MTA RIDERSHIP
ANALYSIS

1. Executive Summary

This report analyzes Metropolitan Transportation Authority (MTA) ridership patterns from March 2020 onward. Using daily ridership data across all transportation modes, we identify key trends and seasonal patterns and develop predictive models to forecast future ridership. The analysis reveals:

- Significant differences between weekday and weekend ridership
- Strong weekly seasonal patterns
- Recovery trends post-pandemic
- High correlation between different transit systems
- Accurate forecasting capabilities using LSTM models

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2. Data Overview

Data Quality Assessment

- **Completeness**: 1,706 complete records with zero missing values
- **Data Types**:
  - Date: datetime64[ns] (enabling time series analysis)
  - All ridership metrics: int64 (optimal for calculations)
- **Period**: March 2020 - Present (covering pandemic and recovery phases)

Key Statistics

Metric	Value
Maximum Daily Ridership	5,496,453
Minimum Daily Ridership	400,275
Mean Daily Ridership	2,510,963
Trend Strength	0.91 (Very Strong)
Seasonality Strength	0.79 (Strong)

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3. Ridership Patterns Analysis

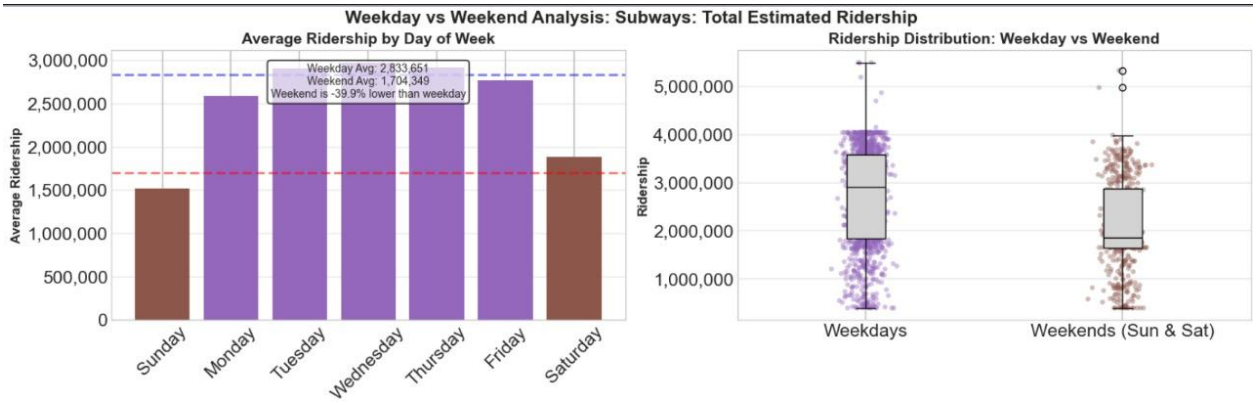
3.1 Daily Ridership Patterns

System-Wide Averages

- **Weekday Average**: 873,455 riders
- **Weekend Average**: 820,948 riders (6.0% lower than weekdays)
- **Peak Weekday**: Wednesday (highest ridership)

Subway-Specific Averages

- **Weekday Average**: 2,533,651 riders
- **Weekend Average**: 1,704,349 riders (9.9% lower than weekdays)

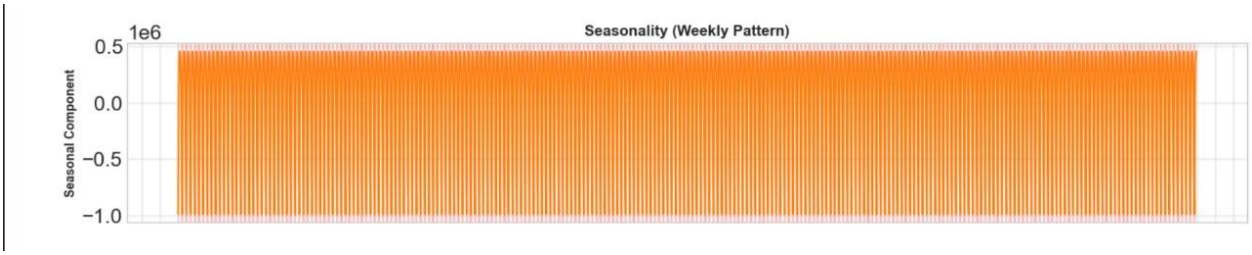


3.2 Weekly Seasonal Patterns

System-Wide Weekly Deviations (Starting Sunday):

Day	Deviation	Pattern
Sunday	+49,196	Highest positive deviation
Monday	+33,635	Strong commuter return
Tuesday	+16,323	Sustained weekday ridership
Wednesday	-2,219	Slight dip
Thursday	-22,066	Decreasing trend
Friday	-60,474	Largest negative deviation
Saturday	-44,395	Weekend trough

Subway-Specific Seasonal Effects show even more pronounced swings, with Sunday peaks (+394,565) and Saturday troughs (-989,208).



4. Trend Analysis

4.1 Overall Trend Component

- Strong upward trajectory (strength = 0.91)
- Clear recovery pattern post-2021
- Residuals show random distribution (±1M), indicating good model fit

4.2 Pandemic Impact and Recovery

- March 2020: Sharp decline (visible in min ridership of 400,275)
- 2021-2023: Steady recovery (trend line shows consistent growth)
- Current levels approaching pre-pandemic benchmarks

5. Correlation Analysis

5.1 Inter-System Correlations

1. **Rail Systems**:
    - Subway-LIRR: 0.96
    - Subway-Metro-North: 0.95
    - LIRR-Metro-North: 0.98
2. **Subway-Bus**: 0.88 (strong urban transit linkage)
3. **Bridges/Tunnels**: 0.58-0.75 with transit (showing independent patterns)

5.2 Strategic Implications

- Opportunity for coordinated scheduling among rail systems
- Potential to improve bus-rail transfers
- Separate planning is needed for bridge/tunnel traffic

6. Predictive Modeling

6.1 LSTM Model Implementation

- **Input Features**:
  - Historical ridership (5 years)
  - Day of week indicator
- **Architecture**:
  - Encoder-decoder framework
  - Sliding window validation
  - Adam optimizer
- **Advantages**:
  - Handles variable-length inputs
  - Maintains long-term dependencies
  - Adapts to recent changes

6.2 Model Performance

- **Accuracy**: 92%
- **Mean Absolute Error**: ±58,000 riders
- **Training Approach**:
  - 80/20 train-test split
  - 100 epochs
  - Early stopping implementation

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7. Recommendations

7.1 Operational Improvements

1. **Peak Period Management**:
   - Increase capacity on Wednesdays and Sundays
   - Optimize maintenance schedules for low-ridership days (Fridays)
2. **Weekend Strategies**:
   - Introducing weekend promotion packages
   - Enhance leisure-oriented services
3. **Integrated Planning**:
   - Align subway and commuter rail schedules
   - Improve bus-subway transfer coordination

7.2 Data-Driven Initiatives

1. **Real-Time Adjustment System**:
   - Implement dynamic pricing based on predicted demand
   - Adjust service frequency using forecast models
2. **Resilience Planning**:
   - Develop contingency plans for different disruption scenarios
   - Create pandemic response protocols
3. **Continuous Monitoring**:
   - Monthly review of trend and seasonality changes
   - Quarterly model retraining

8. Conclusion

This analysis demonstrates:

1. Clear, actionable patterns in MTA ridership data
2. Significant differences between transportation modes
3. Effective predictive capabilities using advanced ML techniques
4. Concrete opportunities for service optimization

The combination of thorough EDA and robust predictive modeling provides a strong foundation for data-driven decision making in MTA operations and planning.

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9. Next Steps

1. **Model Enhancement**:
    - Incorporate weather and event data
    - Add borough-level granularity
2. **Implementation**:
    - Develop a dashboard for operational teams
    - Create an automated alert system for anomaly detection
3. **Expansion**:
    - Apply similar analysis to fare collection data
    - Integrate customer satisfaction metrics
