Insights from Service Data Analysis

## Interconnected Demand Across Services

Services like Local Route, Light Rail, and Rapid Route show strong correlations, indicating that demand changes in one service often affect others.  
This suggests that joint scheduling or resource optimization can be beneficial for these interconnected services.

## Seasonal Effects on Specific Services

Certain services, such as Rapid Routes, experience higher demand during peak seasons (e.g., summer), driven by tourism.  
Identifying which service types spike most during each season helps optimize resource allocation for seasonal demand.

## Recovering from Disruptions

Demand dropped significantly in 2020 and 2022 due to external disruptions (e.g., COVID-19), but services like Rapid Routes recovered faster.  
This insight can help identify services that are more resilient and plan for future disruptions.

## Unique Role of 'Other' Services

'Other' services (e.g., shuttles) are less correlated with main services, indicating distinct passenger needs or usage patterns.  
This suggests the need for separate strategies to improve their usage or better align them with the main services.

## Inefficiencies in 'Other' Service Utilization

Weak correlation with core services suggests 'Other' services may be underutilized or inefficient.  
Investigating the reasons for low correlation can help optimize routes, schedules, and overall service utilization.

### 1. Overview of SARIMAX Model

The SARIMAX (Seasonal AutoRegressive Integrated Moving Average with eXogenous regressors) model is a robust time series forecasting method that combines ARIMA with seasonal adjustments. It’s particularly useful for datasets exhibiting seasonal trends and patterns, making it ideal for forecasting services with demand fluctuations like transit systems.

### 2. Model Parameters

* **Order (p, d, q):**
  + *p* (AR): Number of lag observations for autoregression.
  + *d* (I): Degree of differencing for stationarity.
  + *q* (MA): Number of lagged forecast errors used in the model.
* **Seasonal Order (P, D, Q, m):**
  + *P* (SAR): Seasonal AR parameter.
  + *D* (SD): Seasonal differencing.
  + *Q* (SMA): Seasonal MA parameter.
  + *m*: Length of the seasonal cycle (e.g., 7 for weekly seasonality).

### 3. Why SARIMAX for this Problem

SARIMAX is well-suited for this problem because it captures both seasonal trends and irregularities in service demand. By including both non-seasonal and seasonal components, SARIMAX can effectively model the periodic rise and fall in service demand (like summer peaks), improving forecast accuracy.

