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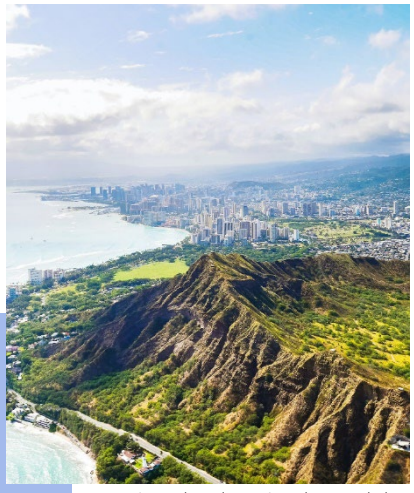
Peer Review Group: Kayla Myros, Inkoo Kang, Mengyao Li

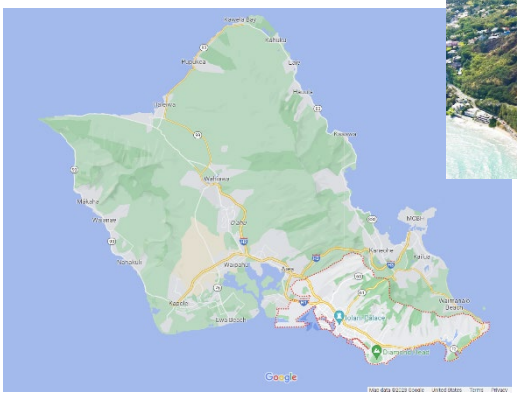
Urban Honolulu, Hawai'i



Source: Diamond Head, Cosmin Serban, unsplash.com

Urban Honolulu is located in Hawai'i, the 50th state of the United States. It is under the jurisdiction of the City and County of Honolulu, comprising of the entire island of O'ahu and nearby outlying islands. According to the 2020 U.S. Census Bureau, the current population is 1,016,508, which is about 70% of the state's total population.

Surrounded by the Pacific Ocean, 71.8% of the island's total area is water, and the land area of 601 square miles (1,556,582,788 square meters). Air travel into and off the island goes through the Daniel K. Inouye International Airport. The public transit system on the island currently includes only bus services. The Honolulu Rail Transit will soon offer rail services in the summer of 2023.



Source: Google Maps (2023)

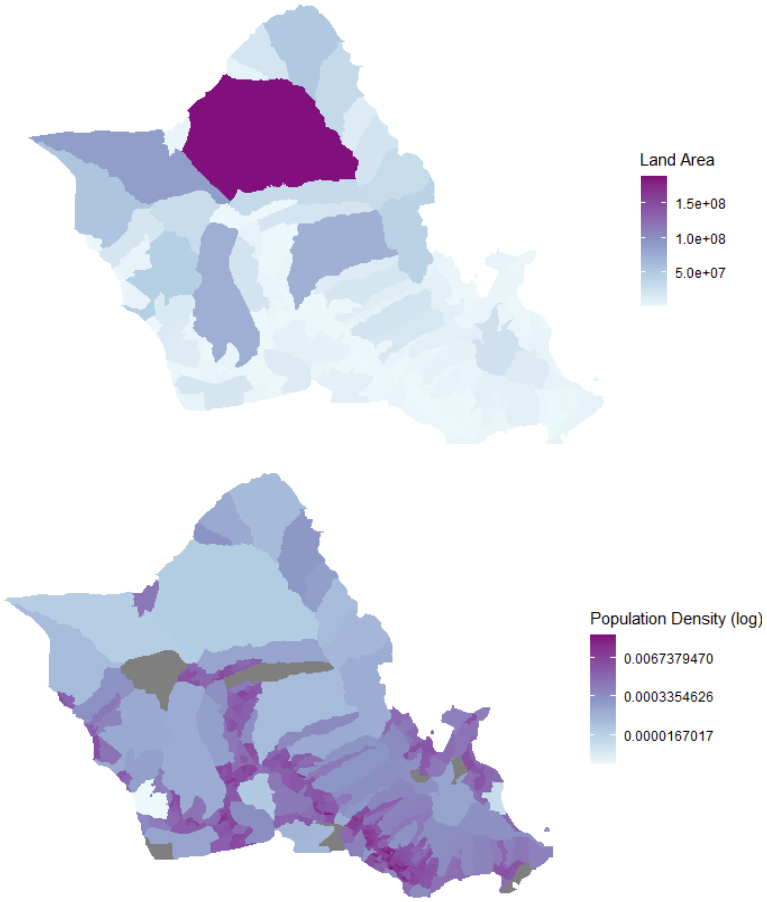


Figure 1: Land Area and Population Density

Zonal Statistics

Geography

With a total land area of 601 square miles, mountain ranges divide the island, limiting activity of where development can take place. (Note: the land area map is in square meters).

The census tract with the highest land area on the island is tract 100, shaded purple in the land area map of Figure 1. Tract 100 has a total land area of 73.32 square miles with an estimated total population of 4,599, which is not as densely populated (population density of 9.351292e-12 per square mile) compared to the tracts along the southern coast line.

Census Tract 115, a tract located in Kapolei, a town located southwest of the island has a land area of 1.7 square miles but with a population of 11, 529. Therefore, it has a higher population density of 1.019207e-09 per square mile.

Household Characteristics

With a total of 328 census tracts, omitting tracts with zero population and zero employment, there is an estimated total of 330,393 households. The average number of households within a census tract is about 1,007 households that range from a household size of one person to four or more people. The average household size is 3.04.

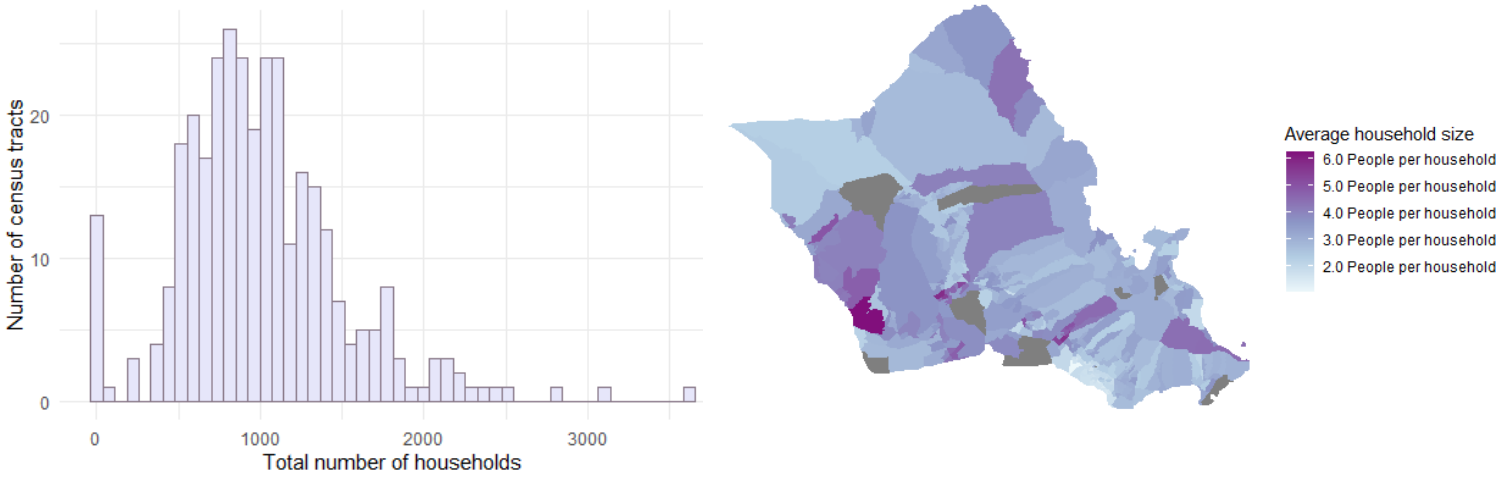


Figure 2: Total Households and Household Size

Vehicle ownership on the island is crucial for transportation on the island. 90% of total households own at least one vehicle. Most of these households live in the city of Honolulu, as seen in the dot-density map in Figure 2.

34% of total households own one vehicle, 35% of households own two vehicles, and 13% of households own three vehicles. About 9% of households are estimated to own four or more vehicles. About 10% of households do not own a vehicle.

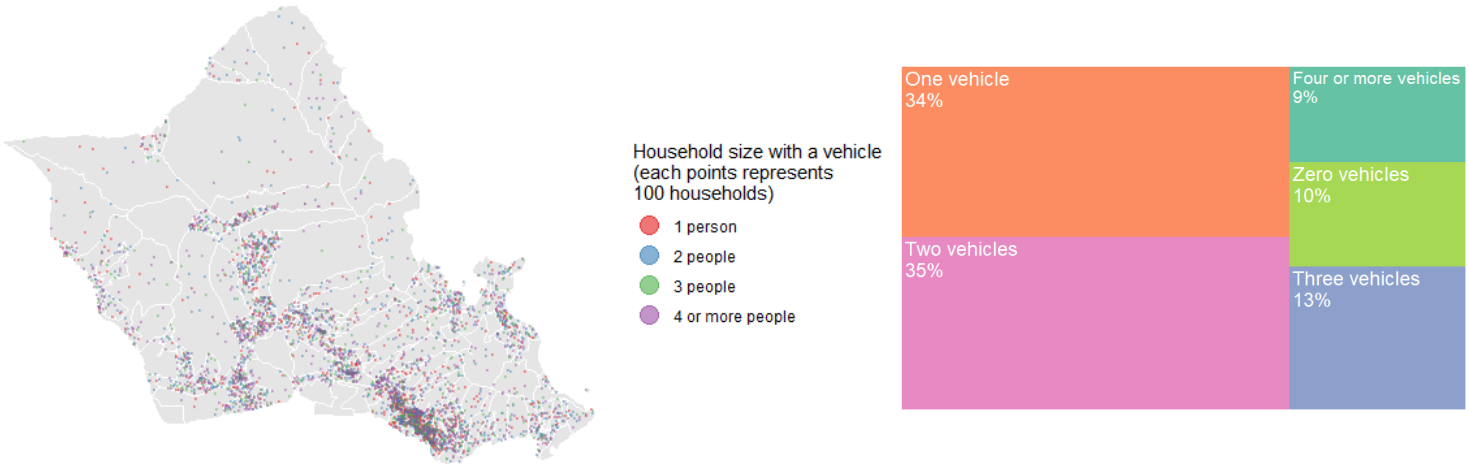


Figure 3: Household size based on vehicle availability

The average median household income within a census tract is about $96,964. About 4% of households have an income less than $10,000, about 21% of households have an income between $10,000-$50,000, about 28% of households have an income between $50,000-$100,000, about 20% of households have an income between $100,000-$150,000, about 12% of households have an income of $150,000-$200,000, and about 14% of households have an income greater than $200,000.

Table 1: Household Income

Household Income	Number of Households
$10,000 and less	14,041
$10,000 - $15,000	7,504
$15,000 - $20,000	6,752
$20,000 - $25,000	8,137
$25,000 - $30,000	7,760
$30,000 - $35,000	9,972
$35,000 - $40,000	9,230
$40,000 - $45,000	10,593
$45,000 - $50,000	9,833
$50,000 - $60,000	18,313
$60,000 - $75,000	30,399
$75,000 - $100,000	44,709
$100,000 - $125,000	37,606
$125,000 - $150,000	28,565
$150,000 - $200,000	40,092
$200,000 or more	46,887
Total	**330,393**

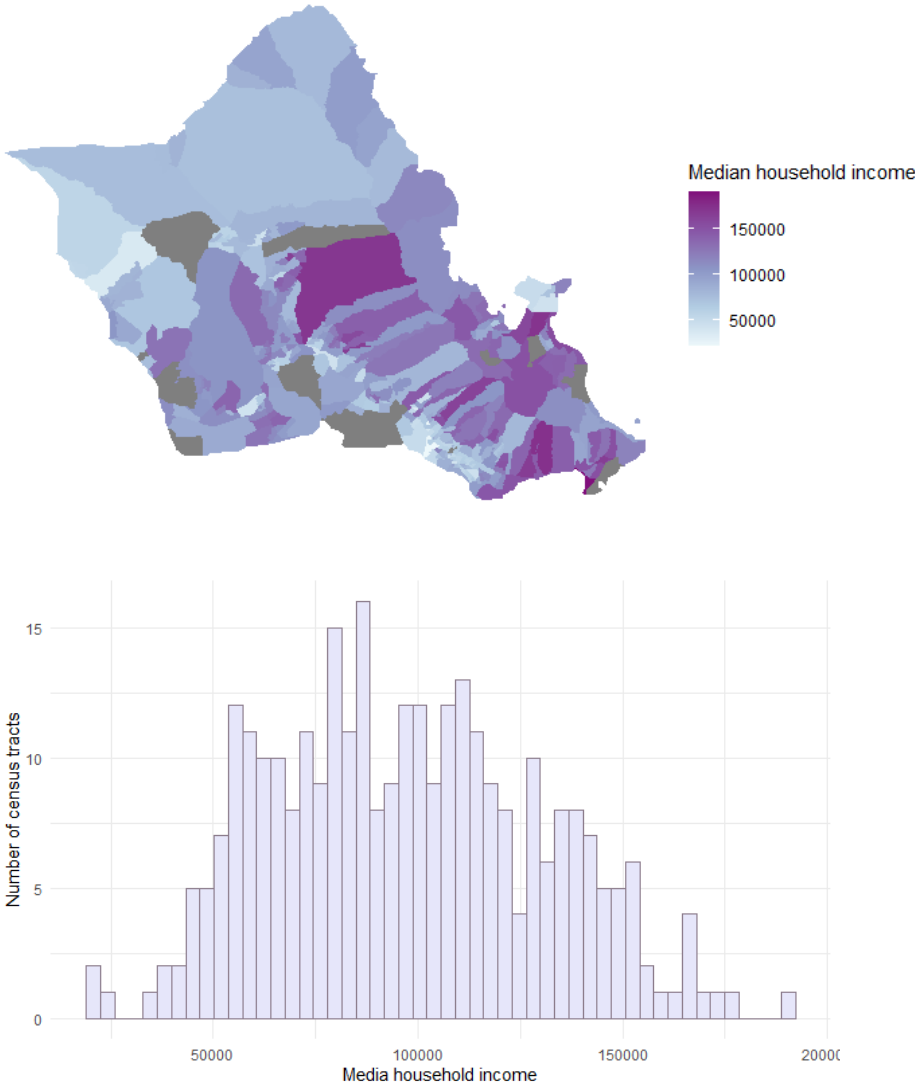


Figure 4: Median household income

Employment

Most of the employment on the island is located along the east-west corridor of the southern coastline as shown in the log-transformed employment density map. There are only 184 tracts out of the 328 tracts that provide employment in the formal labor market with a total of 267,447 employees. Census tract 40, Nuuanu – Punchbowl in Honolulu has the highest employment density of 3.886753e-08 per square mile, with a total of 30,003 employees.

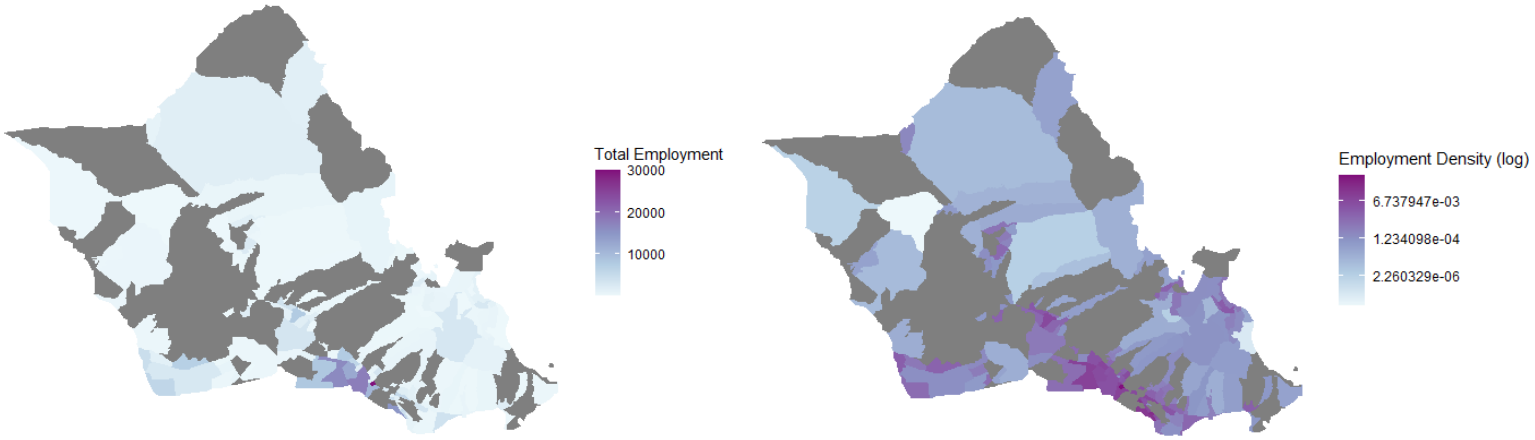


Figure 5: Employment

Basic employment comprises of jobs in the trade industries, which makes up 27.7% of the island's employment. 10.4% of employment is in the retail industry. The industry with the highest number of employment are those who work in the service industry (not in the trade or retail industry), which is 61.8% of the total employment.

Table 2: Employment descriptive statistics

Employment Type	Mean	Median	Total	% of Total Employment
Basic	515.3	68.5	74,206	27.7%
Retail	193.5	31.0	27,871	10.4%
Service	1148.4	434.5	165,370	61.8%

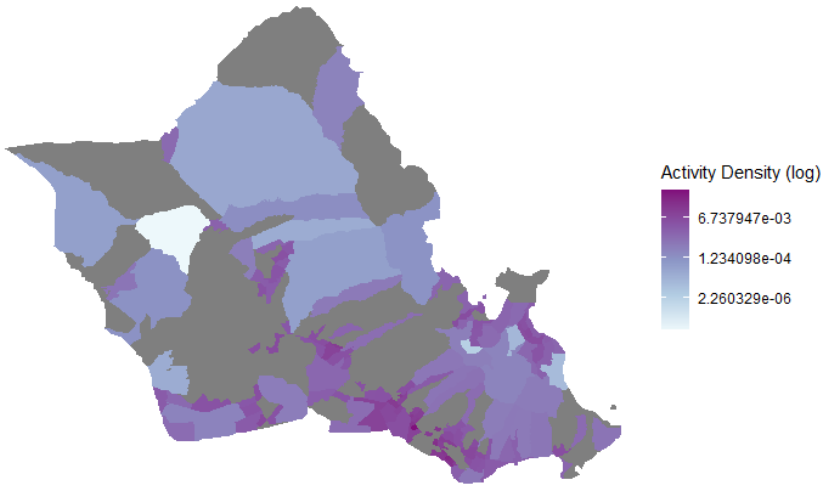


Figure 6: Activity Density

Based on the population density and employment density, figure 5 shows the log-transformed activity density of where people live and work on the island.

Road Network

In constructing the island's road network in TransCAD, there are still flaws in which not all centroids that may have appeared to be in the water or connectors that are linked to one-way roads have been deleted. Note: this has been iterated three times on TransCAD and still is not a complete road network. 84,681 possible origin-destination possibilities have been generated but only 54,166 (64%) have travel time calculations.

The road types included in this network with the following vehicle speeds in miles per hour (mph) are:

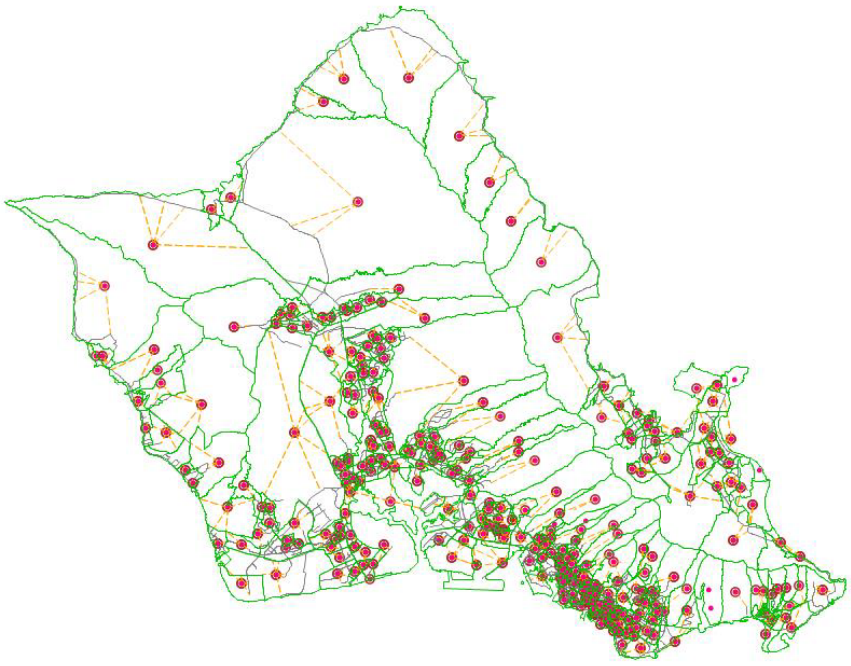


Figure 7: Road Network
Green: Census boundaries, orange: connectors and centroids, grey: roads

- Primary roads at 60 mph
- Secondary roads at 40 mph
- Tertiary roads at 30 mph

A total of 10,555 roads are included in the network. 1.4% constitute primary roads, 24.4% are secondary roads, and 54.6% are tertiary roads.

Assuming an ideal drive without traffic, the average travel time on the road is 23.18 minutes.

Table 3: Origin-Destination Travel Time

Measure	Travel Time (minutes)
Mean	23.18
Median	19.28
Minimum time	0.38
Maximum time	96.02
Interquartile Range	10.46-32.96

Public Transit Network

TheBus is the public bus transit system that provides bus service on the island. Most of the the service is focused primarily on the east-west corridor that runs from the western towns into the city of Honolulu.

Based on weekday service during 4pm to 7pm of 991 bus stops, the average in-vehicle travel time (IVTT) is 67.73 minutes and 97.33 minutes when including a wait time, that includes transfers, of about 30 minutes.

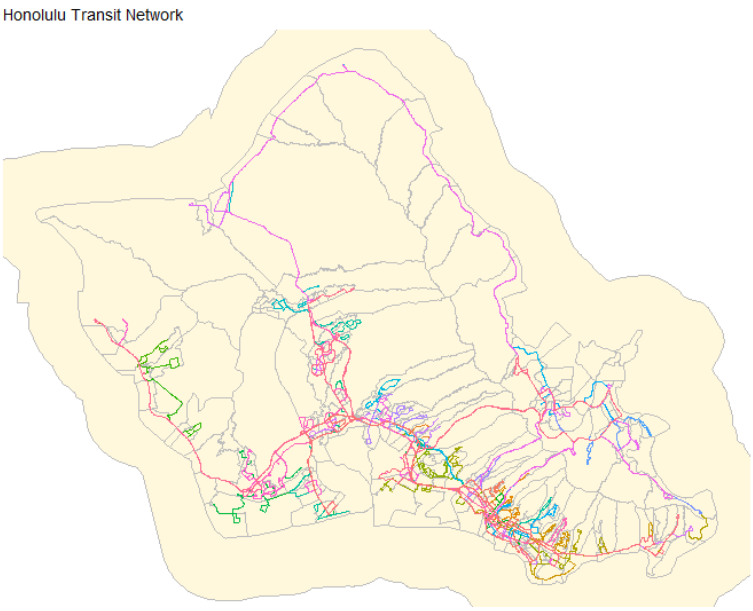


Figure 8: Public Transit Network

Table 4: Transit statistics: transfers, IVTT, and total travel time

Measure	Number of transfers	In-vehicle Travel Time (minutes)	Total Travel time (minutes)
Mean	1.95	67.73	97.33
Median	2	62.42	93.88
Minimum	0	0.0076	0.50
Maximum	5	342.63	383.1
Interquartile Range	1-3	36.37-90.46	62.3-125.4

Since Nuuanu-Punchbowl (census tract 40) has the highest employment on the island, an average commute into that part of Honolulu is 63.24 total minutes. The lowest commute time being 9.81 minutes and the highest commute time being 244.77 minutes. Bus service from the west corridor into the east corridor is lacking, in which travel times are ranging higher than 100 minutes. Transit service to address this gap is anticipated with the opening of rail services.

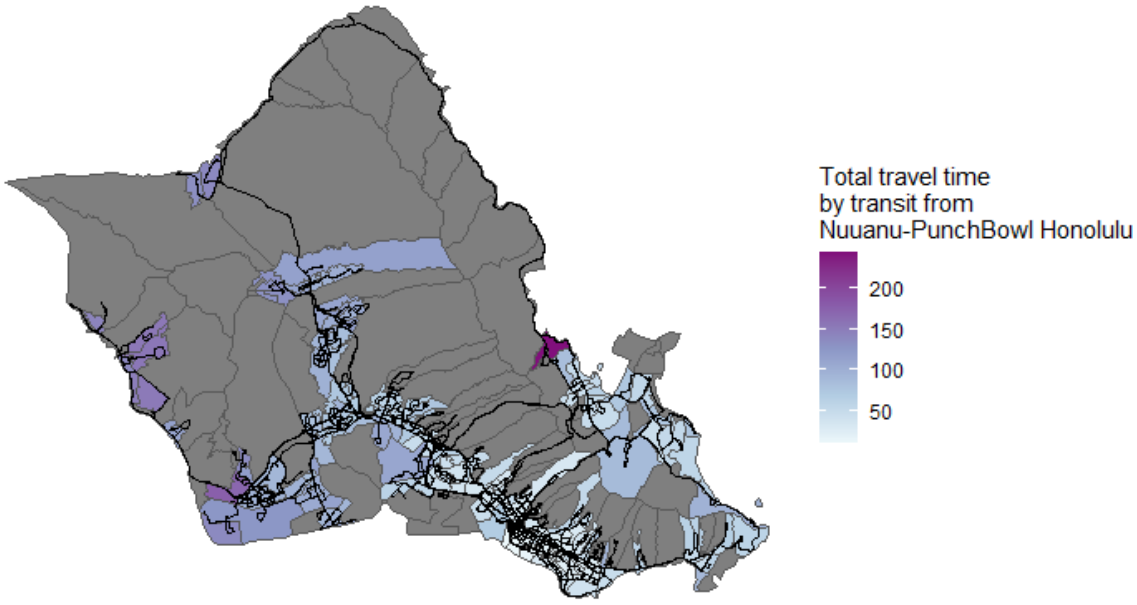


Figure 9: Transit to Nuuanu-Punchbowl

Accessibility

Methods

Using the road networks and public transit networks produced in TransCAD, accessibility in this case models travel time using the modes of a car or bus to employment opportunities.

For bus service, to account for time that is spent out-of vehicle travel time (OVTT), the following calculation is made for a person's perceived time of taking public transit:

$$OVTT = total\ travel\ time - IVTT$$

$$Perceived\ time = IVTT + 2.5 * OVTT$$

A logistic decay function was used to set a weight on employment opportunities based on travel time using a car and the perceived time of taking the bus. An average of 30 minutes for travel time was set with an inflection point at 10 minutes. To examine accessibility to destinations, trip origin was aggregated by taking the sum of jobs for each mode of transportation.

To get a relative accessibility metric was calculated, where the maximum access by a given mode is assigned a value of 100, and all other values are scaled proportionately.

Results

The relative accessibility index of a car is higher than transit as shown in Figure 10. The average car index is 65.62 compared to the transit accessibility average of 13.24. To access more employment opportunities, it is easier for an individual to own a vehicle than to take transit.

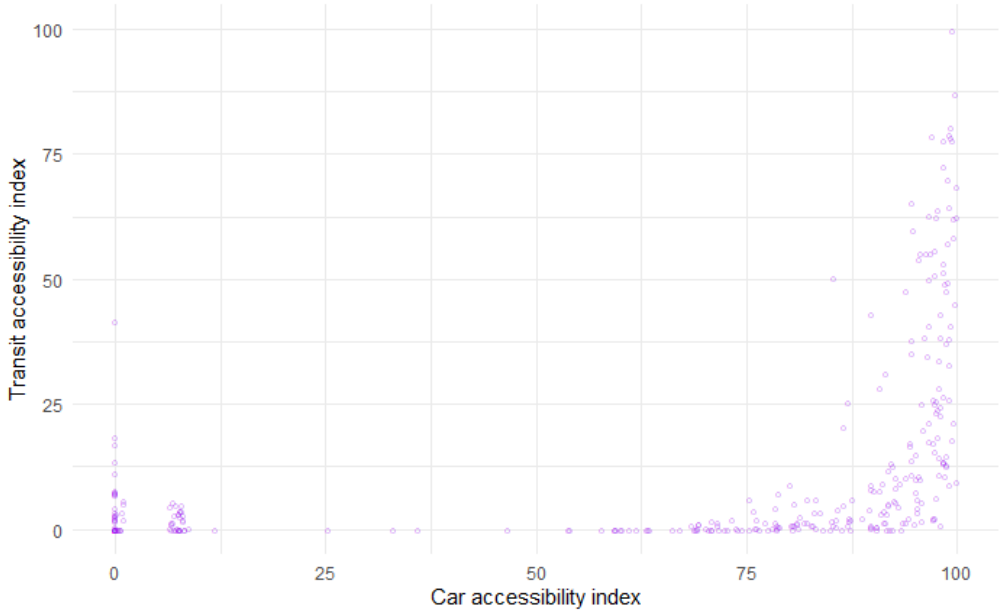


Figure 10: Accessibility index of car and transit

Car accessibility is high, particularly along the east-west corridor. Kukui Plaza in downtown Honolulu (census tract 42.01) has an accessibility index of 100, while the greyed-out tracts in Figure 11 shows the tracts that are not accessible by car.

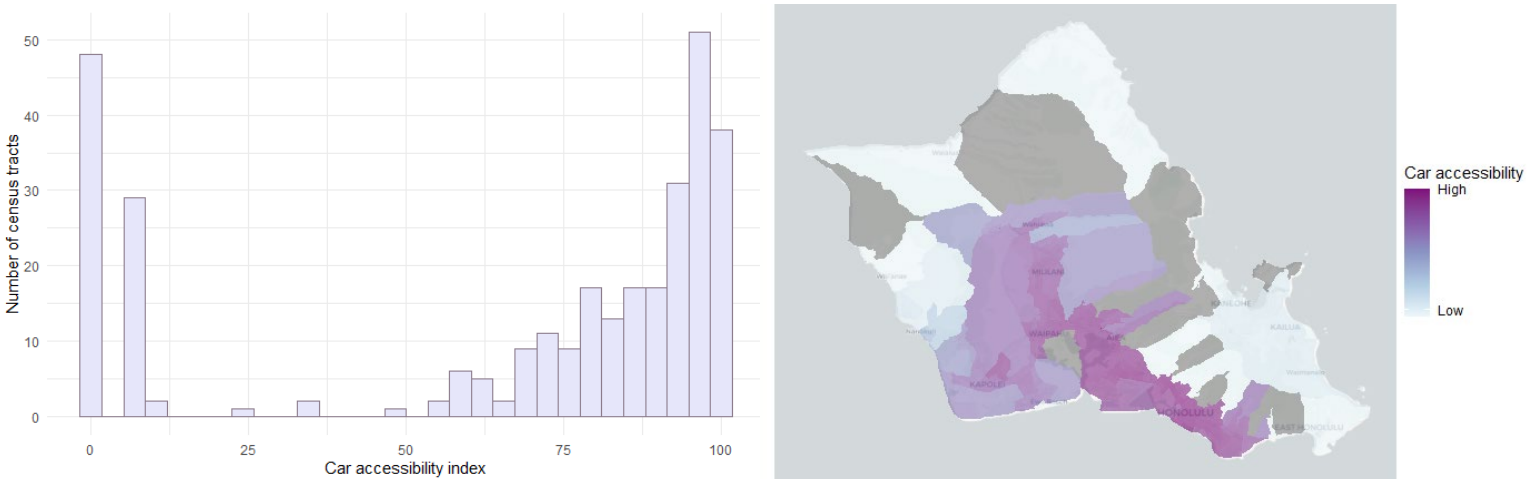


Figure 11: Car Accessibility index

Transit accessibility is highest in Downtown Honolulu (census tract 52), which comprises of Chinatown. While there may be more employment opportunities in the Downtown Honolulu area, households with a low median income also live in these tracts. Households with a higher median household income live in tracts that have a higher car accessibility index.

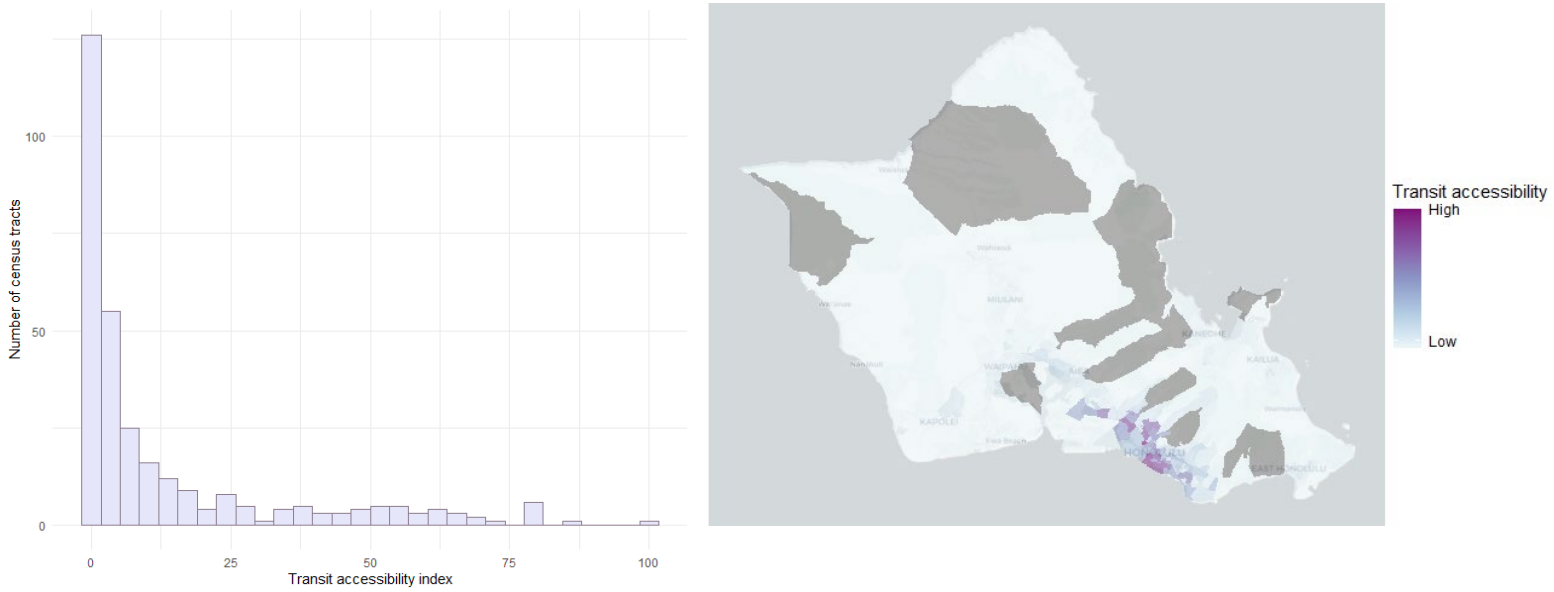


Figure 12: Transit Accessibility index

Sources:

U.S. Census Bureau American Community Survey 2017-2021

Open Street Maps

GTFS, TheBus

Longitudinal Employer-Household Dynamica, 2019

Wikipedia 2023 https://en.wikipedia.org/wiki/Honolulu_County,_Hawaii;

Kayla, A03: Rita -- First, it was interesting to see the road network for Honolulu because the mountain topography is so clear. I am curious of how complete your road network is--how many census tracts do not have matches? When I did my first few skims I was missing data from five to seven census tracts, did you have more or fewer tracts missing, and are they unable to connect to any TZAs or a few TZAs? I also think including your descriptive statatisics is great, it seems that the central part of Honolulu has good connection, since the mode is 3.5 minutes.

Inkoo, A04: I'm sorry that you could not extract only Honolulu part in the Oahu Island, but it is interesting to see how the public transit system is concentrated along the southern part of the island, including the city of Honolulu. According to the table you provided, both average and median gaps between in-vehicle travel time and total time are approximately 30 mins, which is nearly half of the in-vehicle travel time. The fact that the average number of transfers is almost 2 is also noticeable. Based on these facts, I guess that the public transit system in Oahu Island may not be very efficient in connecting destinations directly and may require frequent transfers.

Mengyao, A05: Rita-I really enjoyed reading your report - it is so well formatted, and I love the color scheme! For the "Accessibility" section, I think you presented the method and your assumptions very clearly, so it is straightforward to understand what you are doing at each step. It is interesting to learn that Downtown Honolulu, which is comprised of Chinatown, is the most transit-accessible tract. This shows an excellent public transit design for low-income groups owning fewer vehicles. I only have one question about the map showing transit accessibility - the public transit network in A4 seems to reach the far end of the island, but those tracts are not mapped as of high transit accessibility. Is it because there are less employment opportunities in the area? Overall, great job!