

RECLAIMING URBAN SPACES:

A PEDESTRIAN-ORIENTED MULTI-MODAL TRANSPORTATION SYSTEM THAT IMPLEMENTS  
AUTONOMOUS VEHICLES TO IMPROVE THE QUALITY OF LIFE IN WAIKIKI.

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## Abstract

It's no secret that Honolulu has a major traffic problem and ranks one of the worst cities in the country to drive during rush hour. According to Inrix, a transportation analytics firm, in 2012 Honolulu was ranked the worst city in the country for traffic with drivers wasting an average of 58 hours sitting in congestion. It has long been known that the increasing use and ownership of automobiles has led to crippling traffic around the island. The infrastructure designed to support automobiles failed to predict the volume and intensity of drivers traveling to and from work each day.

To combat this issue on the lack of transportation, I will investigate how Autonomous vehicles can create a positive impact on the city. Autonomous vehicles require less road space than a manually driven vehicle because of their ability to communicate with a network and move uniformly amongst other AVs which requires less following distance. As a result, our streets do not require to be as wide, and the number of lanes in the road can be reduced to accommodate for more sidewalks and green spaces. This study is designed to analyze the impacts of autonomous vehicles and how implementing it would improve the quality of life for the community in Waikiki. Through research and design, I am proposing a bold multi-transportation system that can improve pedestrian circulation and encourage a healthy lifestyle in dense urban areas like Waikiki.

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## Preface

Autonomous vehicle technology is expected to transform the nation's transportation system over the coming decades, with major implications for the planning and design of cities and regions. Everyone knows that AVs are coming, it's a question of "when and how" versus "if" and it's obviously going to be a huge transformation to our landscapes. From how space is reconceptualized to urban planning. With finite land resources and an ever-increasing population, the new urbanization is dominating the existing landscape.

The problem we are facing is that manually driven vehicles take up large amounts of land in a city for transportation and parking. How can we transform these excess spaces into something beneficial for our community? Most streets have a whole lane designated for loading and unloading but with the introduction of AVs, we can take this lane out of the equation and convert it to more green spaces, extended sidewalks larger property lines. The introduction of AV's provides safer streets that in return create a healthier community. This boosts a community's economy by giving us a source of revenue and maintaining a valuable urban environment.

## Chapter 1: Introduction

Historically, streets have served several functions, mainly associated with traffic movement and social interaction. Today when we think of the word “street” the first image we often picture is a car. However, in history, streets were originally built as a place for commuting on foot rather than by vehicle. In an article, “Reimagining our streets as places: From Transit Routes to Community Roots,” Annah Mackenzie writes:

Streets are our most fundamental shared public spaces, but they are also one of the most contested and overlooked. Today, we have taken for granted the idea that our streets are primarily zones for cars, parking, and the transporting of goods. According to Victoria Transport Policy Institute, a single occupant automobile moving at 20mph requires space 75 times bigger than a pedestrian does. No wonder that, today in a motorized city, 30-60 % of the urban land is devoted to roads and parking, compared to the 10% mainly for pedestrians in the pre-automobile era.<sup>1</sup>

Transportation in Hawaii has evolved greatly over the past centuries, but the number of automobiles create several issues in the state. Hawaii being one of the top ten worst cities in the US to drive in traffic during peak work hours, it is important to think of innovative transportation systems to improve the quality of life and well-being of people. The material used for construction, fuel efficiency, and improved technology, have drastically changed in creating a safer transportation vehicle. Throughout this evolution, one thing that has been under scrutiny is the

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<sup>1</sup> Annah MacKenzie, “Reimagining our streets as places: From Transit Routes to Community Roots,” *Project for public spaces*, accessed December 2, 2020

safety and well-being of people. It appears with the advancement to technology; the greater number of fatal injuries seem to occur in major cities with dense population. Creating Complete streets to make a multi-modal network for Waikiki is the primary focus of this study. Improving gateways, residential spaces and increasing green space forms a centralized location that connects residents and visitors alike to nearby attractions, and increase access and mobility to work, home and play.

A typical street was designed to be a place of interaction where people would communicate and socialize with others. We often see that streets are designed to force users into certain spaces such as malls and retail stores. This strategy is slowly evolving, and I believe that transforming our streets to a pedestrian friendly environment can have major positive impacts. This transformation can come in the form of autonomous vehicles which allows people to spend less time driving, and more time enjoying their daily life. Urban planning and landscapes can have a drastic impact due to autonomous vehicles (AVs).

In order for Waikiki to continue attracting both domestic and foreign visitors successfully—in such a way that gives them a reason or desire to return—serious attention must be paid to the current and outstanding issues regarding congestion, transportation, traffic, and transit; all of which will only get worse as Oahu’s population continues to grow. One issue involves the separation and segregation of zoning and topography within the Waikiki area itself.

The research is divided into chapters covering history, technology, strategy and design. Thanks to advances in technologies, including GPS, high-definition digital maps, sensors and artificial intelligence, autonomous vehicles could improve our lives by offering increased safety,

optimized efficiency and freeing-up space from cars for pedestrians. More importantly, the new technologies provide an opportunity to create new forms of pedestrian experience and new ways of inhabiting cities where efficiency and livability are both addressed. This is a challenging undertaking requiring interdisciplinary collaboration between technologists, who are working to improve the automated driving systems and hardware, scientists, who are running simulations to ensure efficiency, and planners, who are revising policies to regulate the use of the new technology.

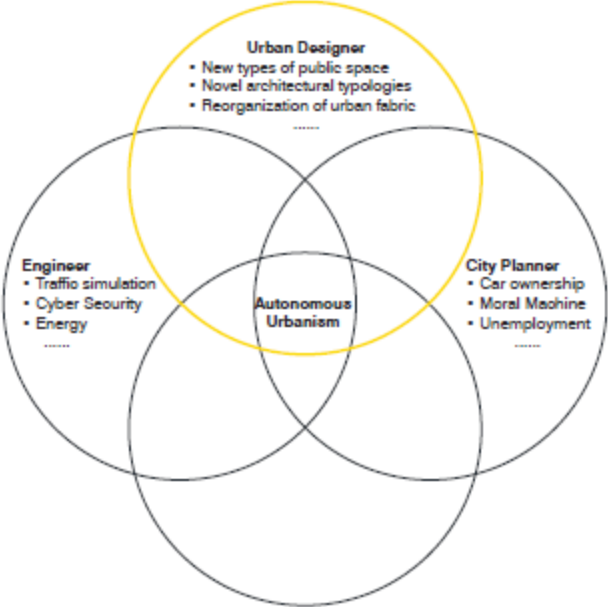


Figure 1: Key Industries helping the movement

Source: *Rethinking Streets: Urban Life with Autonomous Vehicles*

To complement the studies mentioned above, this thesis calls for reorganization of urban fabrics, new forms of public space and novel architectural typologies.<sup>2</sup>

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<sup>2</sup> Daya Zhang, “Rethinking Streets: Urban Life with Autonomous Vehicles” (Master Thesis, MIT, 2018) 5-20.

Since the application of transportation technology can cultivate lifestyle and shape streetscape, this thesis sees the transition from conventional automobiles to shared autonomous vehicles as an opportunity to create a new standard for people-centric urban design.

## **Problem Statement**

Honolulu continues to face problems related to transportation and over the years has proven to have a failed infrastructure to accommodate the current number of vehicles and pedestrians. The current pattern of urbanization has led to a congested, auto-centric landscape that has limited access and mobility throughout the urban core. In response to these issues, Honolulu is currently in the process of building a new rapid rail transportation system along with other strategies to reach a greater sustainable footprint. However, the rail has had its own setbacks along with extended timelines that have the local community curious about its future success in the islands.

I am not advocating to ban cars but agree with Alex Wall that the challenge of the 21st century is “the reworking of movement corridor as new vessels of collective life”. Vehicles should not be banned but be restrained as an equal participant on the street.<sup>3</sup> To achieve this goal of shared spaces, different experiments have been done across the world. One way to tackle this issue is to propose and integrate traffic infrastructure and the public realm by minimizing the

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<sup>3</sup> Alex Wall, “Programming the Urban Surface,” in *Recovering Landscape: Essays in Contemporary Landscape Architecture*, ed. James Corner (Princeton Architectural Press, 1999).



segregation between modes of travel to let pedestrians, cyclists, cars use street more efficiently at different times.

This thesis proposes to identify the innovation of autonomous vehicles and its impacts on street design. By creating a multi-modal transportation system, we will be able to reclaim these urban spaces for the pedestrians that are in dire need for safer and more efficient streets. Shared space has been adopted by cities in other European countries and in often car- dominated U.S. cities, with benefits such as less congestion, lower speed, reduced accidents, increased traffic, and more vibrant and attractive streets. For example, Winthrop Street at Harvard Square was transformed into the Shared Space in 2007. The conversion led to more efficient use of space, accommodating pedestrians, cyclists, outdoor diners, and cars simultaneously or at different times (NACTO). The concept of Shared Space addresses both livability and efficiency as indispensable factors for a city's sustainable development. Cars are not excluded but restrained as equal participants on the road.

### **Overview of the impacts on the Urban Environment**

The Merriam-Webster defines the term Urbanization as “the process by which towns and cities are formed and become larger as more and more people begin living and working in central areas”. In this generation, we find living in an urban environment defined as living in a place that is attractive, prosperous, and advancing towards a better future. If we look at Kakaako for example, we see the ever-increasing rise in urban living while in the meantime the fall of the natural environment. As this city grows, we see countless amounts of buildings being constructed with very little green spaces or an acceptable walkable neighborhood.

In today's urban environment, we see several attempts to design and plan a city that is walkable. We see this strategy being implemented in neighborhoods like Kakaako and Kapolei where they create larger sidewalks that are easier to access by pedestrians. However, the lack of forestation and therefore shade, create a negative experience where pedestrians are discouraged to walk.

For the context of this paper, the urban environment refers to the physical aspects of a space or Waikiki for this example. The focus is not only on the built environment, but the elements of nature, as well as a multi model transportation system. As society shifts towards a more urban environment lifestyle, this paper discusses the positive impacts of a multi model transportation system with the introduction of autonomous vehicles. The increased focus on human health and behavioral patterns along with advancements to technology have yielded new research to improve the quality of life and modes of transportation.

Due to these advancements in automobile technology, these autonomous vehicles could improve our lives by offering increased safety, increased efficiency and freeing up space from cars for pedestrians. Although in an early stage, global cities are initiating AV piloting programs in hope to take advantages of what the new technology claims to achieve. According to the Global Atlas of Autonomous Vehicles in Cities released by the Bloomberg Philanthropies, as of December 2017, 50 global cities, such as Boston, have been hosting AV tests in the designated area, or have

committed to doing so shortly. Another 23 cities are developing proactive policies and plan to prepare the coming of AVs.<sup>4</sup>



Figure 2: Both traditional automakers and rising tech companies are designing autonomous vehicles. types vary from taxi to minivan to bus.

Source: *Rethinking Streets: Urban Life with Autonomous Vehicles*

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<sup>4</sup> “Global Atlas of Autonomous Vehicles (AVs) in Cities,” Aspen Institute, Bloomberg, accessed March 3, 2020, <https://avscities.bloomberg.org/global-atlas>.

## Purpose and goals of the research

The overall purpose of the research was to identify how autonomous vehicle technology could bring improvement to the field of architecture and urban planning.

At first thought, one might be concerned about the safety with the introduction of AVs, but in fact they have the potential to be much safer for reasons such as accidents caused by distracted drivers due to texting, talking on the phone or other unwise activities while driving. According to the National Highway Traffic Safety Administration, in 2015, there were 3,477 people killed and an estimated additional 391,000 injured in motor vehicle crashes involving distracted drivers in the United States.<sup>5</sup> Most drivers are distracted at intersections where they are prone to use their cellphones or other forms of items that take away from their focus on the road.

Intersections account for most accidents caused due to human error. Each year, nearly 1.3 million people die, and as many as 50 million are injured in road traffic accidents. That means every 30 seconds a person dies in a car related accident.<sup>6</sup> These errors can be drastically reduced if there were a system that can control the traffic circulation and wait times of commuters. These benefits can further translate to improved traffic signal timing, intersection collision avoidance, intersection infrastructure and autonomous driving. Changes to traffic signals, signs and street markings will likely be implemented to help reduce confusion between AVs and other road users

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<sup>5</sup>"Autonomous Vehicles: Planning for Impacts on Cities and Regions," American Planning Association, accessed December 03, 2018, <https://www.planning.org/research/av/>.

<sup>6</sup>"Traffic Accidents Kill 1.3 Million People Each Year, but with Commitment Roads Can Be Made Safer for All, Secretary-General Says in Video Message," UN Meetings Coverage and Press Releases, United Nations, accessed December 03, 2018, <https://www.un.org/press/en/2013/sgsm15005.doc.htm>.

like cyclists and pedestrians. These improvements to our streets create a more efficient way of transportation which translates to better services and fuel efficiency. A system that is efficient allows vehicles to move smoothly within dense urban settings, in return they idle less in traffic and produce less carbon emissions

## **Research Methodology**

My research will utilize a combined method which includes a wealth of literature reviews, quantified data and analyses to provide a thorough understanding of existing and projected transportation development issues in order to propose a design solution that is appropriate for the future growth and success of Honolulu. The conducted body of work is organized in five chapters, with the main subject focusing on a multi-modal transportation system that will benefit transportation and quality of life in the Waikiki district. The analysis is done to understand the current built infrastructure in Waikiki and see how a new street design with an advanced transportation system can have positive effects on the city. The research first considers the issues on a global scale what affects transportation and pedestrian circulation and then localizes it to Hawaii and the challenges similarly felt within the archipelago.

The literature review portion of the study is used to demonstrate an in-depth grasp of the subject. Using credible resources to point out current issues in our transportation infrastructure as well as its impacts on life. Combining the learnings from the research and design process, I can develop a new model of transportation infrastructure. Finally, the goal of the precedent studies is having an understanding of similar design implementations that have proven successful in the past in other locations around the world.

## Chapter 2: Literature Review

I have chosen these specific documents to focus solely on the impacts and improvements that are possible with urban development and automobile technology. I have chosen several scholarly articles and included the following texts that helped me with my research:

- The City after the Automobile; Moshe Safdie
- Streetcar Days in Honolulu: Breezing Through Paradise; Simpson & Brizdle
- Reinventing the Automobile; Mitchell, Bird, Burns

## Defining the public realm

In the book, *The City After the Automobile*, Moshe Safdie states “the principle streets and squares were landscaped with grand trees and flowering gardens. The best sites were selected and designated for major buildings, such as Boston’s public library facing Copley Place, or the New York Public Library on Bryant Park – New York’s Central Park, stood as urban amenities for all.”<sup>7</sup> I believe the point that he is trying to make is that in the contemporary city, much of this has changed. As traditional streets focus on the storefront design and super-block commercial towers, these green spaces that were once considered as amenities deteriorate. Streets empty of pedestrians and sidewalks become increasingly unsafe, as a result making the public realm less attractive, comfortable and commercially desirable.

At the turn of the twentieth century, during a period of unprecedented urban population growth, industrialization, and then crowding and filth- now familiar faults of industrial cities – there occurred a breakdown of many of the traditional urban systems of hierarchy and scale. Greater speeds and heights held out the promise of breaking boundaries of all sorts, and throughout the early decades of the century, inspired numerous explorations for a new kind of city. As we continue in our journey of evolution, we find ourselves venturing deeper into the built environment and further away from nature, we become increasingly disconnected with the qualities of the habitat that we have evolved to thrive and flourish in.<sup>8</sup>

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<sup>7</sup> Moshe Safdie, *The City after the Automobile*, (Westview Press, 1998), 40.

<sup>8</sup> Ibid.

In 1865, landscape architect Frederick Law Olmsted was convinced that beautiful green spaces should exist in cities for all to enjoy. He wrote, “It is a scientific fact that the occasional contemplation of natural scenes of an impressive character... is favorable to the health and vigor of men and especially to the health and vigor of their intellect.”

As humans evolve, we find the location we choose to live is often based on the popularity of a city, lifestyle, and the overall quality of life. Global consultancy Mercer analyzed more than 230 cities around the world, using criteria such as housing, education, public services and transport, natural environment, recreation, and political, and social environment to assemble its 2019 Quality of Living Ranking.<sup>9</sup>

Engineered solutions, such as streetscapes, transportations systems, green walls/roofs, and urban farms can be designed and implemented to serve specific, intentional functions and services. Even implementing smaller design functions like small parks and street side landscaping provide major health benefits.

### **Qualities for Walkability**

Walking is a multipurpose activity that provides many opportunities for adults to incorporate physical activity for exercise, leisure and transportation into their busy lives. Promoting an environment that is walkable is an essential strategy to help adults meet physical activity guidelines and to enhance overall public health. The United States receives a C because

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<sup>9</sup> Theron Mohamed, “The 10 cities with the best quality of life in the world,” Business Insider, accessed August 10, 2019, <https://www.businessinsider.com/the-10-cities-with-the-best-quality-of-life-in-the-world-2019-3>.



63.9% of adults reported walking for transportation or leisure in at least one bout of 10 minutes or more in the preceding 7 days. The prevalence of walking for transportation or leisure was higher among women (65.1%) than men (62.8%).

The 2008 Physical Activity Guidelines for Americans recommend at least 150 minutes (2 hours and 30 minutes) a week of moderate intensity physical activity, such as brisk walking, for adults. Walking is a multi-purpose activity that provides opportunities for adults to incorporate physical activity for exercise, leisure, and transportation into their busy lives. It's accessible, inexpensive, and safe for almost everyone. Walking also provides a simple way for people who are inactive to become physically active, because it can be adapted to fit a wide range of needs and abilities. As a result, promoting walking is an essential strategy to help adults meet the physical activity guidelines and to enhance overall public health.<sup>10</sup>

For a city that depends heavily on its tourism, Waikiki has one of the worst conditions for walking. Recently, the city started improving Waikiki's sidewalks and street conditions to improve pedestrian safety and walkability.

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<sup>10</sup> U.S. Department of Health and Human Services, *2008 Physical Activity Guidelines for Americans* (healthier.us.gov, 2008), vii-6.

## Human Scale



*Figure 3: European Urban Square*

*Source: ArchDaily*

An architect that inspires me to design by focusing on the people first is architect, Jan Gehl. As someone who has studied abroad in Copenhagen, I was able to understand firsthand how it is to design for the human scale. Jan Gehl is recognized as a follower of Jane Jacobs, the “grandmother” of urbanism and humanist planning.

I take human senses as a starting point and how we, people, move. Man is, of course, a walking being, and our senses are made perfectly for people to walk at around 5 kilometers per hour. The old cities were made so that homo sapiens felt comfortable. The spaces were not too wide or too big, that's why people felt comfortable.



*Figure 4: Pedestrian Zone Located in Copenhagen*

*Source: ArchDaily*

In the old metropolis, everything was made to a suitable size for a person, but after the introduction of modernism and the automobile, the importance of this scale was forgotten. We went from having architecture suited to the travel speed of 5 kilometers per hour, to entire cities of 60 kilometers per hour, which meant wider streets, bigger advertisements, higher buildings, where we weren't able to see anything in detail as we moved so fast.<sup>11</sup>

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<sup>11</sup> Rodrigo Alonso, "Jan Gehl: In the Last 50 Years, Architects Have Forgotten What a Good Human Scale Is," ArchDaily, accessed May 24, 2019, <https://www.archdaily.com/877602/jan-gehl-in-the-last-50-years-architects-have-forgotten-what-a-good-human-scale-is>.

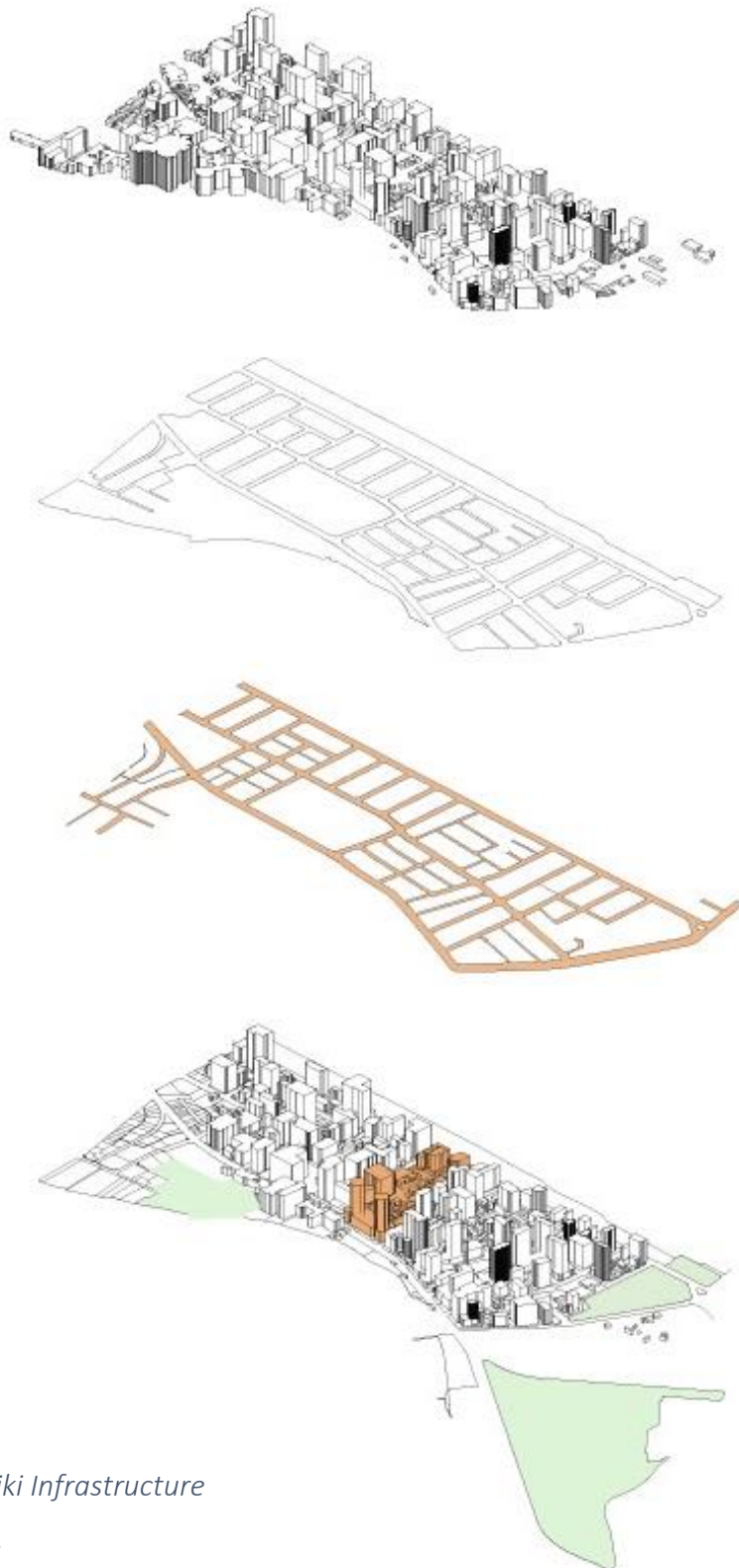
## 1.4 Transparency and Linkages

Privatizing the public space has forced people to congregate in shopping malls and other indoor spaces. For most Americans, the chief place to meet fellow citizens is at the shopping malls. In dispersed areas, the effect of this privatization is even more extreme. Once the basic requirements of ample parking, commercial square footage, and connections to the major streets are fulfilled, private developers have little incentive to spend money and time on beautifying the site, the landscape, the large asphalt lots and the surrounding environment.

We must go beyond this to invent a new breed of place, an “interactive center.” Which, whether in public or private hands, lives up to its role as a major component of the urban landscape.

What kind of place will this be? Well, as a basic requirement it must connect different parts of the neighborhood. It needs to be able to extend the public streets and spaces of the neighborhood, connecting to public transportation, and relate existing urban institutes into the pedestrian circulation paths.

## 1.5 Conditions of Urban Infrastructure



*Figure 5: Waikiki Infrastructure*

*Source: Author*

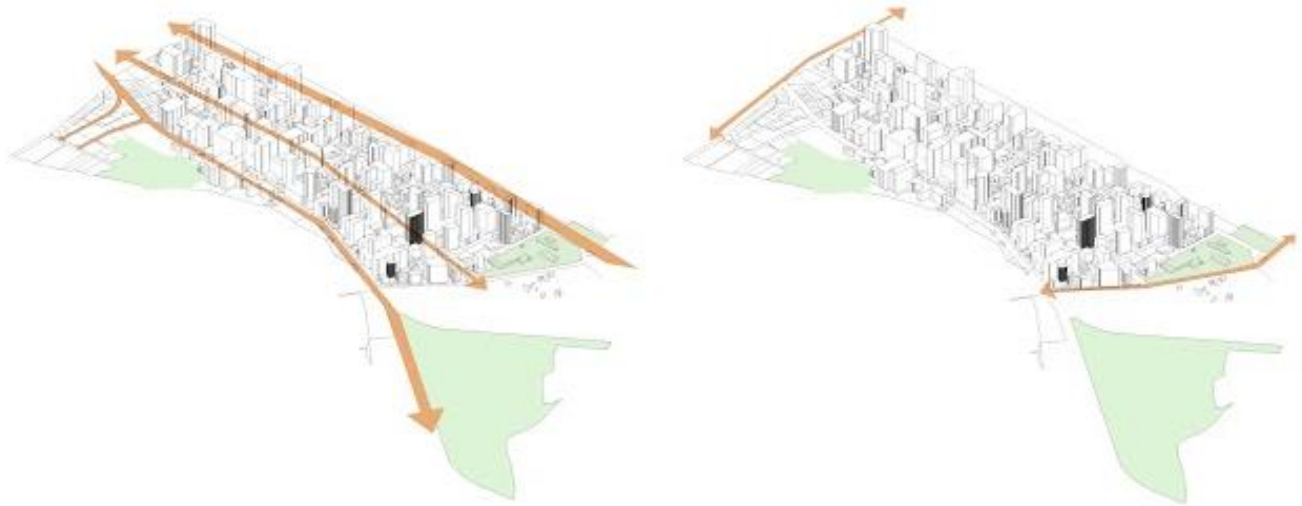
The high-rise tower is the hallmark of the late twentieth century city. If we look at today's practicality and symbolism, the skyscraper is the most dominant building type in our city. Its scale and impact affect every aspect of urban life, distinctively affecting the very form of a city. The high-rise gave opportunity to create dense neighborhoods and therefore the ability for cities to place large numbers of people in a significant area. Money being the major driver, less attention was spent improving pedestrian friendly public spaces that brought its near to no income. <sup>12</sup>

As the price of depleting natural resources continues to rise, promoting sustainable urban infrastructures can benefit the environment and shield cities from potential economic and social instability in an increasingly resource-constrained 21st century.

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<sup>12</sup> Rodrigo Alonso, "Jan Gehl: In the Last 50 Years, Architects Have Forgotten What a Good Human Scale Is," ArchDaily.

## The Nature of space



*Figure 6: Major Access Points of Waikiki*

*Source: Author*

Life is often inspired by our surrounding environment. As architects, it is our challenge to continue to explore the elements that cross boundaries. We should continue to be aggressive in our approach, so cities understand the emotions we are trying to provoke in the spaces we design. Public spaces within buildings are great opportunities to infuse items that will stimulate our senses and plant a seed to develop different experiences. The more spaces we build with this phenomenon in mind, the more we can begin to learn and become familiar with other natural senses we do not use as often as nature intended. In the end, this can provide a better living experience.

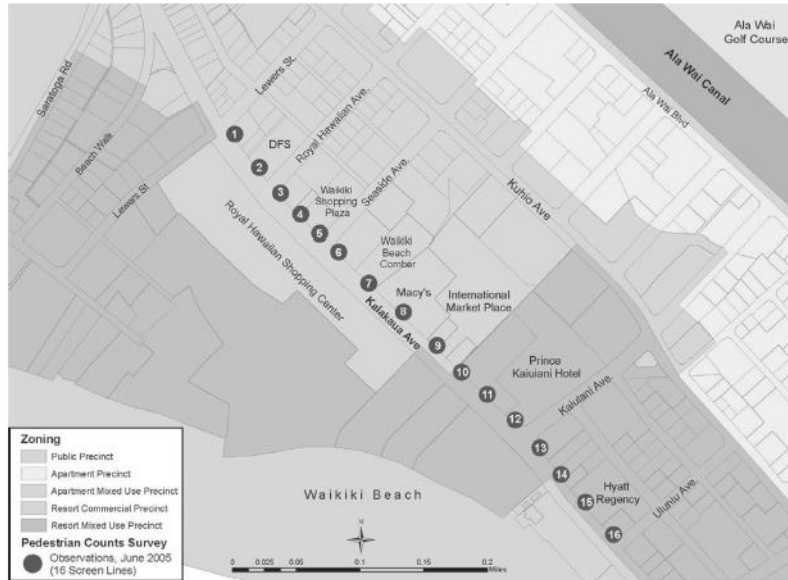


FIGURE 1 Location of 16 screen lines for pedestrian observations.

TABLE 2 Sidewalk Pedestrian Volumes

Screen Line	Number of Pedestrians <sup>a</sup>		
	Westbound	Eastbound	Total
1	351	265	616
2	508	396	904
3	442	429	871
4	443	385	828
5	514	438	952
6	481	450	931
7	456	462	918
8	351	481	832
9	394	542	936
10	601	623	1224
11	522	475	997
12	485	333	818
13	331	517	848
14	326	446	772
15	400	348	748
16	482	380	862
Average	442.94	435.63	878.56

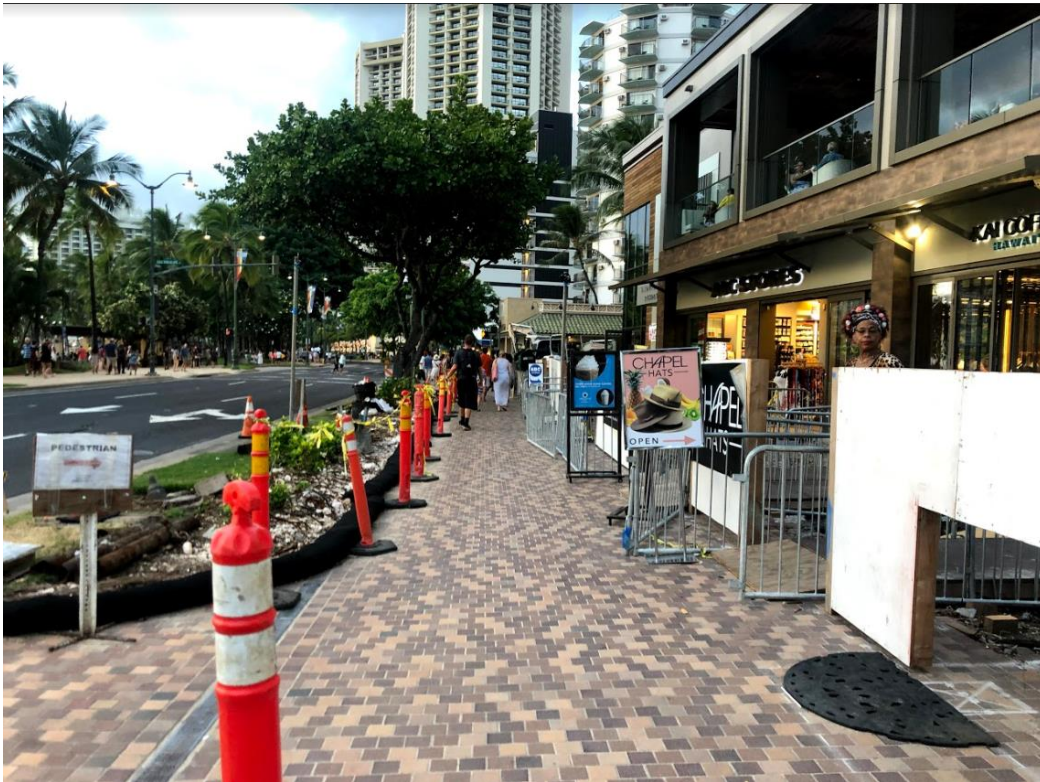
<sup>a</sup>Number of pedestrians walking across the screen line within a 15-min interval. Data obtained from the survey conducted on June 21, 2005.

Figure 7: Waikiki Walking Survey

Source: *Walking in Waikiki, Hawaii: Measuring Pedestrian Level of Service in an Urban Resort District.*



## Perception of Walkable



*Figure 8: Current Walking Conditions in Waikiki*

*Source: Author*

In environments constructed for your leisure you go for walks, play ball or run, take in a theatrical performance, attend a sporting event, contemplate a museum exhibition, shop in stores, relax in cafes. Waikiki creates this illusion of a walkable city by implementing green space within its already narrow sidewalks. The space between the storefront and the street is very narrow for pedestrians to walk freely. And across the street on the Mauka side, there is barely any shade for rest and relaxation. In our current society, there is a growing interest in understanding the influence of gathering spaces and how it affects the quality of life in an urban city.

## Visual Accessibility

As the trend of migration continues from rural areas to urban areas, it is estimated that by the year 2050, one billion people with disabilities will relocate to live in busier cities. This large number of migrating people pose a greater challenge for architects, urban planners, and city officials to address the issues of accessibility, from narrow sidewalks to busy, high traffic streets.

A lot more work needs to take place in public spaces to maintain the independence and wellbeing of our community. Specifically, design strategies need to consider mobility and safety.

Some of these strategies include:

- Thinking about mobility. As mobility decreases proximity becomes important – there is a need to provide en route seating and public toilets within short distances, for example
- Usable universal design seating – the ageing population is less flexible and may find it difficult to sit on grass
- Handrails on stairs and steep paths improve safety, confidence and ultimately usability of the space
- Tree cover provides shade and protection from heat and sun exposure
- Wider walking paths to accommodate scooters and wheelie walkers, and paths that are well lit
- More pedestrian road crossings

In the urban environment, pedestrians are often lost in the rush of vehicular movement, thus they tend to forfeit their individual, personal mobility to be influenced by the navigation of transportation services. The modern perception of the freedom of movement is represented by the ability to catch a lift, pun intended.

## **Attraction Points**

Humans in general are curious in nature, and we are creatures of habit that often have the desire to want more. This behavior encourages exploration and interaction, promising continued or further pleasure and enjoyment. Attraction points are places of interest, places that provide a sense of desire or comfort.

A place of attraction usually has to do with expectations when visiting a place, these features can vary from culture, architecture, landscape and events. These features attract people to the destination and contribute to the overall experience which they then pass on to other people. This experience plays a crucial part in promoting certain places and is a vital part of future success. A destination that has a higher recommendation by locals as well as tourists have a greater chance of success.

A uniqueness to the destination is key to making a place attractive and successful in the future. The characteristics surrounding health, resilience and sustainability are major components to designing better cities for people. By understanding what humans desire for an attractive space, we are capable of designing for various future scenarios.

“Sara Vinyals Mirabent, a researcher of the Communication, Advertising & Society (CAS) Research Group of the Department of Communication at UPF has raised the issue and has studied it at the twelve most popular urban destinations in Europe. This research helps to understand how

European cities use their most attractive features to compete in the market segment of urban destinations and to stand out from other competing cities.”<sup>13</sup>

A well-designed open space that encourages outdoor activities and social interaction is a community asset that could potentially contribute to the health and well-being of local residents. For an increase in usage of these open spaces, architects should focus more on creating user-oriented spaces with facilities that encourage active use. Public open spaces are key built environment elements within neighborhoods intended to encourage various physical activities, provide several significant benefits, and serve various important functions that improve the quality of life in cities.<sup>14</sup>

To accommodate diverse lifestyles and varying income levels, a wide variety of housing types and sizes should be provided. A mix of for-sale and rental units would attract a wide demographic, including young families, empty nesters, and singles - making neighborhoods stronger and more sustainable.<sup>15</sup>

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<sup>13</sup> “What most attracts us to a tourist destination? Attractions, culture and gastronomy,” Science Daily, accessed February 17, 2020, <https://www.sciencedaily.com/releases/2019/04/190408114002.htm>.

<sup>14</sup> Yijong Chen, et al. “What Attracts People to Visit Community Open Spaces? A Case Study of the Overseas Chinese Town Community in Shenzhen, China,” *International journal of environmental research and public health*, vol. 13, 7-644.

<sup>15</sup> CallisonRTKL, *Ala Moana Neighborhood Transit-Oriented Development Plan* (City and County of Honolulu, 2016), [http://www.honolulu.gov/rep/site/dppto/alamoana\\_docs/Ala\\_Moana\\_-\\_Draft\\_Final\\_TOD\\_Plan\\_Report\\_042516web.pdf](http://www.honolulu.gov/rep/site/dppto/alamoana_docs/Ala_Moana_-_Draft_Final_TOD_Plan_Report_042516web.pdf).

## Scale of Experience

The use of automobiles cannot realistically be supplanted by walking or active transportation means. The scale and means of the human habitation require extensive transportation demands of not just people but resources as well. Scales of interactions need to be analyzed and considered. A transitioning of modes is likely to occur, implementation of terminals that grant the opportunity for people to transition from long range to short range activity. The urban environment is full of diverse ranges of activities and functions. Connectivity of different land use and transportation modes is important to the urban experience. In instances where walking is not efficient or effective, alternatives should be present. Alternatives offered in the form of active transportation modes can be integrated alongside the pedestrian infrastructure network. The network can be segmented and stitched with different alternatives to provide variations and options to optimize one's experience.

These scales for experience not only benefit the community but also tourists and businesses around the chosen network. The multiple transportation options create a better movement of people and reducing congestion will benefit the cities infrastructure and natural environment.

## Culture & Demographic

The culture and demographics of a site is an important consideration to designing not only the aesthetic features but also the functional quality. An understanding the unique culture of individual place, city, district, neighborhood, and community and those who inhabit them will promote interaction. Providing functionally spaces along the pedestrian infrastructure will encourage its dwelling. Universal needs such as gathering/meeting spaces can serve to accommodate various functions and can even host programs or cultural events to help foster a stronger sense of place. Through the encouraged interaction with spaces integrated with the pedestrian infrastructure, individual locations can exhibit the unique characteristics of those who inhabit them. Information about a place can then be extracted along the travel route.

Considering a sites cultural significance and demographic is a vital part of successfully integrating a new design proposal. Waikiki was once a playground for Hawaiian royalty. The white sandy beaches, surfing and family gathering is all a part of the rich history of traditional Waikiki. In order to continue this culture, we need to research and develop new ideas that will further enhance these features that define Hawaiian culture.

## Natural Preferences in Urban Planning

When we look back to the early days of Native Hawaiians, we can learn that they did not need to travel long distances for daily commuting purposes. Most of their traveling was done on foot and did not require access to an automobile.

We can learn from history how the native people of Hawaii commuted from one city to another. Traveling was necessary for farmers in the early 1800's in Hawaii, the cliff trails of Kailua was where the main route farmers in the area used to bring produce to sell in the city and transport necessary goods back to the windward side. These trails were often scary because of the steep incline and slippery sloped when wet. This made the hike that much harder to travel and required travelers to bring with them ropes and ladders to successfully get to the other side.

The first mule-car service began in 1888. Later the first electric streetcars, operated by the Honolulu Rapid Transit & Land Co., took dozens of passengers in open cars from upper Nu'uauu Avenue to Pacific Heights. Later, the "Silver Fleet" arrived—22 gasoline-powered buses, praised in the January 1934 *Paradise of the Pacific* for its air brakes, weight distribution and courteous drivers. To the Kamaaina, many of whom remember vividly the mule tram cars in the days when Hawaii was yet a monarchy, the digging up of Honolulu's streetcar tracks marked the end of an era in a city that clings jealously to the romantic days of King Kamehameha. The digging up of 13 miles of Honolulu Rapid Transit Co. track is the result of the installation on Nov. 1, 1933, of 22 new



Twin Coach gasoline buses and the abandonment of all except three rail lines of the company's citywide transportation system.<sup>16</sup>

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<sup>16</sup> Christi Young, "O'ahu in 1934: Honolulu's Vanishing Street Car Tracks," Honolulu Magazine, accessed September 14, 2019, <http://www.honolulumagazine.com/Honolulu-Magazine/February-2019/Oahu-in-1934-Honolulus-Vanishing-Street-Car-Tracks/>.

## **Rise of the Vehicular Utopia and its End**

The technological revolution of the automobile at the beginning of the 20th century brought with it the promise of a new era. Cities and urban planners, plagued by the many social challenges and issues associated with horse powered vehicles, were keen on exploring new transport technologies to improve the prosperity of their people. The rise of numerous new automotive technologies and ultimately the gasoline powered automobile heralded a change in how cities would be formed during the next century.

### **Architectural Utopia Vision**

The rising popularity of automobiles and its effect on the structure of cities would also spur architects and urban planners to propose visions of a future utopian city. Two of the most well-known architects, Frank Lloyd Wright and Le Corbusier, each envisioned vastly different urban responses that would begin to form the architectural response to the novel technology. Although each scenario would eventually be accepted as flawed in one way or another, understanding the grounding of each proposal and the logic behind the design choices is important as we transition into another phase of innovation in mobility.

Le Corbusier would take advantage of the range of the automobile in his ideal city, the Ville Radieuse, an orderly and strictly organized metropolis of the future. Leveraging the ability of a

city's residents to travel quickly utilizing a car, the Ville Radieuse implemented strict zoning restrictions as the primary method to better society.<sup>17</sup>

The top-down nature of the design disallowed any flexibility in function within zones nor provided any space for pedestrian encounters. Space within the city prioritized wide stretches of highways, leaving undesirable gaps between buildings that would remain barren. Every aspect of the master plan seemed to be designed around the features of the automobile and lacked any attention to the human scale.<sup>18</sup>

On the other side of the spectrum, Frank Lloyd Wright saw the potential of the automobile as an opportunity to decentralize the city and would present his concept of utopia, Broadacre City, in his book *The Disappearing City*. Within automobiles and its associated infrastructure, Wright saw the opportunity for a happier and liberating life, writing:

*“Young as the highway system is, however, it requires but little imagination to see in the great highway and see in the power of all these new resources of machines and materials a new physical release of human activity within reach of everyone... not only as adventure and romance with nature but a basis for safer, saner, less anxious life for a sane and dignified free people. A longer, happier life waits, naturally, upon this change sense of a changed space relationship.”<sup>19</sup>*

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<sup>17</sup> Gili Merin, “AD Classics: Ville Radieuse / Le Corbusier,” ArchDaily, accessed March 20, 2020, <https://www.archdaily.com/411878/ad-classics-ville-radieuse-lecorbusier>.

<sup>18</sup> Ibid.

<sup>19</sup> Frank Lloyd Wright, *The Disappearing City* (New York: WF Payson, 1932), 44.

The urban plan capitalizes on the convenience of the automobile, to allow the population to disperse across large swathes of land while still staying connected to public realm.

### **Post-Modern: Rise of the Vehicle**

The conception of suburbs and their pervasiveness around every major city in North America would create a dependency on the automobile. Its rise in popularity took place primarily after World War 2, serving to accommodate the influx of returning veterans with the promise of a luxurious life and a place to raise a family. Modernist city planning in the years following the war also played a crucial role in the proliferation and ubiquity of automobiles. The increased mobility of the population, as a result of access to cheap automobiles, enabled city planners to implement zoning policies which shifted the scale of urban design towards cars rather than the pedestrian.<sup>20</sup>

### **The need and role of the automobile**

Across every level of society, from artists to industrialists, people were enamored by its potential impact on future urban life. For instance, the automobile was a prime focus for the artistic and social movement of Futurism during the early 20th century. The relatively new technology stood as an exemplary symbol of many of the movement's core concepts: speed, violence, machinery, and industry. Filippo Tommaso Marinetti, an Italian poet and one of the founding members of the Futurism movement, specifically mentions the wonders of the car in an article of his Manifesto of Futurism published in 1909:

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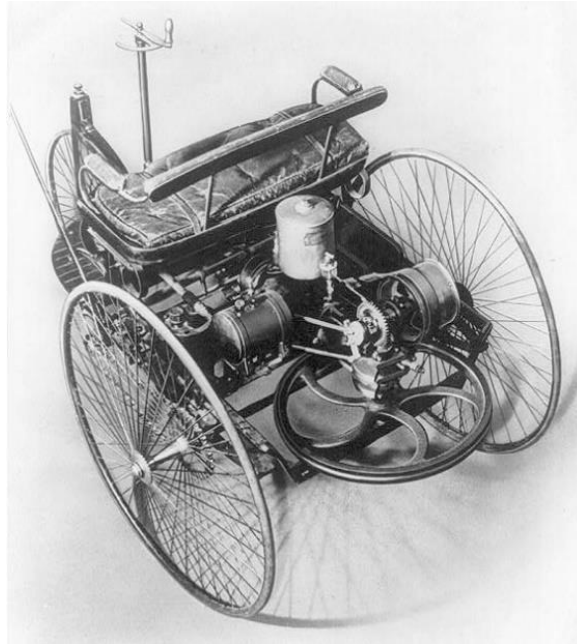
<sup>20</sup> Peter Hall, *Cities of Tomorrow: An Intellectual History of Urban Planning and Design in the Twentieth Century* (Chichester, England: John Wiley & Sons, Blackwell, 2014).

*"4. We affirm that the world's magnificence has been enriched by a new beauty: the beauty of speed. A racing car whose hood is adorned with great pipes, like serpents of explosive breath—a roaring car that seems to ride on grapeshot is more beautiful than the Victory of Samothrace."<sup>21</sup>*

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<sup>21</sup> Filippo Tommaso Marinetti, *The Futurist Manifesto* (Le Figaro: February 20, 1909), 39-44.

## Evolution of the Automobile



*Figure 9: First Gas Powered Car*

*Source: Library of Congress, loc.gov*

When you think of the very first car ever created, what do you imagine? Cars made of tree trunks, branches and tires made of rocks may not be the suitable answer. What did the very first cars look like, and how have they changed over the years? They are probably a little different than you would think!

While some of the very first cars were powered by steam engines, dating back to the 1700s, it was Karl Benz in 1885 who invented the first gas-powered car, which he later received a patent

or in 1886. Benz's first car had three wheels, looked much like an elongated tricycle, and sat two people. Four-wheeled gas-powered cars were later introduced in 1891.<sup>22</sup>

For a century, the automobile has offered affordable freedom of movement within cities; the places where most for the worlds people now live, work, play and pursue their social and cultural lives. An automobile is seen as an object of desire, and especially in the United States and other countries with powerful economies we find the total number of automobiles exceed the number of families in a household.

“Through a complex coevolutionary process involving interdependencies among vehicle engineering and design solutions, energy supply systems, street and road infrastructures, urban land use patterns, economic incentives, and government policies-the automobile has become part of the urgent problem that cities now face. Cities currently consume too much of the Earth's nonrenewable resources to remain viable and livable in the long term.”

The argument for a reinvention of the automobile can become a powerful part of the solution to these problems. Along with major changes to our street design and complemented landscapes can promote greater health opportunities and quality of life. While maintaining and even enhancing current levels of personal mobility within cities, the new kind of automobiles and personal urban mobility systems that I discuss in this research has the potential to reduce the overall energy and materials requirements of mobility systems; create a significant shift from

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<sup>22</sup> “The Evolution of Cars,” CAKNOW, Medium, accessed November 06, 2019, <https://medium.com/@cacknowapp/the-evolution-of-cars-4b6eeeb84f>.

nonrenewable energy sources to clean, renewable ones and in general improve the quality of urban life.

A typical automobile today is larger and heavier than it needs to be to provide personal urban mobility, and its capabilities are excessive for this purpose. It requires more than 100 square feet of valuable urban real estate for parking, and it is parked about 90 percent of the time.

The design of the automobile that I am proposing will need to cater the consumer desire- to be fun, fashionable, efficient and affordable. I believe the biggest factor in designing this automobile is its affordability, it is only through a very high volume of consumer acceptance that reinventing automobiles and mobility systems will make the large-scale contributions to urban sustainability that we need. In return creating exciting new opportunities for the automobile industry, and help to establish a clean, green economy for the coming decades.<sup>23</sup>

## **Car War**

As the ubiquity and dependency on automobiles for urban life revealed its failings, urban design movements championing walkability and the pedestrian scale skyrocketed in popularity. The ideas of the New Urbanism urban design movement gained traction at the end of the 20th century, promoting walkable residential neighborhoods containing a variety of housing types as well as plentiful amounts of parks, playgrounds and plazas, all easily accessible by a network of pedestrian friendly streets.

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<sup>23</sup> William J. Mitchell, Christopher E. Borroni-Bird, and Lawrence D. Burns, *Reinventing the Automobile* (MIT Press, 2015) 1-9.



## Rise of the “Complete Street”



*Figure 10: Waikiki Events Road Closure*

*Source: Author*

Complete streets support healthy and sustainable communities through the introduction of several physical activity spaces, reducing vehicle emissions, increasing pedestrian and bicycle safety, and beautifying neighborhoods. In general, a city would promote the idea of a complete street by providing a transportation network that is safer for travel than our current conditions, promotes public health, and creates stronger and more livable communities.

- Safe and convenient for people of all ages and abilities.
- Accommodating to all modes, including foot, bicycle, transit, and automobile.
- Integrated with the community’s vision and sense of place
- Supportive of community health and transportation equity

In a typical complete street, we would see a space that is provided to the community where they would share experiences and interact on the day-to-day basis. These types of environments tend to provide a safer community where people share a stronger emotional connection to each other. Unlike what we see currently in places like Waikiki, designing a mix of interactive uses such as commercial, retail and food service can encourage an active streetscape.

In the past a street was designed to be a place of interaction where people would communicate and socialize with others. Currently streets are mostly used for transportation and very few countries design streets to encourage human interactions and other forms of transportation. We often see that streets are designed to force users into certain spaces such as malls and stores. This strategy is slowly evolving, and I believe that transforming our streets to a people friendly environment can have major positive impacts. This transformation can come in the form of autonomous vehicles which allows people to spend less time driving, and more time enjoying their daily life. This form of transportation may create a new typology that changes the way a person uses a street. Urban planning and landscapes can have a drastic impact due to autonomous vehicles (AVs). My research involves a new type of transportation system that can make a greater impact on the future of city planning and city development. A system that creates a safer and more efficient driving environment for communities with dense population.

## **Challenges of vehicles today**

For some parts of the world, people are starting to cool off its love for the gas-powered car. The challenge automakers are facing today is the justification of using privately owned vehicles that produce a higher rate of pollution compared to the public vehicle that are shared. From efficiency to the functionality, the automobile industry faces several difficult tasks in improving their designs of the current motor vehicle.

People are slowly outgrowing the gas-powered vehicles and transitioning to electric vehicles. The cost of gas compared to the cost of recharging an electric vehicle is incomparable. The average U.S. household spends nearly one-fifth of its total family expenditures on transportation, saving on fuel can make a big difference.

Another common obstacle we face with the human driven car is that it requires a human to drive it. This can be an issue when you consider the amount of people who are not able to drive on a daily basis. For example, the youth, the elderly and the disabled. This is one of the main categories where AVs will make a huge impact by providing transportation for all.

## Introduction to Autonomous Technology



*Figure 11: Navya Autonomous Vehicle*

*Source: Bloomberg*

What is an (AV) Autonomous Vehicle?

These autonomous vehicles (AVs) can use sensors and other devices to avoid collisions with pedestrians/automobiles and other stationary objects. You can also use a range of technologies known as augmented reality, where a vehicle displays information to drivers in a new and innovative way. Autonomous vehicles require less road space than a manually driven vehicle because of their ability to communicate with a network and move uniformly amongst other AVs which requires less following distance. As a result, our streets do not require to be as wide, and the number of lanes in the road can be reduced to accommodate for more sidewalks and green spaces. The benefits of AVs are endless when you consider the amount of space a city can regain

from smaller streets. Allowing more space for sidewalks and green spaces and converting large parking lots into parks and recreational spaces. AVs are expected to free up vast amounts of land currently used for parking and loading zones. The “extra” space gained can be converted to additional bike lanes, pedestrian paths or street parking and drop off zones for AVs. "Most people in transportation focus on the five percent of the time that cars are moving. But the average car is parked 95 percent of the time. I think there's a lot to learn from that 95 percent." Donald Shoup<sup>24</sup>

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<sup>24</sup> Paul Barter, “Cars Are Parked 95% of the Time”. Let's Check!” Reinventing Parking, accessed December 03, 2018, <https://www.reinventingparking.org/2013/02/cars-are-parked-95-of-time-lets-check.html>.

## **Features of Autonomous Technology**

Automated vehicles (AV) interpret their environments using a combination of real-time sensors, GPS signals, and LIDAR data. Using image and pattern recognition software and engineer-assisted training and software development, the promise of AVs is that they will one day be able to accurately detect all people, objects, conditions, and events in the road and react in the safest manner possible, avoiding collisions and improving safety for all users.

## **Opportunities and disadvantages**

There are 5 key aspects of this vision for Oahu's most populous region:

1. Protect and enhance Honolulu's natural, cultural and scenic resources
2. Cultivate livable neighborhoods
3. Provide a full range of in-town housing choices
4. Establish Honolulu as the Pacific's leading city and travel destination
5. Develop a balanced transportation system

The opportunity to create a successful mode of transportation where people are encouraged to carpool has a greater possibility in Honolulu because research shows that the share of carpool commuters has been declining since 1980. The commuters who carpooled to work decreased by 18.2 percent from 116,496 in 1990 to 95,287 in the 2009-2013 period.

With the advancement in autonomous driving, there can be other improvements to street design and urban planning. The design and planning of cities can improve so much so that we can start creating cities with people first in mind. The improvements in city planning allow us as

architects and urban planners to design streets that have more landscaping and trees. As a generation that is learning to design with sustainability as a driving force, we can promote a healthier style of living and an efficient form of commuting. There are many benefits to creating a greener and more walkable street. Some of these benefits include an enhanced community livability, increased air and water quality, decreased infrastructure costs, and increased habitat and biodiversity.

As a result of these positive changes, we are given the opportunity to create spaces that will benefit our community and more importantly our youth. Currently our streets are designed with the automobile as the driving force, but with this new concept we can create spaces for children to play, adults to relax and the youth to socialize. Our sidewalks can be converted to small parks and green spaces where people go to hangout and interact with others. Restaurants can use these spaces as seating areas where they encourage their customers to go outside and experience the fresh air and greenery.

Further, these common areas outside of homes and apartments in dense urban cities can become shared spaces where neighbors can interact with each other. We can eliminate situations where our neighbors are strangers and instead have the opportunity to have a meaningful conversation. This in return creates a safer neighborhood or living situation where people know each other. This can be especially helpful in a scenario where there is an elderly person living alone. By promoting an environment that allows people to interact, it gives the elderly a peace of mind knowing that their neighbors will notice any suspicious activity.

### **More or fewer cars on the road?**

Cities often have the worst of both worlds when it comes to street design: top speeds that create safety risks but average speeds that frustrate everyone. The common solution is often to add lanes and buffers, but that approach can do more harm than good.

### **More or fewer urban sprawl?**

The way in which we develop the American landscape and its urban areas is a critical component to creating livable and sustainable cities. The footprint of major metropolitan areas, suburbs, and small towns ultimately shapes the environmental and social conditions within our communities. One type of development pattern that has received increasing attention by researchers and policy makers interested in fostering sustainable communities is called "sprawl."<sup>25</sup>

Sprawling development patterns create large distances between dwelling units and segregate different land uses, residents are forced to rely on automobiles at the expense of alternative forms of transportation. Also, the cul-de-sac dominated street patterns within these neighborhoods foster a lack of connectivity and serve as an obstacle for walking and biking to nearby destinations

### **More or fewer road infrastructure?**

Streets today are designed to allow vehicles to move quickly. But this decision requires streets to be designed defensively as well — because speed kills. As a result, engineers design

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<sup>25</sup> Samuel Brody, "The Characteristics, Causes, and Consequences of Sprawling Development Patterns in the United States," Nature Education, accessed April 22, 2019, <https://www.nature.com/scitable/knowledge/library/the-characteristics-causes-and-consequences-of-sprawling-103014747/>.



wider lanes to account for drivers who drift or veer, and they design buffer spaces like shoulders, medians, and street-parking areas to try to improve pedestrian and cyclist safety. But they are not safe; more than 6,700 pedestrians and cyclists died on streets in the United States in 2017 due to automobile crashes. Neither pavement markings nor bollards are enough to protect vulnerable bicycles and pedestrians — and certainly not enough to make them feel comfortable.

### **Literature Review Conclusion**

Eventually, self-driving cars will disrupt every industry around us that's tied closely to transportation. It's nearly impossible to say with certainty whether completely autonomous vehicles will replace human-driven cars in the future. However, in recent years, we've seen the technology progress dramatically, and the rate of technological development has not slowed down since the Renaissance, so it's safe to say we'll see more autonomous vehicles in the future.

### **Urbanism for Multimodality with Autonomous Vehicles**

We plan our cities and their mobility together. The way our cities are built determines mobility needs and how they can be met. Development, urban design and public spaces, building and zoning regulations, parking requirements, and other land use policies shall incentivize compact, accessible, livable, and sustainable cities.

The support of autonomous vehicles in dense urban areas should be operated only in shared fleets. Due to the transformational potential of autonomous vehicle technology, it is critical that all AVs are part of shared fleets, well-regulated, and zero emission. Shared fleets can provide more affordable access to all, maximize public safety and emissions benefits, ensure that

maintenance and software upgrades are managed by professionals, and actualize the promise of reductions in vehicles, parking, and congestion.<sup>26</sup>

### **Why integrating autonomous vehicles with urban planning is more successful.**

The Britannica Encyclopedia defines the definition of Urban Planning as, “design and regulation of the uses of space that focus on the physical form, economic functions, and social impacts of the urban environment and on the location of different activities within it.”<sup>27</sup> Architects, engineers and planners need work together in improving the integration of autonomous vehicle is because it will take each specific fields expertise to tackle minor issues that we will face in the future.

The success of this proposal can be achieved because transportation technology and urban planning go hand in hand. As the benefits of AVs have a direct impact to public spaces, it is crucial to notice these opportunities at an early stage. If the goal of planners is to achieve successful planning of densely populated cities, then one of the biggest impacts that can be researched is in the transportation industry.

### **Streets for an integrated autonomous Mobility System**

Autonomous vehicles programmed to travel at 25 mph or less depending on street context, dictate the speed of traffic for all motorized vehicles, reducing the overall speed on urban streets

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<sup>26</sup> Jon Walker, “The Self-Driving Car Timeline - Predictions from the Top 11 Global Automakers,” Tech Emergence, accessed December 20, 2018, <https://www.techemergence.com/self-driving-car-timeline-themselves-top-11-automakers/>.

<sup>27</sup> “Urban Planning,” Encyclopedia Britannica, accessed January 4, 2019, <https://www.britannica.com/topic/urban-planning>.

and, as a result, reducing the frequency and severity of crashes. Excess road space, created by slower moving, more efficient AVs, is used to build better, safer places for people walking and on bikes. Safer street design helps promote safer cities.

### **Implementation of Autonomous technologies**

Current deployments of autonomous vehicles are also seen within the taxi industry. Uber has deployed self-driving cars in numerous American cities including San Francisco, Tempe and Pittsburgh, travelling over one million autonomous miles over 30,000 passenger rides.<sup>11</sup> A private taxi fleet is also being deployed by Voyage to retirement villages in the US. After a successful launch in a retirement suburb in San Jose, “The Villages”, a retirement suburb in Florida, is introducing a fleet of self-driving taxis to help its 125,000 senior residents travel within the community. The door-to-door service, accessed through an app, will allow residents to travel anywhere within the bounds of the community, which contain 750 miles of road, 3 distinct downtown areas and a whole host of other retail areas.<sup>28</sup>

### **Smart roadways**

Autonomous technology can serve to actively balance the allocation of space within the city by dynamically allowing for a multitude of activities depending on the situation. The safety, efficiency and innovation the technology provides can be leveraged to allow for what was traditionally space reserved for vehicles to be transformed into bike lanes, parks, additional housing and street life. With the advent of intelligent programable vehicles, streets can transform

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<sup>28</sup> Daniel Thomas, “US Retirement Village to Have ‘largest’ Self-driving Taxi Scheme,” BBC News, accessed April 17, 2019, <http://www.bbc.com/news/technology-42648301>.

throughout the day opening multiple lanes of traffic during rush hour or completely disallowing vehicles on weekends. In our case of Waikiki for example, we can designate street use for events such as Eat the Streets, The Honolulu Marathons, and the occasional cultural parades.

### **Sensor technology**

AVs use a variety of sensors, advanced software engineering algorithms, and machine-learning to “see” the street and determine the appropriate path or actions. The decision-making process requires an AV to synthesize four types of information to determine its next move and safely navigate towards its destination.

- **Light Detection and Ranging (LIDAR)** - Two 360-degree sensors use light beams (millions of laser pulses per second) to determine the distance between the sensor and other objects.
- **Ultrasonic Sensors** - Mounted on the vehicle, sensors provide information about nearby objects.
- **Infrared Sensors** - Infrared sensors detect lane markings, pedestrians, bicyclists, and objects that other sensors can find difficult to identify in low light and certain environmental conditions.

### **New infrastructures**

Cities and states have historically made local decisions about infrastructure design. Cities could seek to become more involved in infrastructure planning and construction to create a uniform landscape in which AVs can easily operate among dense neighborhoods. Cities will have the opportunity to redesign its streets in ways that prioritize AVs over other modes of

transportation. AV only lanes, designated pedestrian or bike paths, over-passes, and underpasses can be architecturally designed to enhance the natural landscape and promote easy accessibility.

Waikiki has an opportunity to prioritize and regulate their existing infrastructure for the benefit of residents and the environment while shaping and scaling strategies to deploy new technologies for the betterment of their streets.

## Chapter 3: Inspiration and Precedents

Ever since my first year of architecture school, I have been driven to providing excellent architecture to my community. As a young architecture student, we were taught to be critical in analyzing our design thinking process. I was lucky enough to be influenced by great architects in my community as well as around the world. These lessons which I have carried with me throughout my architecture career. My experiences while studying abroad and interning at firms have inspired me to tackle everyday problems that we face right here in our island.

My study abroad experience in Copenhagen, I have been inspired to design cities by putting people first, then buildings and then transportation. Jan Gehl has been a huge influence for me to focus my designs on *Life, Space, then Buildings*.

Most of the street is sacrificed to the automobile and very little towards people and landscape. A lot of times we find ourselves saying “I will walk today, I will ride a bicycle to work today, I will go to the park”. However, we find excuses relating to traffic, safety and accessibility.

## Multi-Modal Shared Spaces

### Mcity driverless shuttle (University of Michigan as case study)



*Figure 12: Navya Autonomous Vehicle University of Michigan*

*Source: <https://mcity.umich.edu/tag/mobility/>*

In June 2018, Mcity, a public-private partnership at the University of Michigan (U-M), launched the first driverless shuttle project in the United States to focus on user behavior research and extensive data collection. With two shuttles transporting students, faculty, and staff on the U-M campus, the project is designed to support data collection to understand vehicle performance, roadway interactions, and passenger attitudes. The ultimate goal is long-term deployment of driverless shuttles in the real world.

The primary goal of this study was to understand human acceptance, trust, and behavior when riding in a driverless shuttle or interacting with one on the road. The project aimed at

collecting both subjective survey and objective data from interior and exterior sensors, including machine vision cameras, microphones, precision GPS, and vehicle dynamics.<sup>29</sup>

This data was gathered as the shuttles operate on campus, offering the U-M community a real shuttle experience. This ridership information helped U-M understand mobility needs near the North Campus Research Complex and inform planning for future bus and parking needs.

Driverless shuttles have a future only if they are trusted and used by riders, and trusted and accepted by other road users. For the Mcity Driverless Shuttle project, safety was the most important factor in route selection, setting operational speed, and programming behaviors at intersections<sup>30</sup>

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<sup>29</sup> University of Michigan, *Mcity Driverless Shuttle: A Case Study* (Ann Arbor, Michigan: University of Michigan, 2018) 3-42, <https://mcity.umich.edu/wp-content/uploads/2018/09/mcity-driverless-shuttle-case-study.pdf>.

<sup>30</sup> Ibid.



## Optimus Ride in New York (New York City's first self-driving shuttle service)



*Figure 13: Optimus Ride, Autonomous Vehicle*

*Source: <https://www.optimusride.com>*

Optimus Ride, a leading self-driving vehicle technology company, announced the launch of New York state's first self-driving vehicle program, located at the Brooklyn Navy Yard (Yard), a 300-acre industrial park with more than 400 manufacturing businesses and 10,000 employees onsite.

Dr. Ryan Chin, CEO and co-founder of Optimus Ride, said: "Launching our self-driving vehicle system in New York at the Brooklyn Navy Yard is yet another validation that not only is Optimus Ride's system a safe, efficient means of transportation, but also that autonomous vehicles can solve real-world problems in structured environments – today.

Having deployed its technology in several Boston-area locations and successfully completed over 20,000 trips since the company's launch in 2015, Optimus Ride's system aims to

provide a safe, efficient means of mobility in areas where there is a lack of options. Optimus Ride also has agreements to deploy in three other U.S. states: at Brookfield's Halley Rise in Reston, Va.; Paradise Valley Estates in Fairfield, Calif., and the Raymond Flynn Marine Industrial Park and Seaport District in Boston, Mass.<sup>31</sup>

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<sup>31</sup> "Optimus Ride Launches New York State's First Commercial Self-Driving Vehicle System at the Brooklyn Navy Yard," Optimus Ride, accessed October 22, 2019, <https://www.optimusride.com/press/optimus-ride-launches-new-york-states-first-commercial-self-driving-vehicle-system-at-the-brooklyn-navy-yard>.

## Navya and Keolis partner with city of Las Vegas to launch first driverless public transit vehicle



*Figure 14: Navya Autonomous Testing, Las Vegas*

*Source: [www.keolisnorthamerica.com](http://www.keolisnorthamerica.com)*

A new milestone in transportation was reached as NAVYA and Keolis, in partnership with the city of Las Vegas, launched the first completely autonomous, fully electric shuttle ever to be deployed on a public roadway in the United States. The shuttle is being launched in the new Innovation District that was recently created by the city of Las Vegas in downtown Las Vegas.

The pilot was made possible through a partnership between Keolis, a global leader in operating public transportation systems, and NAVYA, which developed the ARMA Shuttle. The public will be able to ride on the shuttle, as it travels along east Fremont Street between Las Vegas Boulevard and Eighth Street, with regular street traffic.

The city plans to transform the downtown urban core into a technology incubator focused on safe, efficient, sustainable and environmentally conscious mobility including autonomous and connected vehicles and establishing a platform for deploying innovation.

*“NAVYA is delighted to be part of the innovative, new model of urban transportation solutions Mayor Goodman of the city of Las Vegas and our transportation partners at Keolis are bringing to the city of Las Vegas. Busy areas such as the Fremont East Entertainment District of downtown Las Vegas are the perfect place for the ARMA as it allows people to move easily and safely while reducing car congestion and pollution,” said NAVYA VP Henri Coron.<sup>32</sup>*

Since first deploying the NAVYA ARMA in France in late 2015, the vehicles have transported more than 100,000 people and have grown to have a fleet of 30 ARMA’s in use in seven countries around the world, including the United States, as of today.

## **Precedent Conclusions**

The precedent studies referenced in this research were used as an example to showcase existing studies and implementations currently being investigated in other states around the country. Similar examples are already being introduced into dense urban environments, and I believe that Honolulu can act early in borrowing these ideas to create a similar yet unique

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<sup>32</sup> Keolis, “NAVYA and Keolis Partner with City of Las Vegas to Launch First Driverless Public Transit Vehicle to Operate in U.S.,” KeolisNorthAmerica, accessed November 1, 2019, <https://www.keolisnorthamerica.com/news/navya-and-keolis-partner-with-city-of-las-vegas-to-launch-first-driverless-public-transit-vehicle-to-operate-in-u-s/>.

transportation system. I believe Waikiki can be unique by designing a new mode of transportation that can be adopted by others in the future.

### **Role of cities for a driverless future**

Cities seamlessly manage streets to mitigate the negative impacts of private motor vehicle traffic on city life. Vehicle infrastructure would be given significantly less space, giving streets and shared spaces back to the people. City planners and architects need to work together in designing and planning the successful transportation improvements of their city. Major changes to a city's infrastructure will require multiple organizations to get involved in achieving the successful completion of this transformation.

### **Managing the Autonomous multi-modal urban landscape**

Pedestrians are prioritized on every inch of the future urban landscape. These landscapes will be designed to provide easy accessibility, shorter crossing and pleasant environmental views for people. More space would be dedicated to pedestrians, and additional amenities like seating and kiosks would liven up the landscape. Additionally, these landscapes create a larger green infrastructure that helps absorb stormwater and keep the city cool. This process has the potential to create several benefits to a city that is facing future threats of flooding and sea level rise.

### **Need for different levels of automation**

Waikiki is a dense neighborhood that is often forced to share its street with pedestrians and automobiles. The proposal to take away several streets and implement AVs can have severe push back from local leaders. By providing the city with a multi-modal transportation system at different levels of experience, we are able to create a type of attraction that promotes business

and create a healthier lifestyle. This further reduces the need for people to come out of their hotels/apartments, and instead they are able to go down to a gondola station and catch a vessel to their destination. These gondola stations can be planned strategically to be located at the popular tourist attraction sites mentioned throughout this research. These places may include restaurants, bars, monuments etc.

### **Separating modes of transportation by speed**

The street is designed to give preference to the pedestrian. If speed is the cause of fatalities, then reducing the speed of AVs in crosswalks or dense pedestrian areas will reduce the number of fatalities.

This design principle should translate into much greater safety, especially for cyclists and pedestrians. Research has found that collisions at 14 mph (22 km/h) may cause injury but are less likely to be fatal than ones over 30 mph (48 km/h), and a vehicle traveling at 4 mph (6 km/h) doesn't create discomfort or a safety risk for nearby pedestrians and cyclists.<sup>33</sup>

### **Safety, flexibility and fluidity at all levels**

As mentioned in the previous section, the design and planning of these autonomous vehicles will be the key to producing a successful, safe and flexible environment. Focusing on the safety aspect as the driver of this research is crucial in planning the future of our streets. By limiting

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<sup>33</sup> "Road Safety Web Publication: No. 16: Relationship between Speed and Risk of Fatal Injury: Pedestrians and Car Occupants," DC Richard, Transport Research Library, Department of Transport, London, September 2010.

the top speed of these AVs to areas with minimal pedestrian population, we can create a transportation system that is efficient and safer for everyone.

# Chapter 4: Hawaii's Environmental Decline Due to Its Addiction to The Automobile

## The Hawaiian Climate + Geography

Hawaii is the newest of the states, joining the union in 1959, it is the only U.S state that is an island archipelago. The location is unique considering that it is in the Pacific Ocean to the southwest of the continental U.S., southeast of Japan and northeast of Australia. Around the world, Hawaii is known for its tropical climate, unique topography, natural environments as well as its multicultural population. The islands of Hawaii are located about 2,000 miles southwest of the continental United States and is one of the few states that continuously have warm climate conditions.

The islands were formed by undersea volcanic activity from what is known as a hotspot. Since Hawaii is in the tropics, its climate is mild and summer highs are usually in the upper 80s and winters are in the low 70s. In addition to the warm climate, residents often are faced with wet and dry seasons. The local climate on each island varies based on one's position in relation to the mountain ranges. Windward sides where there is more nature and growth in trees is usually wetter, while leeward sides are hotter and often experience dry climate.

Because of Hawaii's isolation and tropical climate, it is very biodiverse and there are many endemic plants and animal life on the islands. Due to this exceptional weather conditions, it is not uncommon to see invasive plants and animals thrive in the wild. As a state that emphasizes strict laws when it comes to releasing nonnative species into the wild, locals are encouraged to hunt and gather these invasive species so that it can reduce the impact on native plants and animal life.

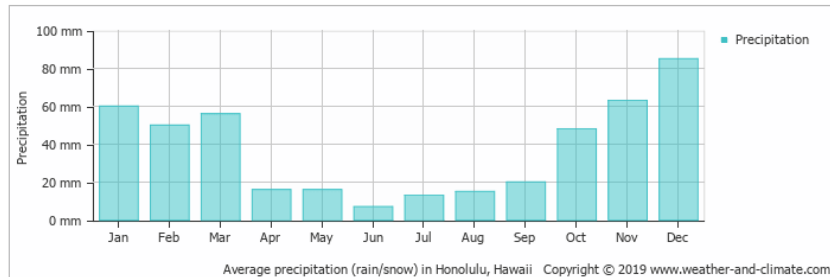


## Why Hawaii for integrating autonomous vehicles into its urban landscape

Hawaii presents itself as a unique location with year-round warm and dry temperature in most parts of the islands. Unlike current cities that have welcomed the testing of autonomous vehicles, the safety and success of this new technology is much greater in the islands. For example, Nevada, Arizona and California have different seasons throughout the year where testing autonomous vehicles may be a major risk factor.

### Average monthly precipitation over the year (rainfall, snow)

This is the mean monthly precipitation, including rain, snow, hail etc. [Show in Inches](#)



[Get the embed code](#) ▶

### Average monthly rainy days over the year

This is the number of days each month with rain, snow, hail etc.

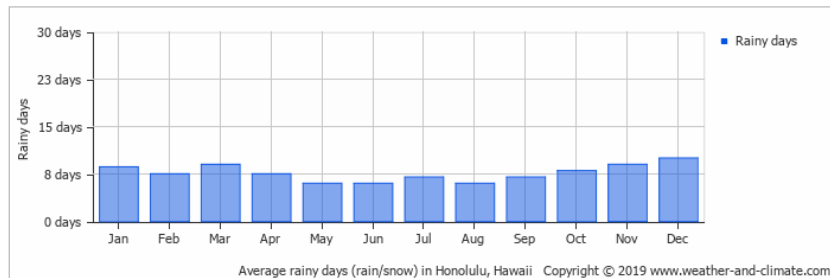


Figure 15: Honolulu Rainfall Analysis

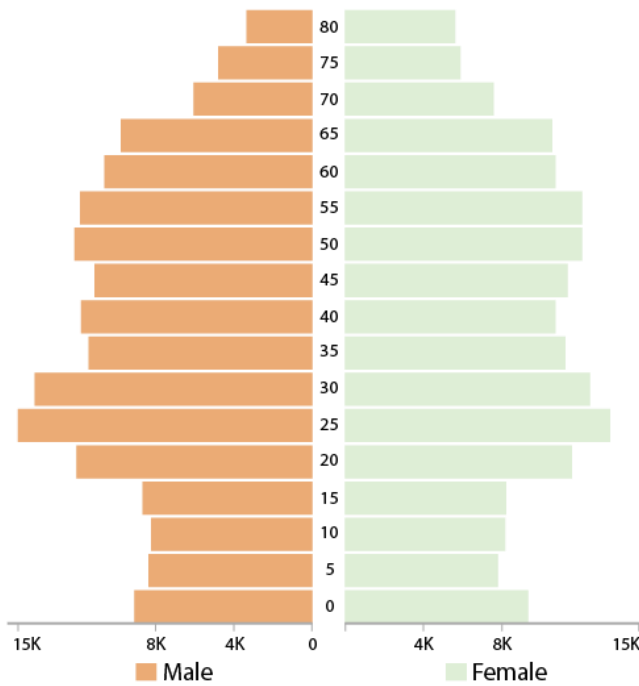
Source: Weatherandclimate.com

# Population Analysis

Honolulu Population By Age

Source: US Census 2017 ACS 5-Year Survey (Table S0101)

Honolulu Population Pyramid 2019



Honolulu Median Age

41.4 39.8 43.2

Total Male Female

Honolulu Adults

There are 290,318 adults, (67,509 of whom are seniors) in Honolulu

Honolulu Age Dependency

57.4 Age Dependency Ratio

30.3 Old Age Dependency Ratio

27.1 Child Dependency Ratio

Honolulu Sex Ratio

Female 177,725 50.66%

Male 173,063 49.34%

Figure 16: Honolulu Population Analysis

Source: US Census

Illustrations: Author

According to the last census, the population of the island of Oahu, on which Honolulu is located, grew 8.8% from 2000 to 2010. By 2030, the state is projected to have a population of 1.47 million, up more than 9% from the 2010 population of 1.34 million.

Honolulu has a healthy population that has seen a steady increase. The overall median age is 41.4 years, 39.8 years for males, and 43.2 years for females. For every 100 females there are 99.1 males.

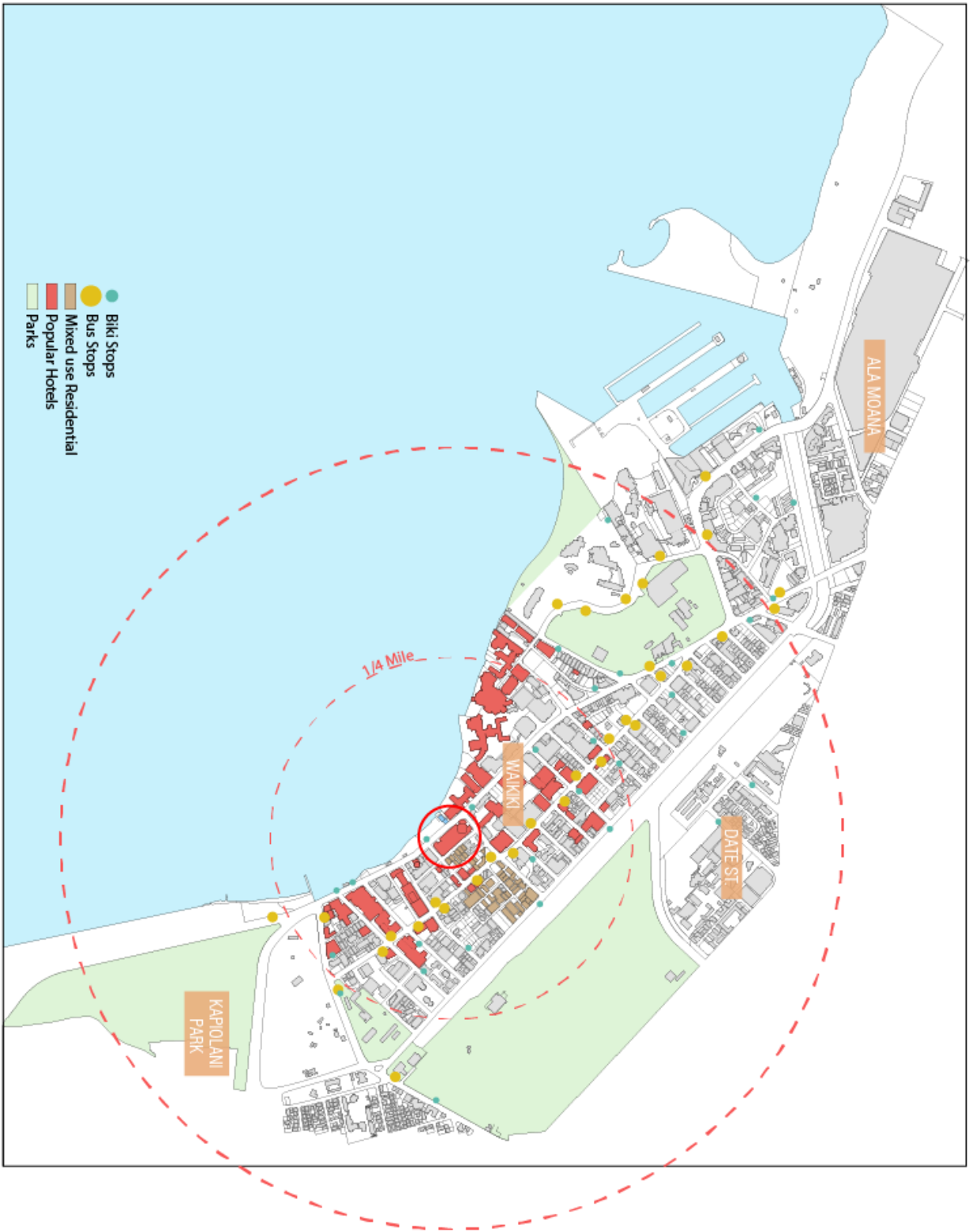


Figure 17: Movement analysis

Source: Author

Hawaii received a record 9.3 million visitors last year, a 4.6% increase from 2016. The island of Hawaii experienced the biggest growth last year. Nearly 1.8 million travelers explored the island during 2017, a 14% increase from the previous year.<sup>34</sup> With just three major points of access into Waikiki via Ala Moana Boulevard, Mccully St, and Kapahulu Avenue, Waikiki sits in a unique location that is highly affected by the daily commuters as well as the surge of tourists that find themselves in and out of Waikiki.

Historically, Waikiki was once the playground for elite families and Hawaiian royalty. The island's "royal playground" essence still lingers as the area has become a premier international travel destination, though due to steady development growth and increasing visitor interest, Waikiki has become a more modern urban center for tourism. In 2017, Oahu alone saw a combined 9.3 million domestic and foreign visitors with 81,782 people visiting Waikiki daily; and, future projections indicate up to 9,355,000 visitors during the year 2019. Furthermore, according to ESRI's demographic summary, Waikiki's population for 2016 totals 25,081 and projects the population to increase to a total of 26,713 in the year 2021, while job positions in the area are expected to rise from today's 38,085 to 49,100 in the year 2030. And, with a high proportion of total transportation trips already being made to and from Waikiki each day, a growing population, rising employment opportunities, and the soon-to-be, nearby rail station will only further increase the number of daily trips made to and around the area.<sup>35</sup>

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<sup>34</sup> Jay, Jones. 2019. *LA Times Travel Hawaii*. February 08, 2018. Accessed 11.04, 2019. <https://www.latimes.com/travel/hawaii/la-tr-hawaii-hotel-prices-increase-as-does-tourism-20180207-story.html>

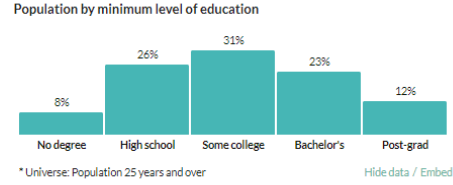
<sup>35</sup> "Traffic Counts—Esri Demographics Arcgis", Doc.Arcgis.Com, 2019, <https://doc.arcgis.com/en/esri-demographics/data/traffic-counts.htm>.

# 1. Demographics

## Educational attainment

**91.8%**  
High school grad or higher  
about the same as the rate in Hawaii: 92%  
a little higher than the rate in United States: 88.3%

**35.2%**  
Bachelor's degree or higher  
a little higher than the rate in Hawaii: 33.5%  
about 10 percent higher than the rate in United States: 32.6%



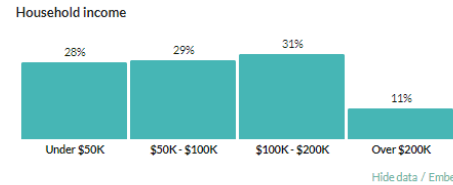
Population by minimum level of education (Table B15002) [View table](#)

Column	Honolulu County			Hawaii			United States		
No degree	8.2%	±0.6%	55,984 ±4,004.3	8%	±0.5%	80,079 ±5,054.2	11.7%	±0.1%	26,044,163 ±101,905.8
High school	25.7%	±0.9%	175,410 ±6,016.8	26.8%	±0.8%	266,728 ±7,856.1	26.9%	±0.1%	59,961,893 ±128,198.8
Some college	30.9%	±1%	210,213 ±5,848.7	31.7%	±0.9%	315,209 ±8,900.5	28.9%	±0.1%	64,402,330 ±143,764.4
Bachelor's	23.1%	±0.8%	157,316 ±5,186.4	22%	±0.7%	218,828 ±6,508.1	20%	±0.1%	44,599,186 ±118,979.5
Post-grad	12.1%	±0.6%	82,465 ±3,814	11.5%	±0.5%	114,745 ±4,772.4	12.6%	±0%	28,151,275 ±94,029.8

## Income

**\$35,958**  
Per capita income  
about the same as the amount in Hawaii: \$35,255  
a little higher than the amount in United States: \$33,831

**\$84,423**  
Median household income  
a little higher than the amount in Hawaii: \$80,212  
about 1.4 times the amount in United States: \$61,937



Household income (Table B19001) [View table](#)

Column	Honolulu County			Hawaii			United States		
Under \$50K	28.3%	±1.5%	87,090 ±4,681.2	31.3%	±1.3%	142,368 ±6,134.3	40.8%	±0.1%	49,618,733 ±117,266
\$50K - \$100K	29.1%	±1.3%	89,784 ±4,237.6	28.8%	±1.2%	131,141 ±5,496.8	29.9%	±0.1%	36,352,818 ±95,603.8
\$100K - \$200K	31.4%	±1.3%	96,913 ±4,211.5	29.7%	±1.1%	135,384 ±5,335.1	21.6%	±0.1%	26,268,260 ±85,003.1
Over \$200K	11.2%	±0.7%	34,421 ±2,282	10.2%	±0.6%	46,416 ±2,965	7.6%	±0%	9,280,369 ±45,589

Figure 18: Honolulu Education/Income

Source: [censusreporter.org](https://censusreporter.org)

The demographic about the population in Honolulu affect how major decisions are made that could benefit or hurt the community. The study of the demographic gives communities information they need to plan future development investments and services. This research help city official designate funds needed for improvements in transportation services in the Waikiki neighborhood. The demographic data impacts nearly everything that we do: how far to travel to the store, how much you pay in property taxes, to how much support local schools receive. Figure 19 shows the percentage of Honolulu’s population that has achieved a High School diploma or higher. We can also learn from this data the average income per capita in the Honolulu district. The data shows that the average income is slightly higher than the US average although you need to take in to account that Hawaii households are generally much larger than the US average

## 2. Different populations: Resident vs Tourists

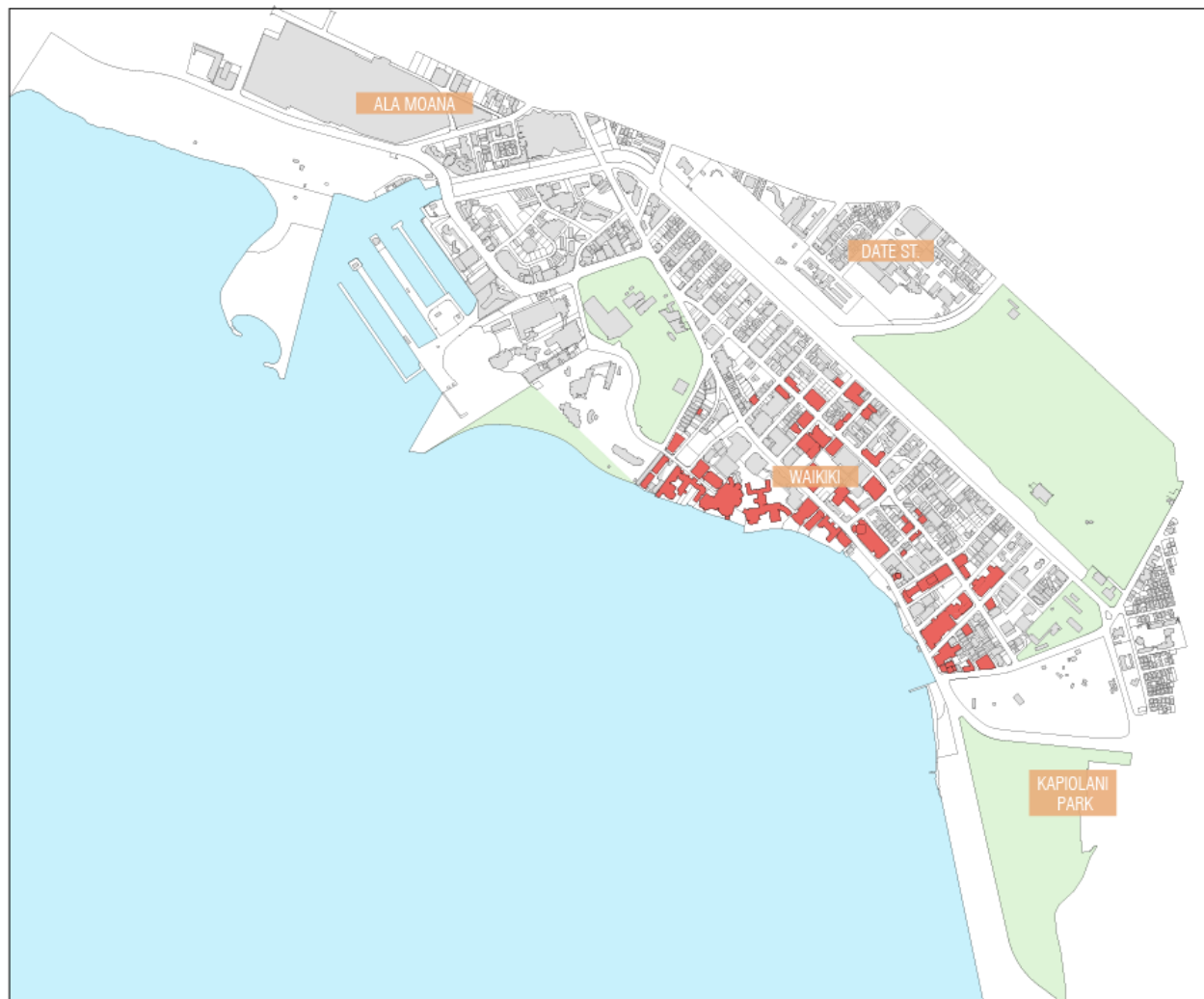


Figure 19: Popular Hotels in Waikiki

Source: Author

Over many decades, Waikiki has become an “urban resort” and is often compared to places like Miami Florida or Venice Beach. Waikiki remains the state’s flagship destination in terms of sheer size. An average of about 72,000 visitors per day occupied the area. Waikiki and attracts proportionately more international visitors than the state. About 43% of Oahu’s visitors are international travelers. This compares with just 32% for the state as a whole. The international market has grown rapidly over the past several decades.

## Need for Housing

Waikiki real estate is primarily made up of small (studio to two bedroom) to medium sized (three or four bedroom) apartment complexes/high-rise apartments and single-family homes. Most of the residential real estate is occupied by a mixture of owners and renters. Many of the residences in the Waikiki neighborhood are established but not old, having been built between 1970 and 1999. A number of residences were also built between 1940 and 1969.

The average rental price in Waikiki is currently \$2,556, based on NeighborhoodScout's exclusive analysis. Vacant apartments or homes are a major fact of life in Waikiki. The current real estate vacancy rate here is 42.6%. This is higher than the rate of vacancies in 97.6% of all U.S. neighborhoods. A relatively large percentage of housing here is seasonally occupied (31.3%). This can occur in vacation areas, and occasionally it is also found in neighborhoods that are primarily filled with college students, as some apartments could be vacant when school is not in session. If you live here year-round, you may find that a number of buildings in your neighborhood are actually empty.

These empty apartments are a major concern for city officials as Waikiki has seen an increase amount of homeless population. Ironically, there are more than enough housing units available but the cost of purchasing or renting makes it difficult for people to buy or rent. This issue needs to be further investigated and that is why converting the surplus parking structures into affordable housing units may seem as a smart option.

## Housing in Waikiki

Housing Units	23,076
Median Year Built	1971
Built in 1939 or Earlier	526
Built between 1940 and 1949	765
Built between 1950 and 1959	2,204
Built between 1960 and 1969	6,779
Built between 1970 and 1979	9,085
Built between 1980 and 1989	1,512
Built between 1990 and 1999	703
Built between 2000 and 2009	1,215
Built in 2010 or Later	287

Occupied Housing Units	13,458
Owner Occupied	5,792
Renter Occupied	7,666

With Mortgage	2,967
Without Mortgage	2,825
Median Value with Mortgage	\$494,800.00
Median Value without Mortgage	\$488,600.00
Median Housing Costs per Month	\$1,495.00

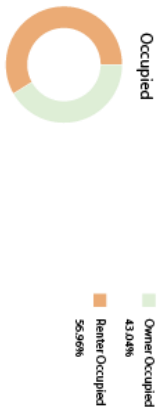
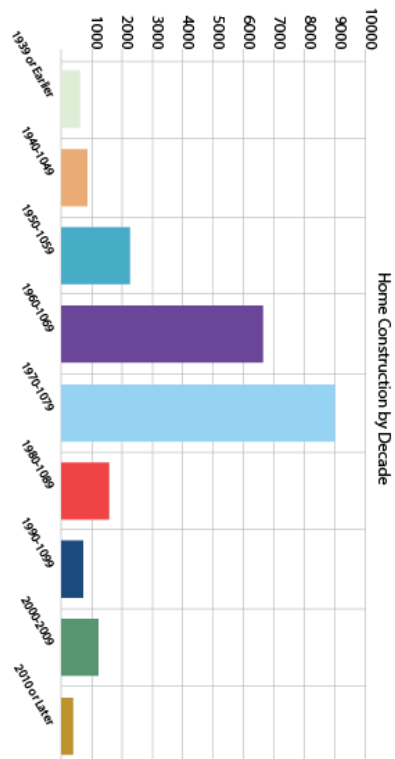


Figure 20: Honolulu Housing Analysis  
 Source: <https://www.point2homes.com>  
 Illustrations: Author



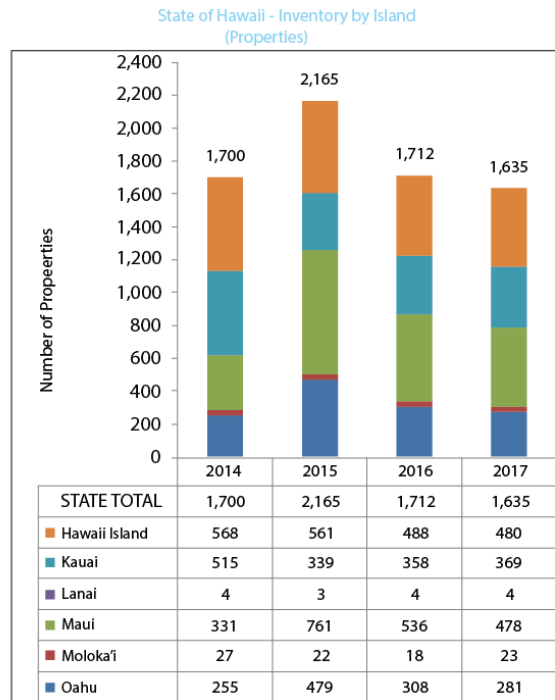
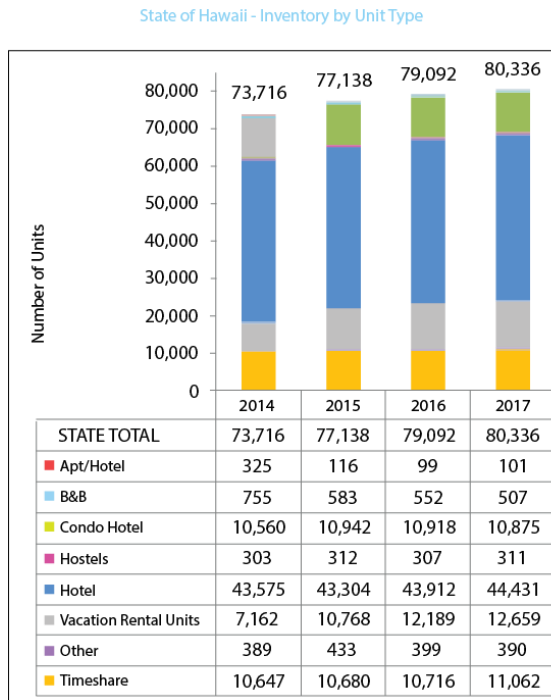
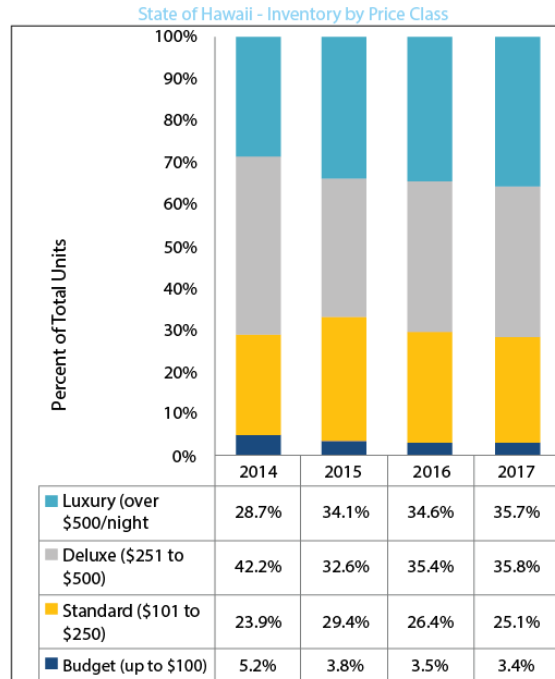
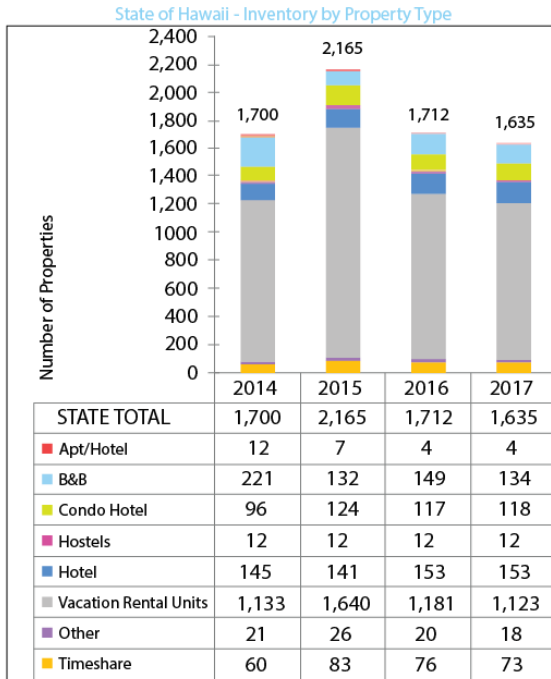


Figure 21: Honolulu Housing Inventory

Source: <https://www.point2homes.com>

Illustrations: Author

In addition to a source of employment, income, and tax revenue, Waikiki is also one of the state's major economic growth assets through its role as a resort destination. In regards to that role, Waikiki based visitor expenditures thus facilitate the injection of billions of outside tourist dollars into the rest of the economy. However, because of the projected growth and continual influx in visitor numbers each year, Oahu is going to have to find a way to continue catering to its increasing Waikiki visitors—providing them with a richer experience and fulfilling both vacation and living expectations while being able to keep up the paradisiacal destination reputation that is indispensable to the tourism industry and thus to the stability and growth of the state's economy.<sup>36</sup>

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<sup>36</sup> DBEDT, The Economic Contribution of Waikiki, DBEDT E-Reports (Honolulu: The City and County of Honolulu, 2003), [http://files.hawaii.gov/dbedt/economic/data\\_reports/e-reports/econ\\_waikiki.pdf](http://files.hawaii.gov/dbedt/economic/data_reports/e-reports/econ_waikiki.pdf), 1-7.

## Parking Cost

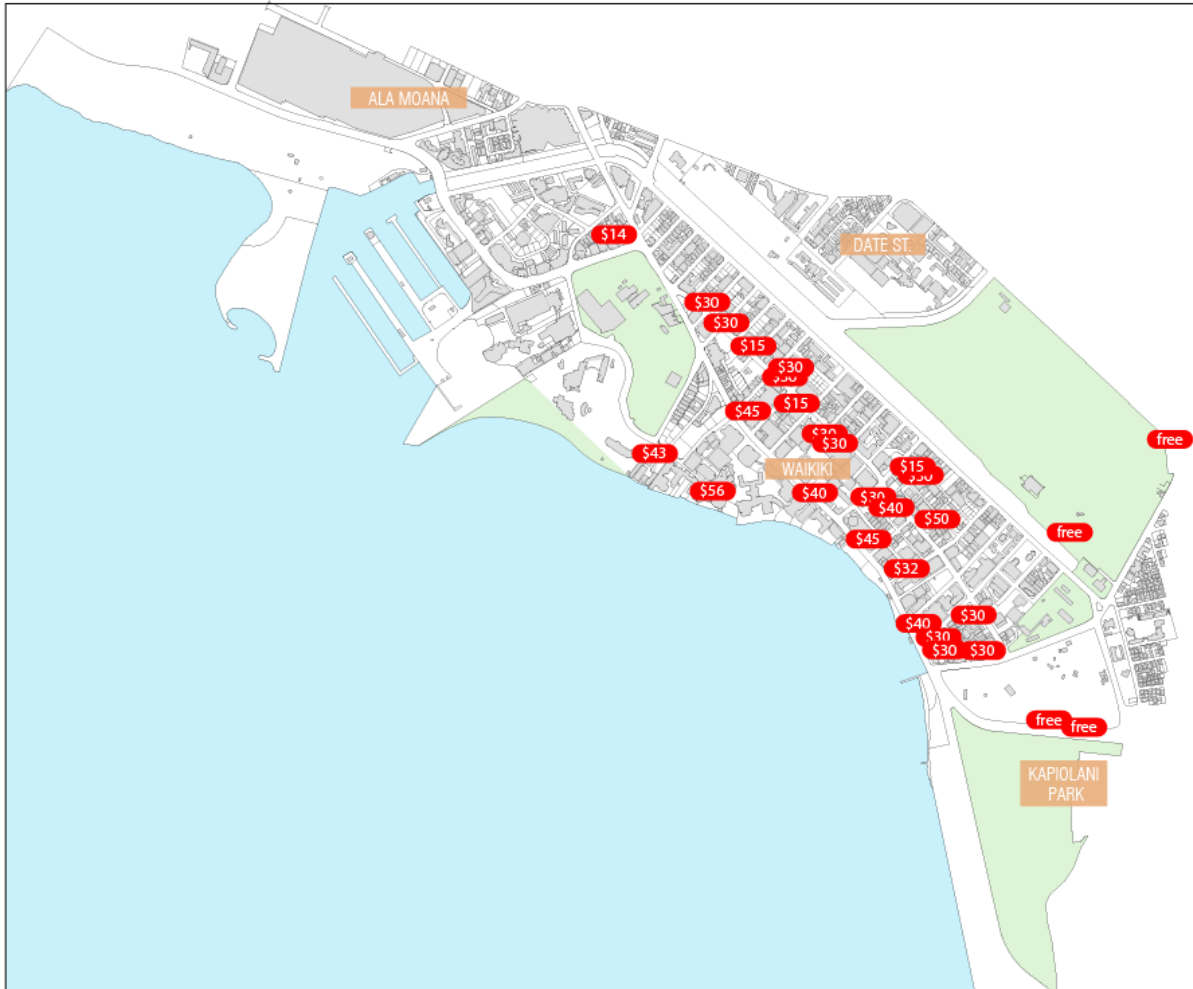


Figure 22: Average Parking Costs in Waikiki

Source: Author

The isolation of Hawaii from the outside world, and the limited land resource create major logistical problems. Many of Hawaii's natural wonders are free, except the land for parking. Waikiki often welcomes 10 million annual visitors, so it's a great place for meetups, making new friends and hosting large events.

Unfortunately, all that convenience also comes at a cost. Like any big American city, Honolulu has its fair share of traffic and you may find parking a bit difficult in the dense urban area.

You'll have to pay for street parking, and your hotel may even charge you an additional fee for parking. These parking costs range from \$10 - \$60 per day.

### **Autonomous Vehicle opportunities in Hawaii**

In terms of public space, Waikiki does not have a lot of it to offer. Future efforts are currently being made to enhance the sidewalk spaces, but this is simply a Band-Aid solution that is covering up a much larger problem. Efforts are being done to promote Waikiki as a safer neighborhood and Kalakaua as a safer street. But I do not believe these attempts will be successful as humans are known to make mistakes and driven by money. Hawaii needs a different perspective on a complete street and I believe that we need to look at implementing Autonomous Vehicles to help us achieve these goals of providing safer and healthy streets.

## 1. Revenue for business



*Figure 23: Waikiki Aerial View*

*Source: Architectural Digest*

Waikiki is the anchor for the State’s visitor industry, which is in turn the major driving force in Hawaii’s economy. Hawaii’s economy depends significantly on conditions in the U.S. economy and key international economies, especially Japan. According to the November 2019 *Blue Chip Economic Consensus Forecasts*, U.S. real GDP is expected to increase by 2.3 percent in 2019, 0.1 of a percentage points below the growth rate projected in the August 2019 forecast. For 2020 the consensus forecast predicts an overall 1.8 percent growth in U.S. real GDP.

Visitor arrivals increased 5.7 percent in 2019, 2.2 percentage points above the previous forecast. The forecast for visitor days in 2019 also increased 2.2 percentage points to 3.2 percent. The 2019 forecast for visitor expenditure growth was revised upward to 0.9 percent, from a

negative 0.2 percent growth projected in the previous forecast. For 2020, the growth rate of visitor arrivals, visitor days, and visitor expenditures are now expected to be 2.5 percent, 2.0 percent, and 2.5 percent, respectively.<sup>37</sup>

## **2. Inclusivity: Net Positive for all populations (both resident and tourist)**

Visitors average to about 10.5 million in 2019 to the Hawaiian Islands and spent \$17.75 billion in 2019, an increase of 1.4 percent compared to 2018, according to preliminary year-end statistics released today by the Hawaii Tourism Authority. Visitor spending includes lodging, interisland airfare, shopping, food, car rental and other expenses while in Hawaii.

Often the case with visitors is that they rent cars to travel around the island. With many distractions that Waikiki has to offer, a few seconds of distracted driving can lead to major collisions for newcomers who are familiarizing with the city. These situations also relate to the residents of Waikiki who commute daily for work and pleasure.

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<sup>37</sup> "D. Tourism," Department of Business, Economic Development, and Tourism, Hawaii.gov, accessed December 9, 2019, <https://dbedt.hawaii.gov/economic/qser/tourism/>.

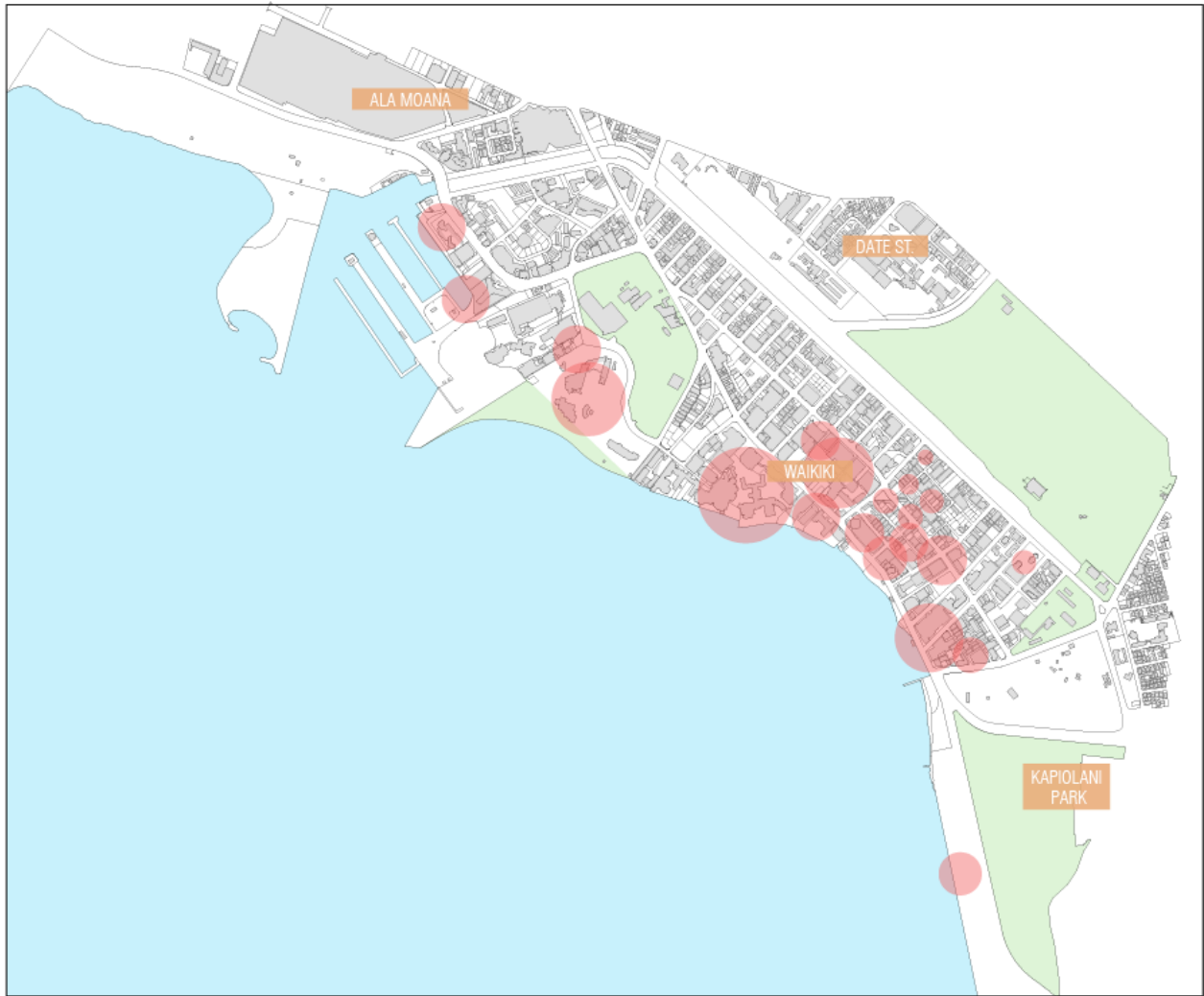


Figure 24: Popular Tourist Visited Areas

Source: Author

When proposing the idea of AVs, it is important to see the positive outcomes it can have on the tourists as well as the locals. Waikiki is arguable the densest area in the island of Oahu and it is the location for several activities that require many lane closures throughout the day- for several days. These lane closures create an inconvenience for tourists and residents alike. Therefore, it is important to consider the benefits that will be felt by all people that occupy Waikiki on a daily basis.

## Introduction to the site

Looking at Waikiki today, it's hard to imagine that less than 150 years ago this tourist mecca was almost entirely wetlands filled with fishponds and *lo'i kalo* (taro fields). Old Waikiki (Waikiki means "Spouting water") had abundant resources for agriculture and aquaculture to sustain the population of the area. Throughout the 1800's, Waikiki remained both a place of productive agriculture for commoners and a place of relaxation for the Royal family.

Also, during the 1800's there came an influx of foreigners who settled in Waikiki and the entire island chain, these included the merchants, missionaries, soldiers, and later plantation and agriculture workers. As capitalism inexorably began to replace the somewhat fragile but self-sufficient system of barter, Hawaiians left the land and flocked to the town to get jobs. During the next half century, the whaling trade established the importance of the harbor, allowing the once sleepy outpost to become a financial hub and in 1850 officially a city. The island featured businesses ranging from trading houses and ship chandleries to saloons, her few streets were dusty or muddy (depending on the seasons). Transportation was still a problem, and as Honolulu grew, the city did not seem to get much bigger, just more crowded.

Eventually, the taro patches maintained by the Hawaiians were joined in the late 19<sup>th</sup> century by rice paddies cultivated by immigrants from east Asia. In the early 1920's, citing concerns over mosquitoes and a possible health hazard, the territorial government decided to drain the agricultural areas and wetlands fed by three principal streams from surrounding valleys of Makiki, Palolo, and Manoa, to create the Waikiki Drainage Canal, which later became known as Ala Wai Canal. (Ala Wai means 'fresh waterway' in Hawaiian.) This huge public works project was a boon



to an emerging dredging, construction, and real estate industry. The construction of the Ala Wai was completed in 1928 and set the stage for the rapid urbanization of the area, and the building of residential areas and hotels.<sup>38</sup>

Ancient Polynesians considered the vast Pacific a highway rather than a barrier to the rest of the world. With the urbanization of the city came the introduction of the streetcar in Honolulu. The evolution from horse powered carriages in the late 1800's contributed to the success of electric cable powered tramways and trolleys. The system was organized early in 1898, and despite some delays arising from a plethora of red tape in local official quarters, the cars commenced running on November 7<sup>th</sup>, 1900.

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<sup>38</sup> "The Hidden History of Waikiki (Part 1): From 'Spouting Water' to the Island's Breadbasket," Hawaii Real Estate, accessed November 20, 2019, <https://www.hawaiilife.com/blog/hidden-history-of-waikiki-part-1/>.

# Site Analysis

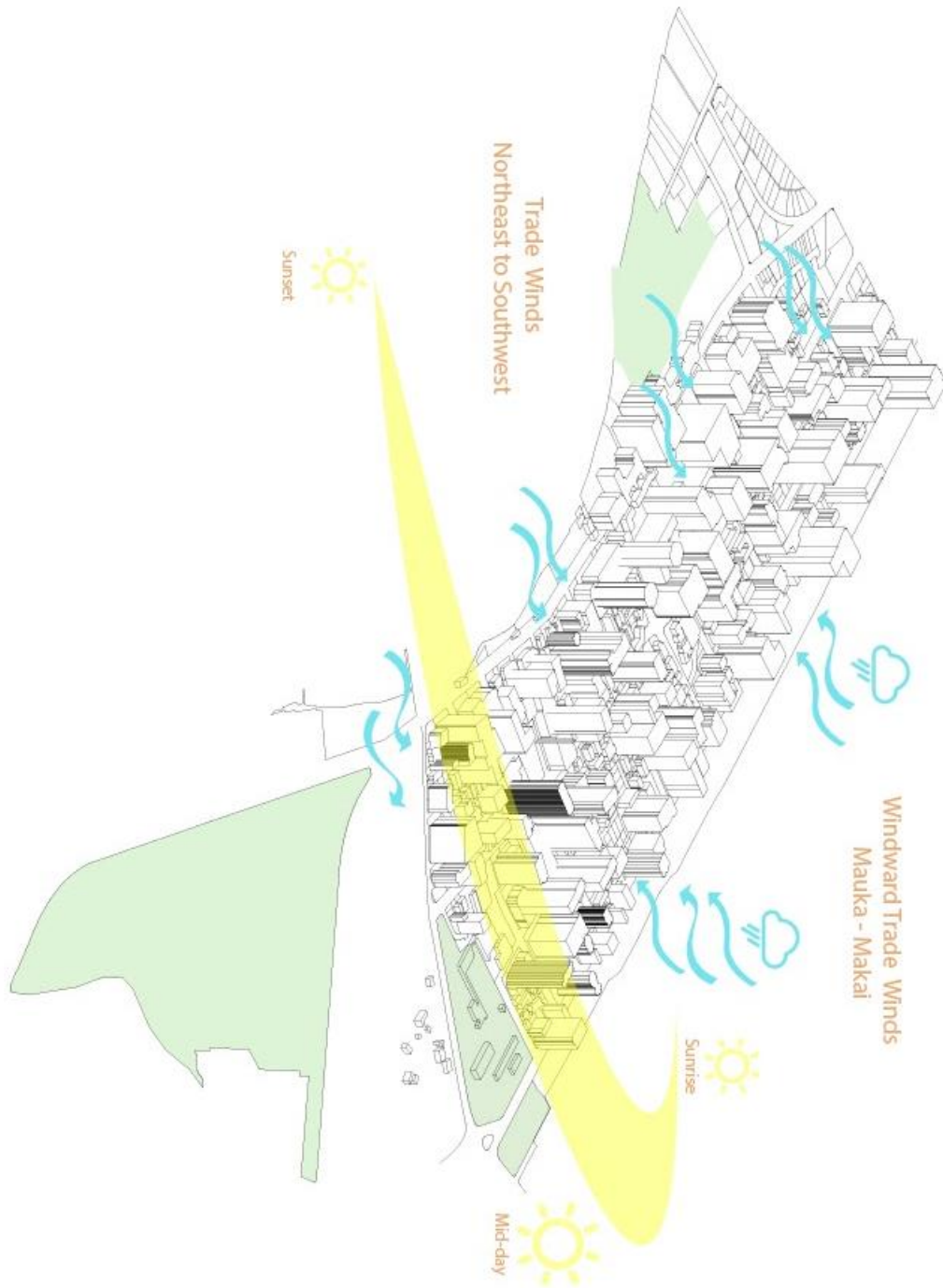


Figure 25: Waikiki Site Analysis

Source: Author

Known for its world-famous beaches, luxury resorts and exotic cuisines, Waikiki for many decades has been one of the top tourists traveled destinations in the world. To analyze the site, we must not only look at the environmental conditions but also the physical conditions.

The islands have an incredible collection of a diverse micro-climates, each with its own unique weather, plants and animals. Historically, Waikiki consisted of wetlands and farmlands that provided for its own people. But with all the development it has faced over several decades, we can now see Waikiki as a destination that is densely populated with tall concrete structures and very little greenery.

With only minor changes in temperature throughout the year. There is really only 2 seasons for the area of Waikiki: summer (called Kau in Hawaiian) from May to October and winter (Ho'oilō) from November to April. The average daytime summer temperature at sea level is 85° F. (29.4 C) while the average daytime winter temperature is 78° (25.6° C). Temperatures at night are approximately 10° F. lower.

The year-round sunny weather conditions and trade winds that keep our islands cool, make Waikiki a unique destination to experiment the study of AVs and how it can improve city planning.

## Impact of sea level rise and other natural disasters

### Sea Level Rise : Honolulu Sea Level Rise Inundation Risk

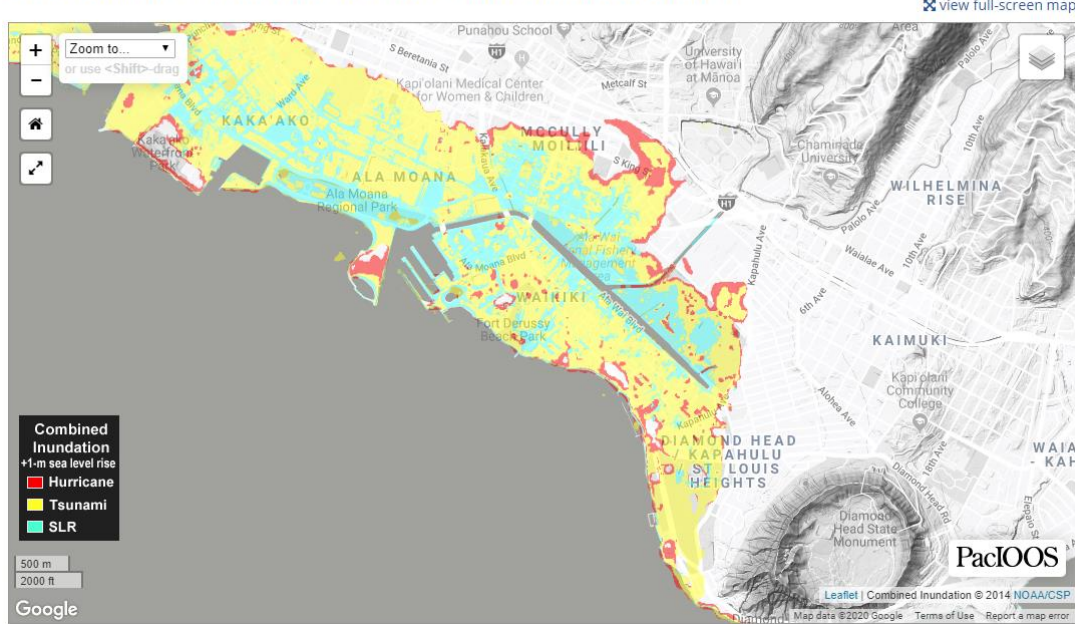


Figure 26: Sea Level Rise Impacts on Waikiki

Source: <https://www.pacioos.hawaii.edu>

Impact of sea level rise pose a major concern for developing cities and especially the ones like Honolulu where the economy is highly dependent on its coastline. Hawaii's economy has a large portion that is dependent on the tourism industry, the beautiful beaches are the biggest tourist attractions, among other areas that promote outdoor living. If the beaches start to disappear because of the rise of sea level, Hawaii's economy could see major impacts that will cause panic among majority of its community that rely on the tourism industry to sustain their jobs.

Sea levels are rising. Tides are inching higher. High-tide floods are becoming more frequent and reaching farther inland. And communities can soon face chronic, disruptive flooding that directly affects people's lives. The beaches of Waikiki have been steadily eroding for years causing major inconveniences to the retail stores and pedestrians alike. Walking down Kalakaua avenue,

lined with hotels, surf shops and convenience stores, it's hard to believe that this area was once a wetland flourishing with taro that fed much of Honolulu.

Today it is a tourist hotspot and the threat of rising sea levels can create inconveniences for Kalakaua Avenue, the busiest street in Waikiki. Home to some of the largest name brand retail stores and accessories, Kalakaua Avenue acts as a major artery that keeps the economy oh Hawaii healthy.

Ask the workers at any surfboard rental company that have been working at the beach for years they will tell you that the king tides are no joke. King tides are known to Hawaiians for being the highest tides of the year that usually occur during the summer and winter months. These tides can get so large that some workers mentioned they would be forced to close their stands for several hours or even days.

## Movement Patterns

Look around you. What do you see from your window? The reality is that architecture is an active influencer in our lives. There is a mutual relationship between a person affecting and being affected by external forces in their immediate surroundings. It isn't an overstatement to say that architecture affects all aspects of our being; how we think, feel, act, and even our health.



*Figure 27: Popular Tourist Clusters in Waikiki*

*Source: Author*

## Waikīkī

Waikiki proved to be the ideal location for this research because it is located less than a mile from Ala Moana Center and is considered the driving force in Hawaii's economy. As the surrounding neighborhoods of Waikiki have developed over the years, Waikiki covers approximately one square mile of shoreline and is a densely built environment made up of high-rise hotel towers, apartment buildings, restaurants, shopping centers, and businesses catered toward Oahu's visitors and residents alike. Throughout history, Waikiki has proven to be a location that is heavily populated and visited by tourists and residents alike. With Hawaii's economy heavily dependent on its tourism industry, research shows that these numbers will continue to rise.

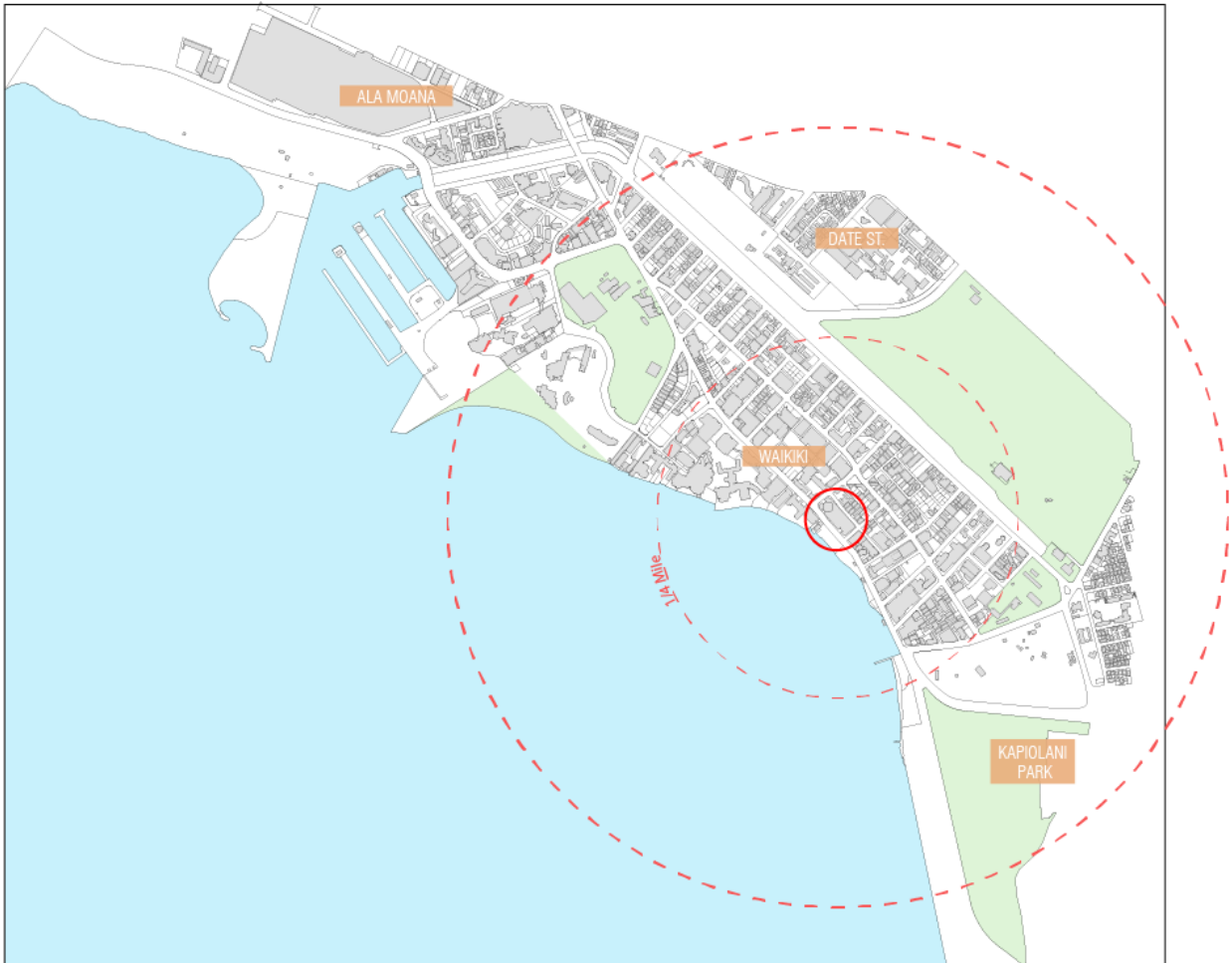


Figure 28: Site Selection

Source: Author

Waikiki presents itself as a unique location to conduct this thesis research due to its rich cultural history, high density, and rapid urban development over the past 100 years. One of the most important characteristics of the chosen site is its proximity to other dense neighborhoods like Ala Moana, Kapiolani and Kapahulu. As a state that is heavily dependent on its tourism industry, Waikiki is often seen as the backbone to Hawaii's economy and stability. It is a place that plays a significant role in Hawaiian history and is home to several sacred sites.



## Justification of Site

Roadway	Volume
Kapi'olani Boulevard	36,998
Ala Wai Boulevard	51,548
Ala Moana Blvd By Shopping Center	45,693
Kalakaua Ave. at Kapi'olani Blvd.	35,946

Figure 29: Daily Vehicular Volume

Source: Rail EIS1

Private Automobiles: are the most used mode of transportation by local residents on Oahu and between Ala Moana and Waikiki. Based on the overall projections of automobile trips made for the entire island, private automobile use is expected to increase. Automobiles traveling between these destinations operate on the same roadways as bus routes and bicycle lanes. The most heavily used roads include Kapiolani Boulevard, Ala Moana Boulevard, McCully Street, Kalakaua Avenue, Kuhio Avenue, and Ala Wai Boulevard, for both eastbound and westbound directions.

Traffic data shows that these roadways experience high vehicular volumes, with the highest along Ala Moana Boulevard, Ala Wai Boulevard, and Kapahulu Avenue. While these numbers reflect the total amount of vehicles, a large majority is attributed to individual automobiles. Most trips are made by residents traveling to and from work as well as tourists traveling between amenities. These high volumes create traffic choke points and automobile

queues at several intersections; the worst being at McCully and Kalakaua Avenue, and Ala Moana Boulevard and Kalakaua Avenue - two major access points between these destinations.<sup>39</sup>

#### **4.1 Nature-Health Relationships**

An ever-increasing percentage of humanity spends all of its time (about 90 percent or more) inhabiting environments that have been conceived and constructed by human hands, and unlike in the premodern world, by hands that in most cases are not their own.<sup>40</sup>

What if all neighborhoods were vibrant and socially inviting? What if they all had convenient access to reliable, affordable, comfortable public transportation? What if everyone's house or apartment was within walking distance of a well-designed and maintained park or gathering space? The decisions people make about the environments currently under construction, what and how we build and where, will affect the lives of billions of people for generations.

#### **4.2 Walking Toward Well-Being**

The typical street is a mess, with everything and nothing everywhere. I thought of splitting the street into a different form of mobility. Thinking of ways to create a faster transportation. Then creating a pedestrian friendly promenade. Then the final type would be a linear street with park areas for people and slower moving transportation.

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<sup>39</sup> City and County of Honolulu, Honolulu High-Capacity Transit Corridor Project, Addendum 01 To The Transportation Technical Report (Honolulu: City and County of Honolulu, 2009), Accessed November 4, 2019.

<sup>40</sup> Sarah Williams Goldhagen, *Welcome to Your World: How the Built Environment Shapes Our Lives* (Harper, 2017).

If we look at the transportation method of an average working resident in Hawaii, we will see commuting patterns differ by social and demographic characteristics respectively. These are some of the concerns to be addressed for effective and successful transportation policy making and planning.

“According to the 2009-2013 American Community Survey data, the vast majority of workers in Hawaii (80.9 %) used cars to get to work during the period. 66.6 percent drove alone, and 14.4 percent carpooled, mostly 2-person.”<sup>41</sup>

The same article shows that the second most popular mode of commuting in Hawaii was using public transportation. Although this mode was a much smaller percentage, it is proven that people in Hawaii are still relying on public transportation as a major means of commuting. As one of the countries most urbanized and populated states, the percentage of workers using cars to commute was much lower than that of other states at (86.1%). Also, the interesting fact is that research found the percentages of workers using public transportation, riding a bicycle, or walking were all higher than the U.S. averages for the same period.

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<sup>41</sup> Research and Economic Analysis Division, Commuting Patterns (Honolulu: Department of Business, Economic Development, and Tourism, 2015) 1-8, [http://files.hawaii.gov/dbedt/economic/data\\_reports/briefs/Commuting\\_Patterns\\_Apr2015.pdf](http://files.hawaii.gov/dbedt/economic/data_reports/briefs/Commuting_Patterns_Apr2015.pdf).

Enhancing and expanding pedestrian access to transit and improving transit facilities are complementary to promoting pedestrian travel. Every transit trip begins and ends with pedestrian travel. A good pedestrian facility makes the trip to transit stations and stops more convenient, safe, and enjoyable. If people do not feel safe or comfortable walking to transit stops, they are likely to choose other modes of transportation, such as a car. Providing a multi-modal transportation system can bring many benefits:<sup>42</sup>

- Decreased household transportation costs.
- Reduced environmental impacts (such as less air pollution and lower greenhouse gas emissions).
- Increased public health (people are likely to walk more to and from transit).
- Improved community livability.
- Decreased dependency on foreign oil resources.
- Reduced overall infrastructure expenditures.

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<sup>42</sup> Hawaii Department of Transportation, *Hawaii Statewide Freight Plan* (Hawaii: Highways Division, 2018) [https://hidot.hawaii.gov/highways/files/2019/03/HDOT\\_FreightPlan\\_FINAL.pdf](https://hidot.hawaii.gov/highways/files/2019/03/HDOT_FreightPlan_FINAL.pdf).

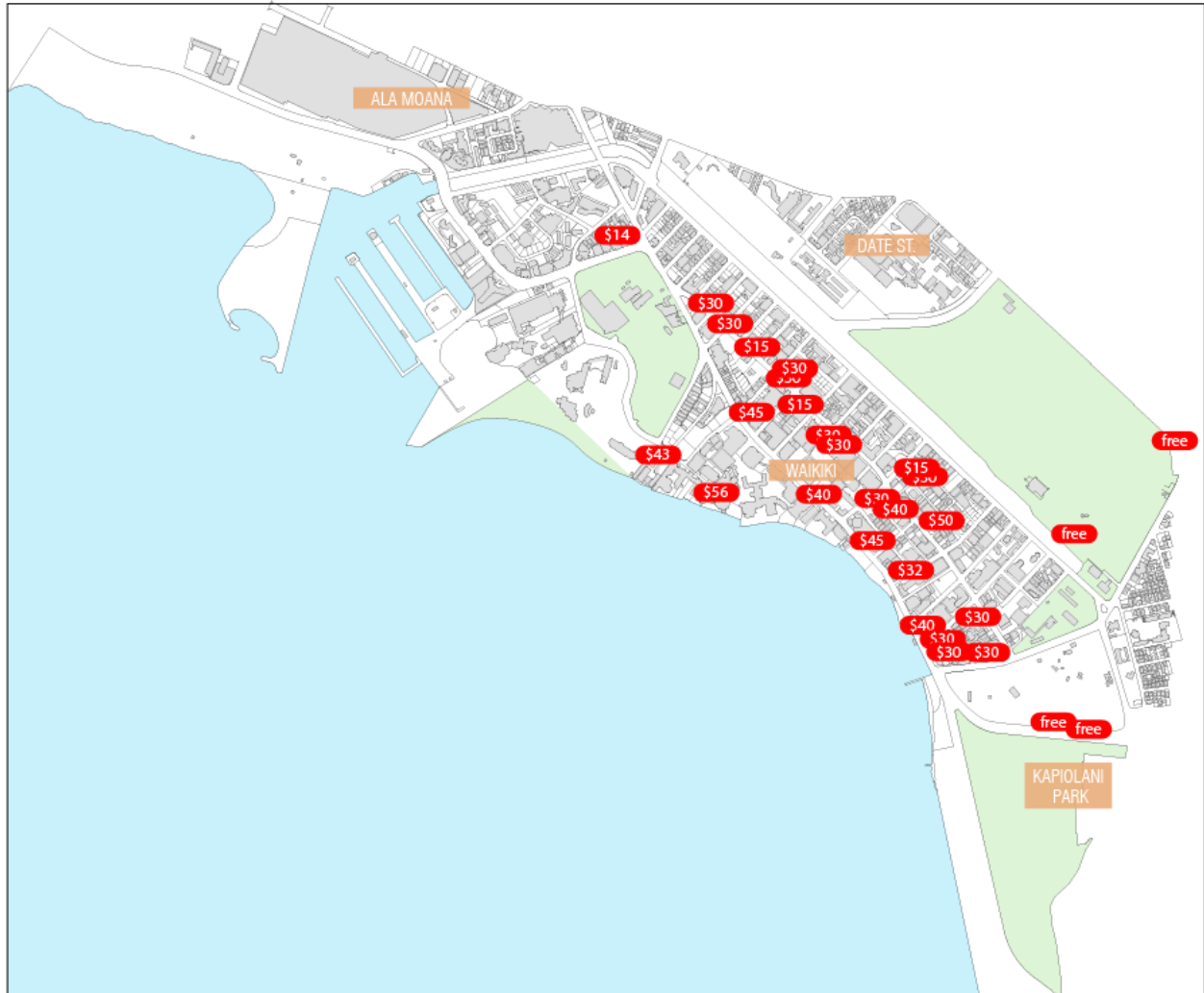


Figure 30: Waikiki Parking Analysis

Source: Author

The success of good transit as a mode of transportation is highly dependent upon good pedestrian access. People with disabilities tend to rely on transit as their primary transportation mode, making these locations easily accessible is a key feature in providing an easier lifestyle for the community.

A variety of public transit services are currently provided in the islands, and some are in the planning stages. The City and County of Honolulu operates TheBus, which provides services

throughout the island. A variety of route choices, timetables, and vehicle types (including hybrid buses) are provided. More than 230,000 people use the service on a typical weekday.<sup>43</sup>

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<sup>43</sup> Hawaii Department of Transportation, Pedestrian Access to Transit (Hawaii: Highways Division, 2013)  
[https://hidot.hawaii.gov/highways/files/2013/07/Pedest-Tbox-Toolbox\\_6-Pedestrian-Access-to-Transit.pdf](https://hidot.hawaii.gov/highways/files/2013/07/Pedest-Tbox-Toolbox_6-Pedestrian-Access-to-Transit.pdf).

## TheBus



*Figure 31: TheBus Public Transport*

*Source: CivilBeat.org*

It is no secret that Honolulu's traffic is terrible. So why aren't more people riding the bus? When it comes to ridership, TheBus is heading in the wrong direction. Since the beginning of 2015 there has been a steady decline in the number of riders in Honolulu's public transportation systems. In 2019, TheBus logged its second-lowest ridership of the past quarter century, at 62.3

million rides. The only time ridership was lower during that era would be fiscal year 2004 when Honolulu had a 49-day bus workers strike.<sup>44</sup>

The years of rail construction have not helped either. Nor has Oahu's generally awful congestion which translates to bus drivers often having to sit through the same rush hour traffic as the rest of us. This in turn hurts the systems speed, efficiency and reliability.

It is an alarming fact that residents around our island are struggling to get around as the roads grow even more packed with cars. Given that we are living in an island with a limited amount of space, there is an urgent need to cut down on car trips that carry just one person. A public transportation system such as TheBus can carry dozens of people. Unfortunately, we have lost over 15 million annual bus compared to a decade ago.

A new form of transportation system that I am proposing may be the bridge that connects public transportation with private transportation. The evolution of transportation can be a method where humans are able to conveniently hop into an autonomous vehicle pod - along with other riders and arrive at their destination without any congestion or delays.

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<sup>44</sup> Marcel Honore, "Honolulu Traffic Is Terrible. So Why Aren't More People Riding TheBus?" Honolulu Civil Beat, accessed December 12, 2019, <https://www.civilbeat.org/2019/11/honolulu-traffic-is-terrible-so-why-arent-more-people-riding-thebus/>.



## The Rail



*Figure 32: Future Rail Transportation System*

*Source: Honolulu Star Advertiser*

The Honolulu Rail Transit system will serve 21 stations between East Kapolei and Ala Moana Center. Over 60% of Oahu's population currently lives within this transit corridor, and the population in the corridor is projected to continue to grow faster than the rest of Oahu. Within this corridor it is estimated that there will be over 40% of jobs.

Rail transit provides an opportunity to help reduce some of the congestion found in highly populated areas like Waikiki and Ala Moana. By taking some of the cars off the road, there is a greater possibility of improving travel reliability, shortening travel times, and increasing transportation options.

Though the rail project has the potential to fundamentally reshape Oahu's future development, the project has faced major criticism and push back from most of the local community. The project has faced several difficulties that has left the community unsure if the potential benefits outweigh the negatives. Also, one of the biggest challenges the rail project faces, which has also contributed to the birth of this research, is that the construction of the rail has been limited to only the Ala Moana district. This leaves some of Honolulu's major urban nodes like Waikiki, University of Hawaii at Manoa, and Kaimuki disconnected.

## Chapter 5: Design

The design engages multiple scales of interactions that take place along Kalakaua Avenue. The proposed pedestrian oriented infrastructure will allow urban dwellers the opportunity to adventure further out in the busiest parts of Honolulu and give opportunity for social interaction among neighbors and visitors alike. The redefined streetscape allows for a more comfortable walking environment with a tree canopy that provides shade and rest areas. The future of autonomous vehicles gives the opportunity for a narrower road dimension that is designated for vehicular transportation. With tourism fluctuating in a place like Waikiki that relies heavily on its tourism industry, it is crucial to design and develop a new strategy that brings creativity and functionality to the affected area.

### Design Objective

The disconnection with the natural environment, experiences and interactions have dehumanized dwelling and life outside of buildings and homes. In the urban environment, cities driven by technological advancements, primarily the automobile, have led to a decline in physical, mental and social human wellbeing. Activating the street will refine the streetscape to reintroduce natural environmental features that will create a better living experience.

The improved urban street provides increased opportunities for pedestrian mobility in the environment while promoting the benefits of active outdoor spaces. The design for a multi modal transportation system allows for a smoother flow of vehicular transportation and pedestrian movement. Creating an attraction space to funnel tourists into the city center is a major benefit to the city's economy and future growth. The objective is to create a positive experience for the

residents and tourists living within the Waikiki district. An experience that is unforgettable, calming, and rejuvenating. A site that has a healthy growth of greenery, outdoor activity spaces and pedestrian friendly streets can be a major selling point in inviting tourists to visit our islands.

- Reclaiming the streetscape as a pedestrian realm to promote walkability.
- Establish interconnectivity and a network of multi-modal transportation in the urban fabric scaled toward human/human interaction.
- Improve health and wellbeing by providing naturalistic features
- The greatest benefit will be received through the most naturalistic experience, walking.

Transportation is also dependent on accessibility. People in Honolulu tend to rely on transit as their primary transportation mode, all transit facilities and the pedestrian routes that lead to them must be accessible to all people including the disabled.

## Design Project (Macros)



*Figure 33: Kalakaua Street Perspective*

*Source: Author*

On a larger design scale, I took on the challenge of looking at Waikiki as a whole. Waikiki faces several issues regarding transportation and the quality of life. The bustling streets of Waikiki are notorious for its large events that shut down major streets, traffic and lack of social gathering spaces. Waikiki is known for its activities and amenities within easy walking distance. Besides the white sandy beaches, there are also many different restaurants, shopping areas, amusements, parks, a zoo, an aquarium and various cultural dinner activities in the neighborhood. But all these activities seem to lack that bridge that connects everyone together. These events often occur in isolated places that tend to separate people.

## The Components

Urban surfaces have three components, the two basic types – softscapes and hardscape, as well as the nodes between them.

### **Landscape: Softscapes**

#### **Possibility of greenspaces due to less need for parking**

Increasing or providing a tree canopy will serve as a huge benefit to the local businesses as well as improve the quality of life. Studies show that people are more likely to feel happy, safe and healthy if they maintain the green areas and natural spaces in their cities. Creating a new vision for Waikiki where there is a large number of greeneries, we are able to reduce the impacts of carbon emissions released by automobiles. A tree canopy provides much needed shading and acts as a sound buffer and filter in Kalakaua Avenue that is currently lacking these elements. Plants are proven to reduce pollution and act as a buffer for noise transmission from the heavy flow of vehicles.

## Hardscapes



*Figure 34: Kalakaua Street Section Render*

*Source: Author*

The spaces are strictly dedicated for autonomous vehicles, shuttles, morning commercial vehicles and bicycle paths to connect people to workplaces, important nodes, and different neighborhoods in a timely manner. Two lanes at a width of 12 feet are provided for these AVs to travel as a generous speed of about 20mph. The speed of these AVs can be adjusted accordingly to their surrounding context. For example, in a less dense urban area, the vessel may travel at a slightly higher speed due to the smaller population of pedestrians.

### **Shared street surfaces for all modes of transport**

A shared street may be a complete street due to the efficient use of sharing a street with other users. By reducing the width of the average street, we can provide other users to travel safely to their destination at a much higher efficiency. Hardscape can be placed in the center of the shared street, be pushed to one side, or be split up in two. For this study I propose to place

this hardscape towards the middle of Kalakaua Avenue. Proposing a location towards the middle allows us to widen the pedestrian's spaces on both the Mauka side as well as the makai side beach access area.

## **Nodes**

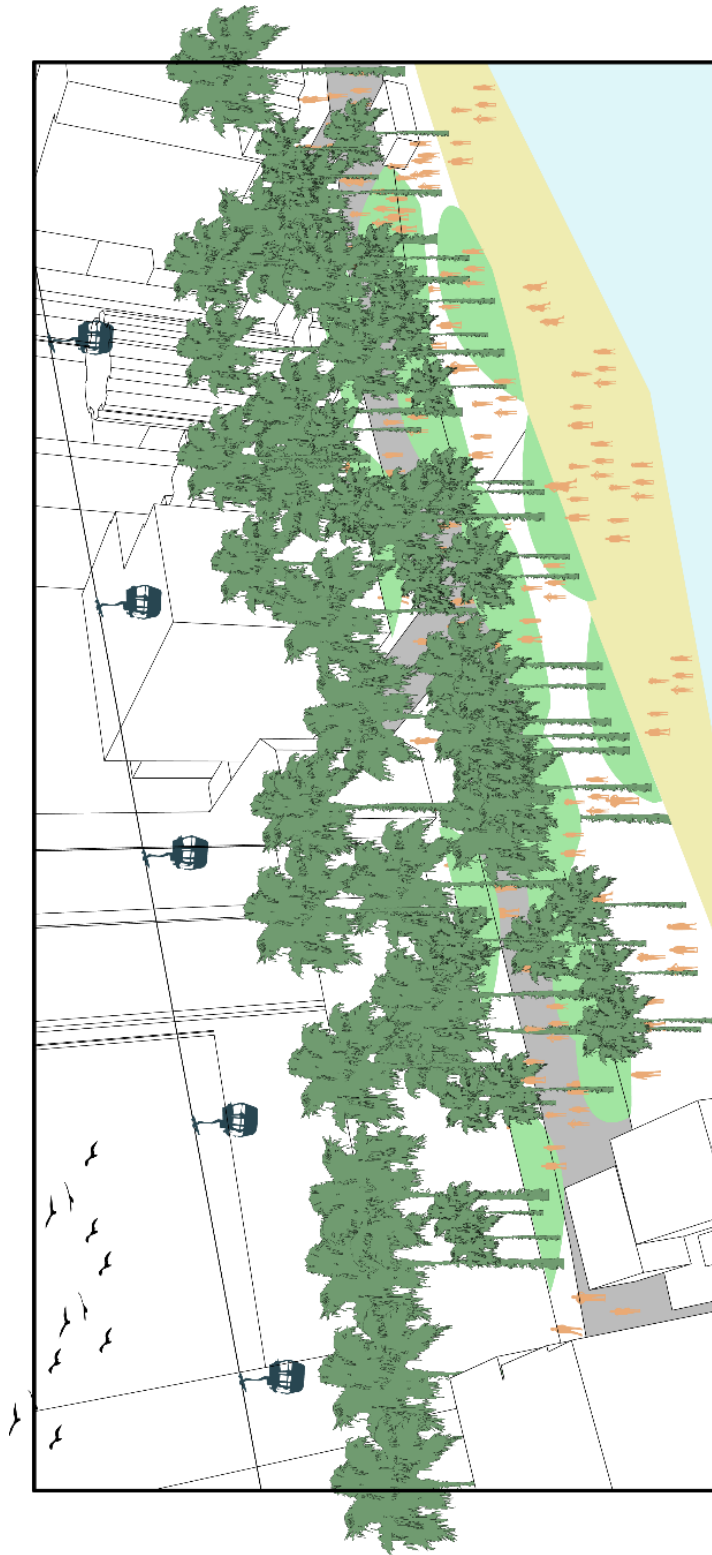
The importance of nodes can be defined by the wellbeing of a community, due to the connectivity and hub of activity and opportunity it brings. There are many categories that factor into the success of nodes. They factor in access to public transport, jobs, a variety of age demographics and activities. Nodes tend to tick most of these boxes.

### **Importance of nodes as transition points between different modes of transportation**

Featured along the pedestrian path, the nodes are spaces that are unprogrammed and are defined by the fluid nature of users and uses. The nodes also function as rest areas that are offset from the main path, providing space for interaction as well as views to the city. Its where there's activity and the infrastructure to support it, such as residential, commercial, and retail buildings, usually alongside public transportation options.

The connections to the multiple modes of transportation services make these nodes a major part of the success of urban cities. It is great for connectivity to popular tourism destinations as well as residential housing without the prospect of social isolation. This leads to a city that encourages densification around these transportation hubs.

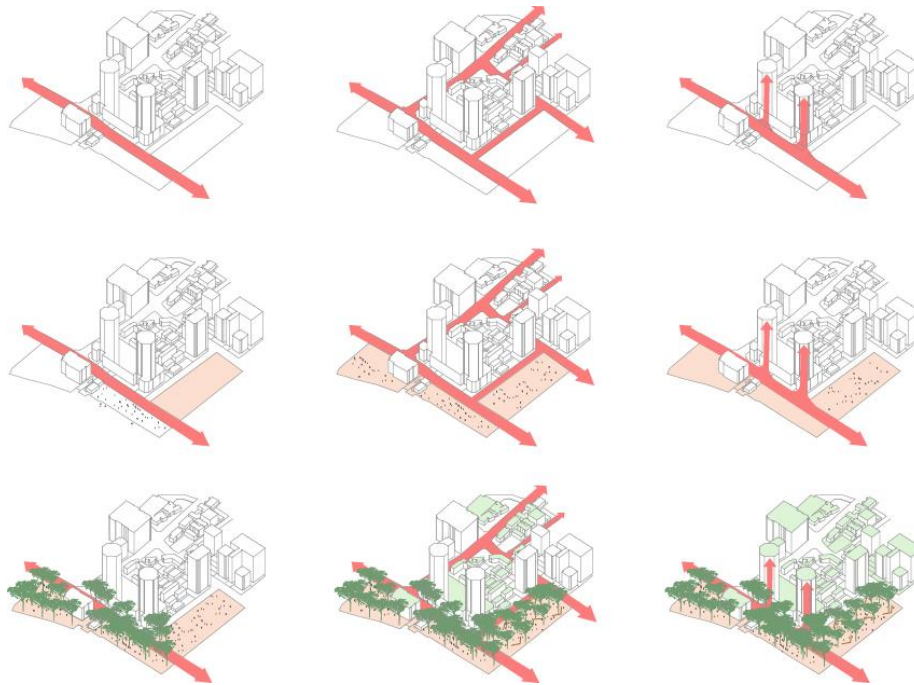




*Figure 35: Building the Tree Canopy*

*Source: Author*

## Connective Network



*Figure 36: Different Phases of Experiences*

*Source: Author*

As a young architecture student, I've always wanted to be a leader in designing spaces that connect people. The thought of autonomous vehicles creating a positive impact on cities gave me the opportunity to further investigate my passion for connecting people. Architecture is more than just buildings that are occupied and experienced by people. In Hawaii, communities are comprised of a diverse mix of people, functions, and uses. The built form that we give to our communities helps to foster meaningful connections and build a unique culture. Then there are the single destination buildings like Ala Moana mall that serves as a single function. When the mall is open, it becomes a popular destination for locals and tourists alike, however when the mall is closed, there is no life and no purpose to the destination. In recent times there are several apartment

buildings that have been built and surround Ala Moana Mall, but after a certain time, the mall which takes up a large portion of the area is left empty.

The saying “all roads lead to Rome” has been used since the Middle Ages and refers to the fact that the Roman Empire’s roadways radiated outwards from its capital. But does that statement still apply today, now that we have so many more roads leading to so many more places?

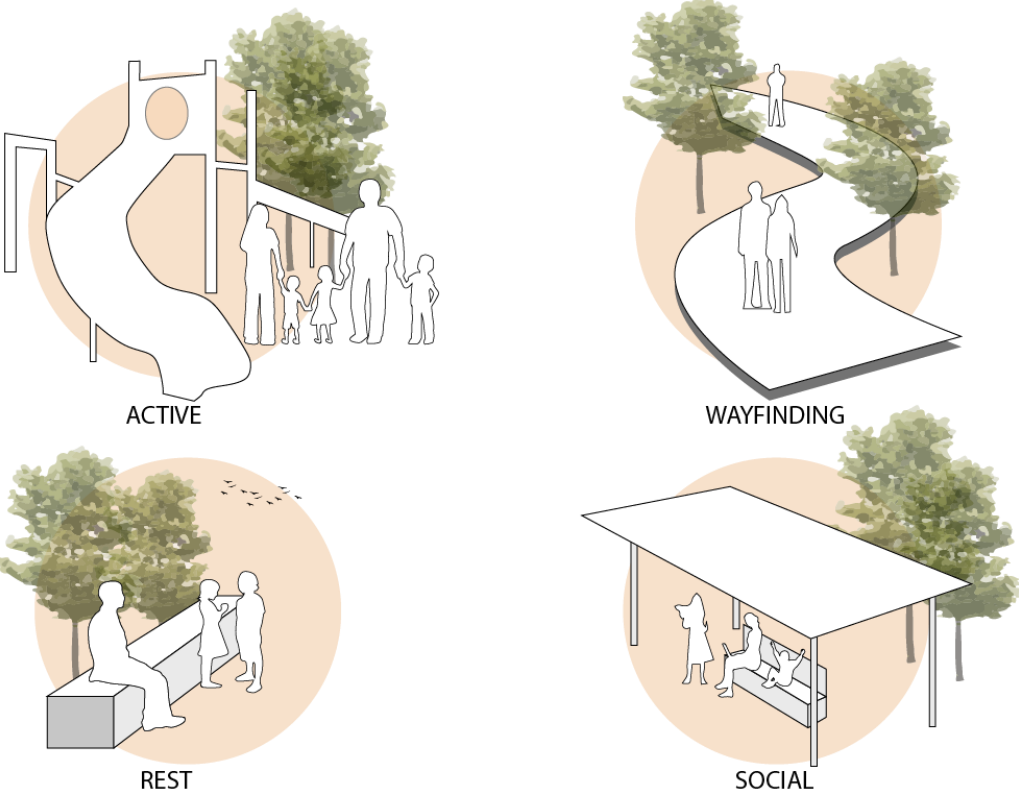


Figure 37: Creating Outdoor Opportunities

Source: Author

## Scale 1: Waikiki (Mauka - Makai)



*Figure 38: Longitudinal Section*

*Source: Author*

Although self-driving technology is still mostly in development and undergoing pilot phases throughout the industry, autonomous vehicles have already been deployed in a handful of locations around the world in a limited fashion. In most cases, AV deployments are being used for public transportation rather than private use and restricted to a pre-defined route.

For the case of this research I want to examine the idea of a multi scale process that involves several steps to achieving the final goal of a multi modal transportation system. At this scale it is a much larger site and it is focused on the revitalization of the Waikiki neighborhood. By promoting trees and green infrastructure, we are able to begin the initial stages that will lead to further development of the area. Planting these trees will give us the foundation we need to implement a shared road with autonomous modes of transportation.

## Flexibility to move between transportation modes

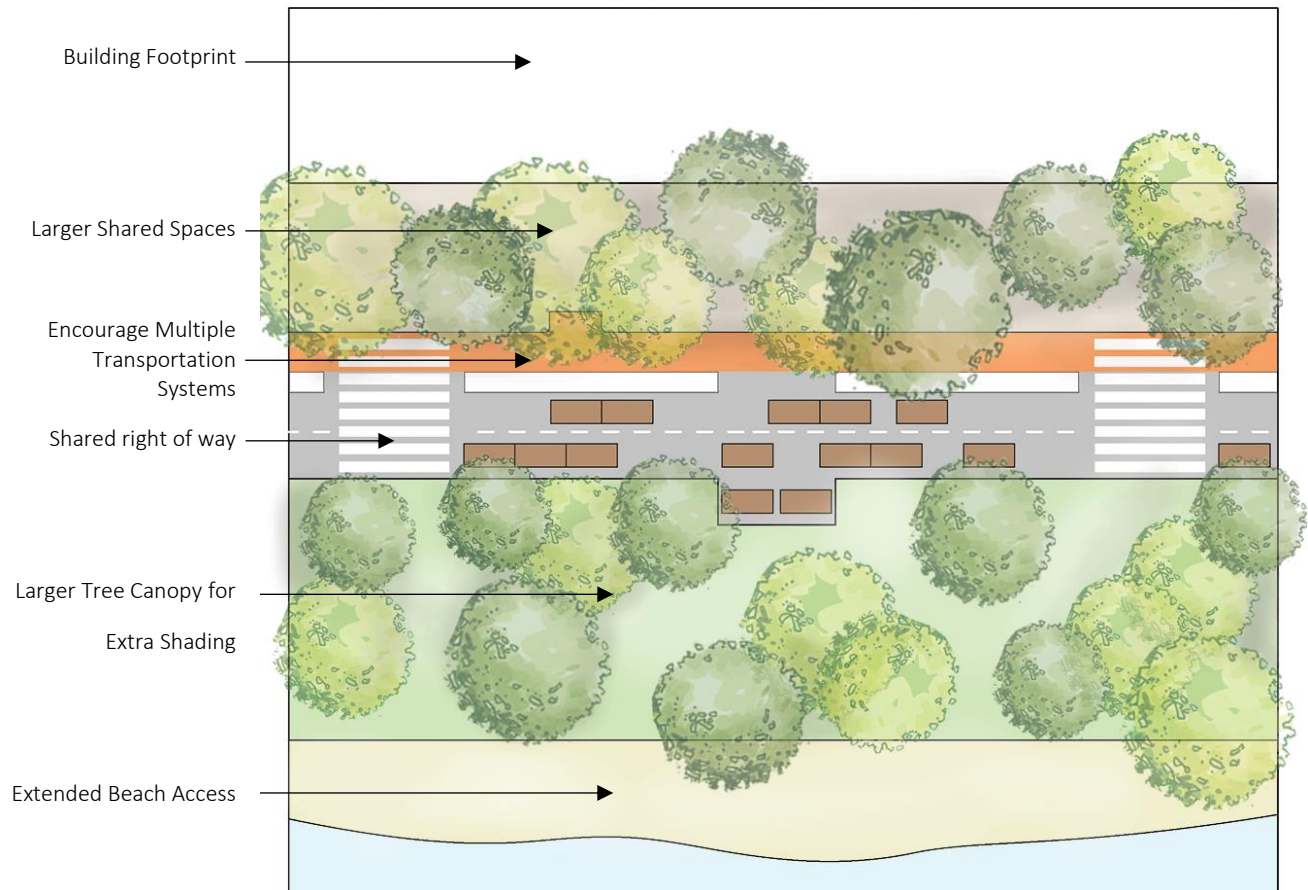


Figure 39: Site Plan

Source: Author

Historically, cities have been shaped by their urban mobility systems. Most cities currently are formed along the paths of the gas-powered automobile. A very few cities such as Amsterdam and Venice, were planned around canals and boats that focused on moving people and not the automobile. An opportunity afforded by autonomous vehicles is that, because movement can be tracked, anticipated and coordinated, streets can be programmed to change by number and direction of lanes. In addition, since autonomous vehicles travel more predictably and do not emit

exhaust, they are safer to pedestrians, allowing for a more flexible use of roadways, narrower roads and for streets without curbside parking.

One of the fundamental roles of transportation within an urban environment is to shape the social, physical, and economic landscape by providing spatial movement for people to move fluidly throughout the city. At this scale it is focused more into the project's location, beginning with the conversion of Kalakaua Avenue to a pedestrian oriented street.

## Scale 2: Automated Site Section (Zoomed In)

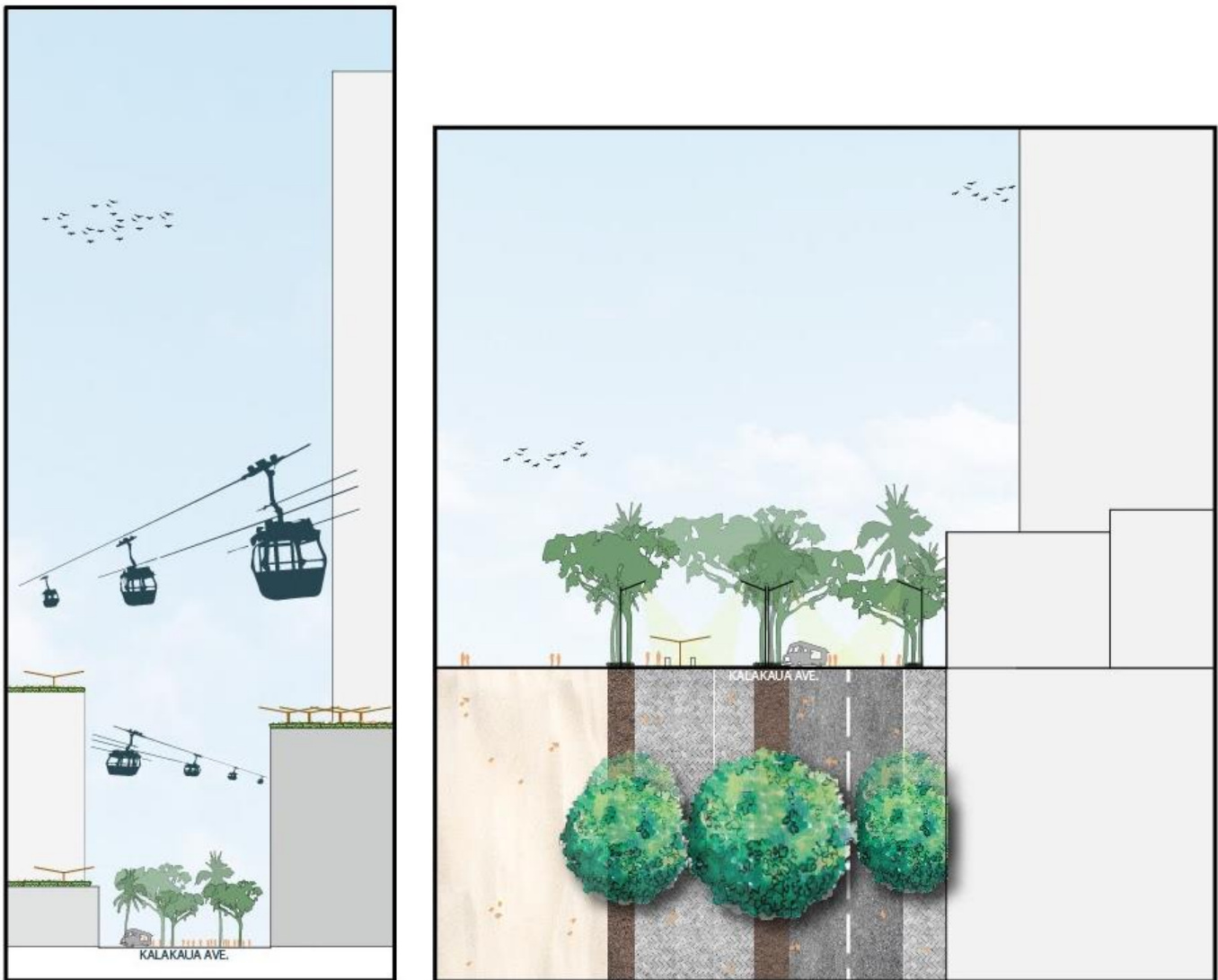


Figure 40: The Proposed Autonomous Street, Kalakaua Avenue

Source: Author

One of the fundamental roles of transportation within an urban environment is to shape the social, physical, and economic landscape by providing spatial movement for people to move fluidly throughout the city. At this scale it is focused more into the project's location, beginning with the conversion of Kalakaua Avenue to a pedestrian oriented street.

To achieve this goal, different experiments have been done across the world. One of them is the Shared Space, which intends to integrate traffic infrastructure and the public realm by minimizing the segregation between modes of travel to let pedestrians, cyclists, cars use street more efficiently at different times. At all levels of experience, the design promotes formal and informal interactions between tourists and residents alike. These new implementations create opportunities for large gatherings and events that require protection from harsh natural conditions like the sun as well as automobiles that would usually take away large portions of the street.

The two scales of experience will be from ground level where it is a shared space for automobiles, bicycles and pedestrians. To an elevated level that provides a scenic experience where tourists and residents are able commute from one popular destination to another. At this scale, the proposal is to maximize street space for pedestrians and provide specific times for people driven vehicles to commute through Waikiki. At this stage we are slowly introducing the concept of autonomy, by allowing human driven vehicles to coexist with pedestrians and other modes of transport.

As the area develops into a world-class innovative district to attract people to live, work and play, some challenges will be faced in convincing the people to accept this new reality. A multi scale project proposal allows us to prepare ourselves for future complications that are bound to happen. The future of autonomous vehicles is not a matter of IF but WHEN it will be implemented.



## Introduction to a new mode of transportation

**The Vessel**– A new type of mobility for all. The scenic route: a gondola like system that fills the gap between existing transportation networks with an attractive experience, a new network that creates an exciting option, a wayfinding path to popular attractions and hotels.

Designed to complement the tropical Hawaiian climate, the simple design allows passengers to feel safe during their travel while also being comfortable breezing through the Hawaiian trade winds lush environments.

## Design Project (Micro)

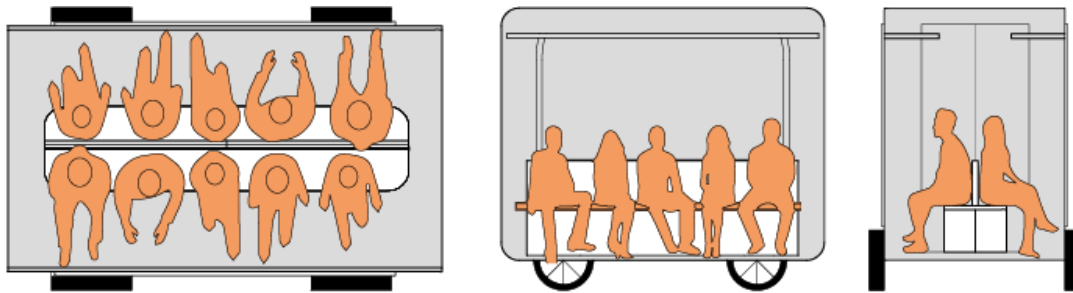


Figure 41: Proposed Vessel Section

Source: Author

The simple design is intentionally built with large open spaces to allow maximum cross ventilation and minimal obstruction of the Waikiki's newly proposed landscape. Unlike the standard automobile, this vessel is capable of transporting a larger number of passengers at a higher efficient rate due to the adoption of autonomous technology.

The compact design allows for smooth maneuvering through the dense population. And at top speeds of about 25mph it is expected to reduce vehicle related accidents at a dramatic rate. By borrowing the existing designs that have been created by major automobile companies, I was able to modify the vessel to enhance the natural resources that Waikiki has to offer. I believe this new design represents the essence of Hawaii because of its use of wooden materials and simple airy design.

### Scale 3: Automobile Design

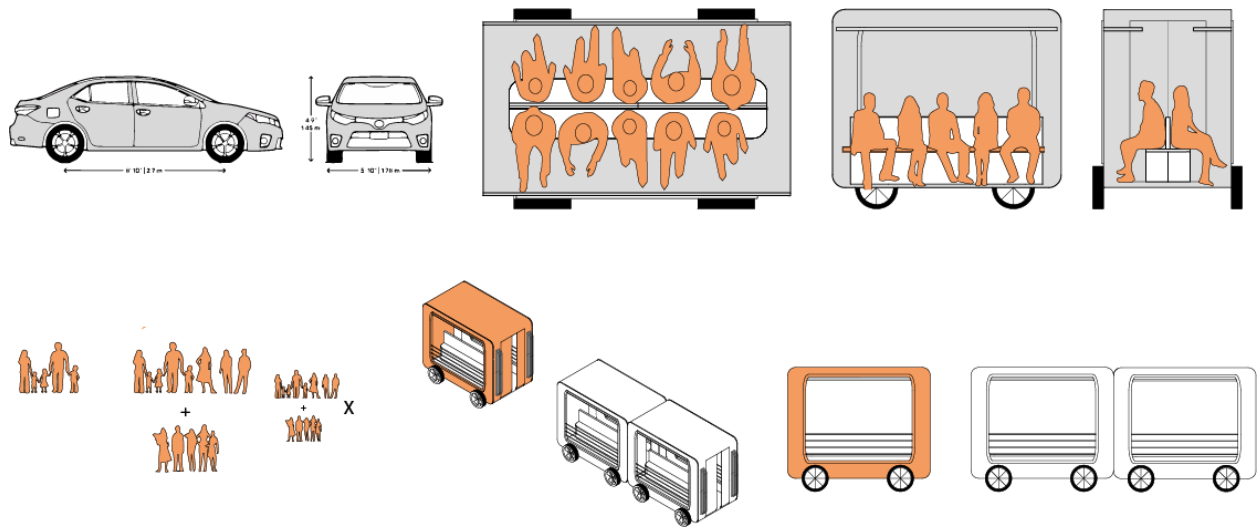


Figure 42: Comparison of Automobiles

Source: Author

At this scale we focus on the improvements to the autonomous vessel that make it far safer and more efficient than current vehicles we see on our streets today. Some key features to remember in implementing this new vessel of transportation are:

- **Increased safety:** may eliminate many crashes that are caused by human error and distracted drivers.
- **Improved mobility:** those who face difficult challenges of driving and even those are unable to drive. These may include the youth, the elderly and the disabled.
- **Reduced parking needs:** The drop-off revolution creates a place that requires no parking spaces, less vessels on the road due to a higher efficiency.

- **Increased car-sharing:** Creating a lifestyle that makes it “cool” to use rideshare and public transportation in hopes of improving the cities life quality and reducing environmental impacts.
- **Increased road capacity:** The evolutions of autonomous vehicles and improved vessel design make way for improved street design and reclaimed urban spaces.

The average sedan we find on our streets now have a total capacity of carrying five passengers in one vehicle. These vehicles are often larger than they need to be and are equipped with excess material that create less space for human occupancy.

## Conclusion



*Figure 43: Final Proposed rendering*

*Source: Author*

Considering a site's cultural significance and demographic is a vital part of successfully integrating a new model of transportation. Waikiki was once a playground for Hawaiian royalty. The white sandy beaches, surfing and family gatherings were all a part of the rich history of traditional Waikiki. In order to continue this culture, we needed to research and develop a new model of transportation that will further enhance these features that define Hawaiian culture.

A pedestrian-oriented multi-modal transportation system provides people the opportunity to experience a dense urban area in different levels. The area that was once heavily influenced by the car can be transformed into an environment that provides fluidity in its transportation and promotes a healthier lifestyle.

The idea is that providing the infrastructure and support services for a multi model transportation system will increase the use of rideshare and result in health benefits as well as a better movement of transportation vehicles. This process can be highly achievable by the use of Autonomous Vehicles, and if it is effectively integrated, can change the way we view transportation. Creating a bicycling and walking environment helps advance various community health benefits and improve congestion. Providing transportation options for all people will be beneficial in creating the future success of an urban city.

The potential of the automated street, as technologically sophisticated as it may be, is in some ways a throwback to the street in the era before the car. Back then, streets were places of social activity, places where people met. Since the introduction of cars, streets became less social, with pedestrians segregated by congested and dangerous traffic lanes. In contrast, a street for autonomous vehicles, if well-designed, can be both a connected and sociable place.<sup>45</sup>

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<sup>45</sup> Kohn Pedersen Fox “The Autonomous Future, Rethinking Cities to Capitalize on The Urban Mobility Revolution” Accessed March 15, 2020, <https://www.kpf.com/stories/the-autonomous-future>

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