

Analytical Study on Flow Dynamics and System Pressure in the HHS Child Welfare System (2023–2025)

Abstract

This analytical study evaluates operational flow dynamics within the HHS Child Welfare System using publicly available data from 2023 to 2025. The objective was to assess system stability by examining inflow–outflow balance, custody pressure, seasonal trends, discharge performance, and inventory accumulation.

Using Python for structured data validation and aggregation, and Power BI for dashboard modeling and visualization, key performance metrics such as Net Flow, CBP Pressure Ratio, Days of Inventory, and Discharge Rate were derived.

The findings indicate recurring seasonal pressure spikes, elevated custody population ratios, and structural backlog risk despite stable discharge performance. While the system demonstrates partial operational stabilization, inventory metrics suggest persistent systemic strain.

1. Introduction

- This project analyzes publicly available data on children moving through federal custody systems between **2023 and 2025**. The main objective was to understand how children enter, stay within, and exit the system, and to evaluate operational pressure at different stages.
- Increased custody population
- Extended average stay duration
- Resource strain
- Reduced throughput efficiency

This study investigates system performance from 2023 to 2025 using structured data analysis techniques to determine whether the system is stabilizing or accumulating long-term pressure.

2. Dataset Description

Dataset Characteristics

- Source: Public dataset
- Time Period: 2023 – 2025
- Total Rows: 720
- Total Columns: 6

Key Variables

- Children apprehended and placed in CBP custody (Inflow)
- Children in CBP custody
- Children transferred out of CBP custody
- Children in HHS Care
- Children discharged from HHS Care

The dataset captures daily operational movement within the custody and care system.

3. Data Validation & Quality Assessment

Data validation was performed in Python using Pandas.

Validation Checks Conducted:

- Missing value detection (`isnull().sum()`)
- Duplicate record detection (`duplicated().sum()`)

Results:

- No missing values detected
- No duplicate records found
- Date consistency verified

This confirms the dataset's structural reliability for downstream analysis.

4. Methodology

4.1 Tools Used

- Python (Pandas, NumPy) — Data cleaning, aggregation, metric creation
- Power BI — Data modeling and interactive dashboard visualization

4.2 Key Metrics Created

Net Flow

Net Flow =

Children Apprehended and Placed in CBP Custody
– Children Discharged from HHS Care

This measures whether inflow exceeds outflow or vice versa.

CBP Pressure Ratio

CBP Pressure Ratio =

Total Children in CBP Custody
÷ Total Children Transferred Out of CBP Custody

This metric evaluates operational strain on CBP facilities.

Days of Inventory

Days of Inventory =

Total in CBP Custody
÷ Average Daily Transfer Out

This indicates how long the current custody population would take to clear at the present transfer rate.

4.3 Aggregation Techniques

- Monthly grouping
 - Quarterly trend analysis
 - Daily average calculations
 - Ratio computation
 - Percentage-based discharge rate calculation
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5. Dashboard Architecture

The Power BI dashboard consists of 2 analytical pages.

Page 1: Executive Flow & KPI Overview

- KPI Cards (Total Inflow, Total Outflow, Net Flow)
- Line Chart (Flow trend over time)
- Area Chart (Custody population)
- Slicer (Time filtering)

Page 2: Seasonal & Pressure Analysis

- Monthly Trend Line Chart
- Bar Chart (Discharge rate %)
- CBP Pressure Ratio visualization
- Average stay and inventory metrics

The dashboard supports executive-level operational monitoring.

6. Analysis & Findings

6.1 Flow Analysis

Net Flow = Inflow – Outflow

Findings indicate periods where outflow exceeds inflow, suggesting operational stabilization. However, the reduction in backlog is gradual rather than structural.

Interpretation:

Negative net flow alone does not eliminate accumulated pressure.

6.2 Seasonal Pattern by Month

Strong recurring peaks observed during **Qtr2 (February–May)**.

Seasonal spikes are consistent across years, indicating predictable system pressure cycles.

Implication:

Resource planning should align with seasonal demand rather than reactive allocation.

6.3 CBP Custody Population Rate

The CBP Pressure Ratio reflects elevated operational strain when custody levels rise faster than transfer rates.

Findings indicate:

- Sustained custody load
 - Periodic pressure spikes
 - Transfer capacity limitations during peak months
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6.4 Discharge Rate Percentage

Discharge rate % reflects system efficiency in processing cases.

Although discharge remains stable, the backlog suggests throughput limitations relative to cumulative load.

6.5 Average Time in System

Days of Inventory indicates how long current custody would take to clear at the present rate.

High inventory values suggest:

- Accumulated backlog risk
 - Potential structural inefficiencies
 - Extended average stay duration
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7. Discussion

The system demonstrates partial operational stabilization but not structural optimization.

Key observations:

- Seasonal spikes create recurring operational pressure.
- Stable discharge does not immediately eliminate historical accumulation.
- Elevated inventory indicates backlog persistence.
- System throughput requires long-term structural improvement.

Operational stabilization differs from systemic efficiency.

8. Conclusion

This analysis highlights that system pressure is influenced not only by the number of children entering custody, but by how efficiently they are transferred and discharged. Flow imbalance, discharge rates, custody pressure ratio, and average stay duration together provide a clearer understanding of operational strain between 2023 and 2025.

The dataset was clean, with no missing values or duplicates, ensuring reliable pattern detection and seasonal trend analysis. The findings indicate that proactive capacity planning is essential to maintain system stability.

By combining Python for structured data preparation and Power BI for analytical storytelling, the project transforms raw operational data into meaningful, decision-oriented insights.

Dashboard Overview:

