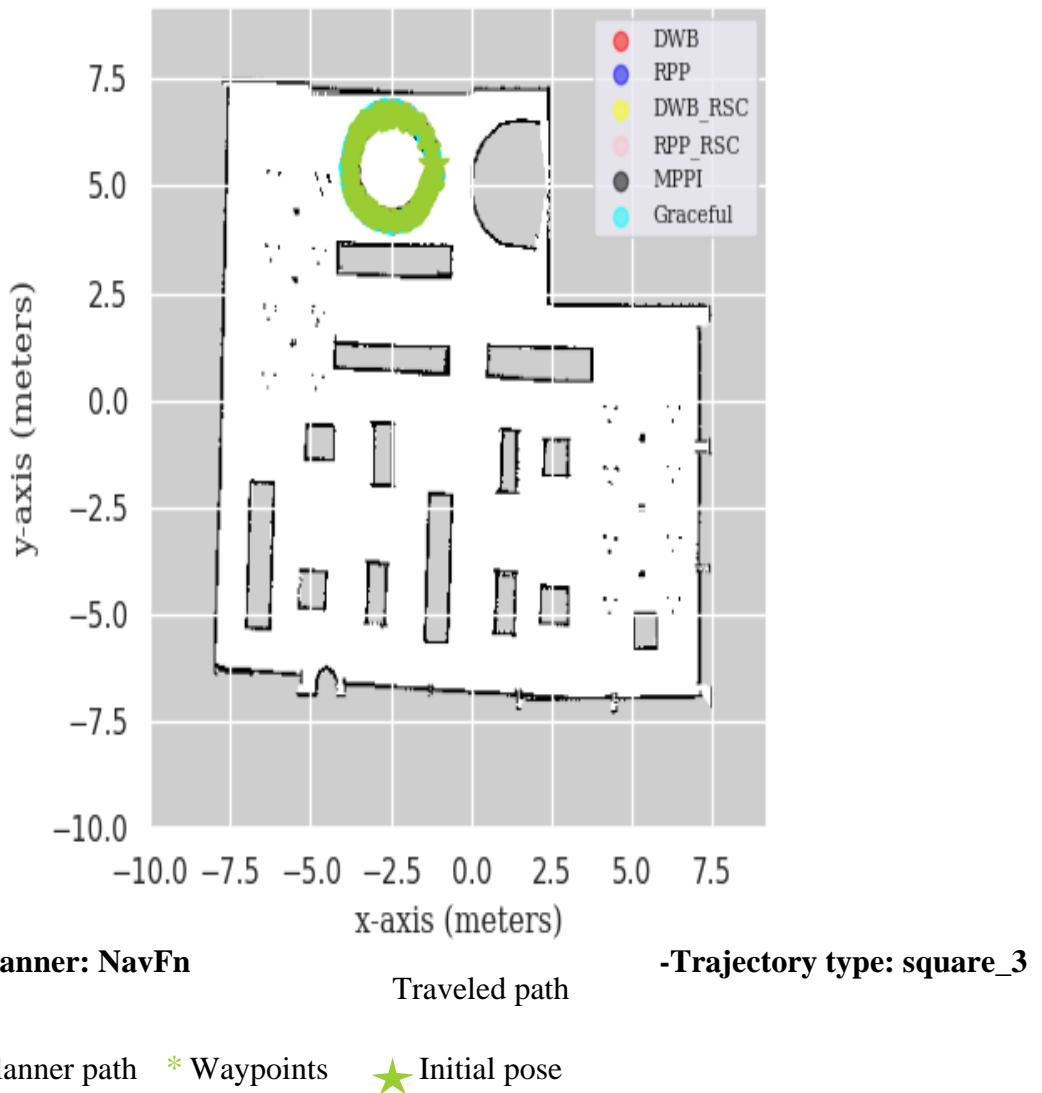
**-Global planner: NavFn**

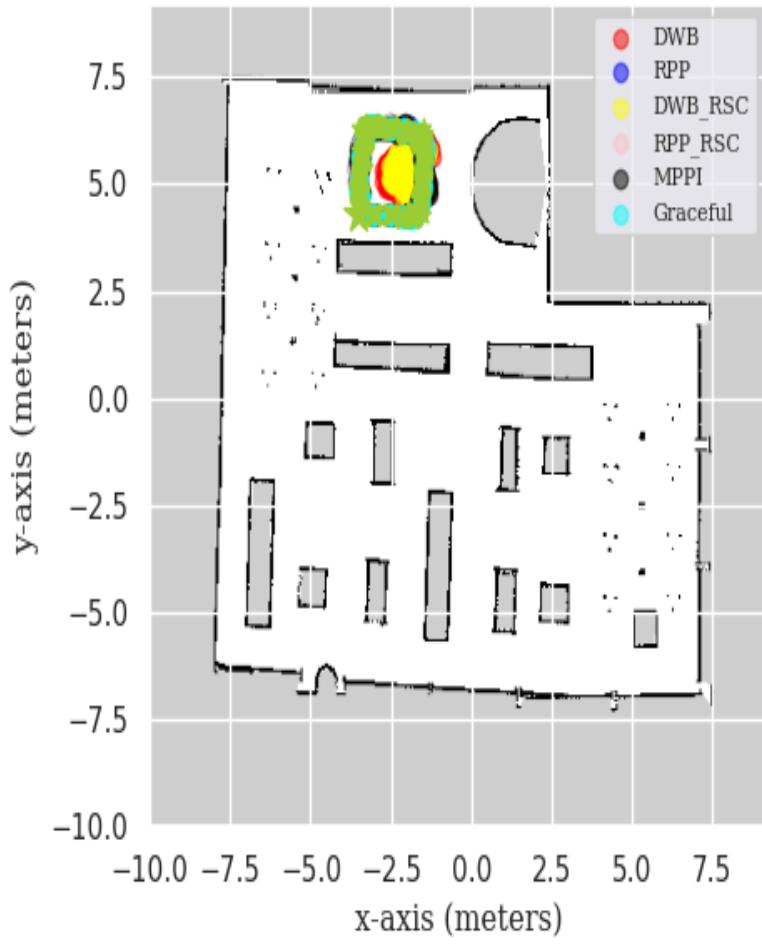
Traveled path

**-Trajectory type: circle\_2**

 Global planner path  Waypoints

 Initial pose

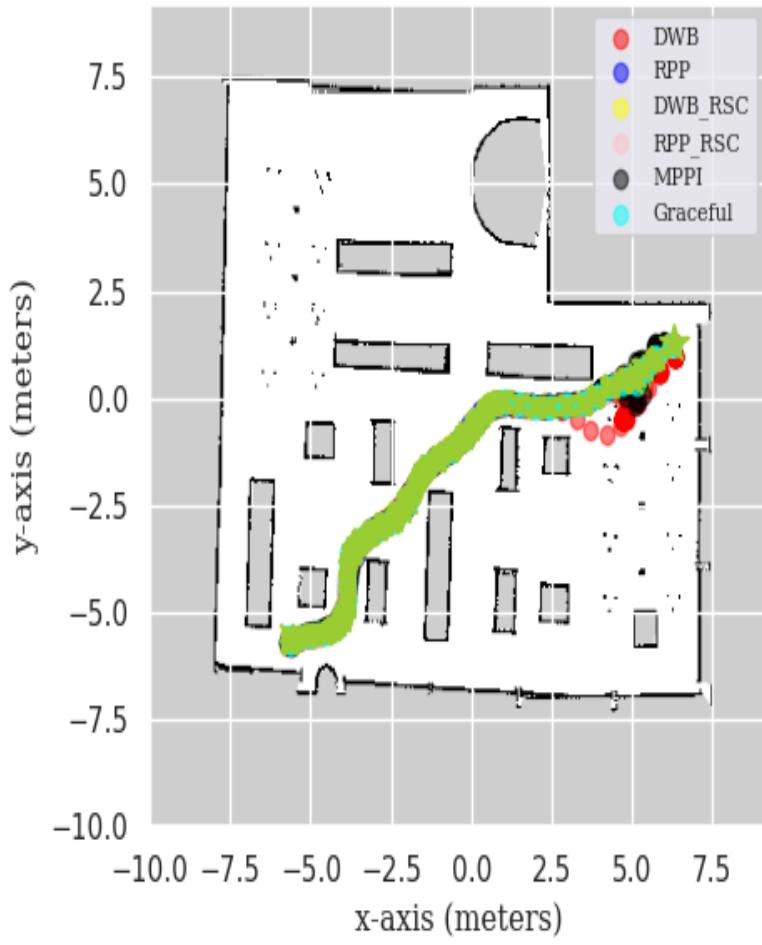




-Global planner: smac\_planner

-Trajectory type: single\_goal\_0

■ Global planner path   \* Waypoints   ★ Initial pose



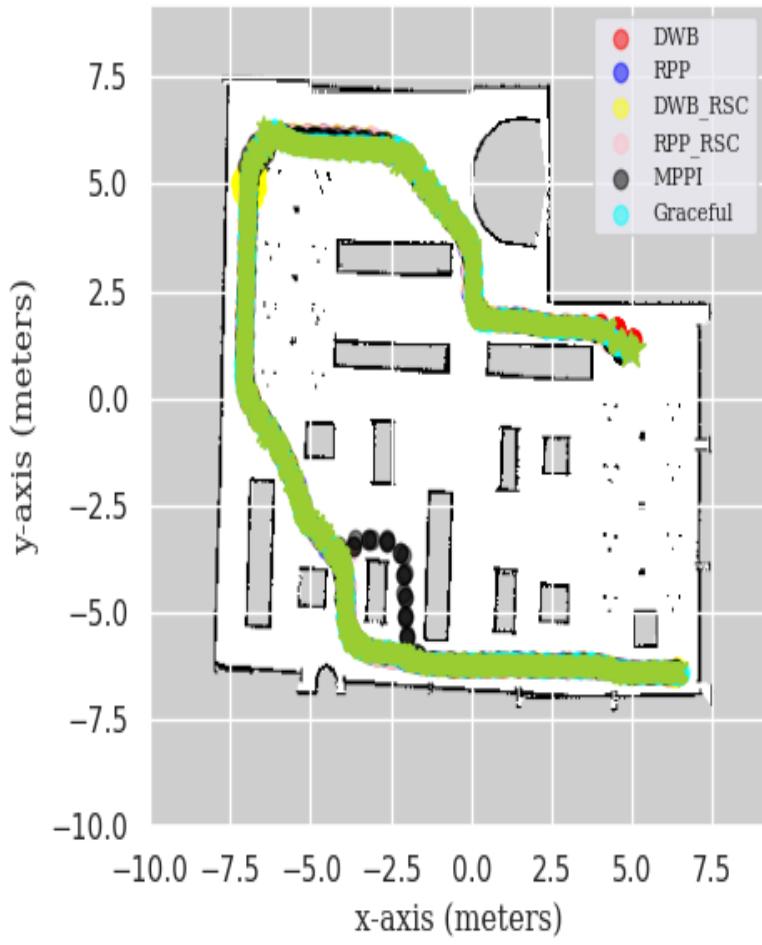
-Global planner: smac\_planner

Traveled path

-Trajectory type: waypoints\_1

✖ Global planner path    \* Waypoints

★ Initial pose



-Global planner: smac\_planner

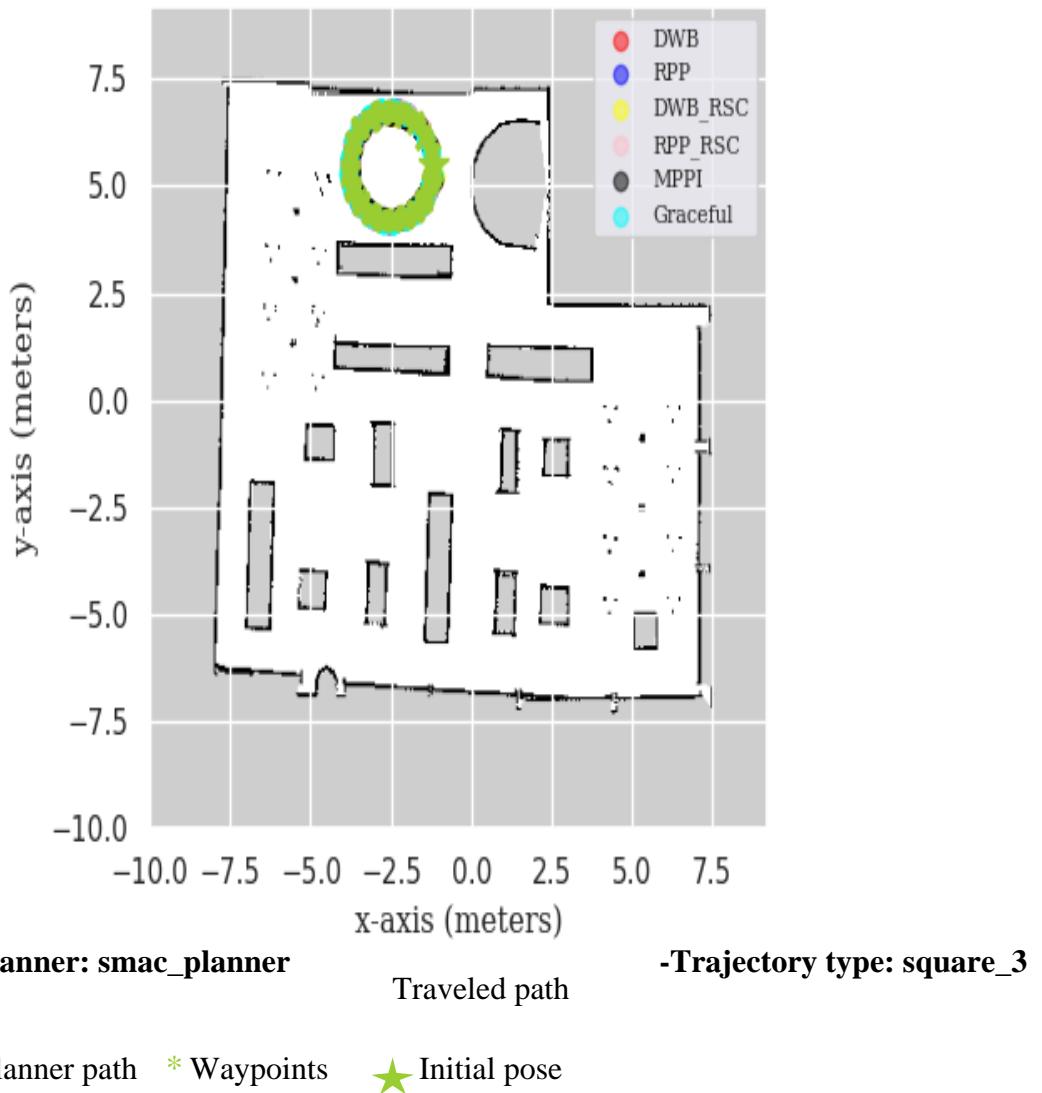
Traveled path

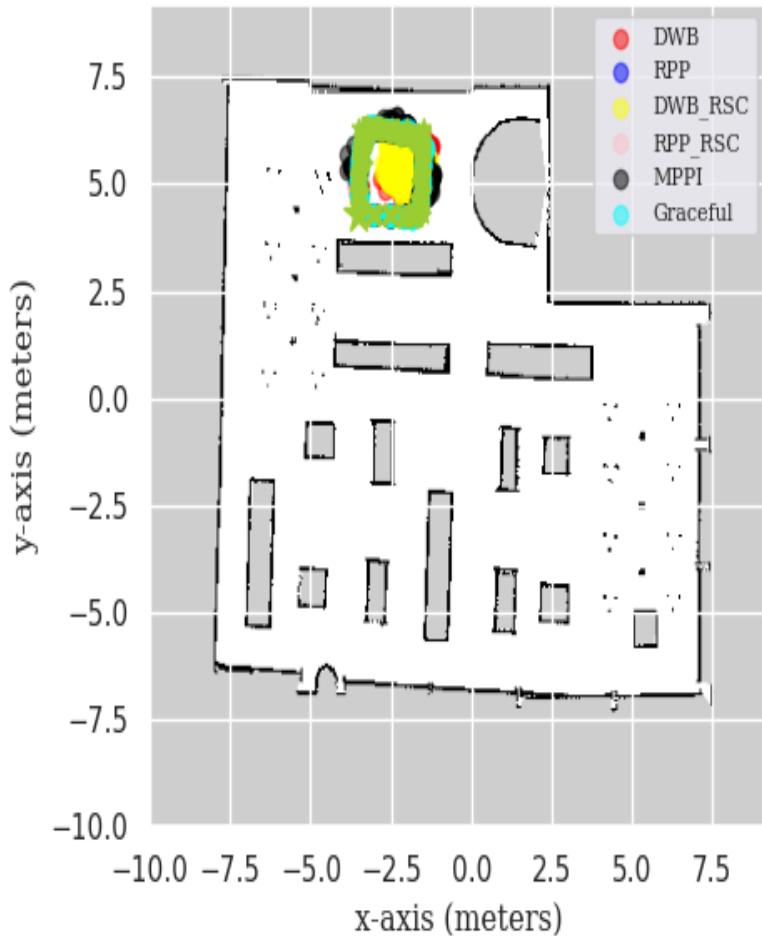
-Trajectory type: circle\_2

x Global planner path

\* Waypoints

★ Initial pose



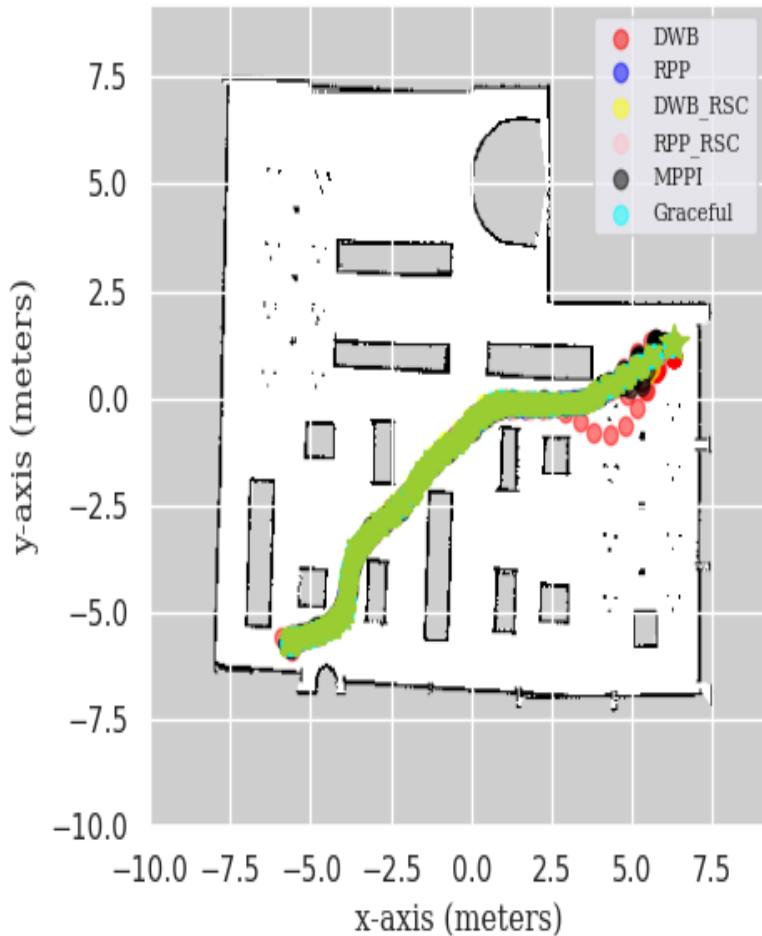


-Global planner: ThetaStar

-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

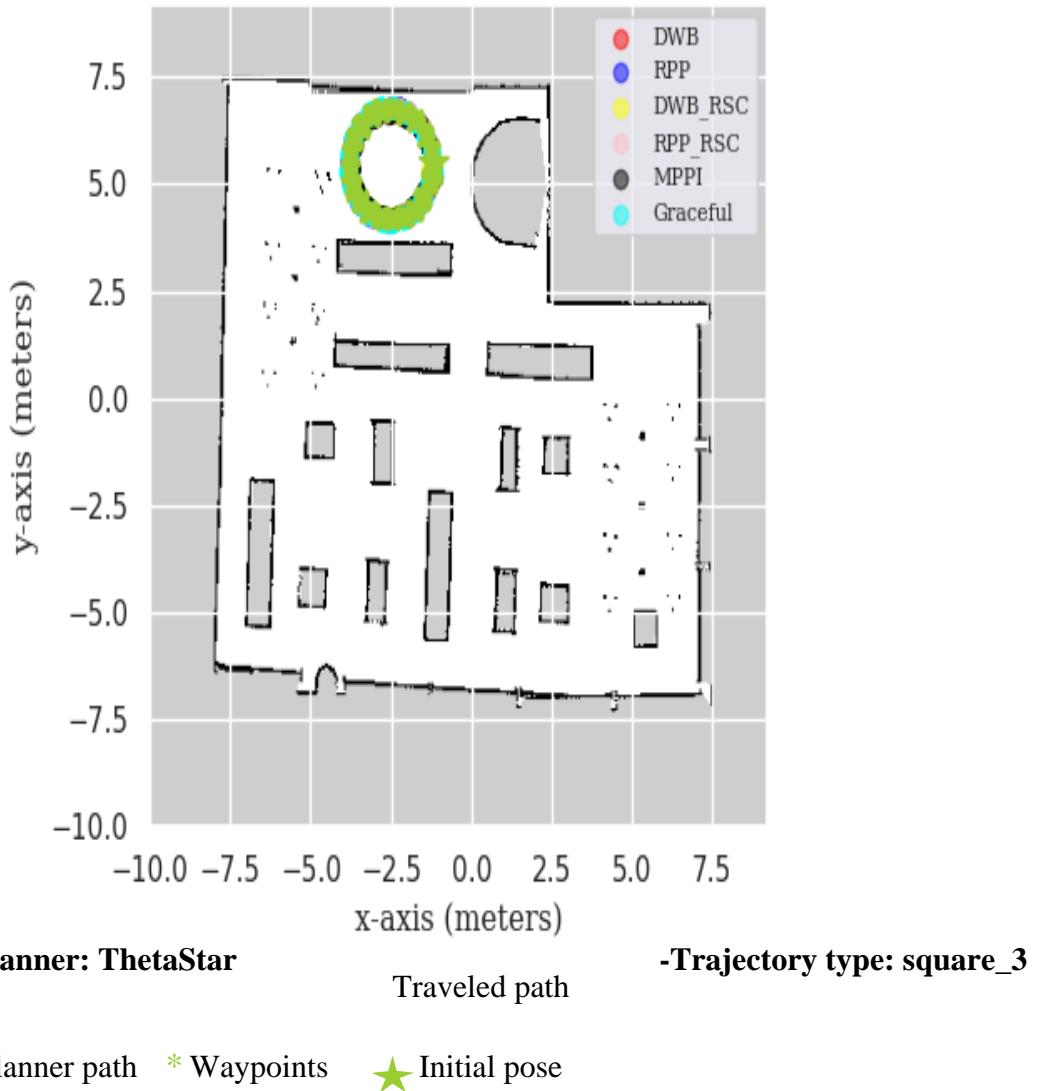
-Trajectory type: circle\_2

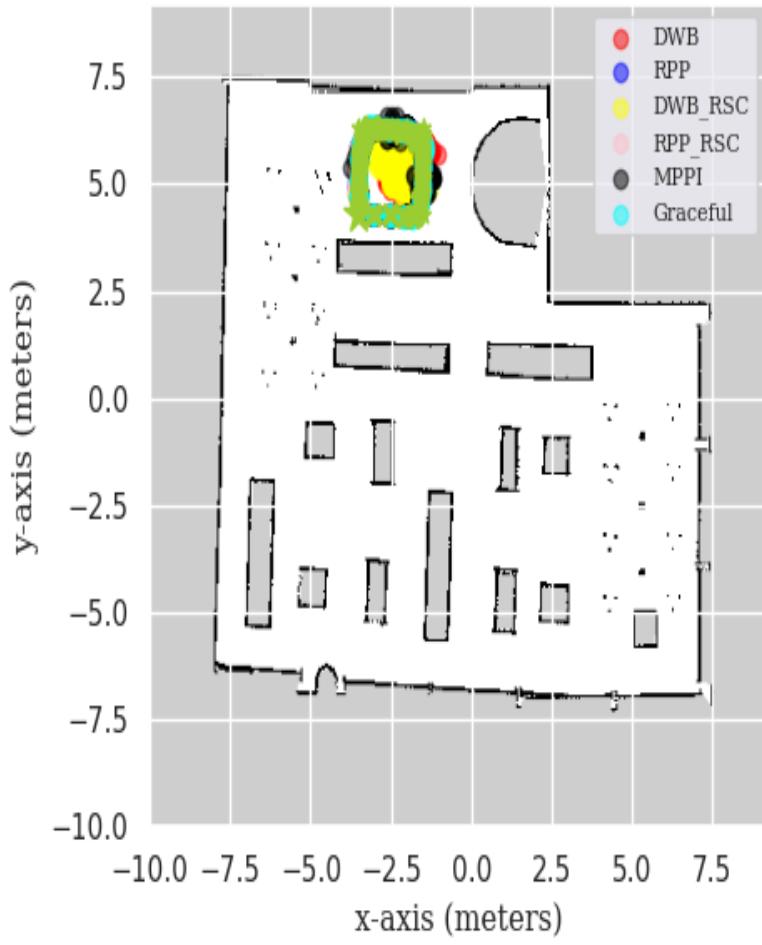
Traveled path

x Global planner path

\* Waypoints

★ Initial pose



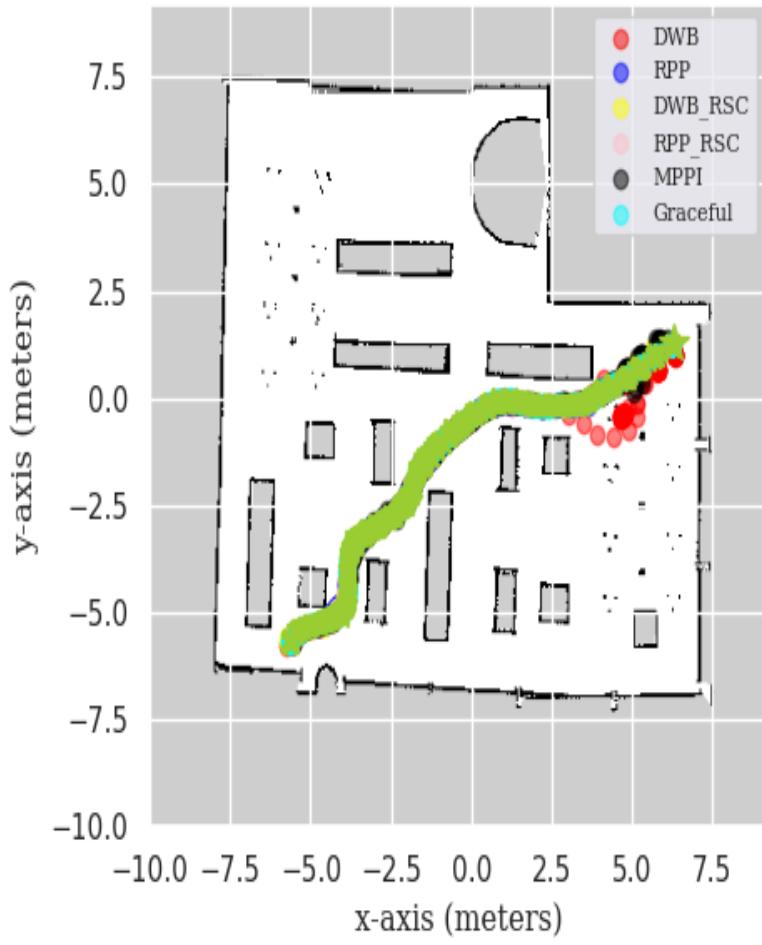


-Global planner: Lattice

Traveled path

-Trajectory type: single\_goal\_0

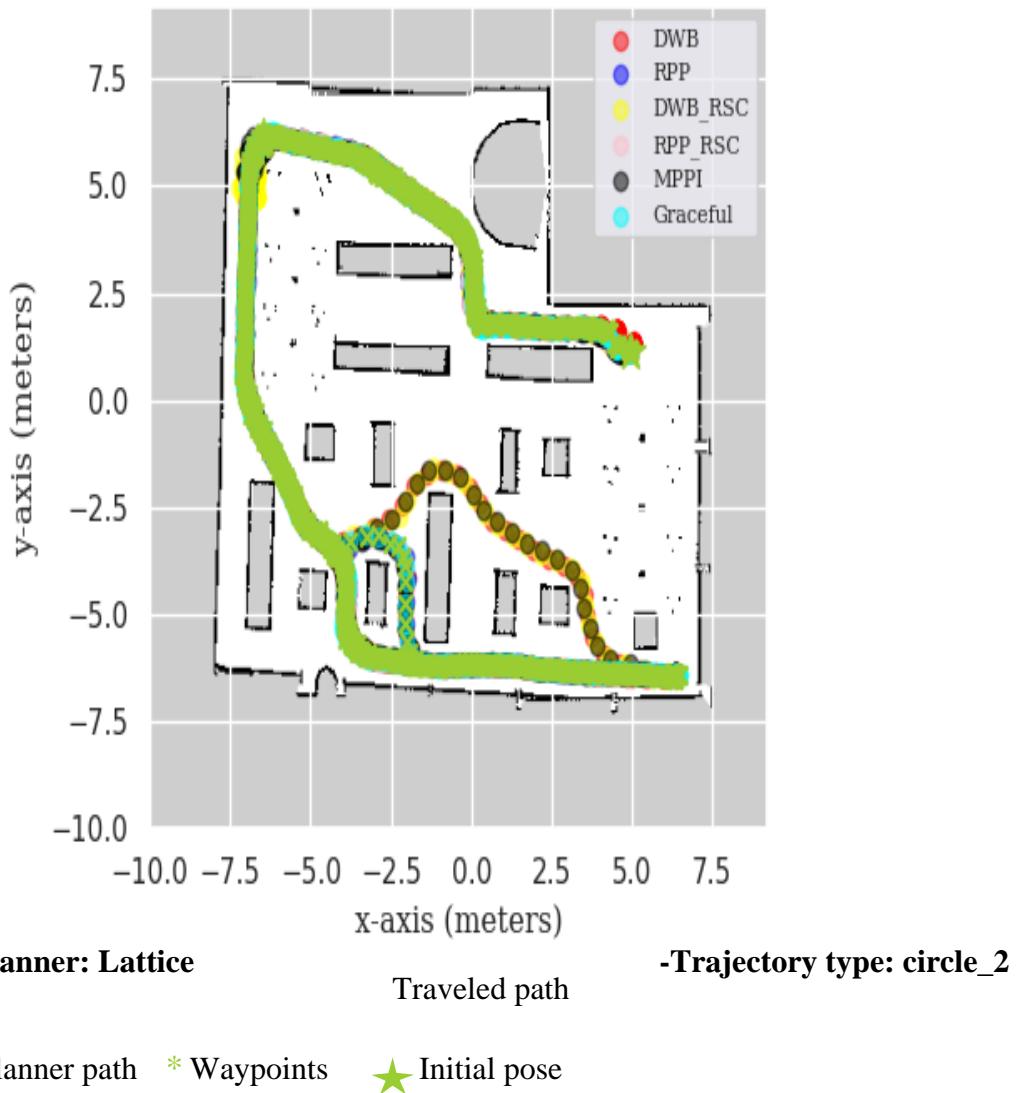
■ Global planner path   \* Waypoints   ★ Initial pose

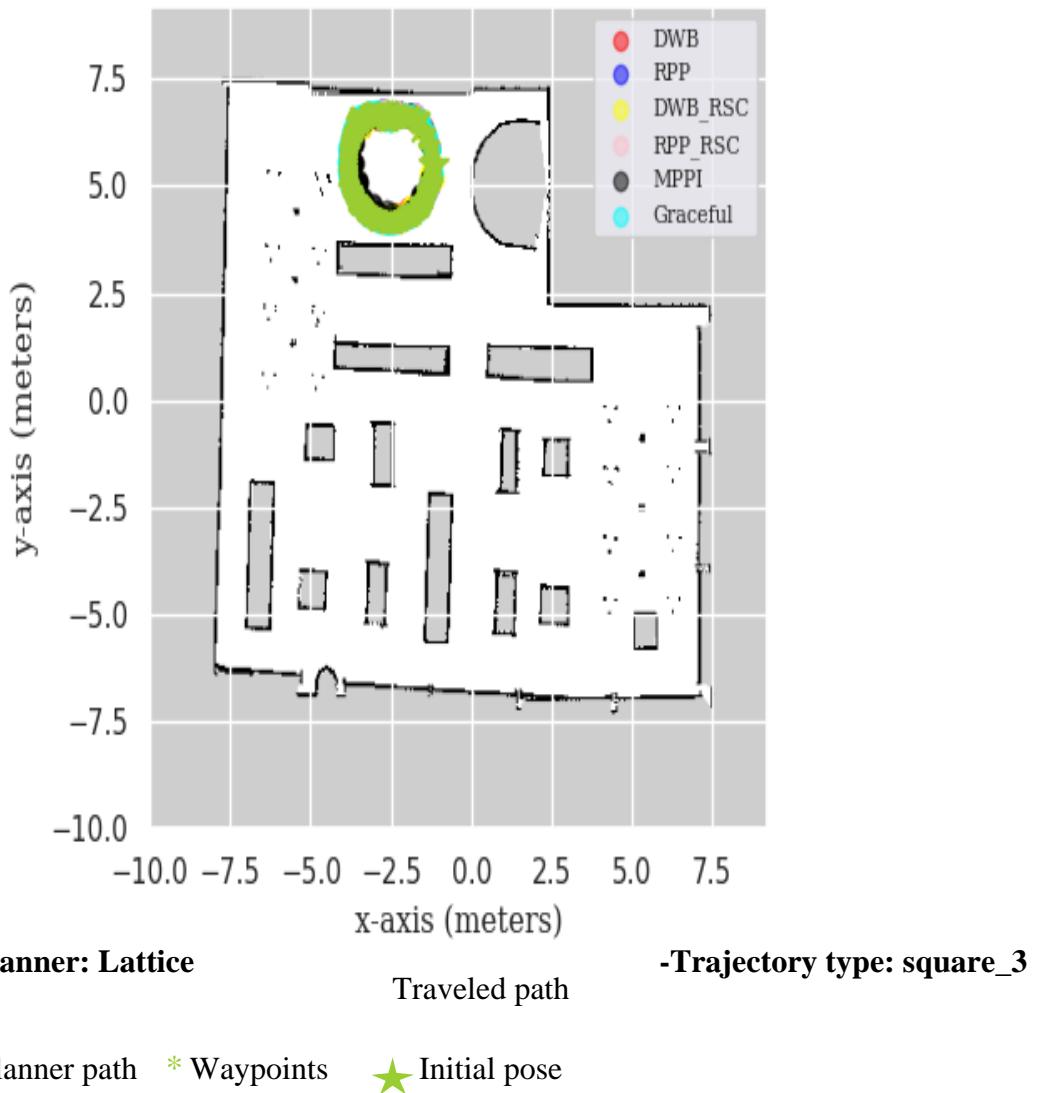


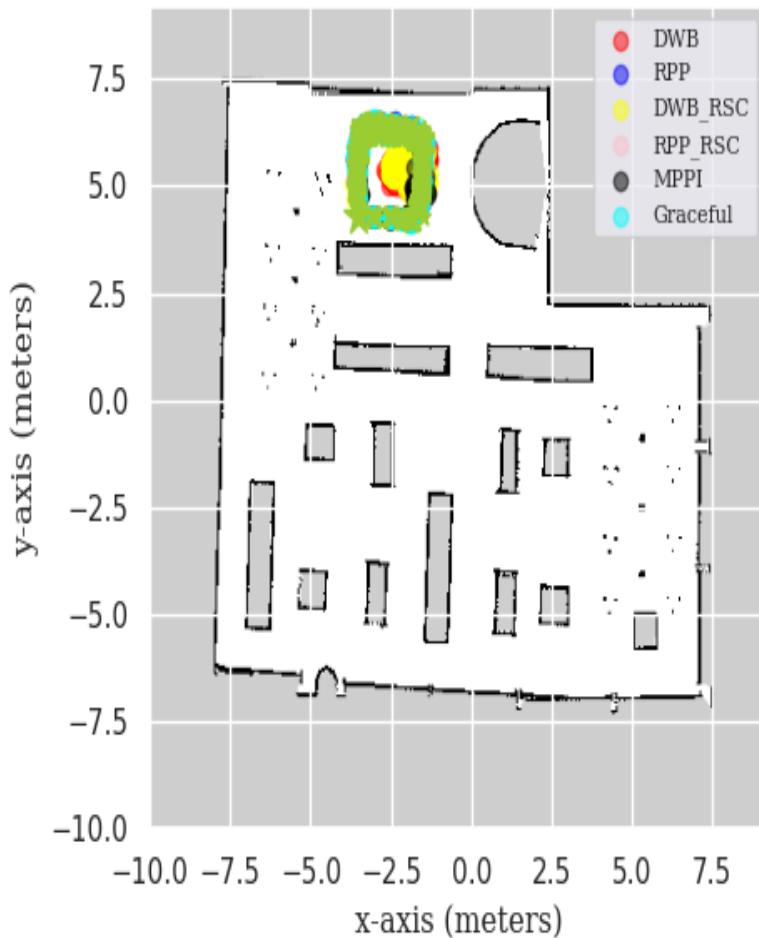
-Global planner: Lattice

-Trajectory type: waypoints\_1

■ Global planner path   \* Waypoints   ★ Initial pose







## Failure report

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