

A series of white geometric lines on a blue background, including a horizontal line at the top, a vertical line, and several diagonal lines that intersect to form a grid-like pattern.

Urban Data Collection

Parking in the Ala Moana Neighborhood and its Impact on Mobility

2019 Summer Workshop

Columbia University
Graduate School of Architecture, Planning and Preservation

University of Hawai`i

With support from



Introduction

Two Twelve Principal and Columbia University Adjunct Ann Harakawa and Columbia University Adjunct Professor Kaz Sakamoto, with support from Two Twelve and a grant funded from the Ulupono Fund at Hawai'i Community Foundation, selected graduate students from the Columbia University Graduate School of Architecture, Planning and Preservation (GSAPP) and University of Hawai'i to pose and begin answering the research questions of: How can technology augment parking studies for improvement in accuracy and efficiency? What are the technologies currently available and gaps in need that could be filled in the parking management industry?

In August 2019, the group led efforts to count and map on- and off-street parking in the Ala Moana neighborhood. They trained on Coord (a Sidewalk Labs spin-off and an augmented-reality curb asset management platform) and traditional GPS data collection methods to document parking spaces and provide the inventory data to the Ulupono Initiative and the City & County of Honolulu. Over a two-week period, the group met with multiple stakeholders across diverse sectors in Hawai'i, field surveyed the streets in the study area, analyzed data, and conducted policy research that interfaces with parking.

This report summarizes this baseline of parking data to understand the current inventory and the infrastructure to provide such information, and identifies the performance measurement around the impact of technology, autonomous vehicles, climate change and provides the framework for the automation to undertake future studies.

Study Area

Bounded by South King Street on the north, Kalakaua Avenue to the east, Ala Moana Boulevard to the south, and Pensacola Street to the West, the group studied the Ala Moana district, which is part of the planned 21 station rail system, and is representative of one of the most urban and complex neighborhoods along the future rail corridor. (See Figure 1)

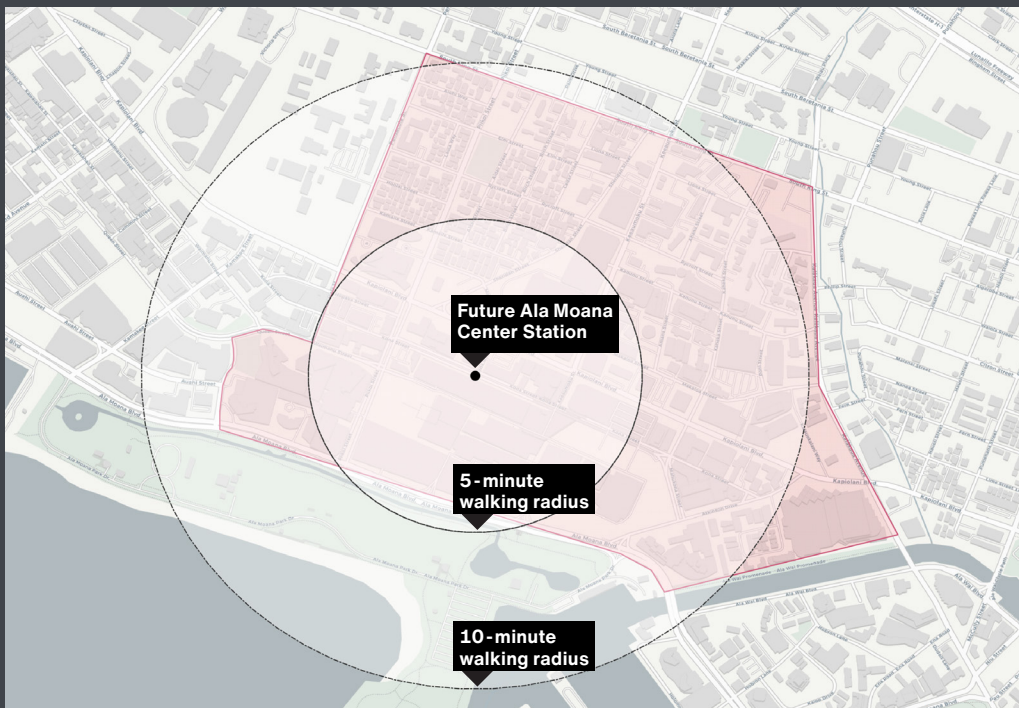


Figure 1 — The Ala Moana district study area

Stakeholders

The group met with constituents in the fields of real estate, economic development, transportation, and academia to immerse and uncover site-specific transportation and parking requirements and considerations in the Ala Moana neighborhood.

Perspectives of both supply and demand were shared by:



HUI: Car Sharing



ELEMENTAL
EXCELSIOR

Elemental Excelsior



The Howard Hughes
Corporation

THE
MACNAUGHTON
GROUP

The MacNaughton Group



EAST-WEST
CENTER

East-West Center /
University of Hawai'i



Honolulu Authority for
Rapid Transportation (HART)

Team

Workshop Leaders

Jennette Cheung
Ann Harakawa
Kaz Sakamoto

Columbia University

Kevin Kim (MS, Urban Planning '20)
Ri Le (MS, Urban Planning '20)
Lorraine Liao (MS, Urban Planning '20)
Tola Oniyangi (Masters in Architecture;
MS, Urban Planning '20)
Qi Yang (Masters in Architecture '20)

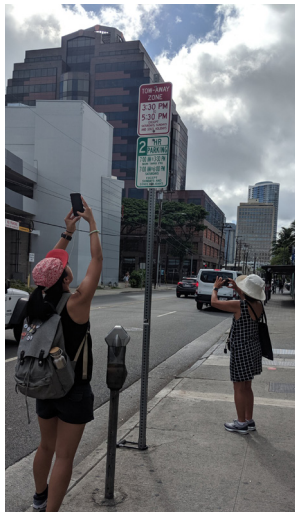
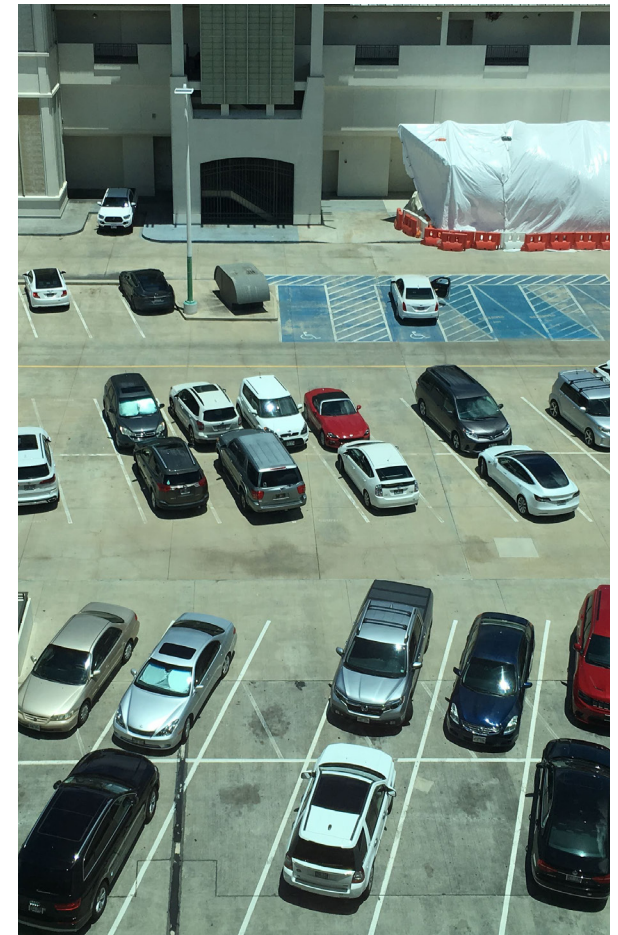
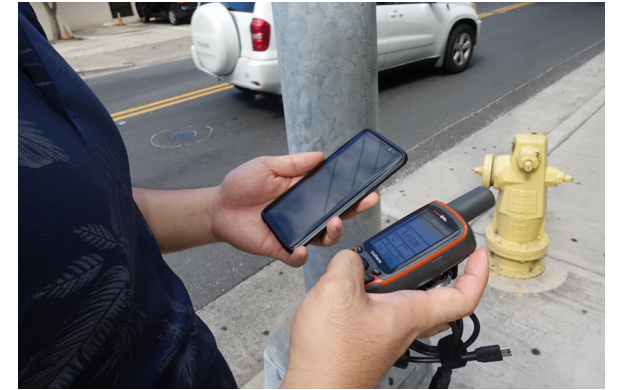
University of Hawai'i

Derek Ford (Masters in Geography)
Kendrick Leong (Masters in Urban
and Regional Planning '19)

City & County of Honolulu Department of Transportation Services

Frankie Burgos
Zachary Ramos





Data Collection Methods

The study defines parking into two sets of data:
on-street and off-street parking.

Method 1

Traditional GPS and spreadsheets



Method 2

Coord



Method 1: Traditional GPS and spreadsheets

The traditional GPS method involves walking with a GPS device and manually recording observations on a spreadsheet.

The traditional method provides a few small advantages: the GPS operation is simple and cannot easily be interrupted by other applications. The data entry process builds on existing knowledge. Many organizations may also already have dedicated GPS units and access to spreadsheet applications.

However, the traditional method is also highly limited and complex. It requires extensive setup and coordination in order to minimize human error and inconsistencies. For example, an extensive amount of supplementary training and logistical setup is required to come up with agreed standards for simple things like naming fields and brainstorming which features to collect. It is easier to make mistakes in the field while collecting data points.

Method 2: Coord

Coord is a platform that uses a combination of augmented reality (AR) and GPS. It does not require specialized equipment—surveyors download the Surveyor app on their iOS device to perform on-site collection. Coord provides a fast survey of street features and workflow analysis: surveyors quickly walk along the curb to log features and take photos in half the time compared to the traditional method.

Data management is also simple. Coord quickly exports datasets into commonly available geospatial data formats and simplifies the reconciliation of conflicting data points. The comparison of data processing between Coord and traditional methods reveals that the spatial locations of features in Coord's data were more reliable than those of the traditional method, which yields less time for data cleanup. (See Figures 2–5)

Comparison of mapping points

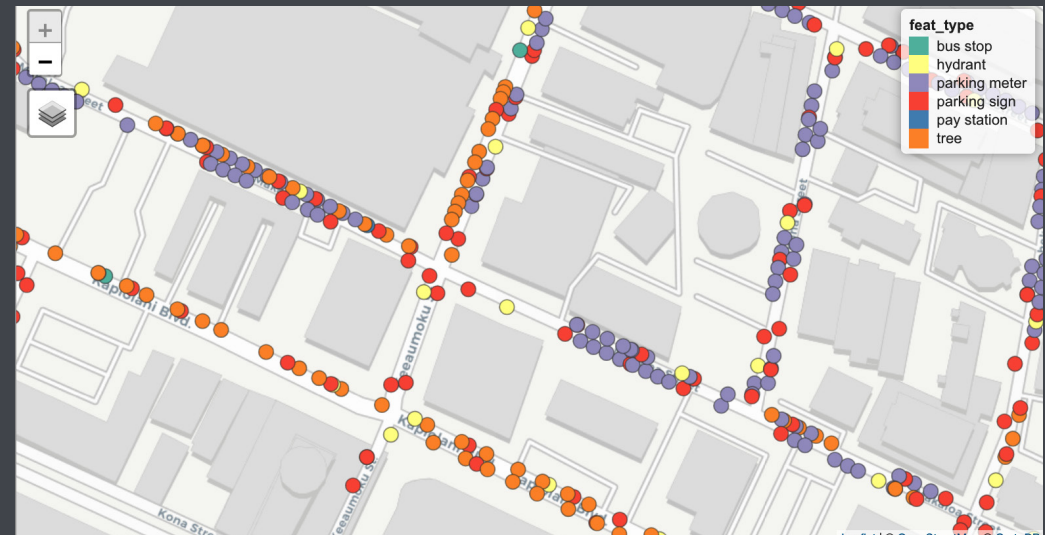


Figure 2 — Coord map points detail

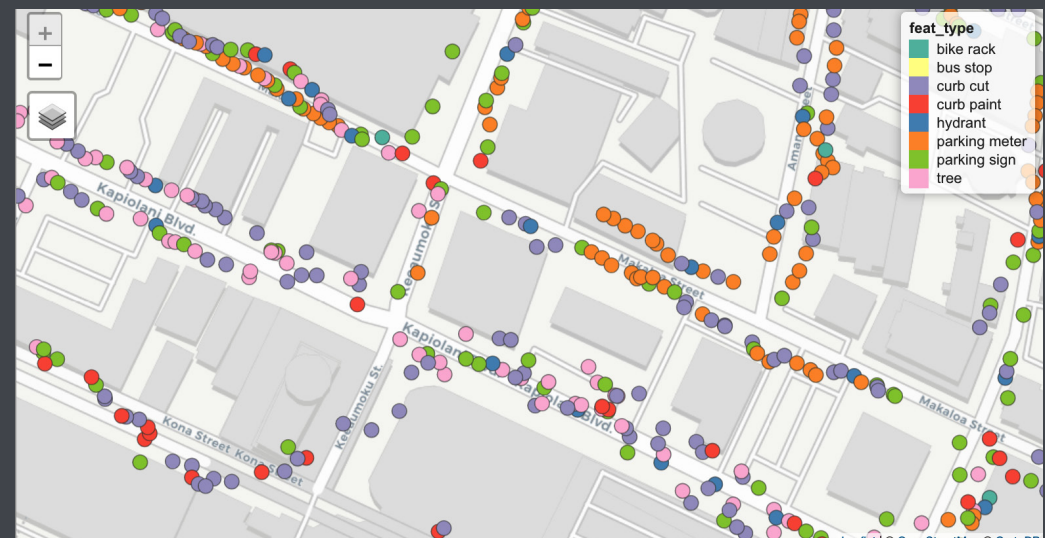


Figure 3 — Traditional map points detail

Comparison of mapped features



Figure 4 — Map of geometry comparison

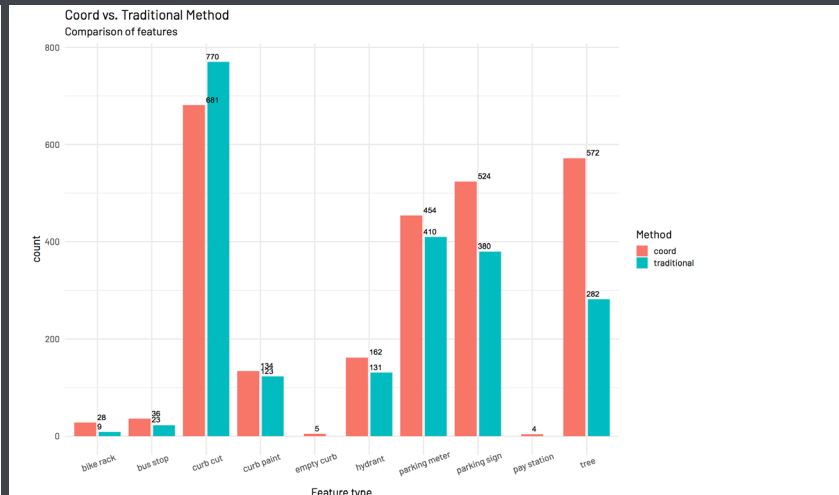


Figure 5 — Comparison of feature points collected (Coord vs. Traditional)

There are operational requirements that need to be considered. Coord is currently only available for iOS, which requires that surveyors obtain compatible devices. The Coord license also requires a set-aside budget, which may impose a significant cost for city agencies or departments who have invested in GPS units. As Coord is a relatively new product, there are also some user experience inconsistencies with the surveyor process which require highly structured and focused surveyor training.

For example, curb representation within the mobile application presented surveyors with some confusion—some long stretches of curb appeared to be a single polyline but were divided into two or three sequential segments. This confusion led team members to survey occasional incorrect curb segments and required additional time to re-survey curb segments. (See Figure 6)

However, the Coord application provides such a streamlined and organized workflow that efficiency gains surpass the cost of the subscription and time spent training.

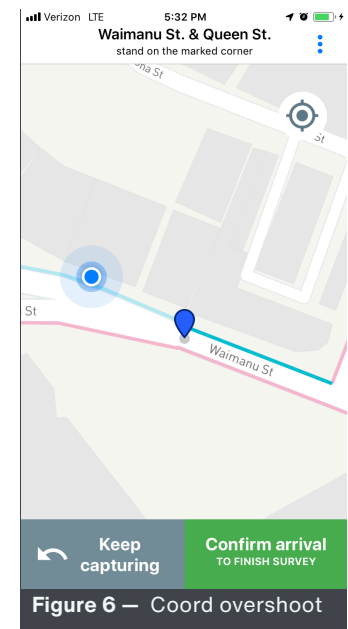


Figure 6 — Coord overshoot

Comparison of two existing sources

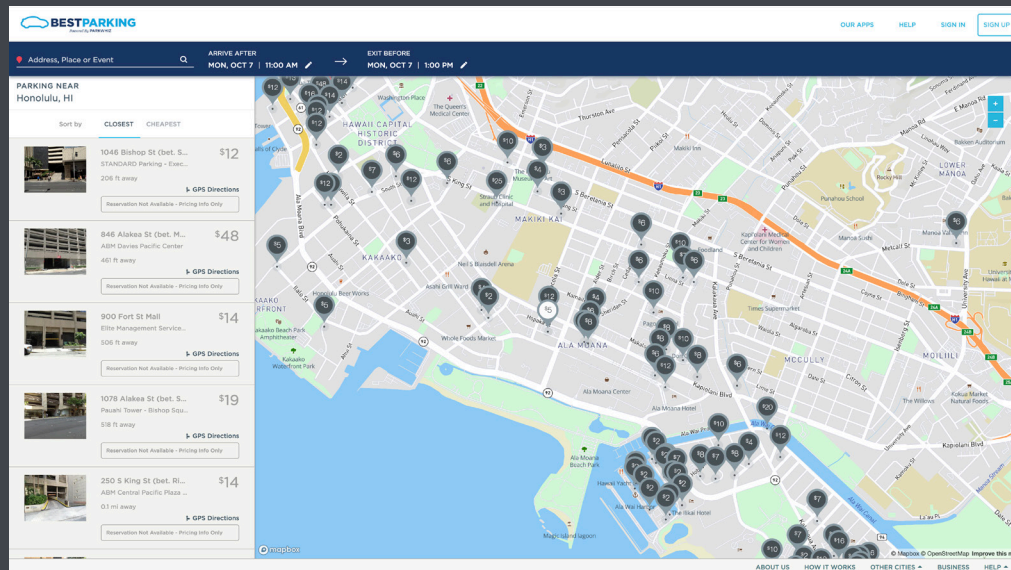


Figure 7 — BestParking user interface and dataset

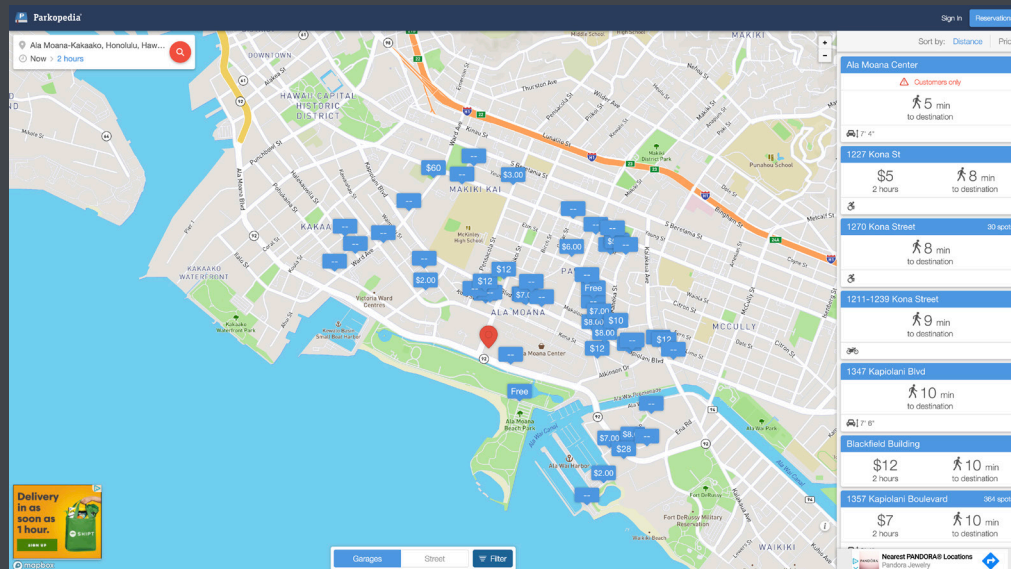


Figure 8 — Parkopedia user interface and dataset

Web-based parking data sources

The City & County of Honolulu and the State of Hawai'i publish publicly-available data on open data websites. These data sources were useful for collecting information and were more reliable because of their official source. However, these datasets are not frequently updated, do not always contain metadata or a data dictionary describing its contents, and availability is sometimes restricted to the organization.

Existing data should always be referenced first. Parking data were collected from the following sources:

- **BestParking**
- **OpenStreetMap**
- **Parkopedia**
- **Google Places**
- **Yelp**
- **Open Data**

These data sources provide basic advantages. They provide numerous sets of information about the spatial location of parking spots and data gathering does not require laborious and time-consuming field surveys.

However, parking data sources are currently limited. Existing sources contain inconsistent data on hours of operation, capacity, and category labeling. (See Figures 7–8) Therefore, merging the data from multiple sources requires additional time and effort to verify overlapping features. The geometry data also varies greatly.

Remote Sensing, Satellite and Unmanned Aerial Vehicle (UAV) Imagery

Satellite Imagery: Off-street parking inventory

Google Earth imagery was examined for the entire study area, and all visible off-street parking was manually counted. The 3D buildings and street view features within Google Earth also allowed for the assessment of parking within covered and multi-level structures. Additional information was needed to determine parking spaces within large, multi-level parking structures such as commercial and residential high-rise parking lots.

Real-time data collection



Figure 9 — Walmart/Sam's Club parking structure at two time intervals (11:00 am and 5:30 pm)



Figure 10 — Street parking at two time intervals (11:00am and 5:30pm) highlighting lack of change

This information was gained through online searches of building names or addresses. Two online sources (www.commercialsafe.com, www.officespace.com) provided parking space counts for some commercial buildings. Two additional online sources (www.hicondos.com, www.thehawaiiastatecondoguide.com) provided unit and bedroom counts for some high-rise residential buildings. In the case where no parking space counts were available, these bedroom counts were used as an estimate of parking spaces available. For the remaining parking structures with no parking or bedroom counts available, Google Earth imagery was used to estimate parking spaces based on quantity of parking levels and likely parking arrangements.

Based on the described methods, it was estimated that the study area contains 32,212 off-street parking spaces. There is high confidence in the count for surface-level parking spaces. Due to the presence of many covered or multi-level parking structures, this estimate could be further refined by examining building permits and contacting parking lot managers for more accurate parking space counts.

The use of satellite imagery for this purpose presents distinct advantages and disadvantages. The primary advantage is that imagery is freely and easily accessible, and provides complete spatial coverage for most of the world. Therefore, this data source can be utilized by a variety of users and locations, and the methodology is easily transferable. The primary disadvantages are that the imagery requires time-consuming interpretation to detect parking spaces, the



Figure 11 — Parking at Don Quijote demonstrating lack of availability at the nearby surface parking lot, while overflow parking areas remained largely unoccupied at two time intervals (11:00am and 5:30pm).

manual count is prone to human error, only surface-level parking spaces are clearly visible, and the imagery is not completely up-to-date. Despite these disadvantages, this methodology provided the most complete estimate of off-street parking within the Ala Moana district study area.

UAV Imagery: Observing parking patterns

UAV imagery was collected and analyzed to gain a sense of parking usage and patterns for select locations within the study area. The three selected locations were representative of different land uses, development types, and parking usage.

Images were taken at two time intervals (11:00 am and 5:30 pm) to capture parking pertaining to daytime workers and shoppers, and evening residents and shoppers, respectively. This imagery was not sufficient for assessing parking patterns across the entire study area, but it did provide insights into specific areas of interest. Additional image collection performed over a wider area and more time intervals would likely provide a greater understanding of parking patterns.

The surface level of the Walmart/Sam's Club parking structure is consistently unoccupied. This is an inefficient use of space and money, which contributes to the greater issue of parking oversupply within the Ala Moana district study area. It is also an environmentally-irresponsible land cover. (See Figure 9)

Street parking within this residential neighborhood is abundantly available. UAV imagery depicts numerous low-turnover parking spaces which contain the same vehicle at both times. Additionally, some of these spaces are located on a main roadway which experiences heavy traffic congestion during rush hour. The presence of street parking on this roadway can exacerbate congestion and create a more hazardous situation for drivers, pedestrians, and bicyclists. (See Figure 10)

Don Quijote Honolulu is a popular 24-hour Asian convenience store located at the center of the Ala Moana district study area. The surface parking in front of the store is consistently full, while its two-level overflow parking area, partially visible at the bottom of the images, is consistently semi- to mostly unoccupied. This indicates that users of this parking lot are strongly influenced by proximity to their shopping destination. Anecdotally, during the 11:00 am image collection, vehicles were observed circling, waiting, and aggressively competing for parking in the surface parking lot, while the overflow lot remained largely unoccupied. (See Figure 11)

UAV imagery is a relatively new data source and is well-suited for this study. The primary advantage of this method is the provision of real-time data and collection of datasets at custom locations and during specific time intervals. Disadvantages of this method include limitations of UAV operations over the entire study area due to Federal Aviation Administration (FAA) regulations and only surface-level parking are visible, similar to the issues faced by satellite imagery. Future efforts utilizing UAV imagery will likely benefit from prior acquisition of a Part 107 waiver for operations over people.

Analysis & Overview

Demographics of Ala Moana

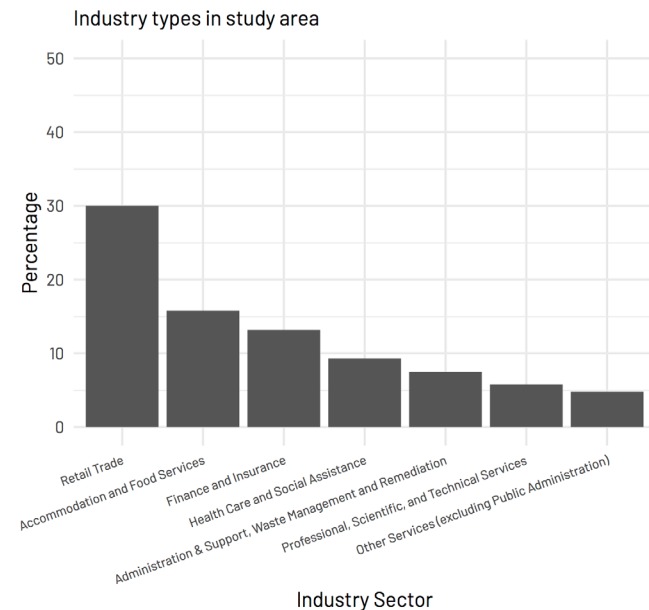
Age of residents

According to the 2017 American Community Survey (ACS) 5-year Estimates, there are approximately 15,992 residents in the area. A significant portion of residents are between ages 35 to 64 years of age, comprising of 41.6% of residents. Overall, it appears that residents' age tends towards 35+. Noting that 65+ comprises about 21% of residents, this could make a case for the reduction of automobile usage, a mode of transit that is not always accessible for senior citizens use.¹

Age	Count	Percentage
1 to 17 years	2,056	12.9%
18 to 34 years	3,845	24%
35 to 64 years	6,645	41.6%
65 and up	3,446	21.5%
Total	15,992	100%

Industry types

As expected, the most dominant industry types in the Ala Moana area are Retail Trade as well as Accommodation and Food Services, according to data from the Longitudinal Employer Household Dynamics (LEHD) dataset. These likely indicate that a significant portion of the parking demand within the study area is associated with these popular labor industries.²



Statistic	Opportunity
54.7% of workers age 16+ drive	Diversify transit opportunities
7.6% of workers carpool	Incentivize carpooling
14.3% of all workers rode public transportation	Increase transit ridership
20.3% walked to work	Build walkable infrastructure
3.4% biked to work	Improve cycling experience

Workers' modes of transport

Considering that the Ala Moana district study area contains more than 9,000 jobs (LEHD 2015), the modes of transport for workers is an important consideration for adjusting parking policy.

Most importantly, more than 57.4% percent of workers in the area used an automobile to travel to work. Only 7.6% of all workers carpooled. This raises questions about the possibility of incentivizing carpooling as a way to reduce parking demand.

While the Ala Moana district study area is a well-connected transit hub, only 14.3% of workers used public transport to get to work. A surprising 20.3% of workers walked to work, which provides a basis for improving walkability in the area. Only 3.4% of workers biked to work, which may help us consider the expansion of or improvement of cycling infrastructure.³

Most workers commute from the general locality of Urban Honolulu (15,621 jobs). But a significant portion of workers also commute from East Honolulu (1,661), Kailua (902), and Pearl City (821). These insights indicate that optimizing these transportation corridors may better target demand for increasing commute efficiency to and from these areas.⁴ (See Figure 12)

Commute directionality

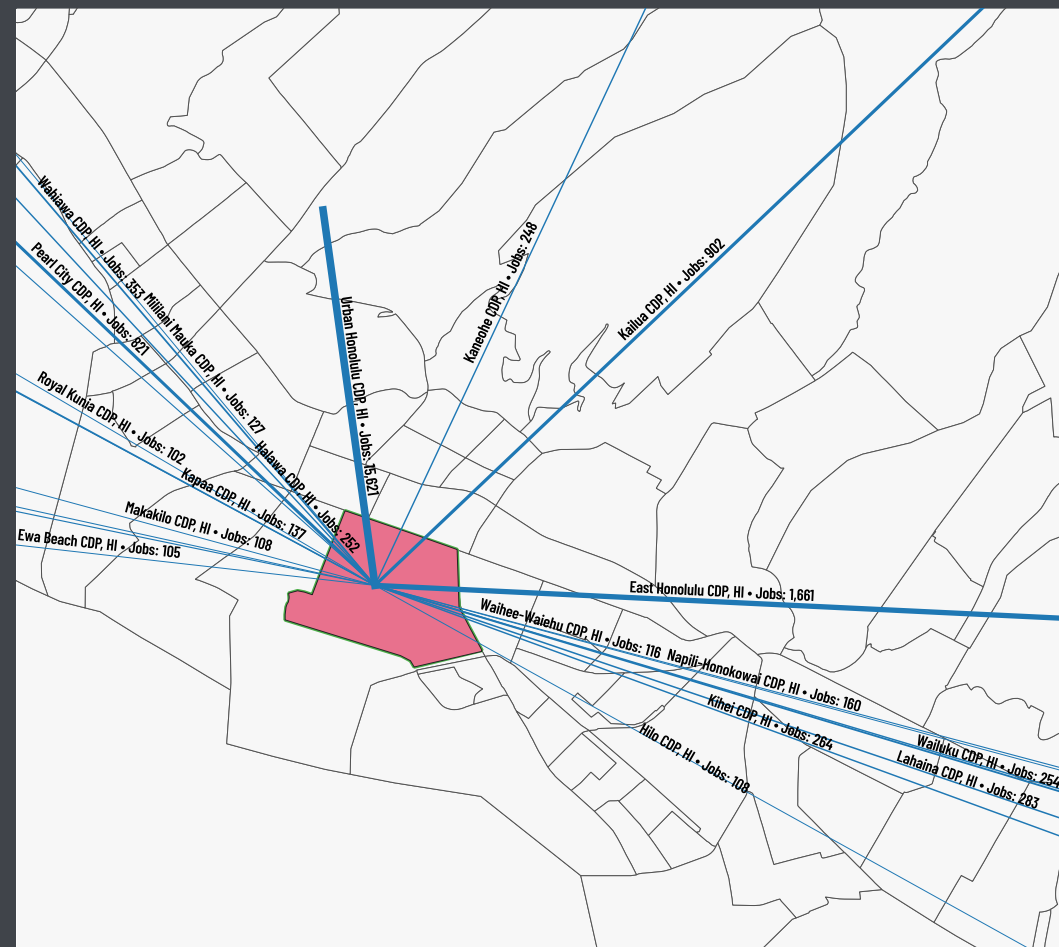


Figure 12 — Diagram demonstrating the relationship of jobs and commute distance for workers

According to the LEHD, of those living in the study area (7,603), most are living in the study area but are working outside of it (6,444) and those who live and work within the study area (1,159) account for a small proportion of the population.

This indicates that walkability is one aspect of the inflow/outflow; however, the number of those employed in the study area (26,283) but living outside of the study area (25,124) is the largest demographic that requires transportation support.

Job Counts by Places (Cities, CDPs, etc.) Where Workers Live - All Jobs

	Count (2017)	Share
Urban Honolulu CDP, HI	15,621	59.4%
East Honolulu CDP, HI	1,661	6.3%
Kailua CDP, HI	902	3.4%
Pearl City CDP, HI	821	3.1%

Inflow/Outflow Job Counts (All Jobs), 2017

	Count	Share
Employed in the Study Area	26,283	100.0%
Employed in the Study Area but Living Outside	25,124	95.6%
Employed and Living in the Study Area	1,159	4.4%

Living in the Study Area	7,603	100.0%
Living in the Study Area but Employed Outside	6,444	84.8%
Living and Employed in the Study Area	1,159	15.2%

Transit infrastructure

(See Figures 13–19)

The study area will contain the Ala Moana Transit Center, which is a transit center that will serve as the terminus or last stop of the planned rail development for Honolulu.

The majority of the Ala Moana district study area is within a 10-minute walking distance from this station, while a good portion of the area is within a 5-minute walking distance. (See Figure 13)

Connecting the Ala Moana neighborhood to an easily accessible rail stop will increase opportunities for transportation options from close by and far away. The bus infrastructure within the study area is also rather robust and currently connects the Ala Moana district study area to the rest of Honolulu in different directions. (See Figure 14)

However, the bike infrastructure is not similarly robust. The existing bike lanes are limited and disjointed—only four bike lanes exist within the study area. The planned bike lanes extend the biking infrastructure, but still face the same problem of undersupply and lack of connection between the lanes. This is an impediment to the safety and the experience of biking in Honolulu. (See Figure 15)

On the other hand, there is a large number of on- and off-street parking within the study area. Off-street parking numbers range from 0 to almost 7000 per lot, and off-street parking is heavily concentrated in the south of the study area by the extremely busy Ala Moana Boulevard. (See Figure 16)

The City & County of Honolulu has created a Transit-Oriented Development (TOD) Plan for the Ala Moana neighborhood that segments it into various districts with specific development plans.⁵ (See Figure 17)

This plan is commendable but it should be noted that the Kalakaua, Kaheka and Sheridan Districts combine residential, mixed-use, and preservation land use categories. (See Figure 18) Without a plan to address the specific nuances of these different areas, or to treat them in dissimilar ways, the TOD plan will be at a disadvantage.

One way to approach a parking management district that prioritizes parking efficiency and maintains a smooth flow of traffic would be to limit or eliminate parking on heavily-trafficked commercial corridors through regulation or higher fees. In this case, parking on side and end streets would be encouraged through lower fees or a system of free parking for a certain amount of time. (See Figure 19)

Infrastructure in Ala Moana

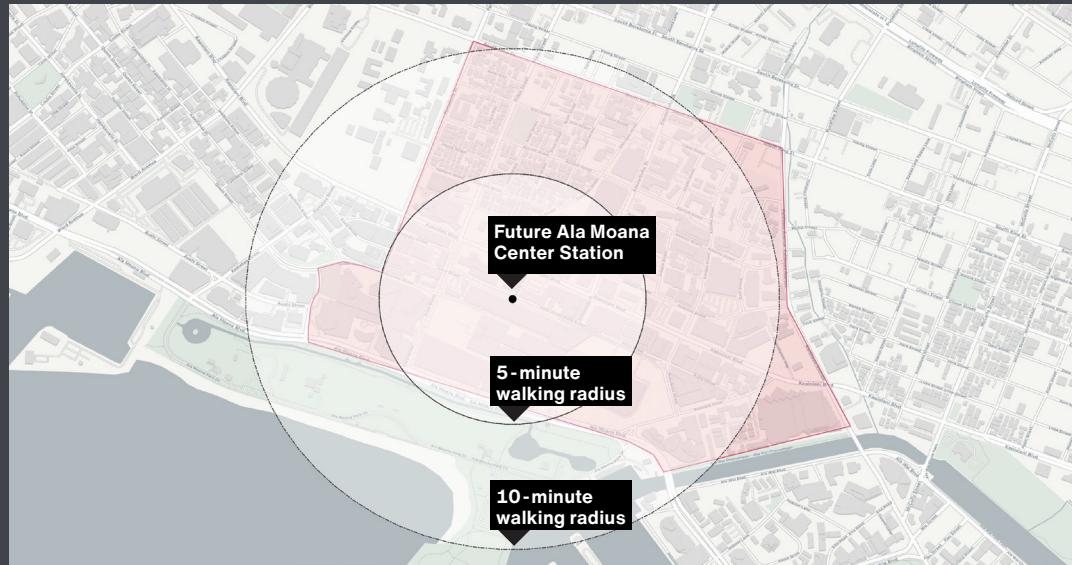


Figure 13 — Study Area in Relation to Existing Transit-Oriented Development Plans. The future Ala Moana Transit Center will be located at its epicenter. The inner circle represents the area within a 5-minute walking distance; the outer represents the area within a 10-minute walk distance from the future rail station.

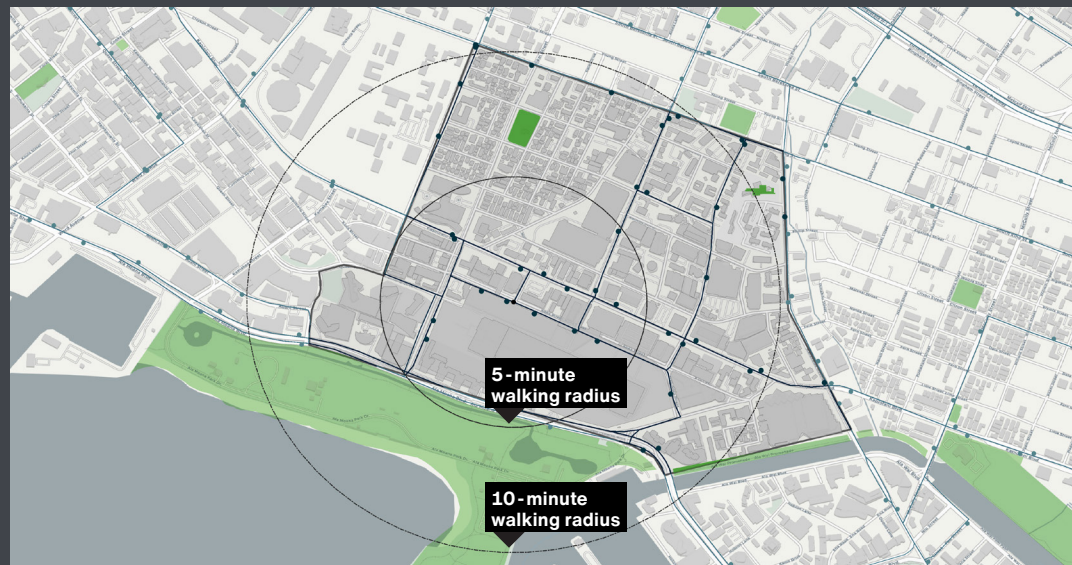


Figure 14 — Transportation Infrastructure within Study Area: Bus

Infrastructure in Ala Moana (continued)

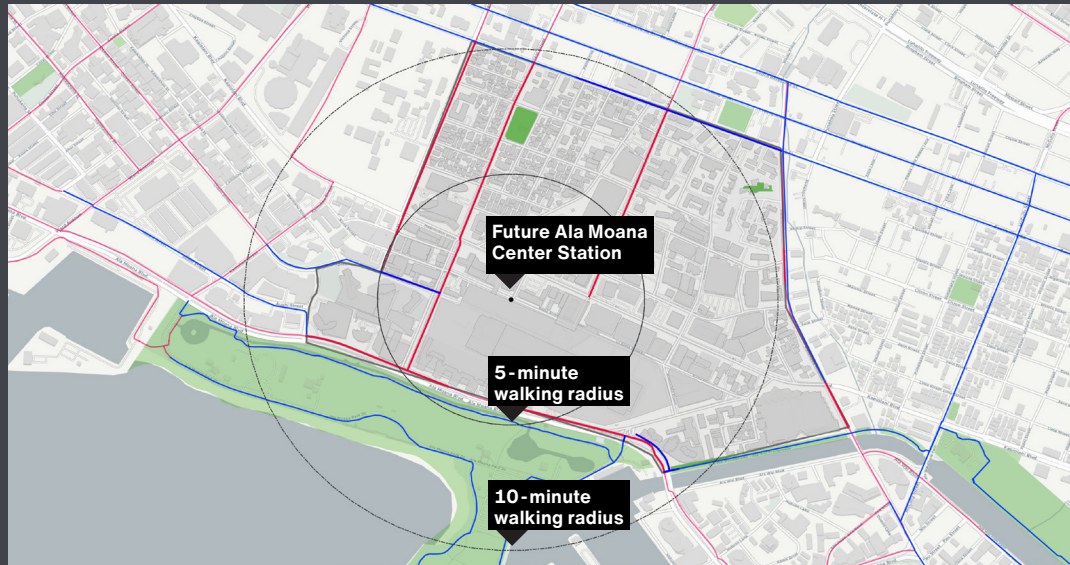


Figure 15 — Transportation Infrastructure within Study Area: Biking (Current and Proposed)

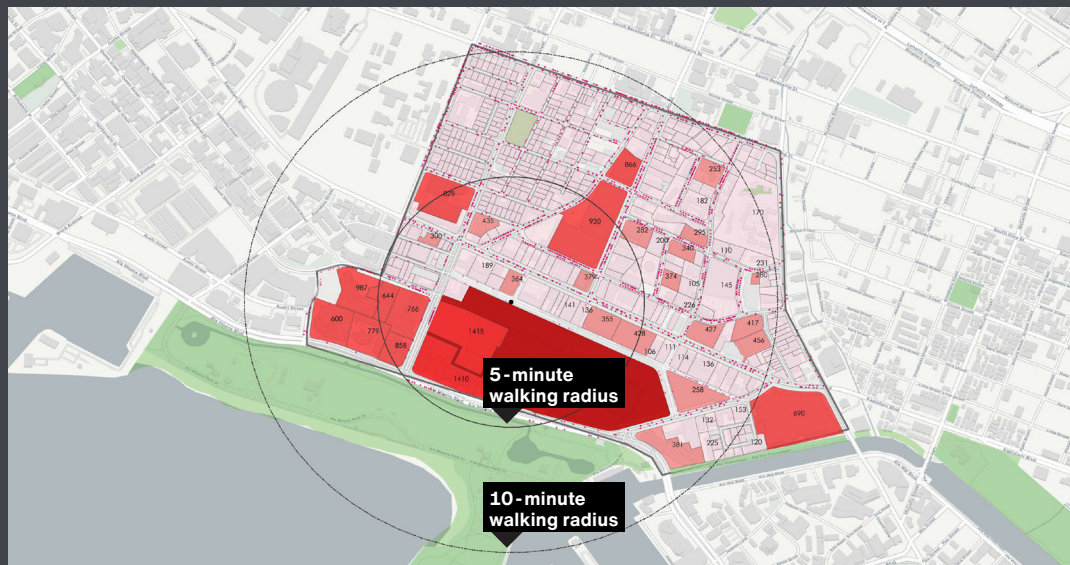


Figure 16 — Transportation Infrastructure within Study Area: Parking

Infrastructure in Ala Moana (continued)

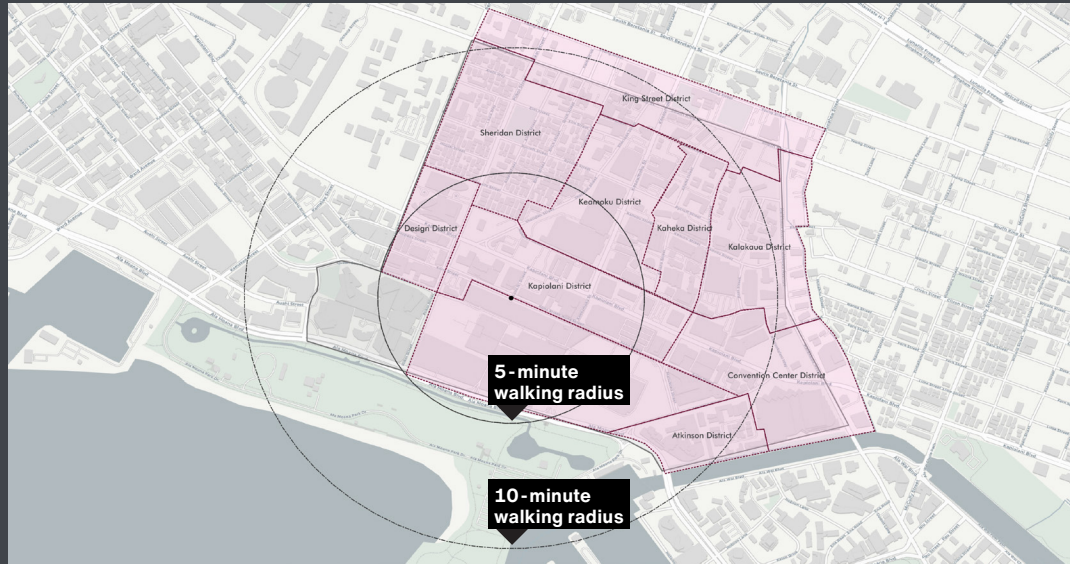


Figure 17 — Ala Moana Neighborhood Transit-Oriented Development Plan

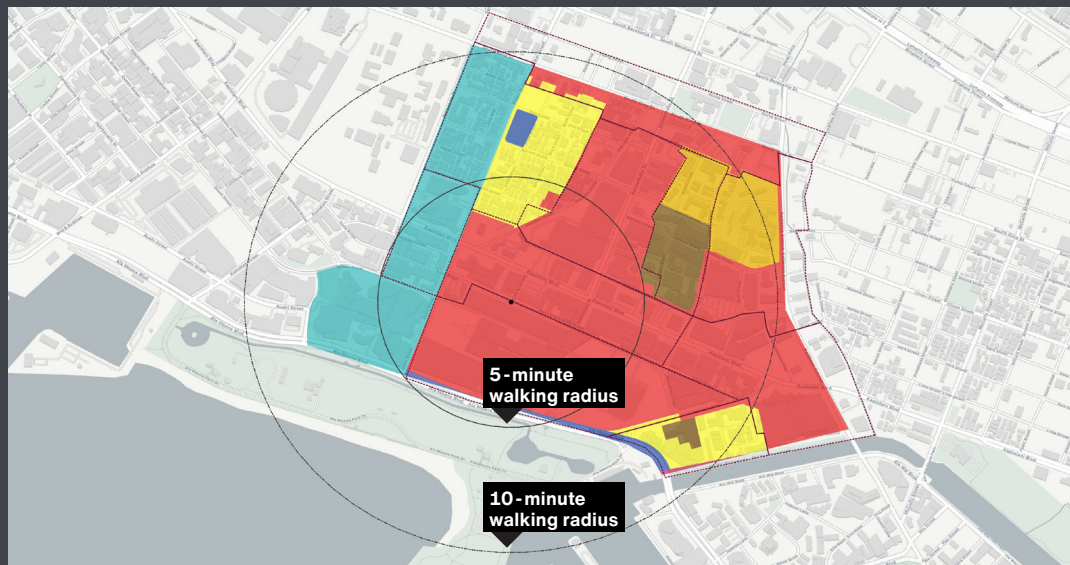


Figure 18 — Land Use in Study Area related to Ala Moana Neighborhood Transit-Oriented Development Plan

Infrastructure in Ala Moana (continued)

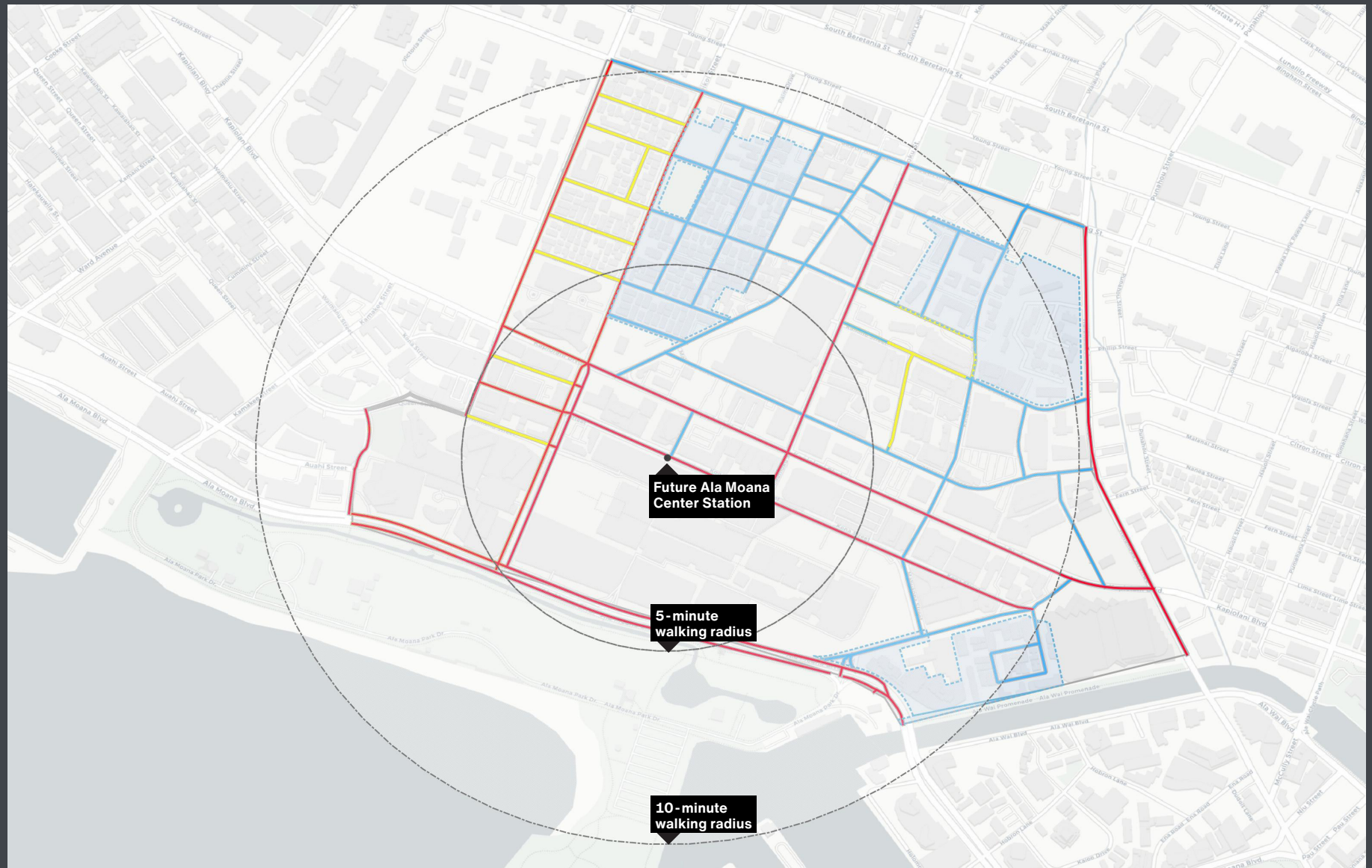


Figure 19 — A Proposal for Parking Management District with consideration towards Existing Land Use

Estimating parking demand

(See Figures 20–24)

The primary question and the purpose of gathering these datasets:

Is there an oversupply of parking?

This study evaluates this question in two parts:

- 1. The parking inventory of on-street and off-street parking stalls*
- 2. Parking demand*

Overlaying these two layers of information demonstrates possible predictions for areas that may lack parking or be oversupplied.

Clean Coord data includes the identification of parking regulation signs as well as the exclusion of curbs that have curb paint, hydrants or cuts. Mapping these curbs reveals where parking is allowable. Green lines are the curbs that allow on-street parking, while red lines denote curbs that forbid it. One pattern is evident: the parking lots near Don Quijote have the most street parking stalls. (See Figure 20)

Off-street parking stalls were counted using a combination of satellite imagery and Google Street View. A choropleth map was created to show the quantity of parking stalls in different districts. Ala Moana, Hawai'i Convention Center, Walmart Ke'eumoku, Moana Pacific, and the area of office towers supply the most parking stalls. (See Figure 21)

In the end, 453~1300 on-street parking stalls and approximately 32,212 off-street parking stalls were captured. Off-street parking accounts for 25~71 times as many stalls as on-street parking. Anecdotally, it is understood that people struggle to find on-street parking. Contrary to this assumption, this study suggests that off-street parking dominates the Ala Moana district study area, likely containing the most underutilized parking stalls. (See Figure 22)

Using data from Google Places and Yelp, the parking demand priority can be estimated by applying weight to the quantity of POI (points of interest). The POI include a list of frequently-used public programs and amenities, such as: supermarkets, restaurants, cinemas, and churches. Weight can be approximated by the quantity of reviews from Yelp data, which represents the popularity of the POI. The choropleth map demonstrates the priority of parking demand. (See Figure 23)

Overlaying the parking inventory map and the parking demand map illustrates parking priority. Green blocks denote low-priority parking demand and high-priority parking supply, while red blocks denote high-priority parking demand and low-priority parking supply. (See Figure 24)

The map may not provide a direct answer to whether parking stalls are oversupplied, but it serves as a useful heuristic in discovering areas with an inequitable supply of parking. From a brief survey of Census data, the Don Quijote area in the northeast co-locates with the lowest income households in the area. These lower-income households are therefore additionally burdened with an inadequate supply of parking.

In contrast, the group discovered that large-scale public buildings, office towers, and high-end residential towers are most likely to contain over-supplied parking stalls, while places in the Don Quijote area may lack parking stalls. These findings support observations made from remote sensing that parking in the Don Quijote area is often at high capacity, while many parking lots, such as the Walmart lot remain underutilized.

Parking inventory in Ala Moana

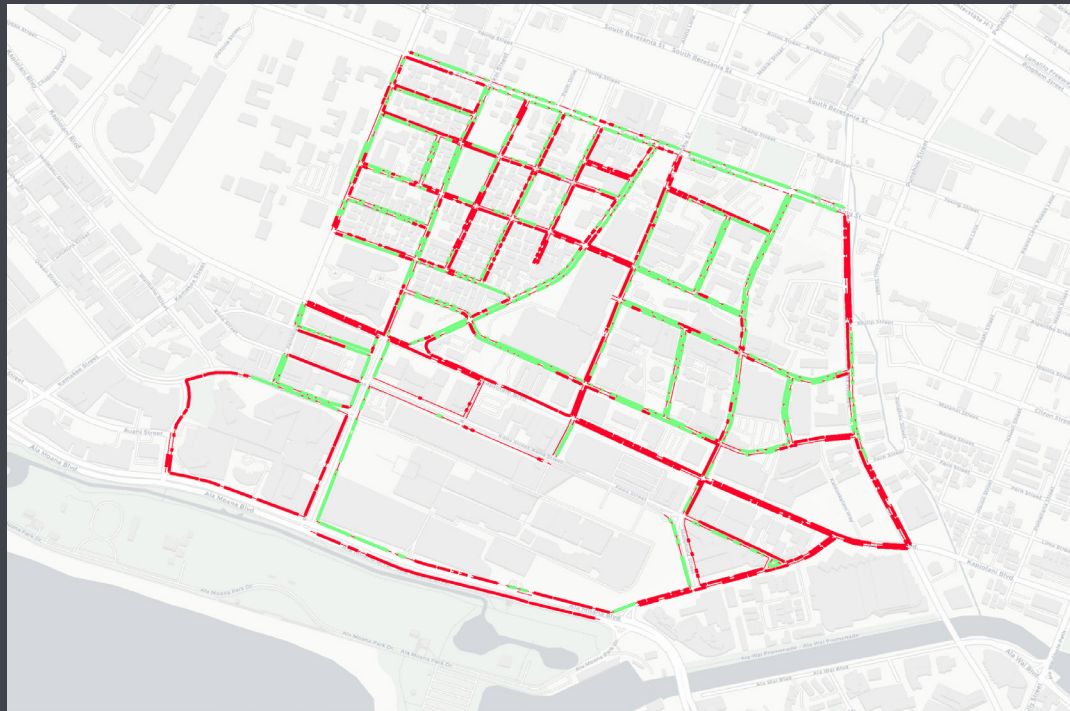


Figure 20 — On-street parking inventory based on curb regulation

Curb Regulation

- Parking
- No Parking

Parking inventory in Ala Moana (continued)

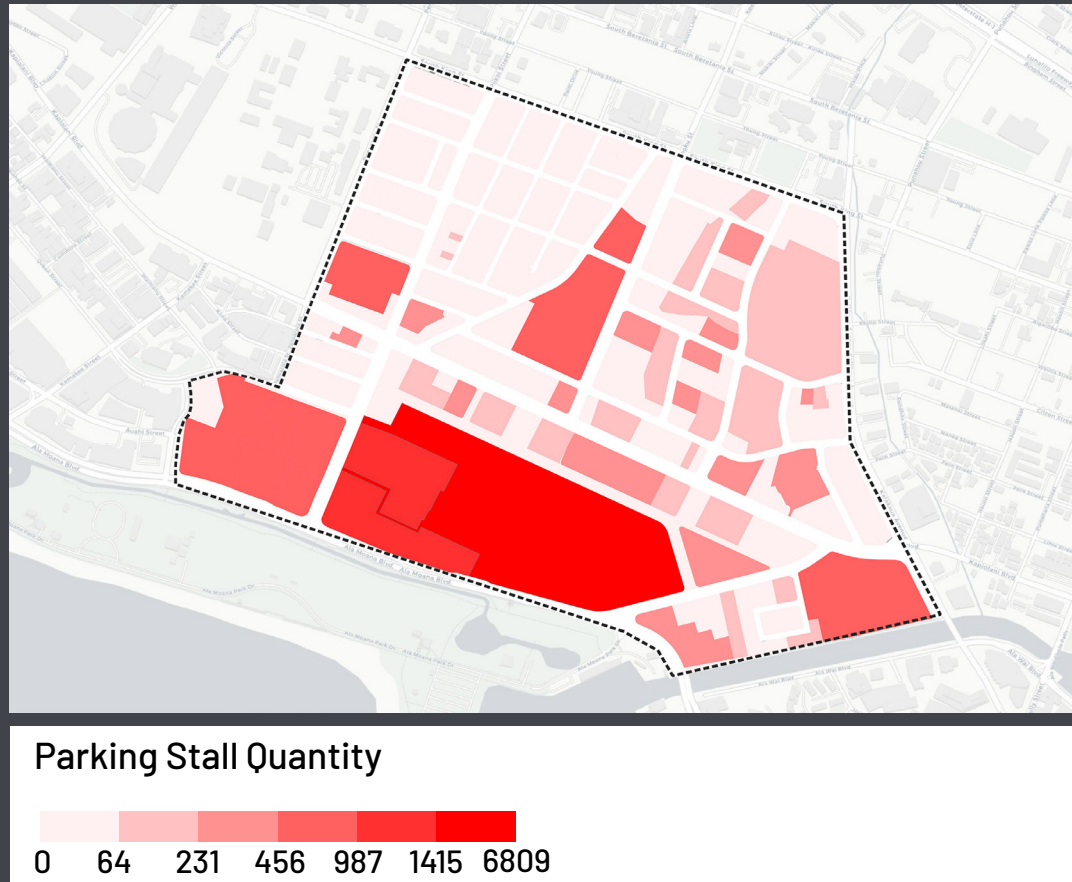


Figure 21 — Off-street parking inventory based on satellite imagery and Google Street View

Parking inventory in Ala Moana (continued)



Figure 22 — Comparison of on-street parking vs. off-street parking spaces

Parking inventory in Ala Moana (continued)

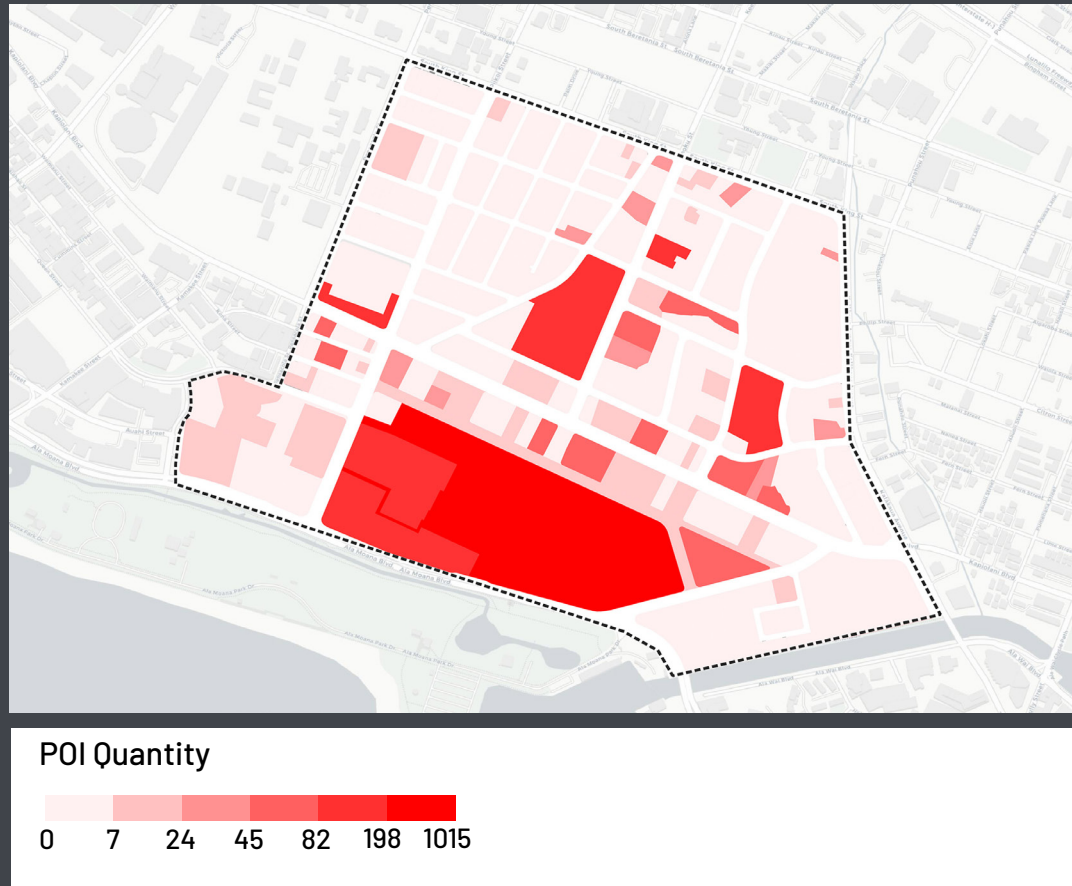


Figure 23 — Parking demand

Parking inventory in Ala Moana (continued)

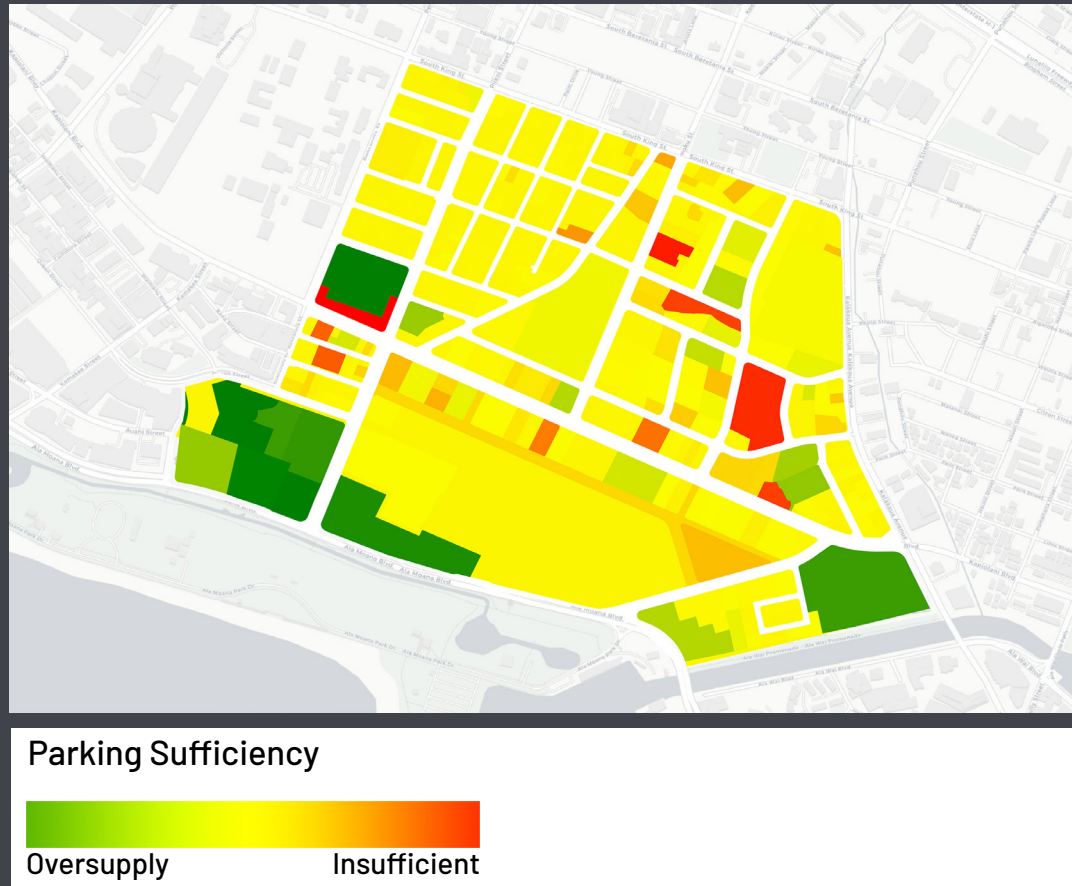


Figure 24 — Parking priority areas

Considerations

The analysis directs our attention to those public buildings, office towers, and high-end residential towers, and presents the following questions:

How can we make the best of the parking stalls in office towers after work so that people looking for dinner can park?

How can we increase awareness of vacant off-street parking stalls near Don Quijote so people can realize that they have more options?

How can we open underutilized private lots to more users?

Can we replace the limited metered parking stalls with wider sidewalks and bike lanes to encourage people to use other transportation modes?

Can we convert existing seldom-used roof parking to other uses such as a living roof?

Recommendations

Policy implementation

(See Figures 25-32)

In this study, the approach to policy recommendations are based in two frameworks:

1. Improve Existing Conditions

2. Create New Services

The first will help us minimize cost while maximizing benefits and the second works on the macroscale of planning for parking.

The proposed new services will aim to mitigate issues of housing affordability and the negative externalities of parking stall development on the neighboring community.



Figure 25 — The relationship between TDM and improvements to existing condition

Improve existing infrastructure

Current and up-to-date data on parking inventory is critical to determining the value of and the costs associated with parking. Improvements can be made to existing infrastructure to reduce the demand for parking.

There are studies that conclude that federal tax exclusions for employer-provided and employer-paid commuter parking adds more cars on the road. This tax benefit only applies to automobile commuters, where only a third of Americans, who are predominantly high-income earners, reap these benefits.⁶ Tax incentives are powerful tools for enacting behavioral changes which the government can utilize as levers towards transit mode shifts. While free parking on the street is very visible, there are other hidden parking subsidies that obscure the true cost of parking.

At a more local level, parking meter revenues could be returned to the business districts for public service improvements including street light fixtures, street furniture, and road repairs.

In the case of the Ala Moana study area, the neighborhood could receive the benefits of attracting consumers spending in their commercial area. This layer of transparency in parking metro revenue is significant to the success of the policy recommendation and building

trust with the public. By communicating that the price paid for parking is returned to fund public services, public awareness and incentives are enhanced while the feelings of “burden” associated with parking fees are diminished.

Using the existing infrastructure in more efficient ways could reduce single occupancy vehicle trips and increase transit users. The idea behind Transportation Demand Management (TDM) is influencing people’s behavior to maximize public transit options. This management system could include partnerships with major employers, institutions, residents to educate them about commuting options.

Local and state laws can help promote these partnerships by requiring or incentivizing employers and developers to provide support for transportation options. It is important to note that TDM must be highly resourced and transit spending must be reallocated to spending on TDM programs for this system to be successful.⁷

Case study: Pasadena, CA

In 1993, Pasadena, California implemented a similar system to return their parking meter revenue to the downtown, commercial center of Old Pasadena. The city had worked with Old Pasadena's Business Improvement District (BID) to establish the boundaries of the district which aims to boost commercial business and will receive the benefit of returned revenue. BID collected the meter money to pay for public services and the results of the project included an increase in sales tax revenue and pedestrian traffic. In addition, the district also redesigned their parking meter stalls to raise awareness and ensure transparency to the public by issuing signage on each meter to remind the public of this positive feedback loop.⁸

(See Figure 25)



Figure 26 — Parking meter in Pasadena, CA

Create new services

A location efficient mortgage is a service that is designed for lenders to recognize the potential savings of a more transit-accessible housing location when assessing a household's borrowing ability. Saved vehicle costs are then treated as additional income that can be spent on a mortgage. This would provide homebuyers with incentives to choose a home in a TOD instead of automobile-dependent areas—protecting the affordability of new residential developments.⁹

Mandatory parking requirements for new developments will be necessary to increase TOD and minimize the cost of construction and subsequently, maximize housing affordability. Existing minimum parking requirements for new residential developments should be eliminated and a maximum cap should be imposed on parking construction based on the number of units.¹⁰

Technology implementation

In recent years, many new technologies have emerged. Different technologies are being implemented to improve the systematic and procedural elements of a mobility landscape. From sensors and the Internet of Things (IoT) to Artificial Intelligence (AI) and automation, different forms of technology serve as the infrastructural foundation necessary to collect and utilize data from various sources. For parking services, new opportunities will materialize around following technologies: Blockchain, IoT, AI, autonomous vehicles, and crowdsourcing.

Multiple technological solutions can provide supplemental capabilities and features that can improve current issues of parking supply and distribution in the Ala Moana district study area. Based on the availability of resources and the parking landscape in the area, three technological features are proposed: 1) sensor/camera-based assets, 2) automated parking systems, and 3) autonomous vehicles and other mobility services. These technologies present easier implementation opportunities that can provide fast results. They can also serve as the basis for providing future-proofing capacity when more radical changes in the mobility environment happen.

Sensor/camera-based assets

Sensor/camera-based assets provide a mutually beneficial service for the agencies who oversee them and the drivers who they serve. Through optimized parking management infrastructure and service integration, sensor/camera-based assets allow providers and users access to real-time information about parking availability. Sensor data helps drivers to find parking spots faster and more efficiently, and helps providers understand parking utilization to guide more efficient use of their space.

Given the dominant industry types in the Ala Moana district study area, providers can benefit from the implementation of a flexible payment system that increases easy payment access for drivers using web and mobile devices. And the seamless integration of payment services allows providers to collect payment data and adopt dynamic pricing as needed. Building a smart parking system via sensor/camera-based assets will lead to vehicle-miles-traveled (VMT) and greenhouse gas emission reductions.

Case study: SFPark

In 2011, San Francisco established SFPark, a smart parking system. It utilized smart parking sensors to adjust parking meter and garage pricing to match demand. The result was a decrease in VMT in pilot areas by 30%, resulting in a 30% reduction in greenhouse gas emissions and 8% decrease in traffic volume.¹¹

(See Figure 26)

San Francisco Adopts Demand-Responsive Pricing Program to Make Parking Easier

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By: Ben Jose

Tuesday, December 5, 2017

Today, the SFMTA Board of Directors took a key step to increase parking availability in San Francisco.

Approved by the SFMTA Board, San Francisco will be the first U.S. city to implement a "demand-responsive pricing" program on the city's 28,000 on-street parking meters and to all SFMTA metered surface parking lots.



The premise of demand-responsive pricing is simple: let's use the basic economic principle of supply and demand to manage parking.

With demand-responsive pricing, San Francisco's hourly meter prices could go up or down gradually, or even stay the same. These rate adjustments will be based on demand, happen once every three months and have a gradual increment of 25-cents an hour. All changes would be communicated to drivers and neighbors in advance and would be based on data that is available to all.

This decision comes after years of implementation and evaluation. As part of a federally-funded pilot called *SFPark*, the SFMTA successfully implemented demand-responsive pricing in 2011. This pricing methodology has been in effect for over six years at 7,000 meters, 14 SFMTA-managed parking garages

Figure 27 — SFPark announcement via SFMTA Blog, December 2017

Automated parking system

Automated parking systems can improve efficiency within the Ala Moana district study area. By optimizing the parking location of vehicles, cars can be retrieved faster without the hassle of walking the extra-mile or locating the parked vehicle. Automated parking use increases parking system efficiencies and exhibits a wide range of benefits to the operator. Providers of automated parking realized a 12% Return on Investment (ROI) on average and were able to save approximately 60% to 70% of facility space.¹²

Parking providers will have the ability to reclaim and utilize these unused spaces for development or other forms of product/service-based revenue-generation.

In cities across the United States parking structures are being redesigned or are in consideration for redesign. For these changes to be adopted, codes and zoning requirements need to be altered to support these opportunities.¹³



Figure 28 — The 808 Center, on the corner of Sheridan and Rycroft Streets, automated vertical parking garage that can store up to 72 vehicles (“Honolulu’s Best-Kept Secret is Out: The 808 Center”, Honolulu Magazine, April 2016)

Proposed Technologies & Expected Benefits



Figure 29 — Sensor-based assets



Figure 30 — Automated parking systems



Figure 31 — Reclaimed space for development



Figure 32 — Adaptive re-use

Autonomous vehicles and other mobility services

Many cities around the world are testing and incorporating different types of mobility services. New forms of services will not only provide opportunities for current parking systems but also interrupt and reshape the parking landscape. Ride-hailing services and autonomous vehicles, along with new modes of transportation such as e-scooters and bike sharing will change the way people travel, impacting the demand for parking spaces. According to Deloitte's "Future of Parking" report, Deloitte forecasts that "by 2040, more than half of the miles traveled in the United States could occur in shared autonomous vehicles".¹⁴

Changes in the mobility ecosystem are imminent and must be considered as planners and providers address current challenges without compromising future changes.

Expected Benefits

So what benefits are expected to be achieved in Ala Moana if proposed technologies are implemented? According to the INRIX 2018 Global Traffic Scorecard ranking, Honolulu drivers lost 92 hours due to congestion, at a cost of congestion per driver of \$1,282. This is about 28% of congestion level, indicating 28% extra travel time for any trip around the city.

Parking spaces occupies the majority of space in Ala Moana district study area. With standard parking sizes at 180 sq. ft. per parking space, the Ala Moana district study area utilizes approximately 5.8M sq. ft in off-street parking spaces. Drivers are wasting their time on the road and providers are underutilizing their spaces through parking oversupply. A combination of optimized sensor/camera-based assets with automated parking systems may yield cost, time, and space savings for drivers and parking providers.

As this study indicated, sensor/camera-based assets can reduce about 8% of traffic volume, which accounts for 8 hours of traffic in road and a congestion cost of \$100 for drivers each year. Automated parking system utilization can reduce the overall parking footprint by 60%. This indicates that about 3.5M of 5.8M sq. ft of current parking areas can be transformed into other spaces that could serve other purposes to generate revenue and provide other services.¹⁵

Conclusion

Methodologies for Parking Research

This study highlights the value of up-to-date information and the importance of a centralized database for parking data collection and analysis. Through the exploration of various data collection processes, each methodology brought its own advantages and disadvantages. Factors that influence the data collection are: time and resource efficiencies, comprehensive collection, learning curve, access to software and hardware, and the potential deltas between accuracy and human error.

The traditional, manual GPS methods proved to be difficult, if not tedious, and required a carefully planned setup and logistics process. The significant advantage of the traditional GPS method is the potential availability of equipment—in other words, it is only the best technique if the logistics and the equipment is already accounted for.

The group also utilized Coord's Surveyor app and recognized that it may vary by group, but Coord is likely to work best for most planning departments due to: ease of use, established and clear workflow, and easy data cleaning and management. We would recommend Coord for most scenarios.

Parking in Ala Moana

This study of the current parking landscape in the Ala Moana district reveals a disconnect between the providers and the users of parking spaces. Oversupply of parking along with uneven distribution contributes to a discrepancy in how parking spaces in the neighborhood are perceived and utilized. Such a discrepancy contributes to underutilized parking spaces, congestion, and other public safety issues. In order to cope with the current situation, infrastructural and procedural changes must be implemented through policy and technology, which can assist in improving concurring costs and concerns. However, these implementations require multifaceted efforts between all stakeholders, public and private entities, to establish standardized data collection and management strategies, in-depth analyses, and increased community awareness.

The City and County of Honolulu is on the precipice of change. The Honolulu Rail Transit Project is becoming a reality, climate change is impacting neighborhoods, and development continues to increase. The City and County can leverage the revision to the land use ordinance and transit demand management model to positively steward the future of mobility and livability for residents. While many argue that parking is a major component of achieving this goal, this report quantifies the number of parking spaces in a specific study area, the Ala Moana district, which suggests direct impacts on developable space and opportunity costs.

The Future of Parking

Parking is at the nexus of urban mobility, from community services, economic development, and quality of life to policy, transportation, and real estate. The automation of parking studies are important to the health of every community and requires technologists who can provide accessible, usable open data. A major challenge that will be faced in studies are inaccuracies in covered and off-street parking data, which is an opportune area for further development. As the parking ecosystem evolves, new technologies are being installed in private garages and are producing real-time occupancy data. Despite the success of the roll-out of these technologies, without overarching guidance and incentive to share private parking data, there will continue to be information asymmetries, and therefore, market insufficiencies.

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