Warehouse Robotics Efficiency Analyzer (Tableau Edition)

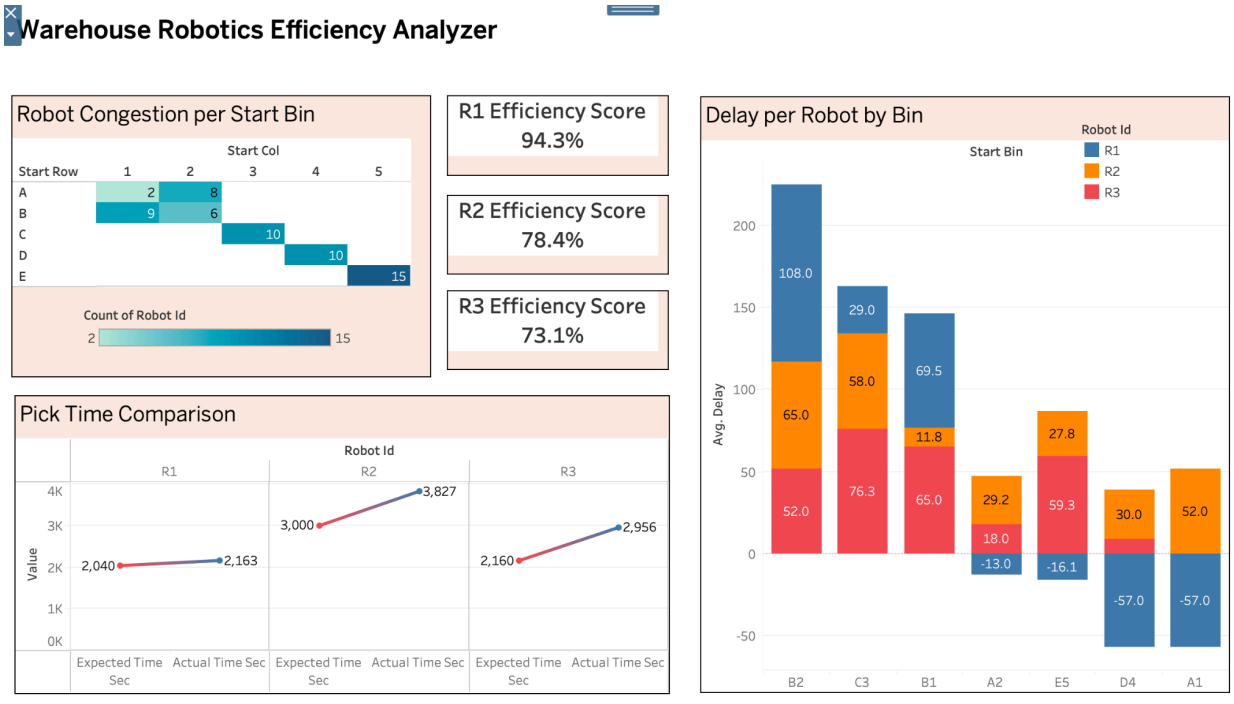
This project simulates and analyzes robotic operations within a warehouse setting, focusing on traffic congestion, delay patterns, pick time performance, and routing strategies. Tableau was used for intuitive and interactive data exploration.

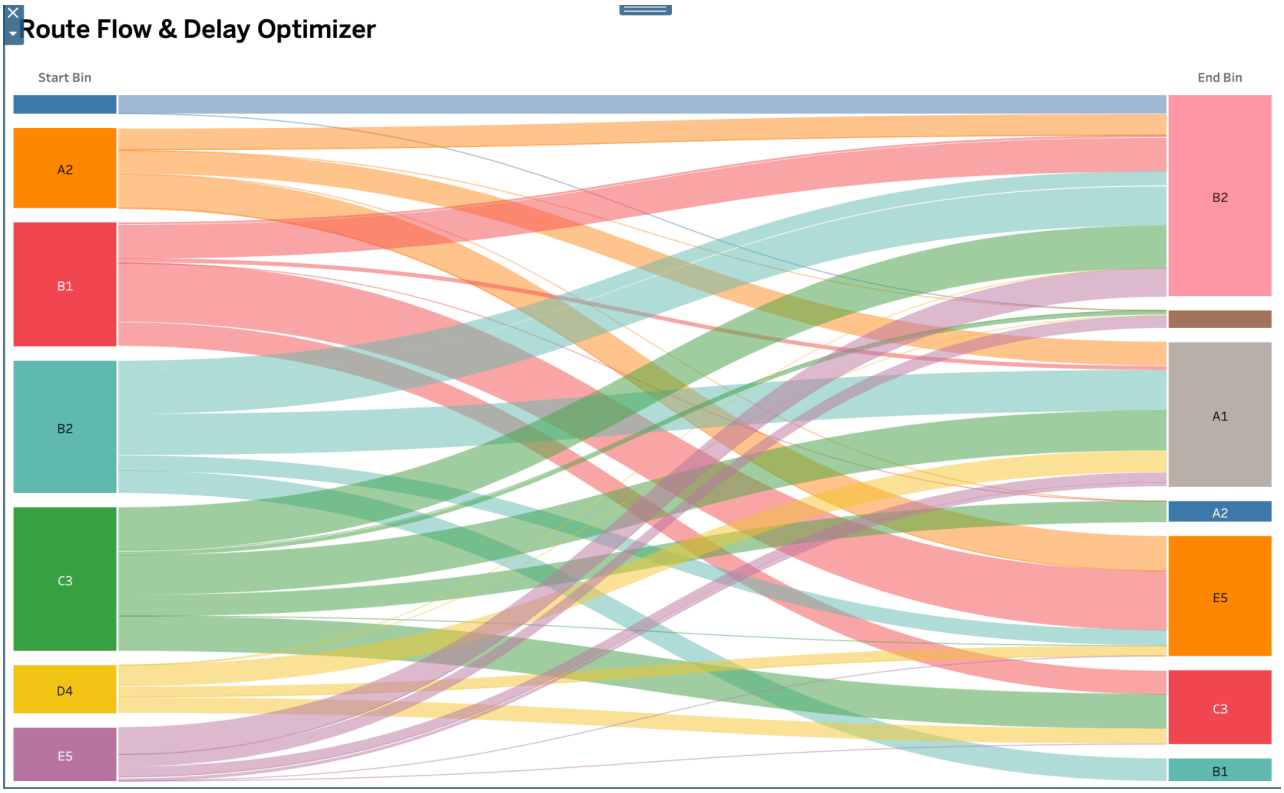
Data Source

The dataset includes robot pick logs with details like robot ID, assigned start and end bins, expected vs. actual pick times, and delays. This forms the basis for all downstream analysis.

# combined_batches.csv Batch Id	Abc combined_batches.csv Robot Id	Abc combined_batches.csv Start Bin	Abc combined_batches.csv End Bin	# combined_batches.csv Expected Time Sec	# combined_batches.csv Actual Time Sec
1	R1	E5	B2	120	87
1	R1	C3	D4	120	90
1	R3	C3	C3	120	226
1	R2	D4	C3	120	137
1	R1	E5	C3	120	94

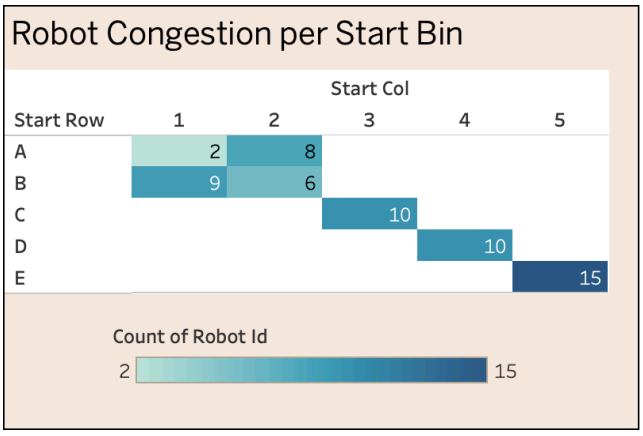
Dashboard





Robot Congestion Analysis

Which warehouse zones experience the highest robot congestion, and are there underutilized areas?

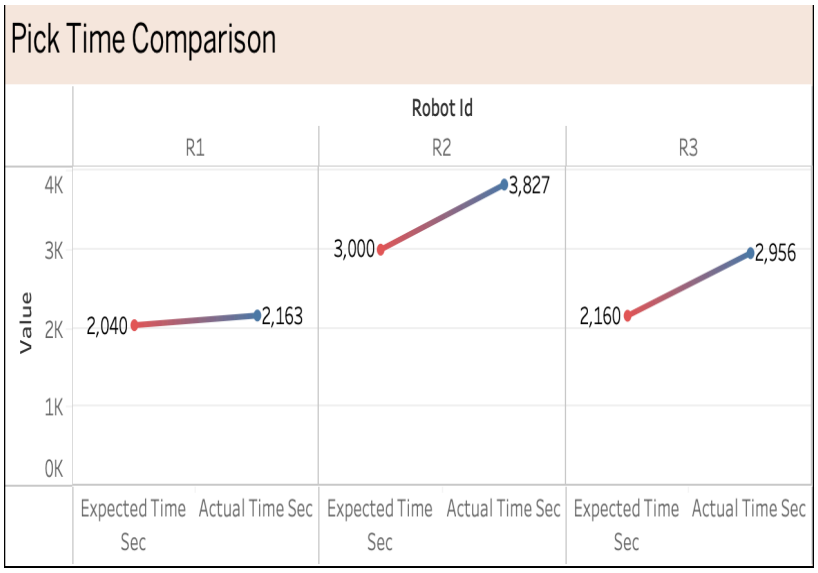


The heatmap provides a visual density distribution of robot traffic originating from bins. Bins such as **E5, B2, and C3** emerged as high-traffic zones.

These bins are likely central or frequently requested item zones, making them hotspots. On the other hand, bins like **A1 and D4** showed minimal traffic, revealing opportunities to redistribute inventory.

Robot Performance Metrics

Which robots are completing tasks closest to expected time, and which are consistently delayed?



R1 Efficiency Score
94.3%

R2 Efficiency Score
78.4%

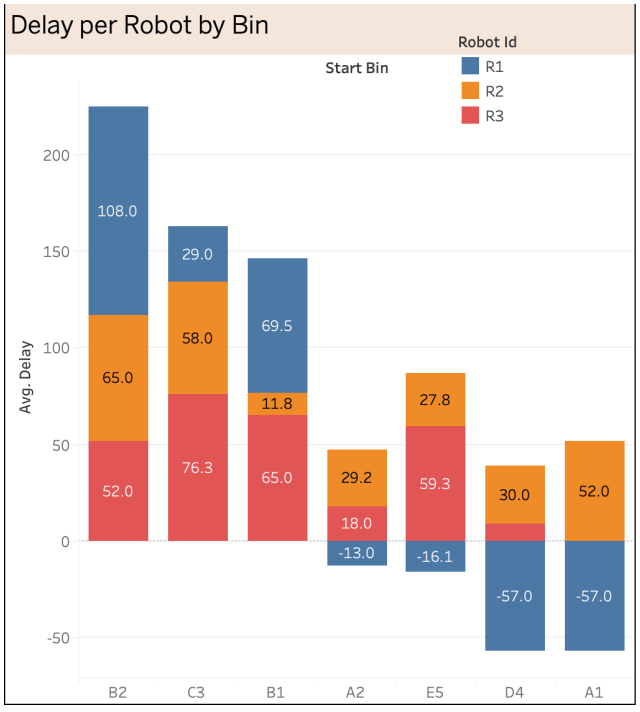
R3 Efficiency Score
73.1%

The line chart illustrates time deviation per robot. Efficiency KPIs reveal that **R1 performs closest to expectations** (~94%), while **R2 and R3 are consistently slower**, dipping below 80% efficiency.

The performance gap between robots suggests uneven workload distribution or differing route complexities. Rebalancing batch assignments can increase overall system throughput.

Delay Analysis by Bin

Where do the most severe delays occur in the warehouse, and which robots contribute to them?

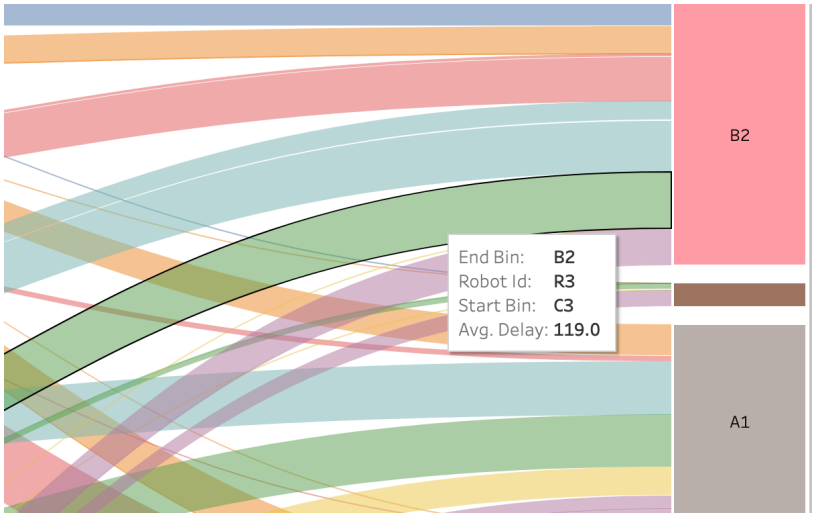


Bins such as **B2 and C3** show the highest delay averages. Robot-wise breakdown indicates **R2 is responsible for a disproportionate share of delay** in these areas.

These bins may be congested or far from robot recharge stations. Assigning faster robots (like R1) or reducing R2's frequency here could improve efficiency.

Route Flow & Optimization

What are the most frequently used Start → End bin paths, and do they correlate with high delay zones?



The Sankey chart reveals heavy usage of routes such as **C3 → B2 by robot R2**, indicating potential task collisions or repeated routing over the same paths.

The frequent use of certain routes causes bottlenecks. Implementing alternate paths for similar tasks can reduce robot traffic on these congested lanes.

Recommendations

1. **Rebalance Robot Assignments:** Reallocate frequent tasks from R2 and R3 to R1, especially on routes where R1 has lower historical delay.
2. **Redistribute Inventory:** Move frequently picked items away from high-congestion bins like E5 and B2.
3. **Implement Route Diversity:** Design alternate pick paths to spread traffic load and minimize collisions.
4. **Monitor Delay-Heavy Routes:** Use this dashboard continuously to flag routes or bins that exceed average delay thresholds.
5. **Use Data for Scheduling:** Create robot-specific schedules where slow performers are routed during off-peak or less congested hours.