The Data Behind Deployment: Simulating Crisis Response in Honolulu

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Introduction

Background

- Inconsistent police response to mental health related emergencies has led to arrests and the use of lethal force against Persons with Mental Illness (PWMI)
- Researchers have developed different police response models to improve the outcomes of mental-health related calls
- White and Albert (In Progress) developed a simulation tool in Python to compare four police response models
- Their study compares traditional police-only responses with responses from Crisis Intervention Teams, composed of trained mental-health professionals
- The model was ran using real data from the Seattle Police Department
- The model used Seattle's call frequency, travel times, service times, staffing levels, call priority distributions, and district neighbors as inputs

Research Objectives

- The aim of this research is to apply the Seattle framework to Honolulu, Hawaii in order to test variability between police departments
- My primary contribution to this project is the development and calibration of Honolulu-specific input parameters
- Parameters needed were call arrival rates (call frequency), driving time (time taken to reach an incident), and officer allocation (minimum staffing levels)
- Priority distribution and service times were assumed from Seattle data due to a lack of publicly available information

Data Collection

- Data was collected from Honolulu City and County Open Data Portal
- Honolulu Police Department (HPD) call data from 05/01/2025 to 10/31/2025 was collected, cleaned, and restructured in Python
- Addresses were geocoded (converted into geographic coordinates) using the US Census Bureau Geocoder

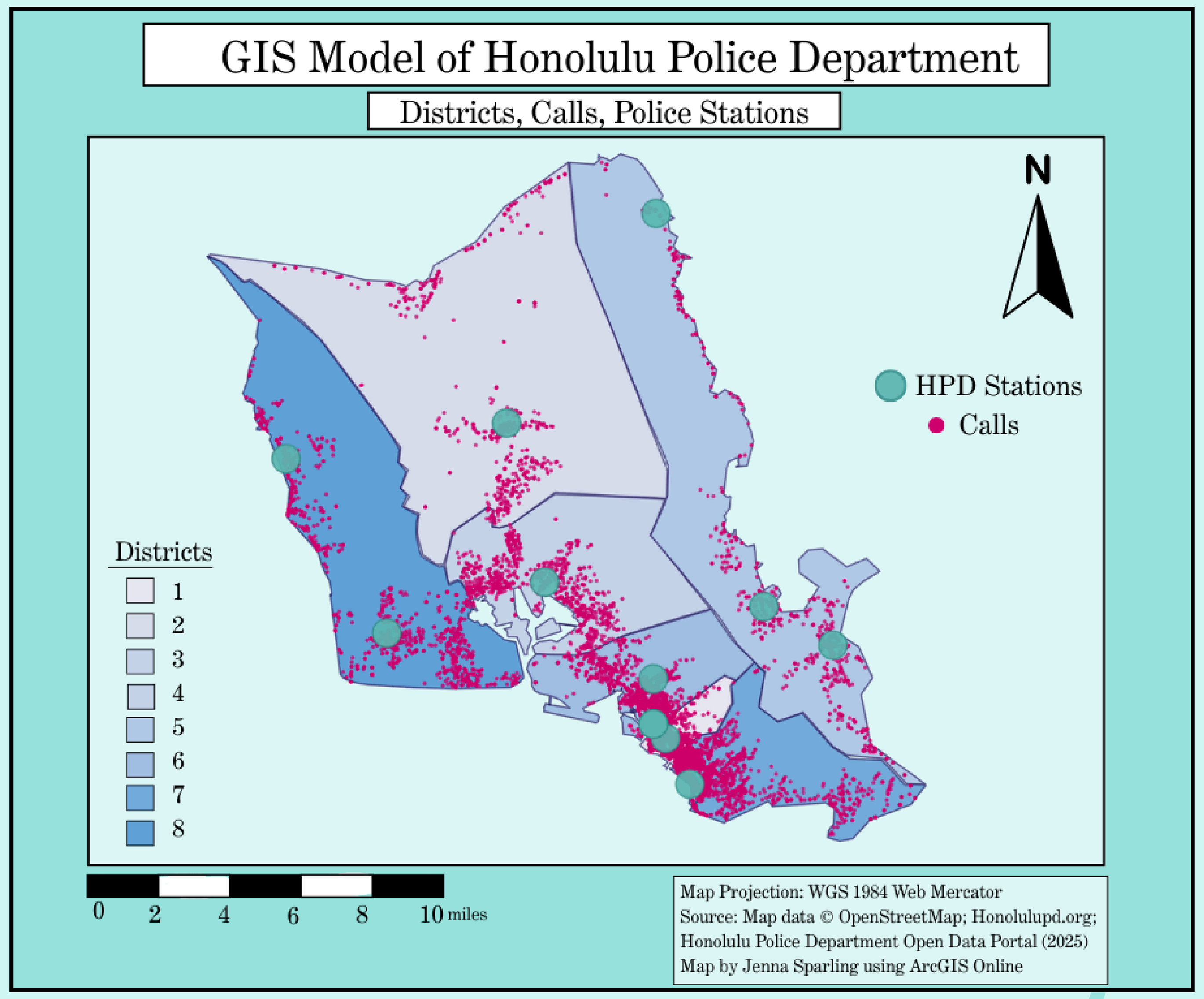
Incident #	Block Address	Date / Time	Incident Type
250501-0026	1200 BLOCK RIVER ST	2025-05-01 00:25	ASSAULT
250501-0031	1300 BLOCK PENSACOLA ST	2025-05-01 00:33	ASSAULT
250501-0051	1300 BLOCK PALI HWY	2025-05-01 00:52	ASSAULT
250501-0087	1200 BLOCK S KING ST	2025-05-01 01:24	THEFT / LARCENY
250501-0096	300 BLOCK W MOANALUA FWY	2025-05-01 01:37	DUI
250501-0175	859000 BLOCK FARRINGTON HWY	2025-05-01 03:48	THEFT / LARCENY
250501-0289	000 BLOCK MAHELE LOOP	2025-05-01 06:24	VEHICLE BREAK-IN
250501-0312	900 BLOCK KAPIOLANI BLVD	2025-05-01 07:15	ASSAULT
250501-0346	2100 BLOCK ALA WAI BLVD	2025-05-01 08:02	BURGLARY
250501-0411	600 BLOCK N KING ST	2025-05-01 09:17	THEFT / LARCENY
250501-0479	1500 BLOCK KEEAUMOKU ST	2025-05-01 10:03	FRAUD
250501-0524	400 BLOCK KALAKAUA AVE	2025-05-01 11:21	VEHICLE BREAK-IN

Sample HPD call data from 05/01/2025 to 10/31/2025

GIS Model

Methods

- Geographic Information Systems (GIS) is a tool used to map and analyze spatial data
- Using the official written boundaries on the HPD website, I constructed a map of the eight HPD districts using ArcGIS (GIS software)
- Using ArcGIS analysis tools, each geocoded call was spatially assigned to a district
- Additionally, all HPD stations were mapped and assigned a district



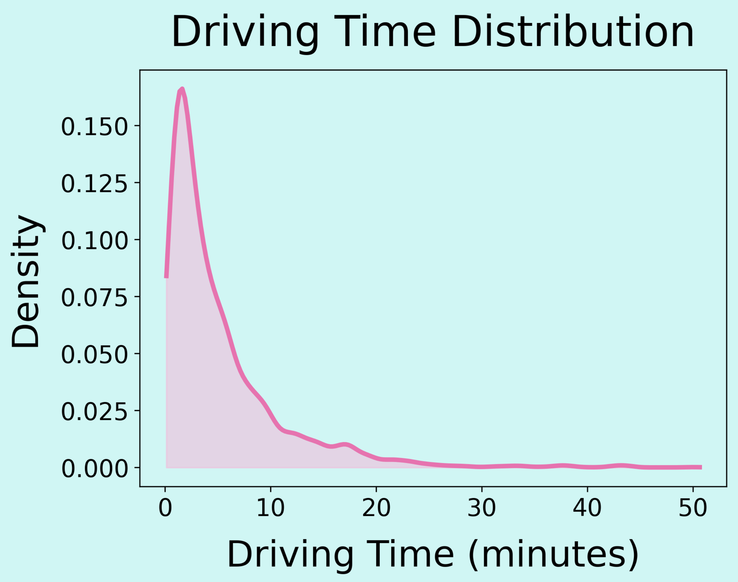
Results

- 15,391 calls were successfully geocoded and spatially assigned to HPD district boundaries
- Urban District 1 (Downtown Honolulu) had the highest call volumes
- Rural District 2 (Mililani, Wahiawa, and North Shore) had the lowest call volumes
- Call demand per district can now be calculated for arrival rates and officer allocation
- Call distance to station can now be calculated for driving times and officer allocation

Driving Times

Methods

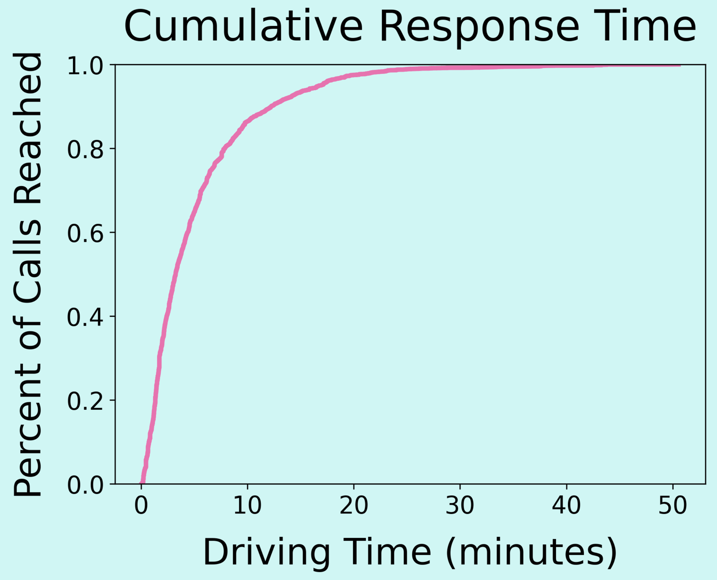
- Driving time was calculated as the distance between a reported incident and its nearest HPD station
- Distance was calculated using the Haversine Formula to get Distance (in miles) from coordinate inputs
- Driving time was calculated as **Distance/Speed x 60**
- Speed was set at an average 27mph



Graph of a Kernel Density Estimation of the relative frequency of Driving Times

Haversine Distance

- $d = 2r\ arcsine\left(\sqrt{sin^2\left(\frac{\varphi_2-\varphi_1}{2}\right) + cos\varphi_1 . cos\varphi_2 . sin^2\left(\frac{\omega_2-\omega_1}{2}\right)}\right)$
- Where
  - φ_1, φ_2 are the latitude of point 1 and point 2 in radian form.
  - ω_1, ω_2 are the longitude of point 1 and point 2 in radian form.



A Cumulative Distribution Graph of Driving Times in terms of probability of a call reached by a certain minute

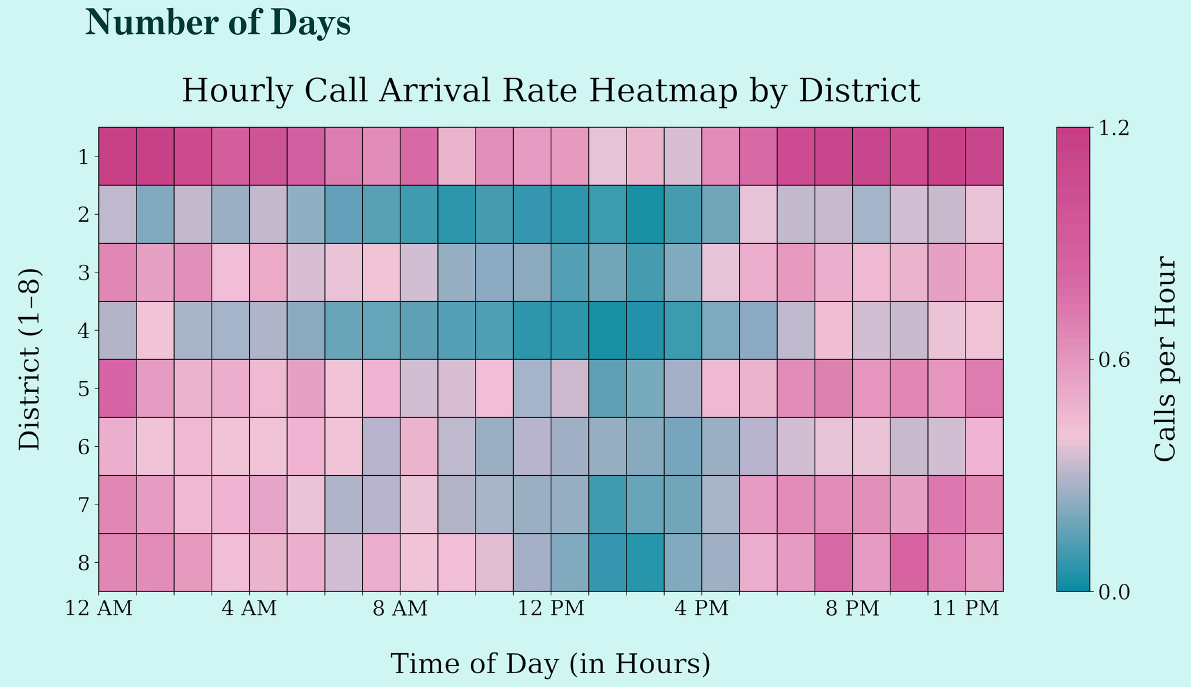
Results

- The mean driving time was 4.75 minutes with a standard deviation of 5.71 minutes
- The median driving time was 3.25 minutes
- Because the mean is greater than the median the distribution is right skewed
- The fastest recorded driving time was 5.4 seconds
- The slowest calculated driving time was 50.5 minutes
- 50% of calls are reached within 4-5 minutes
- 80-90% of calls are reached within 10-12 minutes

Call Arrival Rates

Methods

- Arrival rates represent the average number of calls per HPD district given the day and hour
- Arrival rates are the average calls per hour in each district
- Arrival rates were calculated as **Calls(District, Hour, Day) / Number of Days**



- Crisis and non-Crisis call rates were calculated separately, with 10% of calls assumed to crisis based on policing literature (Yang et al, 2025)
- The Crisis/Non-Crisis Split was appiled to all calculated arrival calls

Results

- 384 Crisis and 384 Non-Crisis arrival rates were calculated
- The highest average call demand occurred in the evening, with rates peaking at 5.44 calls per hour at 11pm
- The lowest average call demand occurred in the afternoon, with rates dropping to 1.14 calls per hour at 2 pm
- Weekdays have a higher average demand than weekends
- Weekday demand was highest at 11pm and lowest at 2pm
- Weekend demand was highest at 12am and lowest at 3pm

Officer Allocation

Methods

- Officer allocation refers to the distribution of officers across districts, shifts, and day types
- An optimization model was constructed to allocate HPD officers to districts based on the call demand
- There are two shifts for the HPD: First Watch (6 am-7:30pm) and Second Watch (6 pm –7:30am)
- Weekend and weekday shifts were calculated separately
- The optimization calculation requires several inputs: call demand per district, district spatial overlap, and a minimum officer requirement
- District spatial overlap allows for districts to assist each other when feasible
- District overlap rule: if any call was less than or equal to 1.5 miles away from another district, that district could provide assistance
- Calculations were completed using Microsoft Excel Solver

$$\min_{x} \sum_{d\in D}\sum_{s\in S}\sum_{w\in W} X_{dsw}$$

The calculation to minimize total officers assigned across all districts (D), shifts (S), and watches (W)

$$\text{s.t.} \sum_{b\in B_d} X_{bsw} \geq \alpha_{dsw}$$

A constraint that states that district overlap (Bd) msut be greater than or equal to demand (alpha)

$$X_{dsw} \geq \beta sw$$

A constraint that states that officers per district per shit-day must be greater than or equal to the minimum required officers (alpha)

$$X_{dsw} \in \mathbb{Z}^+$$

A constraint that states that officer numbers must be whole numbers

Results

- Second watch weekdays required the most amount of officers at 67
- First watch weekends required the least amount of officers at 35
- District 1 consistently required the most officers
- District 2 consistently required the fewest officers

Conclusion

Implications

- All needed inputs for the simulation were found
- These inputs are important for the development of the overall crisis response research project
- The Honolulu case study helps evaluate variability between different police departments
- The results of the simulation will used to propose policy reform

Limitations

- Results are limited by the available data
- A longer date range for call data would improve accuracy
- Greater access to HPD data would reduce data gaps and the need for assumptions

Next Steps

- The calculated parameters will be entered into the simulation model
- Pilot simulations of Honolulu will then be conducted
- When more call data is publicly available, parameters will be recalculated using the same methodology

References

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