

Parking Usage Analysis Report

I. Executive Summary

This report provides an interactive Power BI dashboard designed to help understand card user parking patterns, identify peak usage, and assist in strategic decision-making regarding the issuance of various access groups. Through comprehensive data analysis, the dashboard reveals key insights into hourly, daily, and monthly usage trends, the distribution of parking activity across different access groups and priority levels, and forecasts future transaction volumes. Despite encountering specific technical challenges with Power BI Desktop's forecasting capabilities for granular simultaneous occupancy, the report leverages robust data preparation and modeling to provide actionable insights.

II. Dashboard Overview & Key Metrics

The dashboard is structured to provide both high-level summaries and detailed breakdowns of parking activity.

A. Key Performance Indicators (KPIs) - Dashboard Page Top Row

These cards offer immediate insights into overall parking usage:

Total Transactions: The cumulative count of all card access transactions within the analyzed period.

Average Parking Duration (Minutes): The average time a card is used in a lot, calculated from EntranceTime to ExitTime.

Total Parking Hours: The sum of all parking durations, representing total space utilization.

Max Simultaneous Occupancy: The single highest number of cars observed concurrently active across all lots within the filtered timeframe, indicating peak demand for physical space.

DateTime of Max Simultaneous Occupancy: The exact date and time when the Max Simultaneous Occupancy occurred.

LotNumber of Max Simultaneous Occupancy: The specific parking lot where the Max Simultaneous Occupancy was recorded.

B. Core Parking Pattern Visuals - Dashboard Page Side and Bottom Row

These charts illuminate when and how parking facilities are typically used:

Filter Slicers: Interactive slicers for Lot Number, Year, Month Name and Day of Week allow administrators to dynamically filter all visuals to explore specific periods and locations.

Total Transactions by Hour (Column Chart): Displays the sum of transactions for each hour of the day, highlighting peak traffic flow times.

Total Transactions by Day of Week Name (Column Chart): Shows the total transaction volume for each day of the week, identifying peak demand days.

Total Transactions by Priority (Column Chart): Visualizes transaction volume aggregated by the Priority level (1-5) associated with card access, revealing how frequently different priority tiers are utilized.

Total Transactions by Effective Group Number (Bar Chart): Displays transaction volume for each specific access group (EffectiveGroupNumber), including the "Unspecified Access" category, indicating which groups drive usage.

Total Transactions: Historical & Forecasted Trends (Line Chart with Forecast): Presents the overall historical transaction volume and projects future transaction trends for the remaining months of 2025. This forecast can be filtered by Lot Number to show individual lot volume forecasts.

III. Data Preparation & Modeling Methodology

This section details the steps taken to transform the raw data into a clean, robust, and performant data model in Power BI.

A. Initial Data Loading & Power Query Transformations:

Source Data: The main data files were loaded into Power BI Desktop.

Date/Time Imputation: For CardTransaction data, missing EntranceTime and ExitTime values were imputed based on NoEntry and NoExit flags, following the provided rules (e.g., assuming midnight before ExitTime for missing EntranceTime). This ensured all transactions had complete durations.

Date Range Filtering: CardTransaction data was filtered to the specified period: January 1, 2021, to April 30, 2025.

EffectiveGroupNumber Transformation: The -1 value in EffectiveGroupNumber was identified as a significant category (3rd largest). Given no explicit definition and the presence of valid EntranceTime/ExitTime, these were transformed into the text label "Unspecified Access" for clarity in visuals, and the column's data type was changed to Text.

B. Advanced Pre-aggregation for Simultaneous Usage (Python/Pandas):

Problem: Calculating "maximum simultaneous usage count" directly in Power BI's DAX on the 4.2 million raw CardTransaction rows proved to be computationally intensive, leading to "exceeded available resources" errors when attempting to visualize granular simultaneous occupancy.

Solution: A Python script (using Pandas) was developed to pre-aggregate the raw CardTransaction data. This script:

Performed the same date cleaning and filtering as in Power Query.

Generated a continuous hourly timeline.

For every unique LotNumber and every hour (DateTimeInterval), it calculated the ActiveCarsCount (the number of unique cards simultaneously present in that lot during that hour).

The resulting, much smaller, aggregated dataset was saved as AggregatedOccupancy.csv.

Benefit: This pre-aggregation shifts the heavy computation from Power BI's runtime to the data loading/preparation stage, making ActiveCarsCount highly performant within the dashboard.

The link to the script can be found here:

<https://colab.research.google.com/drive/1svoJPpez5fgxYXs-Q1oQAYWBVB8st5he?usp=sharing>

C. Data Modeling in Power BI (DAX Tables & Relationships):

A robust Star Schema-like model was created for efficient filtering and calculation:

AggregatedOccupancy Table: Loaded from AggregatedOccupancy.csv, containing DateTimeInterval, LotNumber, and ActiveCarsCount.

DataTable (Dimension): A calculated table (CALENDAR DAX function) creating a row for every day within the data range. It includes Year, MonthNumber, MonthName, DayOfWeekName, and a unique YearMonthKey.

Lots (Dimension): A calculated table (DISTINCT(UNION) DAX function) containing a unique list of all LotNumbers from both CardTransaction and HourlyOccupancy.

MonthDim (Dimension): A calculated table (SUMMARIZECOLUMNS DAX function) containing unique combinations of Year, MonthName, MonthNumber, and a unique YearMonthKey. This table was specifically created to serve as a clean monthly dimension.

MonthlyPeakOccupancy (Aggregated Fact Table): A calculated table created in Power Query (via "Group By" on HourlyOccupancy) to find the MaxActiveCarsForMonth for each Lot and Month. This table directly supports the per-lot peak usage forecast.

D. Key DAX Measures:

Total Transactions: Counts all records.

Average Parking Duration (Minutes): Average time cars are parked.

Total Parking Hours: Total time cars are parked.

Max Simultaneous Occupancy: MAX(HourlyOccupancy[ActiveCarsCount]), the highest concurrent count.

DateTime of Max Simultaneous Occupancy: DAX to find the exact date/time of the Max Simultaneous Occupancy.

LotNumber of Max Simultaneous Occupancy: DAX to find the exact lot of the Max Simultaneous Occupancy.

(Note: The DAX for Active Cars at Selected Time was initially developed but not used directly on the dashboard due to performance/bug issues).