2014

EXPANDING TRANSPORTATION OPPORTUNITIES ON HAWAI`I ISLAND

A project submitted in partial fulfillment of the requirements for the degree of Master of Science at the University of Michigan | School of Natural Resources and Environment

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ABSTRACT

Residents of Hawai`i Island pay some of the highest rates for electricity and petroleum products among residents of the United States. Moreover, the islands of the Hawaiian archipelago rely almost entirely on imported petroleum fuels for both transportation and energy generation. Though Hawai`i Island has integrated more renewable energy onto its electrical grid than anywhere else in the U.S., the reliance on fossil fuel remains high because more than half the energy demand of the island can be attributed to transportation. Traditionally mass transit systems can be used to increase energy efficiency, as well as energy sustainability of a transportation system; as a result the University of Michigan team was engaged by The Kohala Center to examine and analyze the public transit system of Hawai`i Island for potential improvements.

The primary objective of the project is to develop a set of recommendations for the County of Hawai`i focused on high-impact solutions to reduce fossil fuel use in the island's ground transportation system, while improving accessibility and lowering travel times for commuters. Our team completed initial research to gain a background on Hawai`i and its energy and transit challenges, completed data collection and analysis through a research trip to Hawai`i, and designed a set of recommendations for optimizing the current system, as well as potential alternatives that include the establishment of carpooling and ride-sharing networks that would employ new business models to help solve some additional transit issues.

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Our family and friends;

And finally each other for being such a great team.

Mahalo!

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1: EXECUTIVE SUMMARY

INTRODUCTION

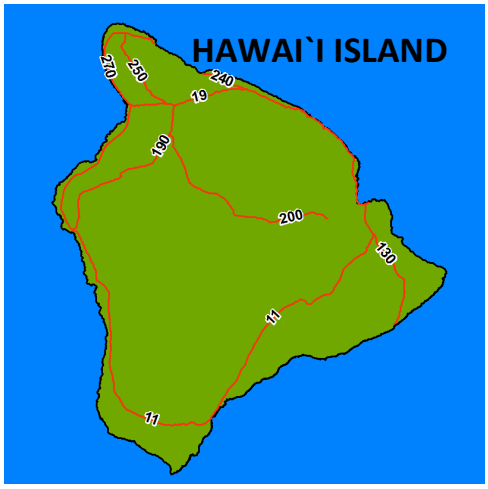
Residents of Hawai`i Island pay some of the highest rates for electricity and petroleum products among residents of the United States.[1] Moreover, the islands of the Hawaiian archipelago rely almost entirely on imported petroleum fuels for both transportation and energy generation.[2] Though Hawai`i Island has integrated more renewable energy onto its electrical grid than anywhere else in the U.S.,[3] the reliance on fossil fuel remains high because more than half the energy demand of the island can be attributed to transportation.[4] Traditionally mass transit systems can be used to increase energy efficiency, as well as energy sustainability; as a result we have designed this project to explore the need for improvements to this system. We will develop suggestions for optimizing the current system, as well as potential alternatives that include the establishment of carpooling and ridesharing networks that would decrease the number of private vehicles used and thus fuel consumption.

The University of Michigan team was engaged by The Kohala Center to examine and analyze the public transit system of Hawai`i Island. The primary objective of the project is to develop a set of recommendations for public and private investments focused on high-impact solutions to reduce fossil fuel use in the island's ground transportation system, while improving accessibility and lowering travel times for commuters.

HAWAI`I ISLAND GROUND TRANSPORTATION INFRASTRUCTURE

On Hawai`i Island the vast majority of residents (69%) choose to commute alone via personal vehicles like cars, trucks and vans, while only 2% of commuters choose public transit to get to work.[5] The remainder of the workforce either carpools to work or works from home.[6]

Figure 1-1: Road Map of Hawai`i Island



Currently, commuters are served by a few major two-lane highways that transport residents from one side of the island to the other. Hawai`i Belt Road (Highway 19) is a major route from Hilo to Kailua-Kona and it takes a driver 2 hours and approximately 95 miles.[7] This is the road preferred by the Mass Transit Agency because the population lives along this road making pick-ups ideal.[8] The other option for this trip is the newly opened Daniel K. Inouye Highway passing between Mauna Kea and Mauna Loa and connecting the existing Saddle Road (Highway 200) to Mamalahoa Highway.[9] This route starting in Hilo and ending in Kona is about 77 miles long and will take drivers 1 hour and 38 minutes to traverse.[10]

COMMUTING ON HAWAI`I ISLAND

THE CHALLENGES OF TRANSIT

The population of Hawai`i Island is highly dispersed and rural, making efficient transportation and particularly public transit challenging. Those that commute alone using their personal vehicles must cover vast distances on a daily basis and are often paying a premium for fossil fuels. Transit service providers also face a number of challenges in delivering high quality, convenient and cost-effective transit options for their clientele. They are asked to serve a large area with a dispersed population with a limited budget. Providers must optimize their systems to cover long distances and occasionally difficult terrain.[11] They must rely on a variety of fleet vehicles, causing the need for more administrative capacity, operational and maintenance knowledge and general coordination.

CHARACTERISTICS OF HAWAI`I COUNTY COMMUTERS

As mentioned previously Hawai`i Island residents primarily choose to commute to work by personal automobile (cars, trucks and vans). While most commute alone, about 15% participate in carpooling to get to work. Compared to the United States as a whole, carpooling is highly successful on Hawai`i Island. Less than 2% of the population takes public transit to get to work, but at the same time that is almost three times the national average for other rural areas.

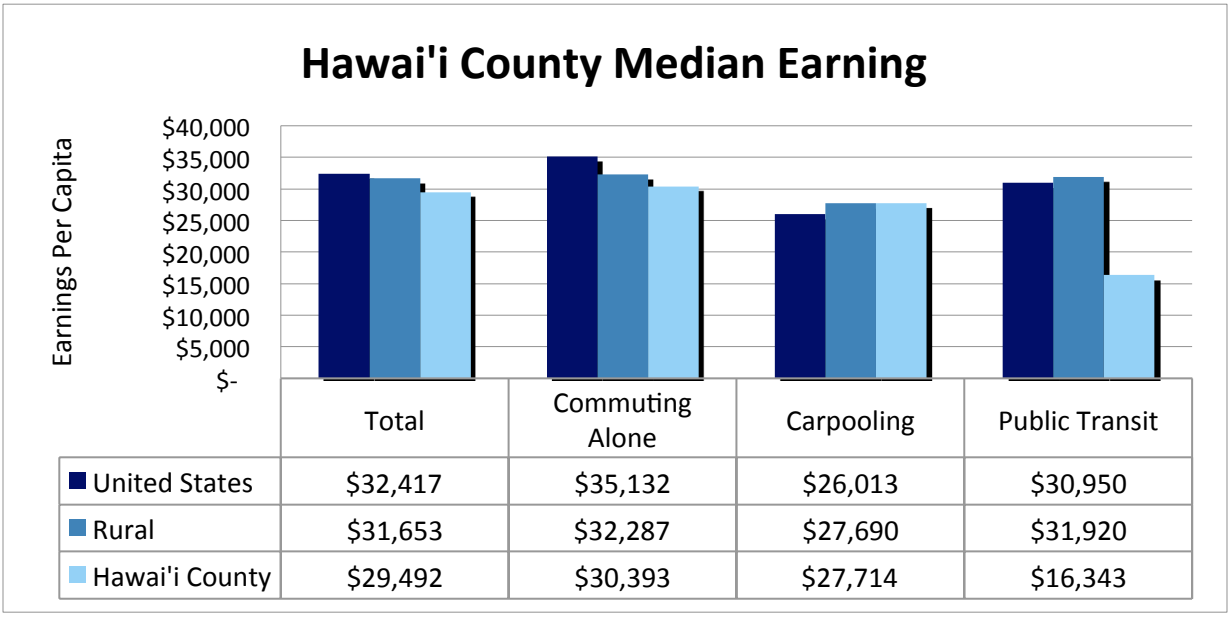
Table 1-1: Modes of Commuting

	United States	Rural	Hawai'i County	Maui County
Mode Used				
Commuting alone	76.4%	81.4%	72.7%	68.4%
Carpooling	9.8%	9.9%	14.5%	14,9%
Public Transit	5.0%	0.6%	1.7%	2.3%
Other	8.8%	8.1%	11.1%	14.9%

Data from American Community Survey

The median income in Hawai`i County is slightly below the rest of the United States and other rural populations. Figure 1-2 shows that those who commuted alone using their own personal vehicle on the whole earned more than those who carpooled or used public transit. Interestingly, in Hawai`i County public transit commuters had a much lower median earnings level. They only earned $16k, while those that commuted alone or via carpool earned almost twice that amount. This suggests that lower income commuters, who do not have access to or cannot afford a personal vehicle, predominantly use the public transit system on Hawai`i Island.

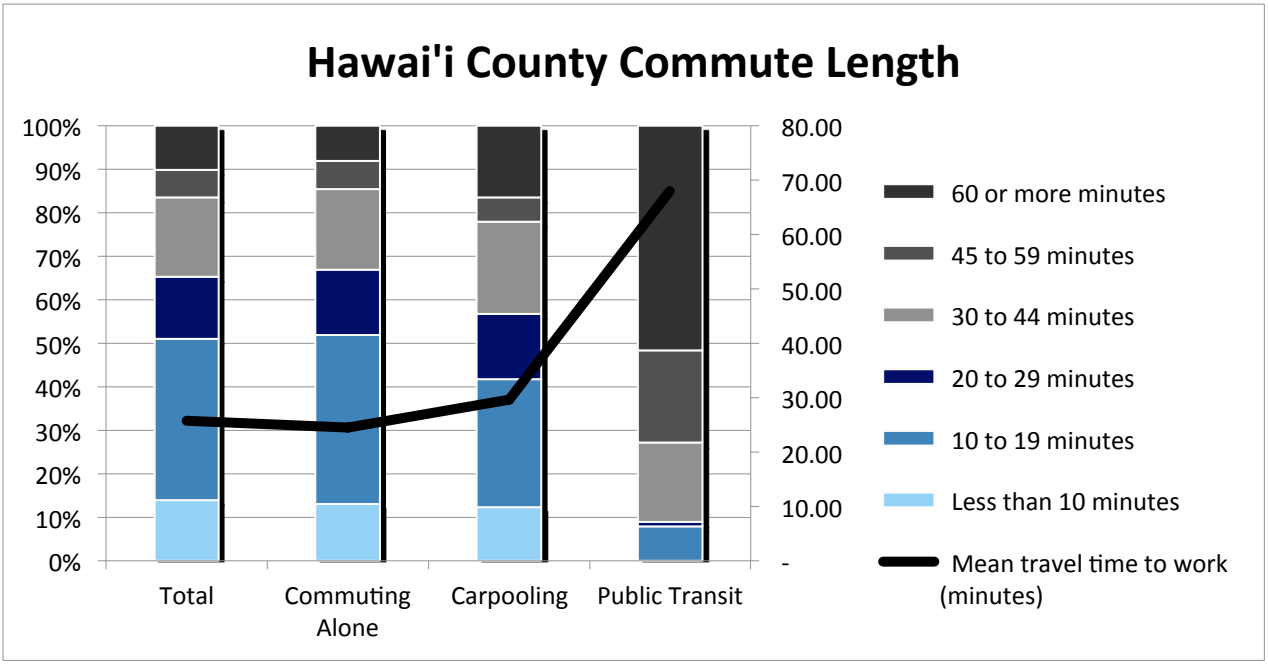
Figure 1-2



	Total	Commuting Alone	Carpooling	Public Transit
United States	$32,417	$35,132	$26,013	$30,950
Rural	$31,653	$32,287	$27,690	$31,920
Hawai'i County	$29,492	$30,393	$27,714	$16,343

The Figure 1-3 shows average commute lengths for the different types of Hawai'i Island commuters.. Among all the residents of the island, the average time it takes to commute to work is between 25 and 30 minutes, which is similar to the national average. Public transit commutes in the United States tend to be longer than solo and carpool commutes with the average of 48 minutes; public transit commutes on Hawai`i Island are substantially longer at 68 minutes. In fact, more than 50% of public transit commuters on the island have a commute of 60 minutes or longer.

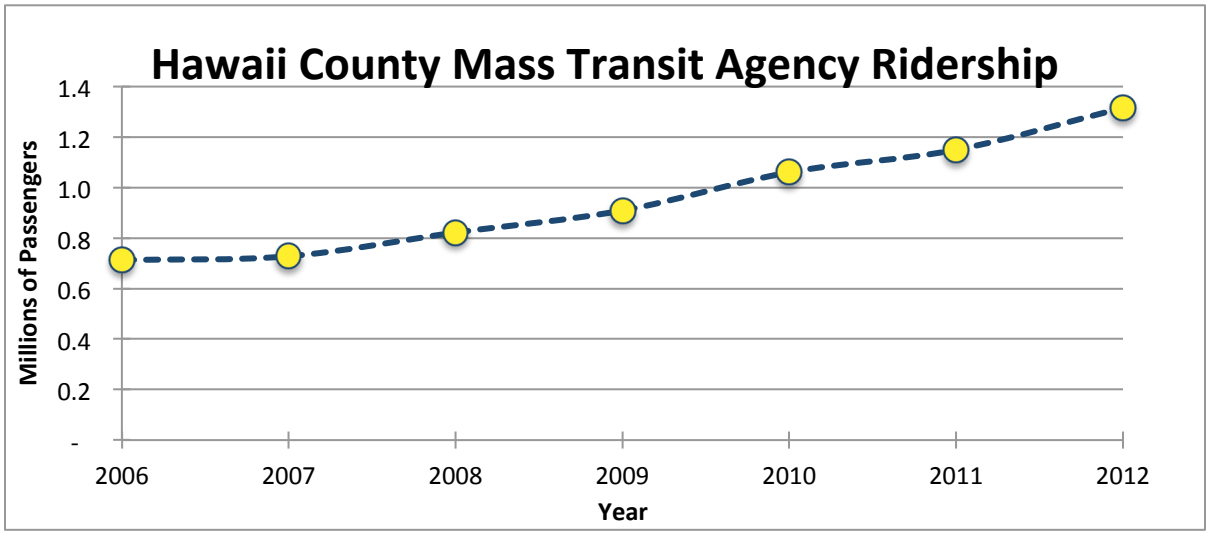
Figure 1-3



HAWAI`I COUNTY MASS TRANSIT AGENCY

The Hawai`i County Mass Transit Agency began collecting ridership data again in 2005 and currently delivers public transportation with its Hele-On bus service and shared taxi program.[12] The Hele-On bus offers 16 route options that range from intra-city (i.e. Kona and Hilo) to inter-city (i.e. Hilo to Waimea) to trans-island (i.e. Hilo to Kohala resorts). The fare for riding the bus has recently increased (as of July 1, 2013) from $1.00 to $2.00 per ride and from free to $1.00 for students, disabled individuals and seniors.[13] The shared taxi program offers door-to-door taxi service within Hilo and Kona for between $2.00-3.00 for trips fewer than four miles and between $6.00-9.00 for trips fewer than nine miles. The agency is funded by money from the local and federal governments, but receives no state funding for their operations.[14]

Figure 1-4



Ridership has been gradually increasing since the service began. According to the most recent available *Comprehensive Fiscal Report* produced by Hawai`i County for the Fiscal Year ending on June 30, 2011, the ridership surpassed 1 million passengers in 2010 and reached approximately 1.15 million in 2011.[15] As of 2011, the agency owned a fleet of 56 vehicles to serve these riders.[16]

MAPPING TRANSIT ON HAWAI`I ISLAND

In the spatial analysis section, we first mapped current bus routes and the spatial distribution of population density, work hubs and recreational hubs. Next, we compared the transit needs (implied by the spatial distribution maps) around Hawai`i Island with current bus route coverage to develop a preliminary understanding about whether the current mass transit system reaches enough riders while evaluating the possibilities of potential improvements.

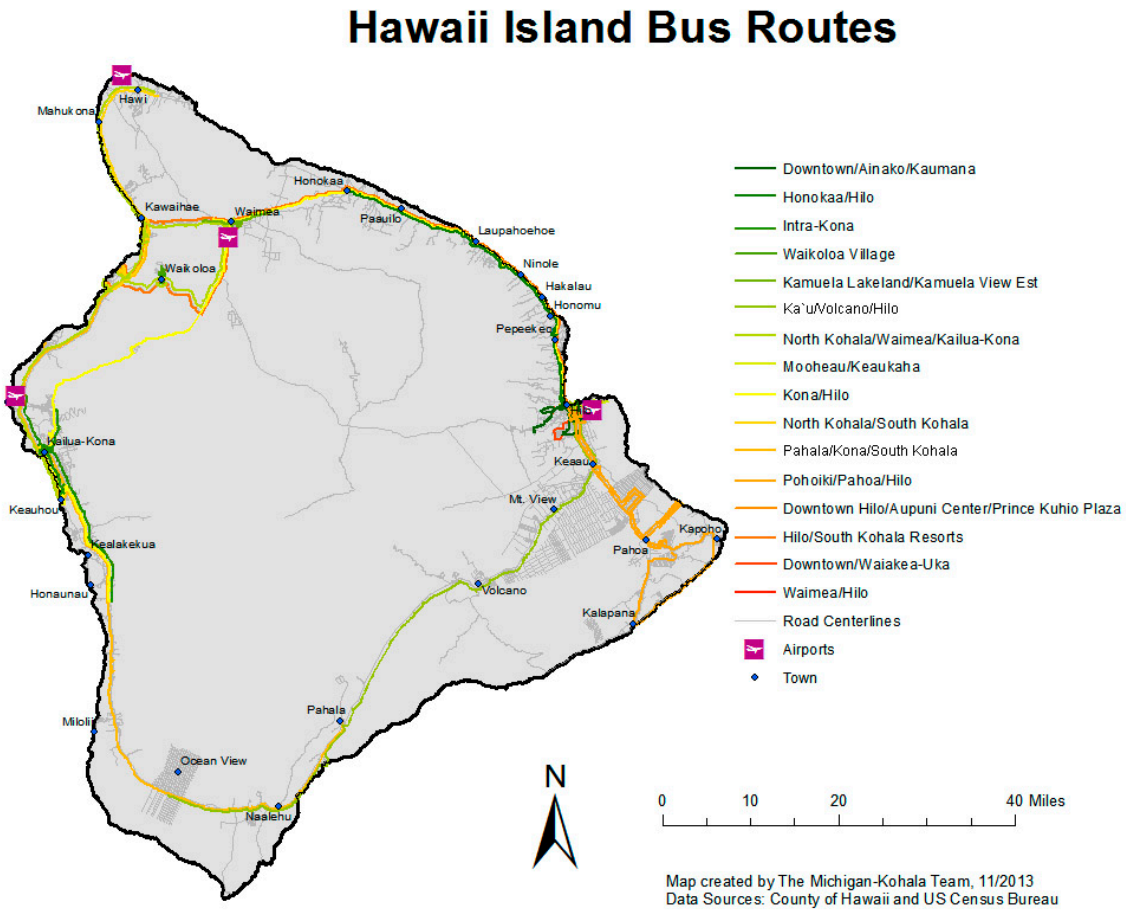
Not surprisingly, these maps we created show that population, work hubs and recreational hubs of Hawaii Island are clustered around the perimeter of the island at major towns including Hilo, Keaau, Mountain View, Pahoa, Ocean View, Kealakekua, Keauhou, Kailua-Kona, Waikoloa, Waimea and Hawi. Work hubs are especially clustered around Hilo and Kailua-Kona. Based on our analysis of the current

public transit system we have determined that Hilo and Kailua-Kona are two of the most-served areas in terms of routes passing through or within, with four routes within Hilo, six routes to or from Hilo and four routes to or from Kailua-Kona.

Our results show that two or more bus routes serve most of the works hubs, recreation hubs, and population clusters. However, Mountain View, Pahoa and Pahala are only served by one bus route. Moreover, Mauna Kea State Park, a very popular attraction, is completely out of bus service at this point because it is on Saddle Road, which lacks bus routes. Hilo International and Kona International Airport, the major airports on the island, also have limited bus service.

This preliminary analysis suggests that the Mass Transit Authority may be able to streamline the Hele-On bus system by identifying redundancies or unnecessary overlap in the current routing and scheduling system.

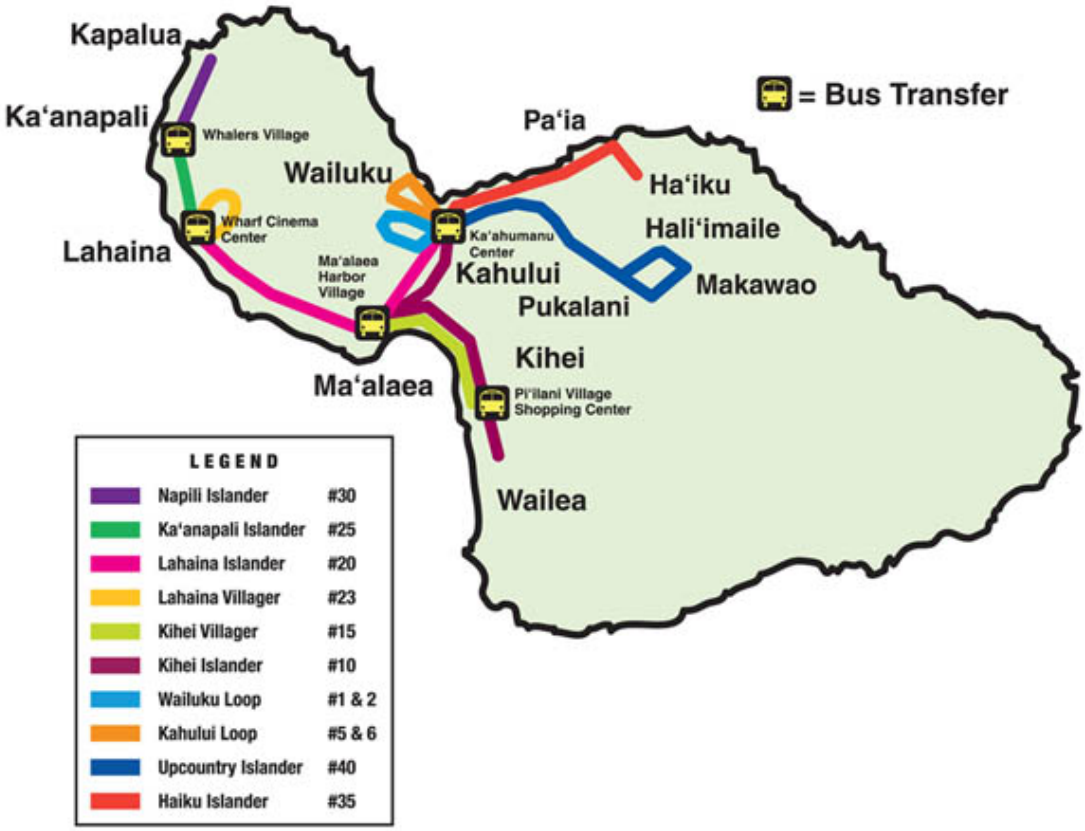
Figure 1-5



MAUI COUNTY PUBLIC TRANSIT

Of the Hawai`ian Islands, Maui County is most similar to Hawai`i County due to their relatively rural settings. Because of these similarities we completed a case study of the bus system on Maui. Investigating the origins of the Maui bus system, its current status, and its plans for future improvements can provide some useful information for Hele-On. Maui's routes and schedules were initially developed based on an objective scoring system, and today service expansion is generally driven by demand from the public. Maui currently uses Geographic Information Systems (GIS) to a much greater extent than Hele-On does. This has allowed Maui to develop route maps and schedules that are visually appealing and clear (see the figure below). Additionally, Maui uses Google Transit to publish information about their services, and the process for collaborating with Google was not difficult at all. While other technological solutions are not currently used by Maui, they are looking into investing in Global Positioning Systems (GPS), as well as a system that can automatically track ridership. The Maui system's budget is over double that of Hele-On, as is its ridership. While Hawai'i Island's ability to immediately offer all of the same services that Maui offers in these areas is not feasible, collaborating with Maui Transit officials and looking into incorporating some of their innovations offers the best path forward and could provide benefits to the residents of Hawai`i Island.

Figure 1-6: Map of Maui Transit



From http://www.mauicounty.gov

THE CASE FOR IMPROVING THE TRANSPORTATION ON HAWAI`I ISLAND

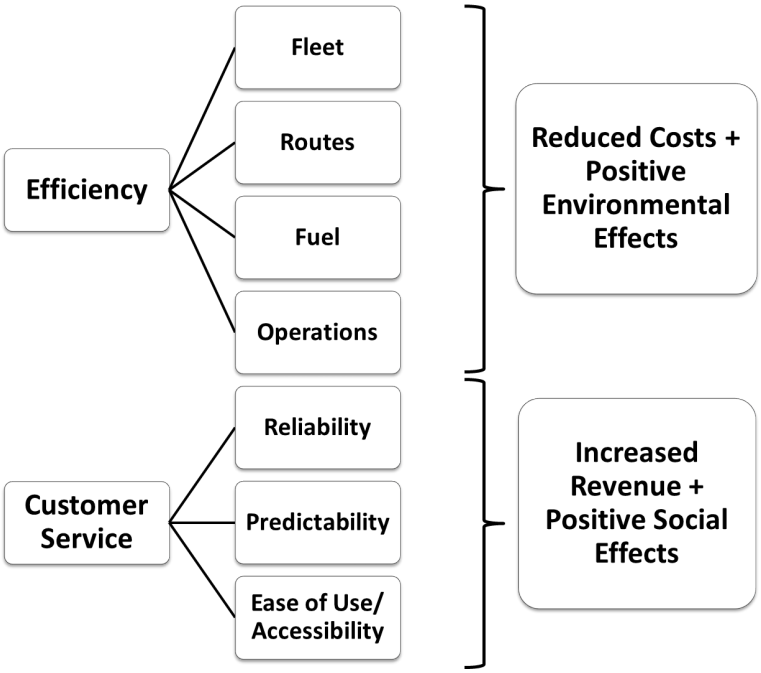
Transportation on Hawai`i Island is complicated and presents great challenges. There is rising and more complex demand for public transit service, operational costs are increasing, and resources are limited. In recent years, the Mass Transit Agency (MTA) has persistently worked towards expanding its Hele-On services and providing residents with suitable transportation options and an improved experience. However, the Agency still faces many challenges to expand while maintaining high quality service. At the same time the Island's traffic is getting worse, fuel expenses are a huge burden and vehicle carbon emissions are increasing, as many people commute alone in their personal vehicles.

We have developed a set of recommendations for stakeholders to consider when working to mitigate these issues. First, we will focus on technology investments for the Hele-On public transit system. Then, we will discuss private sector investments that could provide alternative, cost-effective ways to commute on Hawai`i Island.

OPTIMIZING PUBLIC TRANSIT WITH TECHNOLOGY SOLUTIONS

To address the complexity of transportation on Hawai`i Island and the challenges that the Mass Transit Agency is facing, we identified two overarching areas of opportunity that can facilitate the transition to a more economically, socially and environmentally sustainable mass transit system for Hawai`i Island. The following graphic introduces these two areas, the different segments in which they may be targeted, and the potential benefits they could provide. Subsequently, we identified key technologies that can improve these segments when implemented.

Figure 1-7: Areas of Opportunity



There are many available technologies for improved transportation systems used worldwide. After an extensive analysis of available technology options, we identified the following as the most beneficial for the Hele-On transit system:

1. Automated Passenger Counting (APC) to determine ridership trends and optimize routes, vehicle types and pricing depending on capacity vs. demand.
2. Geographic Information Systems (GIS)- to create and provide easy and appealing information on routes and schedules and maintain a clear vision of the system.
3. Automatic Vehicle Location (AVL)- to understand current operations and optimize route, fleet and driver performance. It can also increase accountability of drivers.
4. Mobile Data Terminals (MDT)- to make the integration of technology systems easier and more seamless, and to maintain digital records of all operations.
5. Real Time Passenger Information (RTPI)- to provide better predictability, reliability and service to passengers and improve their overall experience to increase ridership.

ANALYSIS OF POTENTIAL VENDORS

As in any growing market, there are multiple companies offering products and services for transportation management or optimization purposes. We performed extensive research on existing companies and their offerings. This analysis can serve as a tool for the Mass Transit Agency to determine which company might best fit Hele-On's requirements, while staying within the County's budget or making the case for extra funding to be raised via public or private investment. Aside from economic considerations, an ideal vendor should be able to provide multiple items from the 'Key Technologies for Hele-On' listed above and present customizable solutions. Additional value will come from firms with products designed specifically for public transportation systems and previous experience with rural or island-based clients.

Figure 1-8: Potential Companies and Their Services

Company	Services						
	Automated Passenger Counting (APC)	Routing and Fleet Efficiency Optimization	Operator and Vehicle Performance	Real-time Passenger Information (RTPI)	Mobile Data Terminals (MDT)	Has Specific Service for Public Transport?	Has worked on Rural or Island Projects
Actsoft		x	x				
NextBus				x		x	
Syncromatics	x	x		x	x	x	
Teletrac		x	x	x	x	x	
Trapeze	x	x	x	x	x	x	x
TSO Mobile	x	x	x	x	x	x	x

As shown in the figure above, the companies reviewed in this research provide a wide array of services, and finding the best option for Hele-On to implement will depend on the costs of each and the availability of resources in the County of Hawai`i. After contacting and reviewing these companies, we determined that TSO Mobile offers the full range of products and services the County may consider and has experience working or rural systems and in islands. It would therefore be the best option to work with, even though the investment required is higher.

RECOMMENDATIONS FOR IMPLEMENTING TECHNOLOGY SOLUTIONS

We have identified three different stages of activities and investments for the County to consider. There are some easy and low-cost solutions that we recommend should be implemented right away, and some pricier but more impactful solutions for which additional funds must be procured.

IMMEDIATE SHORT TERM

- Google Transit: Low cost option with easy and fast implementation that can help passengers identify ideal routes, schedules, and connections. It will be necessary to develop a communication strategy to let users know of its availability once it is in place.
- Website enhancements for easier navigation.
- Develop clear route schedules and maps that can be seen on website without the need to download the file.

SHORT TO MEDIUM TERM

- Procure funding for large technology investment. Tentative sources include: federal grants, private impact investment opportunities, environmental or social Impact foundations.

MEDIUM TERM

- Make large technology investment
    - Determine appropriate vendor and obtain a customized quotes
    - Determine new staff requirements and cost (if any)
    - Set project manager responsible for implementation

PRIVATE INVESTMENTS AND TRANSPORTATION ALTERNATIVES

We recommend that Hawai`i County consider partnering with private enterprises for both rideshare and vanpool. As fuel costs increase and government funding for transportation becomes more uncertain, there will be a shifting of priorities at the federal and state level. The time for action is now: energy efficiency and peer-to-peer ridesharing have come to the forefront of transportation energy innovations and this emergence has not gone unnoticed at the state level. Private solutions in vanpool and rideshare could reduce the burden on the Mass Transit Agency, while providing cost-effective realized savings for both short- and long- distance commuters.

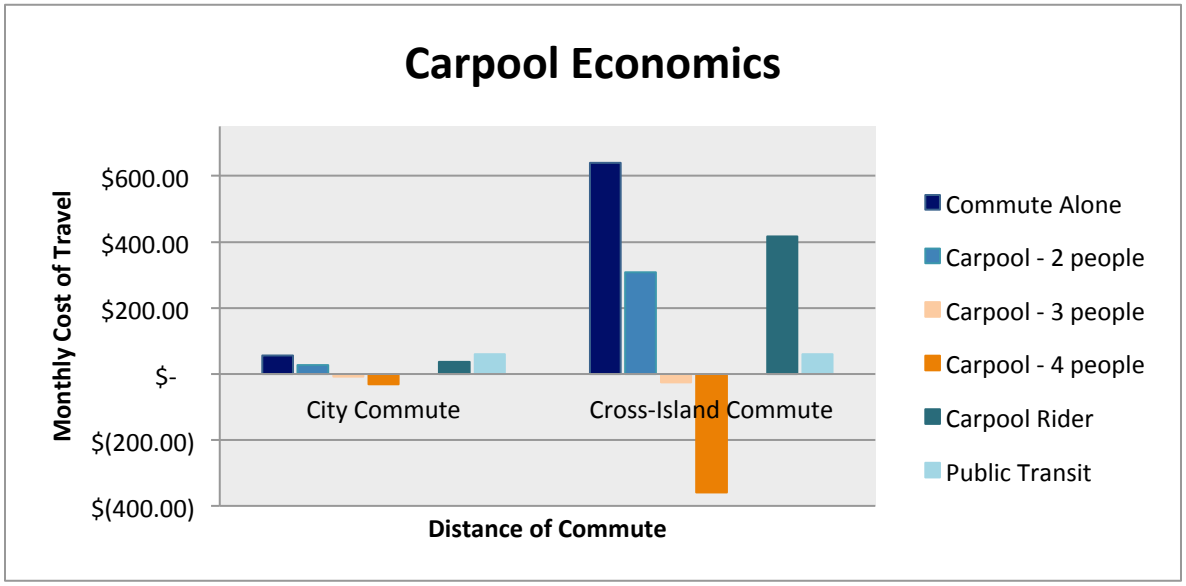
RIDESHARE NETWORKS

Peer-to-peer ridesharing occurs when passengers use mobile applications and GPS tracking to “find” rides. Ridesharing is increasingly popular at universities among both students and faculty, as well as among middle-income commuters who would otherwise commute alone.

Despite its popularity, we are skeptical about government incentives and subsidies like the Commuter Tax Benefits Program, the Guaranteed Ride Home Program (GRHP) and Job Access Reverse Commute program (JARC); these programs may not necessarily do an effective job of enticing ridesharing due to state priorities, competition with more populated counties which spend more on transportation, the actual cost of allocating money to the island for these programs, and the general lack of knowledge of said opportunities. We are, however, hopeful about a new state *Car-Sharing Vehicle Surcharge Tax* bill in the works and the 2007 *Energy Efficient Transportation Strategy Act,* which recognizes and sanctions ridesharing companies as legitimate tax-paying entities, reducing the economic uncertainty of these markets while setting a standard for administration and oversight which can act as catalyst for further expansion. It is expected that the future implementation of ridesharing networks will be complementary to mass transit ridership rather than competitive; ridesharing exists to address unmet demand for lower-cost travel alternatives for middle-income and more affluent commuters.

In spite of our concerns with public policy, the private sector is robust with a rapidly expanding market with increasing private investment. As we mentioned previously, carpooling is already very popular on Hawai`i Island and has the potential to save participants money, as well as limit the consumption of gasoline and the release of carbon into the atmosphere. For long-distance commuting a driver pays an average of $640/month on Hawai`i Island. That cost is cut almost in half by taking on one additional passenger ($332.80 returned to the driver), and fully recovered with additional profit by taking on two or three passengers (making $25.60 or $358.40 per month respectively). For shorter distances, the gains are more modest – the $40/month average cost of gasoline for a single commuter is recovered with the driver earning an additional $1.60 for two more riders and $22.40 for three more riders (see Appendix G for cost calculations).

Figure 1-9



VANPOOL NETWORKS

The County could also benefit from enhancing private vanpool network opportunities for all residents, where users pay a fee to cover fuel and a company provides vehicles. Hawai`i Island is an ideal place to utilize this type of service, as vanpools are particularly effective in providing long-distance transportation between work and residential hubs. In fact, the privatized VRide system is already in place, but underutilized. There are still inherent tradeoffs: the system may poach from mass transit, taking away lower-income commuters. Additionally, many commuters must still drive to reach start nodes. Because the system is already online, the County's largest effort should be focused on outreach to employers and commuters and educating them of the potential subsidies and user benefits of vanpool commuting. The public vanpool system (Vanpool Hawai`i) was defunded in 2011, so VRide remains the only viable vanpool option.

RECOMMENDATIONS FOR ESTABLISHING RIDESHARE AND VANPOOL NETWORKS

There are three major steps that ensure the stability of vanpool and rideshare private networks moving forward:

- **Engage Public Agencies in Developing Sustainable Transportation Goals:** Ensure better coordination between departments to secure future funding; conduct outreach to commuters to educate them of various options; hire staff to liaise between business interests and commuters; oversee rideshare/vanpool programs.
- **Support the Existing Vanpool System:** Immediately encourage users to sign on to existing vanpool system.
- **Understand Public Needs:** Develop a population survey that reaches a broad sample of commuters and employers gauging user preferences, as well as their current knowledge of available and developing commuting alternatives.

If the County wishes to proceed specifically with creating a rideshare network on Hawai`i Island, three options for moving forward include:

- **Send out a Request For Proposal (RFP) to existing rideshare Transportation Network Companies (TNCs)**. Traditionally, TNC expansion in the past has been limited to dense urban areas. They also rely more on private investments to keep them afloat and expand their services and features. Although TNC's pay for themselves (rather than through public agencies), fierce competition both intra-market and inter-market (i.e. taxi, vanpools, buses) may require heavier and more burdensome regulation by the already understaffed and overworked County.
- **Establish a public-private partnership (P3) with the County for a unique regional program.** In this situation a public agency subcontracts to a third-party vendor (Cubic, Trapeze, Rideshare) for a ride matching platform, marketing & outreach, and technical guidance and operation. Though it is more expensive upfront due to consulting services required, this kind of partnership is less risky and capacity-intensive because the private company assumes an operational role and some financial risk. They also work with the agency to find external funding sources, which might supplement project costs. Ultimately, the private entity can help establish a more individualized network uniquely tailored to fit the Island's needs. Because this arrangement is not sensitive to potential company acquisitions, buy-outs or changes in structure and ownership (as is frequent with emerging TNCs and startups), there is greater long-term stability in a P3 contract.

- **Establish a pilot project at the University of Hawai`i – Hilo.** A University project partnership with either an existing rideshare network or another third party vendor to test ridesharing on Hawai`i Island. These types of projects have taken been piloted on the Mainland; results have varied depending on school and commuter populations.

CONCLUSION

Despite the geographical complexities associated with island-wide transportation connectivity and accessibility, there are a number of optimizing cost-effective technological innovations available both in public transit and through the private sector. This report is intended to evaluate the existing transportation alternatives available within the existing administrative framework and organizational structure in order to provide County officials with the most comprehensive information in weighing their options moving forward. We hope these recommendations are useful and salient as the County government begins to develop sustainable transportation planning strategies well into the future.

2: PROJECT OVERVIEW

INTRODUCTION

Residents of Hawai`i Island pay some of the highest rates for electricity and petroleum products among residents of the United States.[17] Moreover, the islands in the Hawaiian archipelago rely almost entirely on imported petroleum fuels for both transportation and energy generation.[18] Though Hawai`i Island has integrated more renewable energy onto its electrical grid than anywhere else in the U.S.,[19] the reliance on fossil fuel remains high because more than half the energy demand of the island can be attributed to transportation.[20]

This project has been undertaken to understand the current transportation situation on the island and offer suggestions that will improve accessibility for the island's residents, while decreasing fossil fuel dependence and promoting more energy efficient options for commuting and transit. We chose this focus because ground transportation is particularly energy intensive on Hawai`i Island due to a reliance on a large energy inefficient fleet of personal vehicles.[21]

On Hawai`i Island the vast majority of residents (69%) choose to commute alone via personal vehicles like cars, trucks and vans, while only 2% of commuters choose public transit to get to work.[22] The remainder of the workforce either carpools to work or works from home.[23] Traditional mass transit systems can be used to increase energy efficiency, as well as energy sustainability; as a result we have designed this project to explore the need for improvements to this system. We will develop suggestions for optimizing the current system, as well as potential alternatives that include the establishment of carpooling and ridesharing networks that would decrease the number of private vehicles trips used and thus fuel consumption.

PROJECT OBJECTIVES

The University of Michigan team was engaged by The Kohala Center to examine and analyze the public transit system of Hawai`i Island. The primary objective of the project is to develop a set of recommendations for public and private investments focused on high-impact solutions to reduce fossil fuel use in the island's ground transportation system, while improving accessibility and lowering travel times. The plan recommendations include:

- Consolidating and analyzing the data collected by the County of Hawai`i on their transportation infrastructure and public transit system;
- Ensuring an inclusive process by engaging a diverse set of stakeholders on Hawai`i Island to understand and communicate their needs and experiences;
- Providing a number of technological, business and infrastructure solutions for the issues identified by the project stakeholders;

PROJECT APPROACH

The University of Michigan team approached the project from a macro to micro perspective, starting with understanding of the energy and fossil fuel dependence challenges of Hawai`i Island and identifying a specific issue area, from which we could narrow the scope of the project. Upon selecting the public transit system as our focus, we developed a set of testable hypotheses to guide our research.

PROJECT HYPOTHESES

Improvements in the current public transportation system will increase ridership and reduce personal vehicle use.

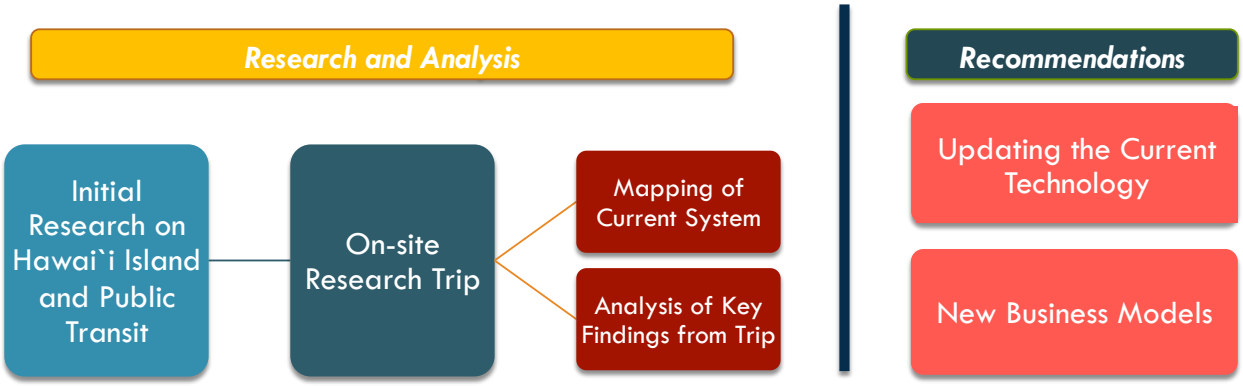
The introduction of car-share and ride-share services will reduce the number of personal vehicles used.

(See Appendix A for more details on Project Hypotheses.)

PROJECT METHODOLOGY

We then followed the project methodology depicted in Figure 2-1 below.

Figure 2-1 Project Methodology Diagram



Our team continued our research by performing a literature review to help broaden our knowledge of existing comparable transportation systems to identify potential solutions through improvements to existing infrastructure or introduction of new practices. We continued gathering data with an on-site research trip. The primary goal of our August 2013 trip to Hawai`i Island was to meet and engage with the groups and people working on a variety of issues related our own project.

OVERVIEW OF STAKEHOLDERS

Residents of Hawai`i Island

- Urban Residents of Hilo and Waimea
- Residents living outside the urban centers of Hilo or Waimea in dispersed communities
- Residents and visitors of the Kona-Kohala Coast

Government Agencies and Officials

Our group was fortunate enough to meet with representatives of the Mass Transit Authority, Office of the Mayor, Department of Research and Development, Department of Planning, as well as the County's Energy Coordinator.

NGOs and other community groups

- The Kohala Center
- The Ulupono Initiative
- Peoples Advocacy for Trails Hawai`i (PATH)
- Hawai`i County Economic Opportunity Council
- UH Hilo Student Association Sustainability Committee

Businesses and business interests

We spoke with representatives of various business associations on Hawai`i Island, including Hawai`i Island Chamber of Commerce and the Kohala Coast Resort Association

MAPPING PROJECT

Our team analyzed existing available data to develop a set of maps of the Mass Transit System. These maps were used to understand the basic efficiency of the system and where to focus our research on necessary improvements. (See *Mapping Transit on Hawai`i Island* on page 33 for more details.)

DEVELOPING OUR RECOMMENDATIONS

The final step in our process was to synthesize all our data and analysis into a set of cohesive recommendations. Based on our original hypotheses and this synthesis we focused on two sets of recommendations.

Opportunities for improvements to the current mass transit system and technology (See page 51.)

New business models to introduce ridesharing and car- or van-pooling (See page 72.)

3: AN OVERVIEW OF HAWAI`I ISLAND

GEOGRAPHY

The Hawaiian Islands are an archipelago encompassing many small volcanic islands stretched along a 2,400 kilometer swath of the North Pacific Ocean. There are eight main islands in the archipelago, Hawai`i, Maui, O`ahu, Kaua`i, Moloka`i, Lana`i, Ni`ihau, and Kaho`olawe.[24] Hawai`i Island, also known as "The Big Island," is the youngest and biggest of all of the Hawaiian Islands; covering 10,432 square kilometers, it is roughly the size of the State of Connecticut.[25]

Figure 3-1

(From lonelyplanet.com)

Hawai`i Island is comprised of five shield volcanoes: Kohala on the north tip of the island and considered extinct, Mauna Kea on the northeast of island and considered dormant, Hualalai in the west and active, but has not erupted since the early 1800s, Mauna Loa in the central part of the island and still active, Kilauea on the southeast side of the island and very active as it has been erupting since 1983.[26] The presence of these large volcanoes creates a unique "microcosm of environments" on Hawai`i Island. Within this single island visitors and residents experience such diverse ecosystems as tropical rainforests, volcanic deserts, polar tundra, grasslands, and of course, beaches.[27] On average, however, the daytime temperature in summer is 29.4°C and 25.6°C in the winter.[28]

Though the volcanoes play an integral part in the geological, environmental, and cultural history of the island, they do have their drawbacks, particularly for transportation. The elevation of the volcanoes and the threat of volcanic activity and other natural disasters make a rail system cost-prohibitively expensive, as well as limits the reach and upkeep of roads and highways. The unique habitats are also part of the natural and cultural heritage of the islands. Their preservation also restricts the construction of an extensive transportation infrastructure on Hawai`i Island.

GOVERNANCE

In 1959, after more than 60 years of being a Territory, Hawai`i became the 50th state to join the United States of America. Hawai`i has all the rights and privileges afforded to other states, including

participating in federal legislation with two senators and two representatives. The state government is modeled closely on the U.S. Federal Government.[29] The seat of government is Honolulu in the Island of O'ahu, where the executive branch is led by Governor Neil Abercrombie[30] and Lieutenant Governor Shan S. Tsutsui.[31] The legislative branch is bi-cameral and composed of a 51-member Hawai`i House of Representatives[32] and a 25-member Hawai`i Senate.[33]

The county governments are charged with the administration of each island. Hawai`i County is governed by the County Mayor, and legislated by a nine-member County Council, which passes laws and creates public policy. The Mayor is elected in a county-wide election and the Council Members are elected by the constituents from a geographically distinct county district.[34]

The Mayor supervises and oversees the functions of all Executive branch departments and agencies and appoints the county officials that work to achieve the public policy goals of the county government. Included in this purview are the Departments of Planning, Public Works, and Research and Development, and the Mass Transit Agency, all of which are important in the development and implementation of transportation policy across the island.

ECONOMICS

Traditionally one of the biggest economic sectors in the Hawaiian Islands has been agriculture. Because of the mild year round climate, companies began to come to Hawai`i to build plantations to ramp up production of agricultural goods for export. In the mid-1830s, sugar plantations gained their footholds on Kaua'i and soon began to spread to the other islands and rapidly became one of the chief products of the islands.[35] The sugar industry economy continued to prosper with a peak production of 1 million tons of sugar in 1931. In the intervening years the industry dwindled with growing foreign competition and availability of substitutes and the last sugar plantations on Hawai`i Island closed in the 1990s.[36]

Figure 3-2

Principal Employers, County of Hawai'i

2010		
Rank	**Employer**	**Employees**
1	State of Hawai'i	8063
2	County of Hawai'i	2663
3	United States Government	1421
4	Hilton Waikoloa Village	881
5	Wal-Mart	770
6	KTA Super Stores	700
7	The Fairmont Orchid, Hawai'i	618
8	Four Seasons Resort Hualalai	550
9	Mauna Kea Beach Hotel	550
10	Mauna Lani Resort (Operations) Inc.	529

2004		
Rank	**Employer**	**Employees**
1	State of Hawai'i	7608
2	County of Hawai'i	2291
3	United States Government	1221
4	Hilton Waikoloa Village	1100
5	KTA Super Stores	785
6	The Fairmont Orchid, Hawai'i	600
7	Mauna Lani Bay Hotel	580
8	Four Seasons Resort Hualalai	557
9	Mauna Kea Beach Hotel	556
10	Hapuna Beach Prince Hotel	542

Source: Hawai'i County Annual Financial Report 2011

Agriculture still plays a pretty big role in the economy of Hawai`i. The state exported an estimated $395 million in agricultural products to the Mainland United States and $499 million to foreign countries.[37] Agricultural lands are now being farmed and ranched in support of a number of diversified products including macadamia nuts, coffee, and pineapples.[38] Hawai`i Island is particularly famous for its Kona coffee and beef from the vast Parker Ranch.

Tourism is another important industry for the Hawaiian Islands. In 2012, 8 million tourists spent approximately $14.4 billion while visiting the islands.[39] Hawai`i Island specifically hosted 1.6 million tourists who spent $1.7

billion.[40] Tourism, in particular, shapes the transportation needs of the county residents and visitors. Some of the biggest employers on the island are the large resorts on the Kohala coast. Employees of those resorts generally live on the opposite side of the island[41] and efficient and cost-effective travel options are very important to them. Therefore, the Mass Transit Agency has designed the island's public transit system, in part, for these commuters.[42]

SOCIO-ECONOMICS AND DEMOGRAPHY[43]

In 2010 Census, the population of Hawai`i Island was 185,079, almost tripling the population of the island since 1970. A plurality (31%) of the population identify as "White." The next largest demographic group (24%) is "Other" which consists of non-specified races and those that identify with multiple races. Those that identify as "Asian" make up 23% of the population, while Native Hawaiians and Hispanics make up 10% and 12% respectively. Of the 64,925 households on the island, 17,417 or 26.8% had children under the age of 18. The majority of the people living in the county (88%) are U.S. Citizens and 57.4% were born in Hawai`i. Residents of Hawai`i County are less likely to move residences as 85% are living in the same house they were living in one year previously and 75% of those who moved remained in Hawai`i County. This data suggests that Hawai`i Island residents form "tight-knit" communities and are reluctant to break up these communities.

4: GROUND TRANSPORTATION ON HAWAI`I ISLAND AND OTHER RURAL LOCALITIES

RURAL TRANSIT IN THE UNITED STATES

According to the American Community Survey (ACS), rural areas are defined by their small populations, low-population density, and geographic isolation.[44] About 75 million or 25% of the US population, including many residents of Hawai`i County, lives in rural parts of the country, many of whom are heavily reliant on automobiles for transportation.[45] Developing and maintaining rural transit networks to serve these populations is a daunting prospect, but can reap rewards through the improvements to quality of life, the environment, and cost of living. According to the AARP, public transit is key to helping older individuals remain independent and active and important in providing access to health care, social services and employment.[46]

CHARACTERISTICS OF RURAL POPULATIONS

The US Census and ACS data is helpful in understanding the characteristics of rural population that distinguish them from urban and suburban populations and require special consideration when providing services like transportation. Generally, U.S. rural populations:[47]

- Have a higher median income than urban populations as urban populations have more individuals living under the poverty line. (This income disparity is reversed in Hawai`i, as the urban populations, like Honolulu have a higher median income than rural Hawai`i.);
- Have a higher median age than urban populations;
- Are less likely to move and when they do move they are less likely to move long distances;
- Are more likely to own a car and to use that car for commuting;
- Are more likely to have a longer commute than urban populations.

These characteristics suggest that rural transit systems must be designed to serve older residents and residents who are used to having the flexibility of using their own vehicles and commute slightly longer distances.

In terms of transit itself, rural residents are less likely to have access to public transit amenities. According to the *2011 Transit and Community Livability Report* produced by Ripplinger, Ndembe, and Hough at North Dakota State University, only 13-22% of people living in rural areas have access to public transit, compared to 57% of the national population. They are also more likely to have longer commutes to reach public transit, averaging more than 8 minutes to the 6-minute national average.[48]

RURAL TRANSIT PROVIDERS

According to the Rural National Transit Database, in 2011 there were 1,392 Rural Transit Providers serving 2,410 counties across the United States.[49] These providers offered a variety of types of service, including fixed-route, demand-response, ferries, commuter buses, vanpools and various combinations of those modes of transportation, demonstrating that rural transit is not a "one size fits all" situation.

On average, fleet sizes have been increasing over the last few years, up from 14.3 vehicles per agency in 2007 to 16.6 vehicles per agency in 2011.[50] Rural transit relies on a number of types of vehicles, with the most popular being the Cutaway, a small adaptable bus or van. This is likely because Cutaways are easy to customize and are more practical for serving smaller rural populations, as on average they can seat 14.9 people.[51]

Rural transit systems experienced growing ridership, with an increase from 120.9 million rides in 2010 to 122.6 million rides in 2011 or about 1%.[52] Reviewing the data more closely, however, we see that there is not an even gain across all rural transit networks. Only 61% of transit providers, including the Mass Transit Authority of Hawai`i County, saw an increase in ridership, with 36% seeing an increase of 20% or more. On the other hand, 28% saw a decrease of at least 5% and 12% saw a decrease of at least 20%.[53]

There are federal tax subsidies that can be realized by the employer or employee, or both, by using public transit for commuting under the Commuter Tax Benefits program. The current limit is $130/month per employee, but it recently dropped to this level from $245/month after Congress failed to renew the tax credit before January 1, so there is a possibility that the limit will be increased again.[54] These are tax savings that are realized through accounting procedures, and details on the process can be found at the IRS website.[55] If employers were not interested in working through the process themselves, they could use outside help in the form of a third-party agency, such as WageWorks, or an accounting firm.[56] While it likely would not result in hugely significant savings, increasing participation in the program would reduce the cost of using public transit for the people of Hawai`i Island without reducing revenues realized by Hele-On.

CHALLENGES FOR RURAL TRANSIT SERVICE PROVIDERS

Rural Transit Service Providers face a number of challenges in delivering high quality, convenient and cost-effective transit options for their clientele. Generally they are being asked to serve a large area with a dispersed population with a limited budget.. Service providers must optimize their systems to cover long distances and occasionally difficult terrain.[57] They must rely on a variety of fleet vehicles, causing the need for more administrative capacity, operational and maintenance knowledge, and general coordination.

Providers have three models for transporting populations. They can offer fixed route transportation that serves a pre-set route on a particular schedule. They can also provide demand response service that employs a fleet of vehicles to pick users up at a requested time and location. The last option is a hybrid of the other two systems. This means that a vehicle will follow a prescribed route only when users request it. Rural service providers are serving a relatively isolated population with intermittent demand.

It can be time-consuming and inconvenient for the users to use a fixed route system. A demand response system is flexible and adaptable, but can be extremely expensive to maintain.

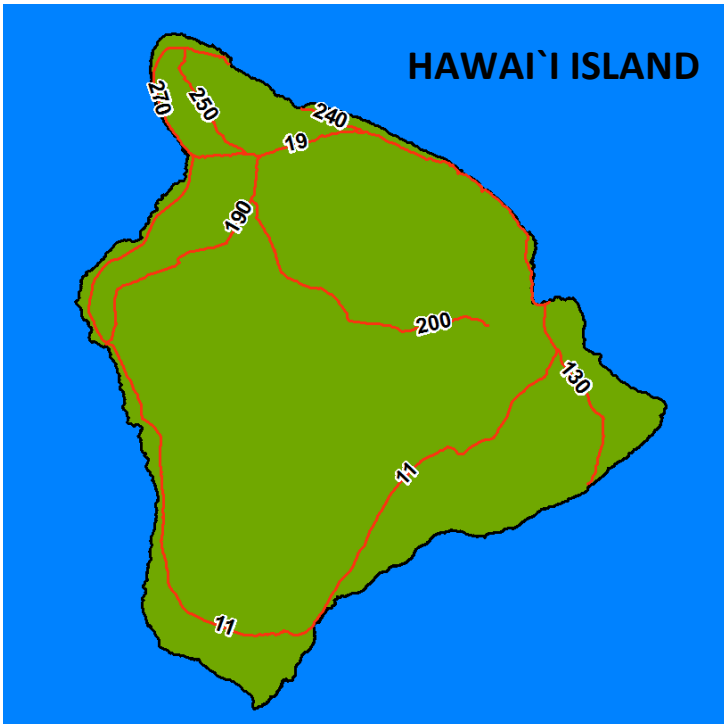
HAWAI`I COUNTY GROUND TRANSPORTATION

TRANSPORTATION INFRASTRUCTURE

Hawai`i Island is the size of the State of Connecticut and consists of five volcanoes, three of which are still somewhat active.[58] Its size, unique geography, and propensity for earthquakes, volcanic eruptions and tsunamis make it a challenge for developing a transportation infrastructure. The island had a number of railroads from the 1800s through 1940s to transport sugar and other agricultural goods for export, passengers from Hilo up to Waimea, and even tourists to the Hamakua Coast. These railroads were extremely expensive to build and maintain and were sold off by the Hawai`i Consolidated Railroad after the destructive tsunami of 1946. The rights-of-way, tracks and remaining bridges, trestles and tunnels were eventually bought by the Territory of Hawai`i and became the routes for the current highway system.[59]

Currently Hawai`i Island is served by a few major two-lane highways that transport residents from one side of the island to the other. Hawai`i Belt Road (Highway 19) is a major route from Hilo to Kailua-Kona and it takes a driver approximately 2 hours, or 95 miles.[60] This is the road preferred by the Mass Transit Agency because it circumnavigates the volcano peaks and the population lives along this road making pick-ups ideal.[61] The other option for this trip is the newly opened Daniel K. Inouye Highway, which completed the realignment and widening of this route, passing between Mauna Kea and Mauna Loa and connecting the existing Saddle Road (Highway 200) to Mamalahoa Highway.[62] This route is approximately 78 miles long and will take drivers 1 hour and 40 minutes to traverse.[63]

Figure 4-1: Road Map of Hawai'i Island



Hawai`i Belt Road also continues south from Kailua-Kona as Highway 11. This road travels down the Kona coast to the most southern point on the island in Ka`u, then northeast past the Kilauea Crater, Puna and arrives in Hilo 125 miles and almost 3 hours later.[64] This route is likely popular with tourists visiting Hawai`i Volcanoes National Park. Puna is served by Highways 130, 132, and 137, though parts of Highway 130 have been buried under the current eruption from the Pu`u ` O`o vent.[65]

CHARACTERISTICS OF HAWAI`I COUNTY COMMUTERS

Residents of Hawai`i Island face many of the same transit challenges as other rural populations, though their characteristics are slightly different than those of the average rural commuter on the mainland. The following graphs detail the trends and characteristics of Hawai`i commuters and were created from data gathered during the 2012 American Community Survey.

COMMUTER TYPES

Hawai`i Island residents primarily choose to commute to work by personal automobile (cars, trucks and vans). While most commute alone, about 15% participate in carpooling to get work. Less than 2% of the population takes public transit to get to work. Compared to the United States as a whole, carpooling is more frequent on Hawai`i Island. While the majority of residents of Hawai`i County commute using an individual personal vehicle, 14.5% carpool to work, 50% above the national average for carpooling in rural areas. Fewer residents of Hawai`i County commute using public transit than other transit options, but the level is almost three times the national average for other rural areas. In general comparing Hawai`i County to other rural populations, fewer residents of the county use personal vehicles to get to work, while more carpool and take public transit.

Table 4-1: Modes of Commuting

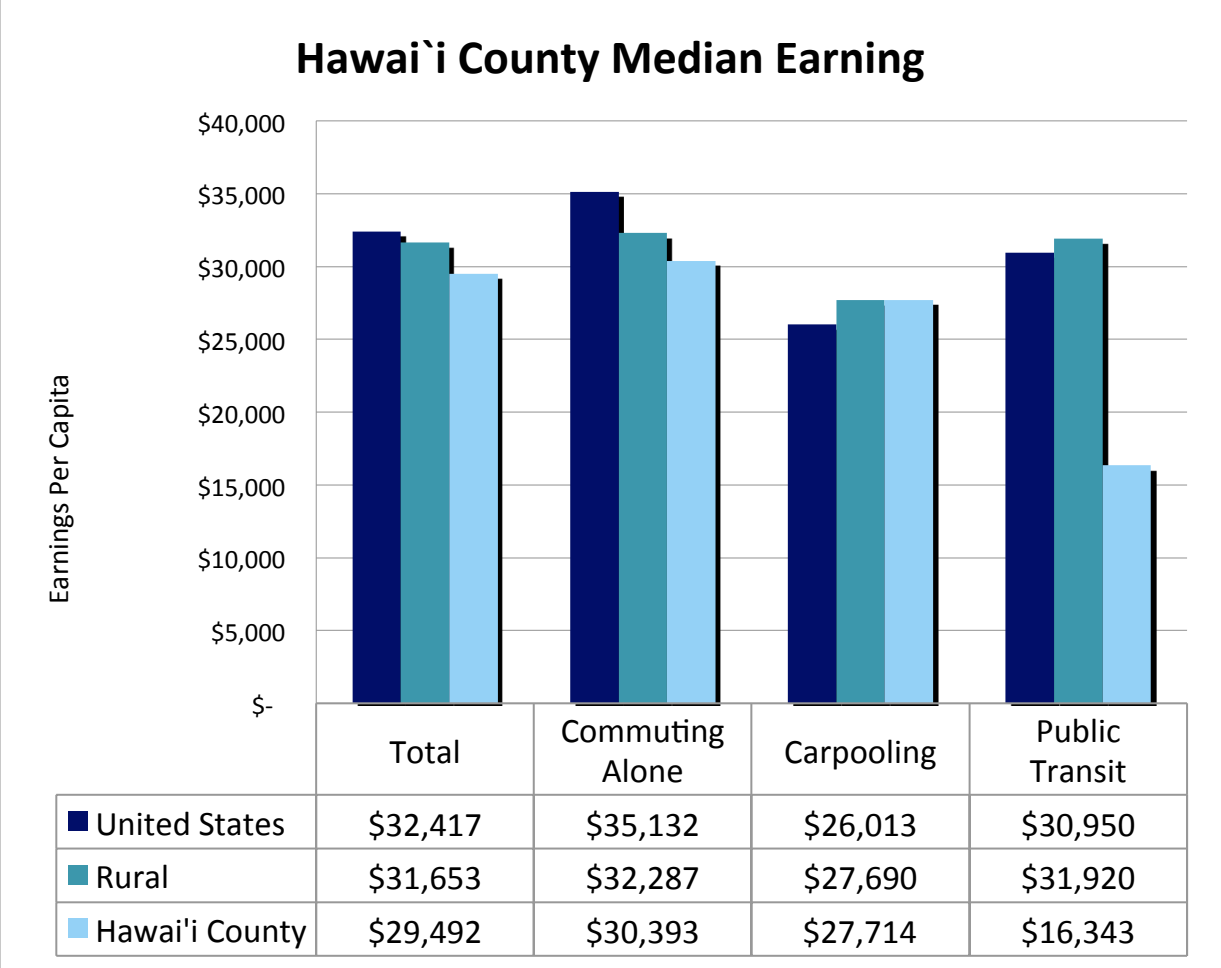
	United States	Rural	Hawai'i County	Maui County
Mode Used				
Commuting alone	76.4%	81.4%	72.7%	68.4%
Carpooling	9.8%	9.9%	14.5%	14,9%
Public Transit	5.0%	0.6%	1.7%	2.3%
Other	8.8%	8.1%	11.1%	14.9%

Data from American Community Survey

INCOME

Compared to the rest of the United States and other rural populations, residents of Hawai`i County generally earn less income. Figure 4-2 below shows that those who commuted alone using their own personal vehicle on the whole earned more than those who carpooled or used public transit. Interestingly, in Hawai`i County public transit commuters had a much lower median earnings level. They only earned $16k, while those that commuted alone or via carpool earned almost twice that amount. This suggests that lower income commuters, who do not have access to or cannot afford a personal vehicle, are the predominant user of the public transit system on Hawai`i Island.

Figure 4-2

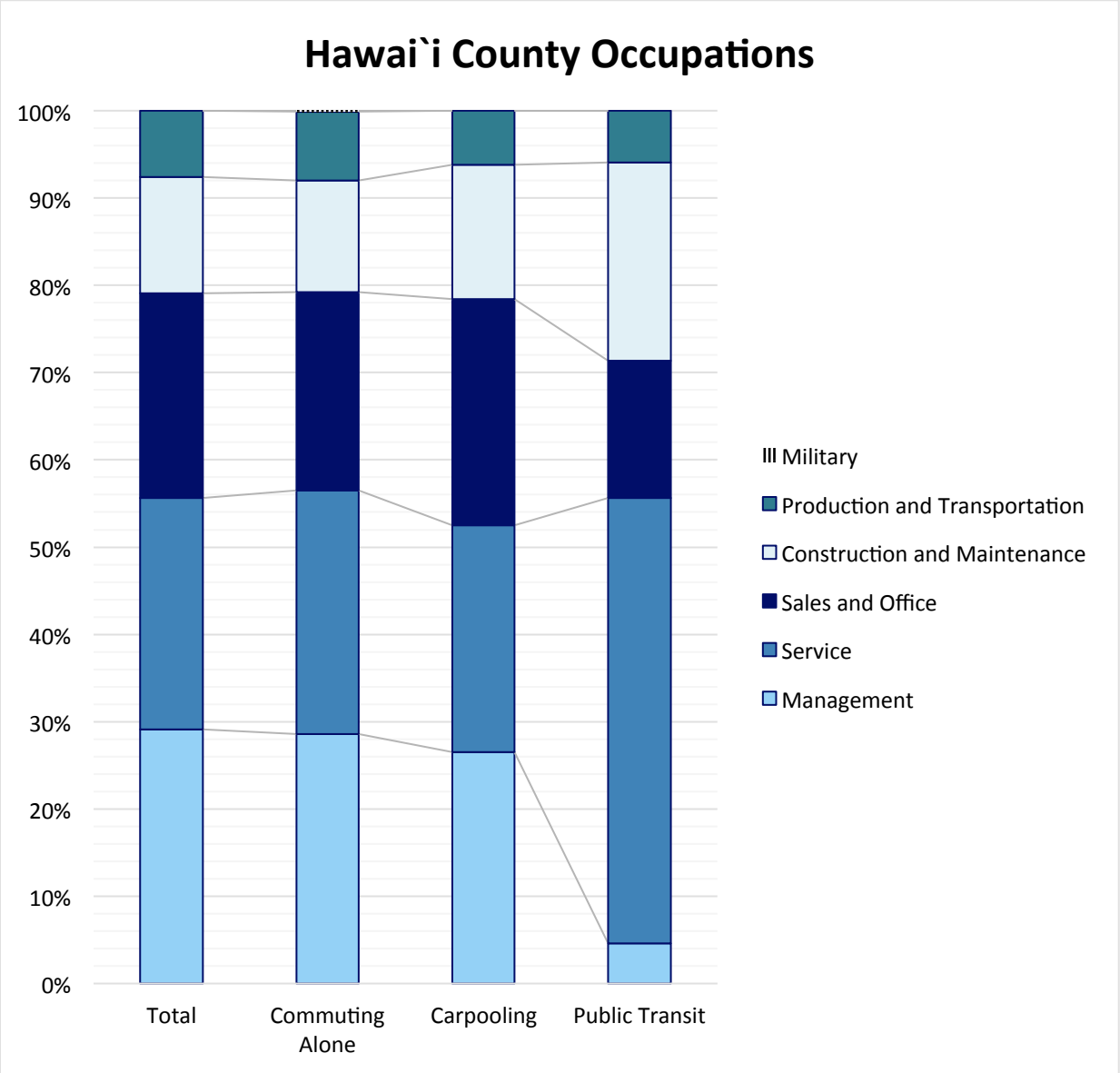


	Total	Commuting Alone	Carpooling	Public Transit
United States	$32,417	$35,132	$26,013	$30,950
Rural	$31,653	$32,287	$27,690	$31,920
Hawai'i County	$29,492	$30,393	$27,714	$16,343

OCCUPATIONS

The workforce of Hawai`i Island is relatively evenly dispersed between management-level, service and sales/office jobs. Sorting these occupations by commute type shows that those who commute alone and carpool have a similar breakdown to the island as a whole. Public transit commuters, however, are predominantly service, construction and maintenance workers, suggesting that a majority of bus users likely fall in the lower-income brackets.

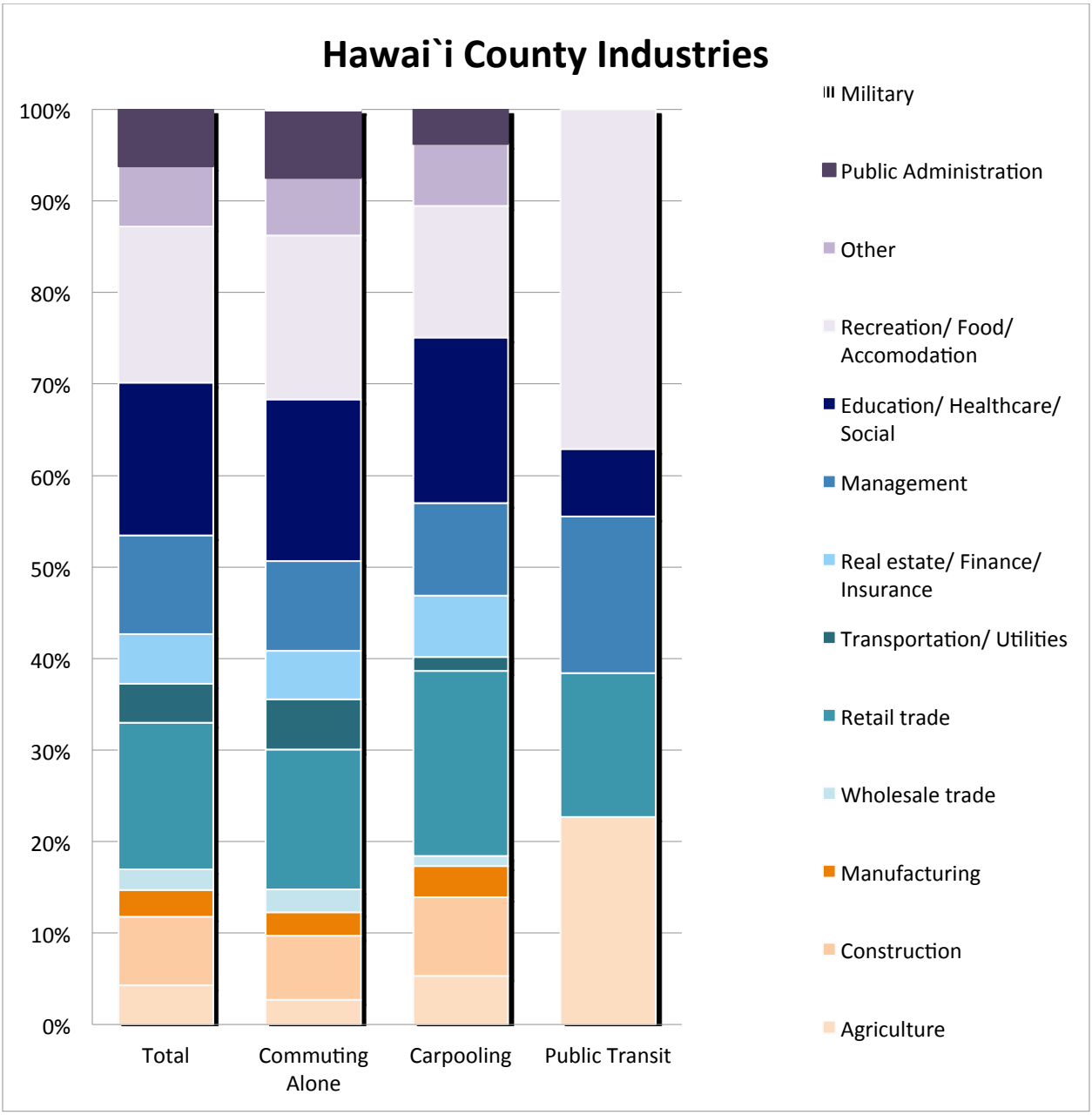
Figure 4-3



INDUSTRY

Overall Hawai`i County residents tend to work in three key industries: Retail Trade, Social Services (Education, Healthcare, etc.) and Hospitality. Public transit commuters, however, are much more likely to work in the Agriculture and Hospitality industries. Traditionally these are lower-wage industries and data is again consistent with the theory that public transit users are low-income and may use the system because it offers a more a cost-effective commuting option compared to the cost of vehicle ownership along with high gas prices.

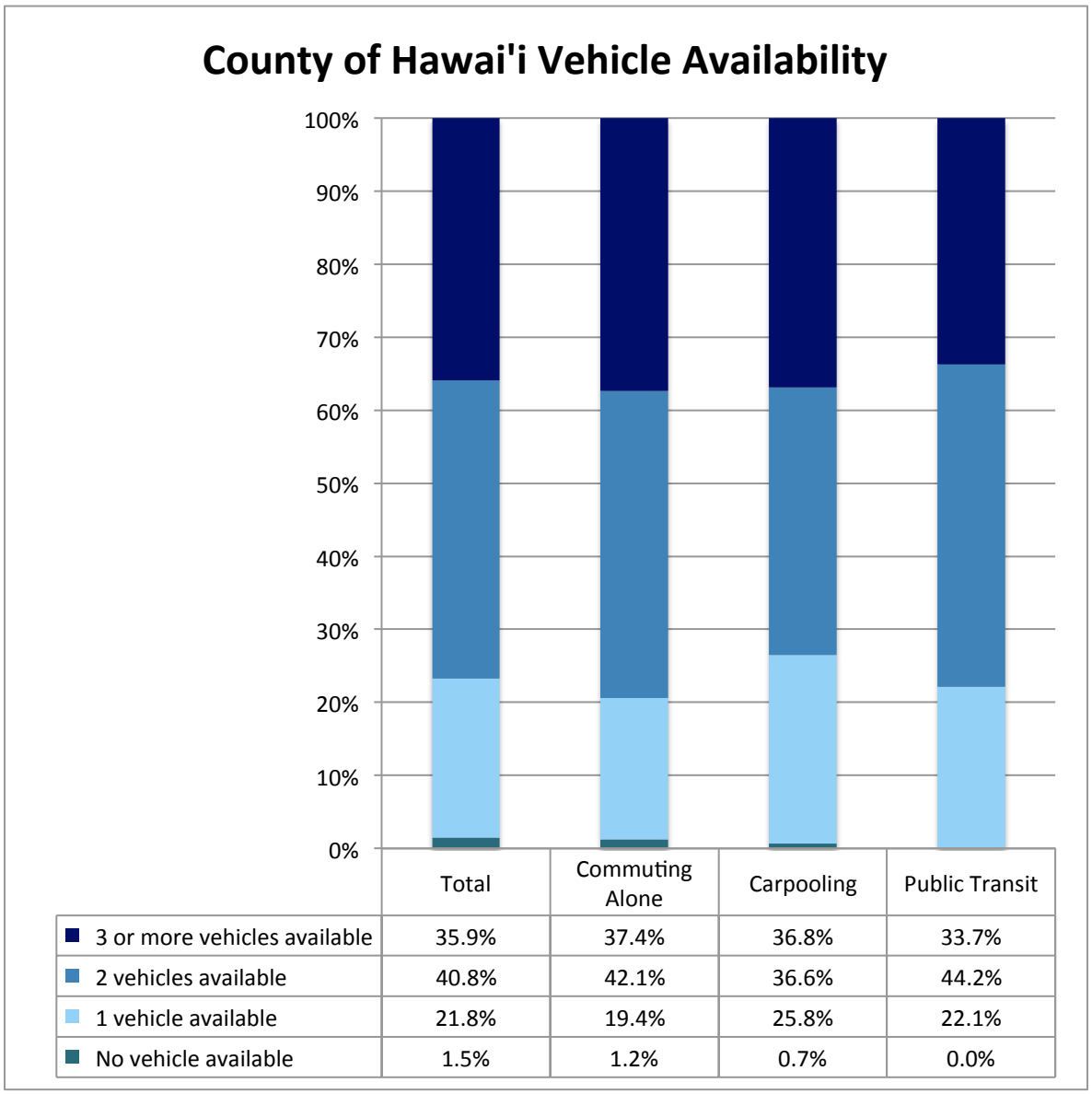
Figure 4-4



VEHICLE AVAILABILITY

Unlike the rest of the United States, virtually all of the residents of Hawai`i County have access to a car. Similar to other rural populations, fewer than 2% of residents of the county have no vehicle access, illustrating their extreme reliance on personal vehicles for transportation. It is interesting to note that the data collected by the ACS indicates that most if not all of the public transit commuters also own a vehicle. This is very different from the United States on a whole; the countrywide data shows that 37% of public transit commuters have no vehicle available for their use. This suggests that public transit commuters on Hawai`i choose to travel this way for reasons other than simple vehicle availability.

Figure 4-5

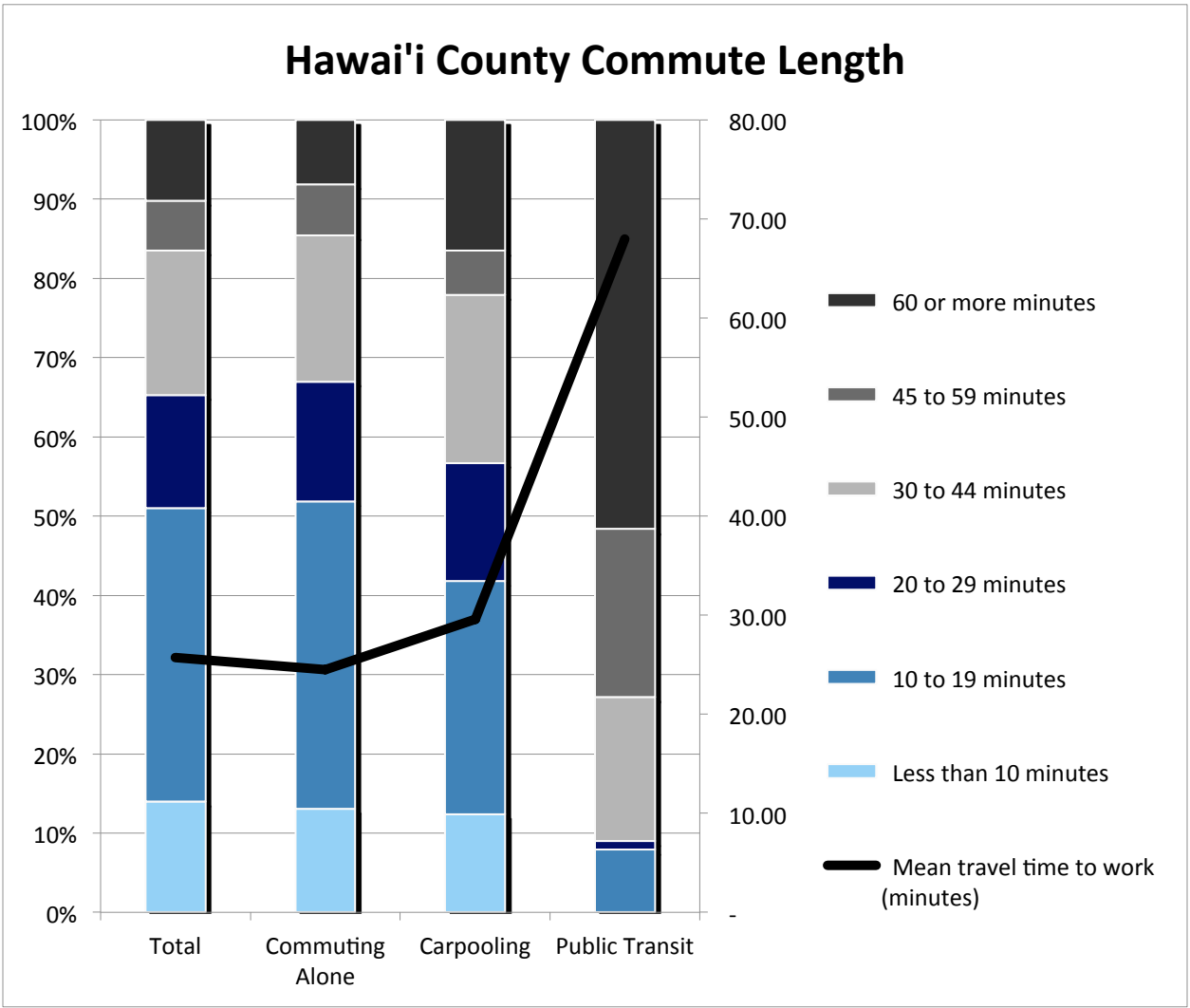


	Total	Commuting Alone	Carpooling	Public Transit
3 or more vehicles available	35.9%	37.4%	36.8%	33.7%
2 vehicles available	40.8%	42.1%	36.6%	44.2%
1 vehicle available	21.8%	19.4%	25.8%	22.1%
No vehicle available	1.5%	1.2%	0.7%	0.0%

COMMUTING TIME

The chart below shows average commute lengths for the different types of commuters of Hawai`i Island. Among all the residents of the island, the average time it takes to commute to work is between 25 and 30 minutes. This is consistent with the data from the United States and the rural areas of the United States. Public transit commutes in the United States tend to be longer than solo and carpool commutes with the average of 48 minutes. Rural areas have slightly longer public transit commutes (50 minutes), while Hawai`i Island is substantially longer at 68 minutes. In fact, more than 50% of public transit commuters on the island have a commute of 60 minutes or longer and almost 75% have a commute of 45 minutes or longer.

Figure 4-6

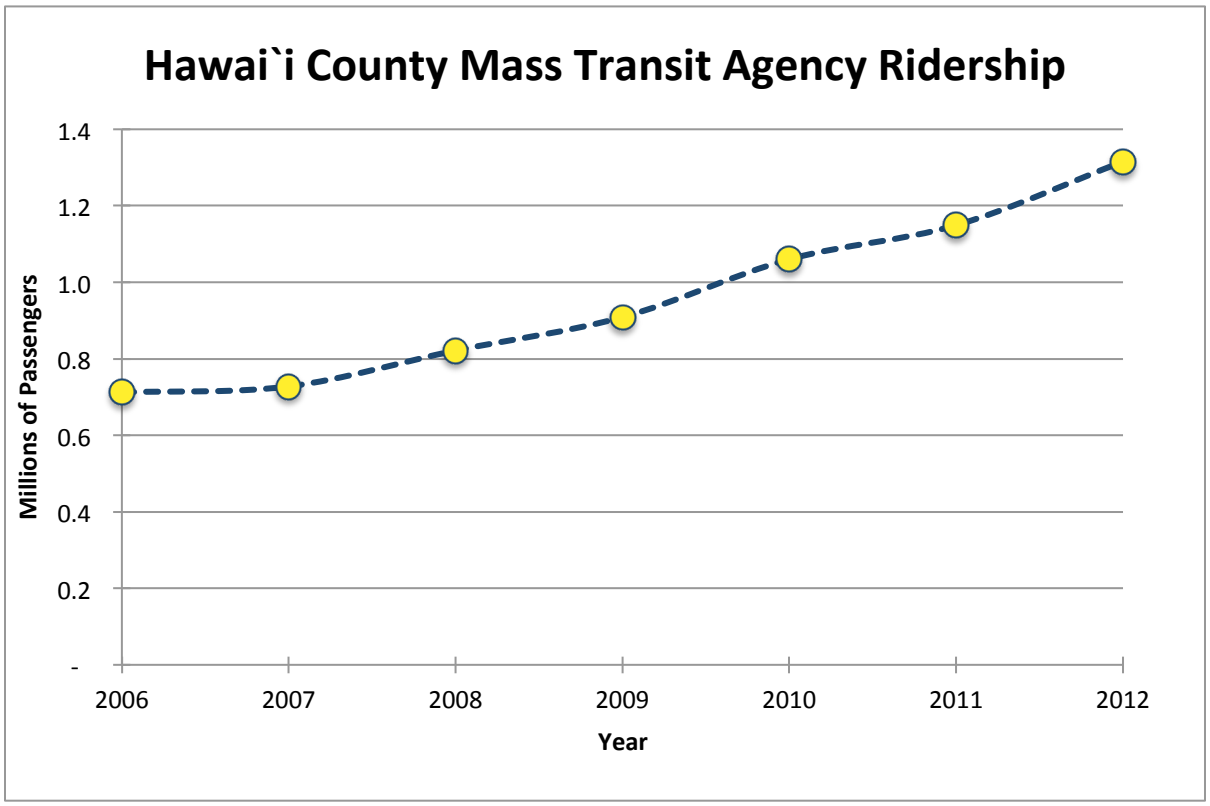


HAWAI`I COUNTY MASS TRANSIT AGENCY

The Hawai`i County Mass Transit Agency began collecting ridership data again in 2005 and currently delivers public transportation with its Hele-On bus service and shared taxi program.[66] The Hele-On bus offers 16 route options that range from intra-city (i.e. Kona and Hilo) to inter-city (i.e. Hilo to Waimea) to trans-island (i.e. Hilo to Kohala resorts). The fare for riding the bus has recently increased (as of July 1, 2013) from $1.00 to $2.00 per ride and from free to $1.00 for students, disabled individuals and seniors.[67] The shared taxi program offers door-to-door taxi service within Hilo and Kona for between $2.00-3.00 for trips fewer than four miles and between $6.00-9.00 for trips fewer than nine miles. The agency is funded by the local and federal governments, but receives no state funding for their operations.[68]

As of 2011 the agency had a staff of seven full-time equivalent employees.[69] According to the Mass Transit Administrator, the agency has hired a new transit assistant, account clerk, and mechanic and will be adding an additional mechanic in the first quarter of 2014 to meet the increasing demand for service, particularly in fast-growing areas like Puna.[70]

Figure 4-7



Ridership has been gradually increasing since the service began. According the most recent available *Comprehensive Fiscal Repor*t produced by Hawai`i County for the Fiscal Year ending on June 30, 2011, the ridership surpassed 1 million passengers in 2010 and reached approximately 1.15 million in 2011.[71] As of 2011, the agency owned a fleet of 56 vehicles to serve these riders. These vehicles ranged in size

from a 43-foot double-decker bus with a seating capacity of 89 people to 40-foot buses with seating capacities of 45-49 people to minibuses with a capacity of 20-32 people to minivans with a capacity of 10 people.[72]

ANALYSIS OF THE MASS TRANSIT AGENCY

In order to provide the most useful suggestions to help to Mass Transit Agency achieve its goals of providing transportation to those who desire it, we completed a SWOT analysis to identify the strengths, weaknesses, opportunities, and threats to the Island's transit agency. This framework acted as a guide for the analysis phase of this project and helped us focus our recommendations on those that are feasible and implementable.

Figure 4-8: Hawai`i County Mass Transit Agency SWOT Analysis

	Helpful	*Harmful*
Internal	**STRENGTHS** • Many routes are available and cross the island. • Trans-island commuter routes are popular and used extensively. • New staff joining the agency in Fall 2013, more capacity. • New administrator, who is interested in optimizing the current system and increasing services available. • County officials are engaged in the project and support innovative solutions. • County government is committed to improving quality of life for residents of the island.	**WEAKNESSES** • The Transit Agency does not employ technology to track ridership or optimize its current route and schedule planning. • Communications and knowledge sharing about transit routes is limited. • There is a funding gap between the cost of service and the revenue received from providing service.
External	**OPPORTUNITIES** • Many new cost-effective technologies are available to help optimize Hawai`i Island's current system. • New businesses are in development on the mainland and the other Hawaiian Islands that could partner with the Mass Transit Agency to provide other types of services. • Many groups on the island can share knowledge and ideas to help the Mass Transit Agency achieve its goals. • There are a number of businesses and students at the UH-Hilo to participate in pilot programs.	**THREATS** • Mass transit must serve very large county with a dispersed population. • Island geography makes creating new infrastructure infeasible or cost-prohibitive. • Residents are reliant on their cars and it may be hard to convince them to use public transit instead. • Federal funding sources are beholden to political forces in Washington, DC.

MAPPING TRANSIT ON HAWAI`I ISLAND

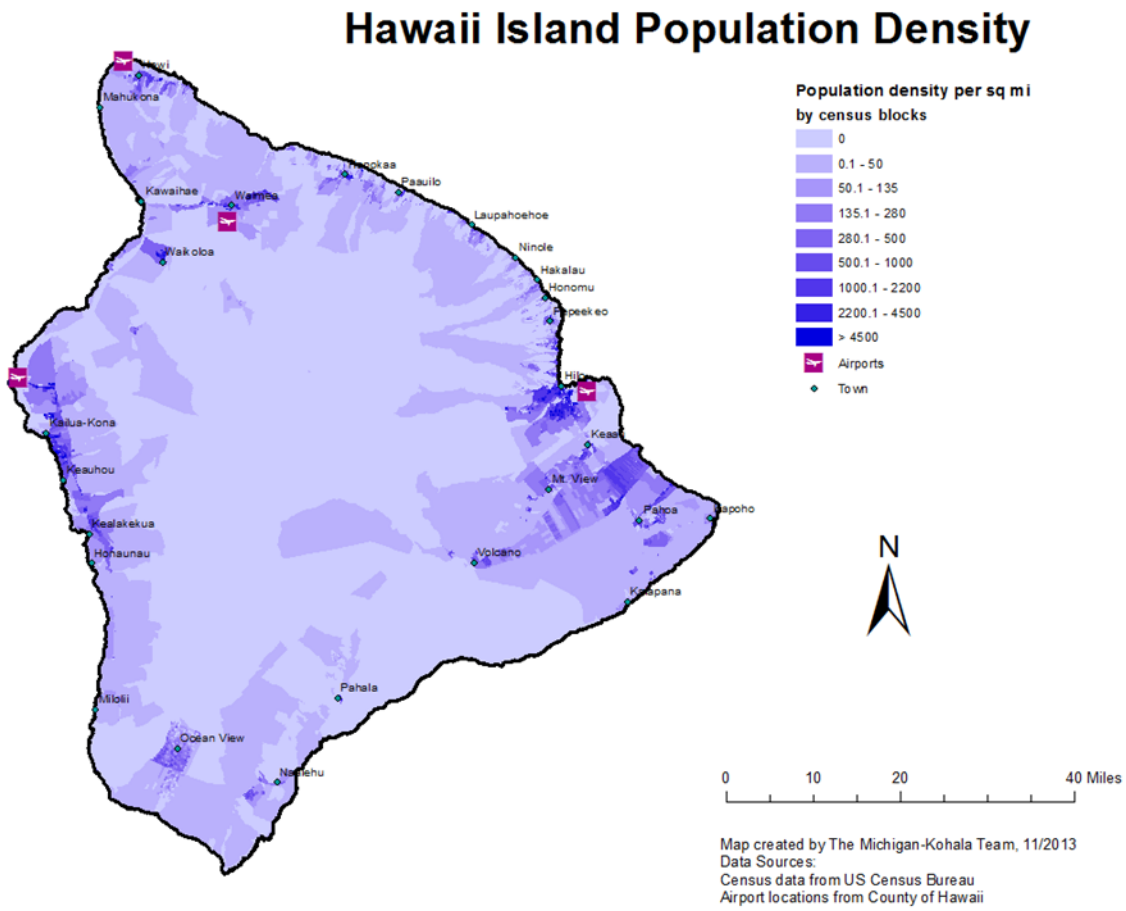
Because transit systems are tied so profoundly to the geography, our team analyzed existing available GIS, Census, County of Hawai`i and other data to understand the unique transit patterns and other interactions between the people and places on the island. We created maps of bus routes, work hubs, recreation hubs and population density to illustrate these unique patterns.

ANALYSIS OF MAPS

POPULATION DENSITY

The population density map in Figure 4-9 shows that population is clustered around the perimeter of the island at major towns including Hilo, Keaau, Mt. View, Pahoa, Ocean View, Kealakekua, Keauhou, Kailua-Kona, Waikoloa, Waimea and Hawi.

Figure 4-9



BUS ROUTES

Figure 4-10 displays the current bus routes on Hawai`i Island. The map in Figure 4-11 compares the bus route coverage with the population density on the island. Population density can indicate the transit need of the corresponding areas. The higher the density, the more transportation services are needed. Bus route coverage roughly represents transportation accessibility. The more bus routes covered in an area, the better the possibility that the mass transit system fulfills the transit requirements of residents. However, different bus routes could have different bus frequencies, and different buses could have different capacities. These factors make a comprehensive analysis of transportation accessibility nearly impossible based on the existing data. Nevertheless, the following table regarding bus frequency can hopefully provide supporting information to the map.

Table 4-2: Bus Frequency for Each Route [73]

Bus Routes	Buses Per Day
Downtown/Ainako/Kaumana	11
Downtown Hilo/Aupuni Center/Prince Kuhio Plaza	49
Mooheau/Keaukaha	17
Downtown/Waiakea-Uka	10
Hilo/South Kohala Resorts	12
Honokaa/Hilo	26
Ka'ū/Volcano/Hilo	10
Kona/Hilo	12
Intra-Kona	20
North Kohala/South Kohala	2
North Kohala/Waimea/Kailua-Kona	2
Pahala/Kona/South Kohala	6
Pohoiki/Pahoa/Hilo	22
Kamuela Lakeland/Kamuela View Est	22
Waimea/Hilo	21
Waikoloa Village	16

We overlaid the bus route layer and the population density layer to roughly indicate whether the regions that require more transit frequency - actually have enough transportation accessibility. If an area has a high population density and requires more transit frequency but has limited bus route coverage, that area would be worth further studying to determine if the current mass transit system providing sufficient service to the area. Analysis of bus route coverage relative to work hubs and recreational hubs are carried out in the following paragraphs with the same objective.

Hele-On Double Decker Bus (source: hawaiicountymayor.com)

Table 4-3 quantifies the number of routes serving each of the most densely populated areas. Hilo and Kailua-Kona are two of the most-served areas with four routes within Hilo, six routes to or from Hilo and four routes to or from Kailua-Kona. However, areas around Mountain View and Pahoa are only covered by one bus route.

Table 4-3: Bus Route Coverage Compared to Population Density

Area	**Hilo**	**Keaau**	**Mt. View**	**Pahoa**	**Ocean View**
Bus route coverage	> 8	3	1	1	2
Area	**Kealakekua**	**Keauhou**	**Kailua-Kona**	**Waikoloa**	**Hawi**
Bus route coverage	3	4	4	2	2

Figure 4-10

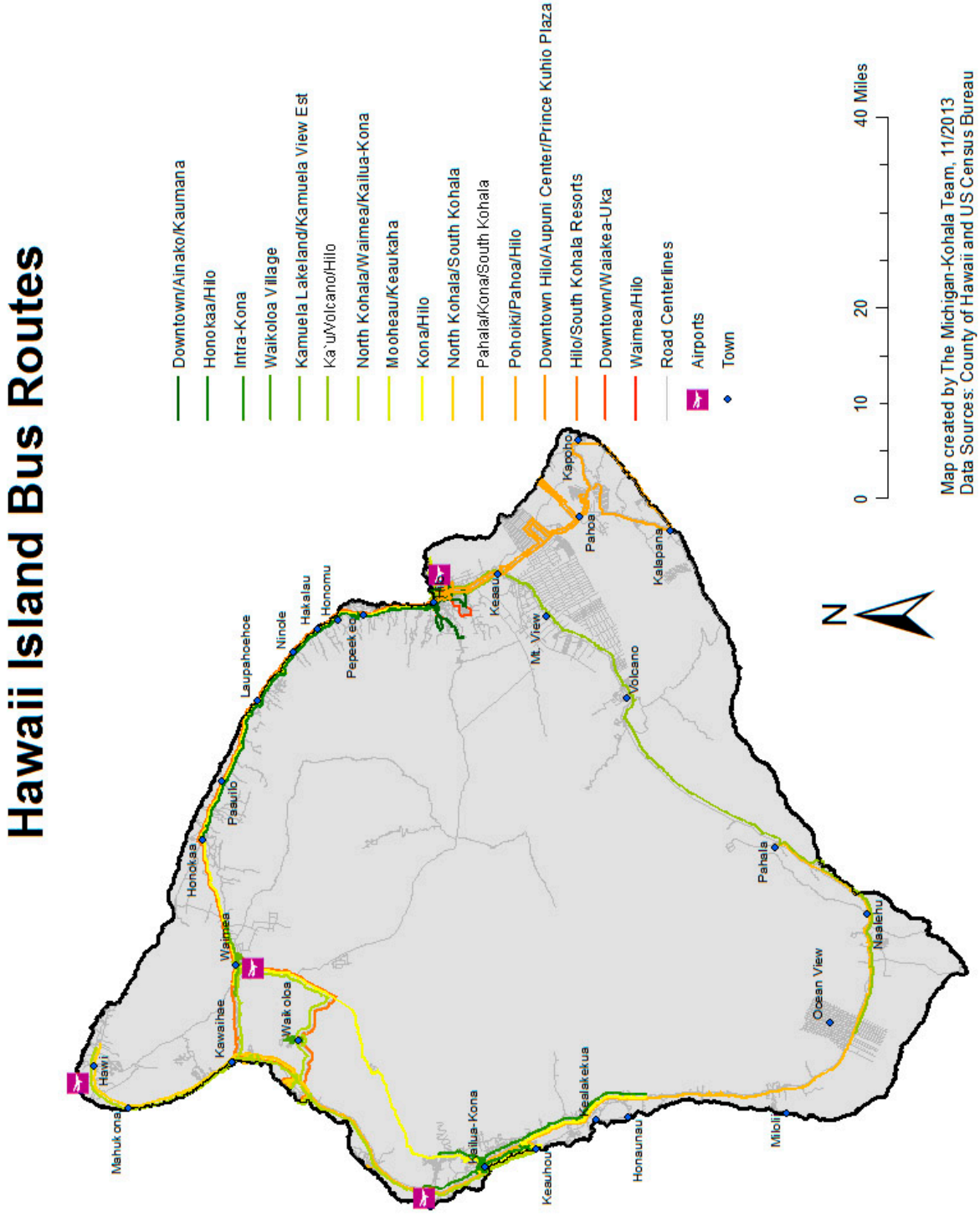
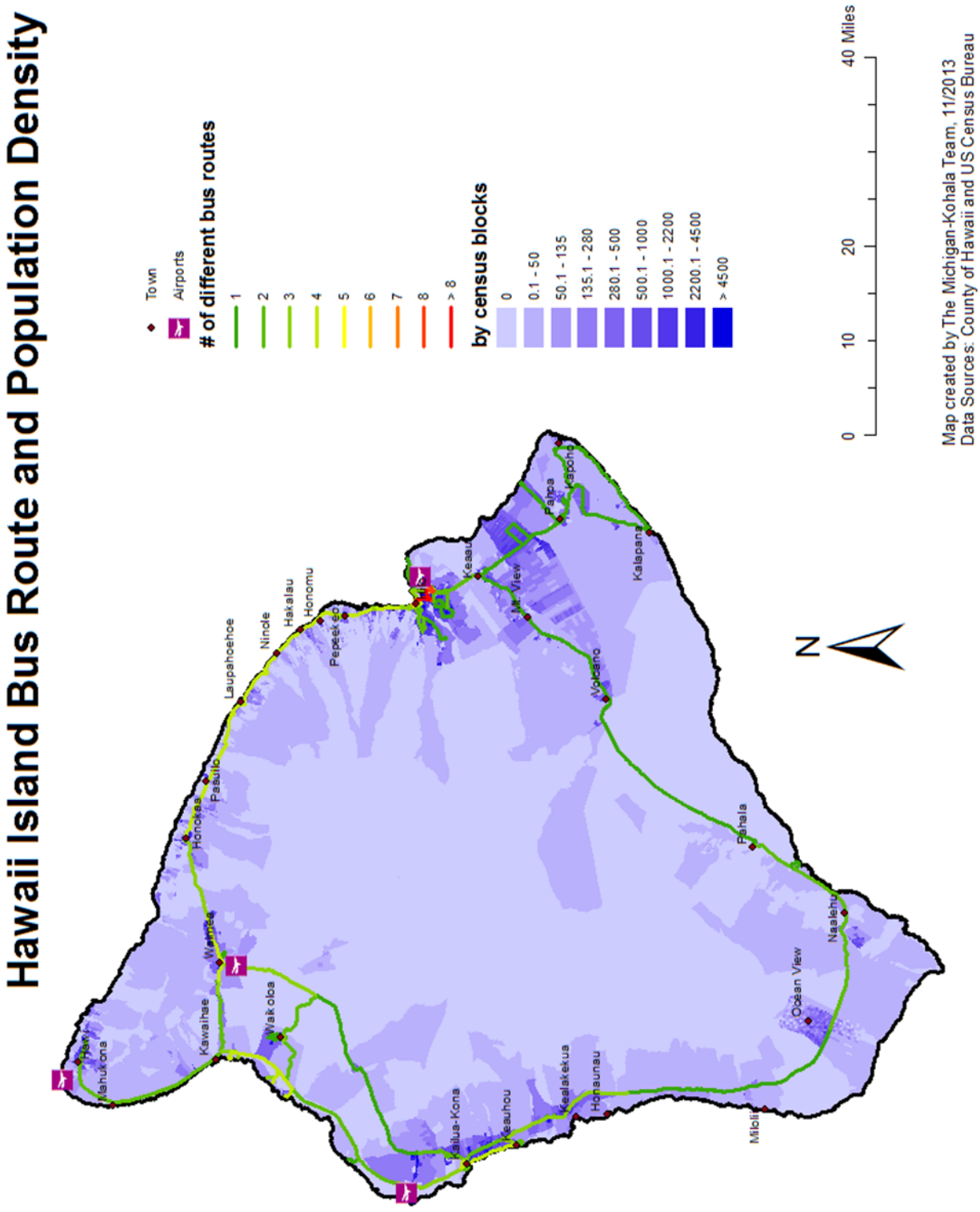

Hawaii Island Bus Routes
Downtown/Ainako/Kaumana
Honokaa/Hilo
Intra-Kona
Waikoloa Village
Kamuela Lakeland/Kamuela View Est
Ka`u/Volcano/Hilo
North Kohala/Waimea/Kailua-Kona
Mooheau/Keaukaha
Kona/Hilo
North Kohala/South Kohala
Pahala/Kona/South Kohala
Pohoiki/Pahoa/Hilo
Downtown Hilo/Aupuni Center/Prince Kuhio Plaza
Hilo/South Kohala Resorts
Downtown/Waiakea-Uka
Waimea/Hilo
Road Centerlines
Airports
Town
0
10
20
40 Miles
N
Map created by The Michigan-Kohala Team, 11/2013
Data Sources: County of Hawaii and US Census Bureau
Kapoho
Pahoa
Kalapana
Kea'au
Mt. View
Volcano
Pepeekeo
Honomu
Hakalau
Ninole
Laupahoehoe
Pauilo
Honokaa
Waimea
Kawaihae
Waikoloa
Hawi
Mahukona
Kailua-Kona
Keauhou
Keslakekua
Honaunau
Miloli
Pahala
Ocean View
Naalehu

Figure 4-11


Hawaii Island Bus Route and Population Density
Town
Airports
# of different bus routes
1
2
3
4
5
6
7
8
> 8
by census blocks
0
0.1 - 50
50.1 - 135
135.1 - 280
280.1 - 500
500.1 - 1000
1000.1 - 2200
2200.1 - 4500
> 4500
0
10
20
40 Miles
N
Map created by The Michigan-Kohala Team, 11/2013
Data Sources: County of Hawaii and US Census Bureau
Laupahoehoe
Ninole
Hakalau
Honomu
Pepeekeo
Hilo
Keaau
Mt. View
Volcano
Kalapana
Papa
Kapoho
Pahala
Naalehu
Ocean View
Miloli
Honaunau
Kealakekua
Keauhou
Kailua-Kona
Waikoloa
Waimea
Kawaihae
Honoka
Pauilo
Kohala
Mahukona

The map in Figure 4-12 compares the bus routes with recreation site density. Hot spots for recreation are around Hilo, Pahala, Honaunau, Kailua-Kona, Kawaihae, Mahukona, Honokaa and Honomu. Their bus route coverage is shown accordingly below. It is worth noting that Pahala is only covered by one bus route. Mauna Kea State Park, a very popular attraction,[74] is completely out of bus coverage because it is on Saddle Road, which lacks bus routes.

Table 4-4: Bus Route Coverage Compared to Recreation Areas

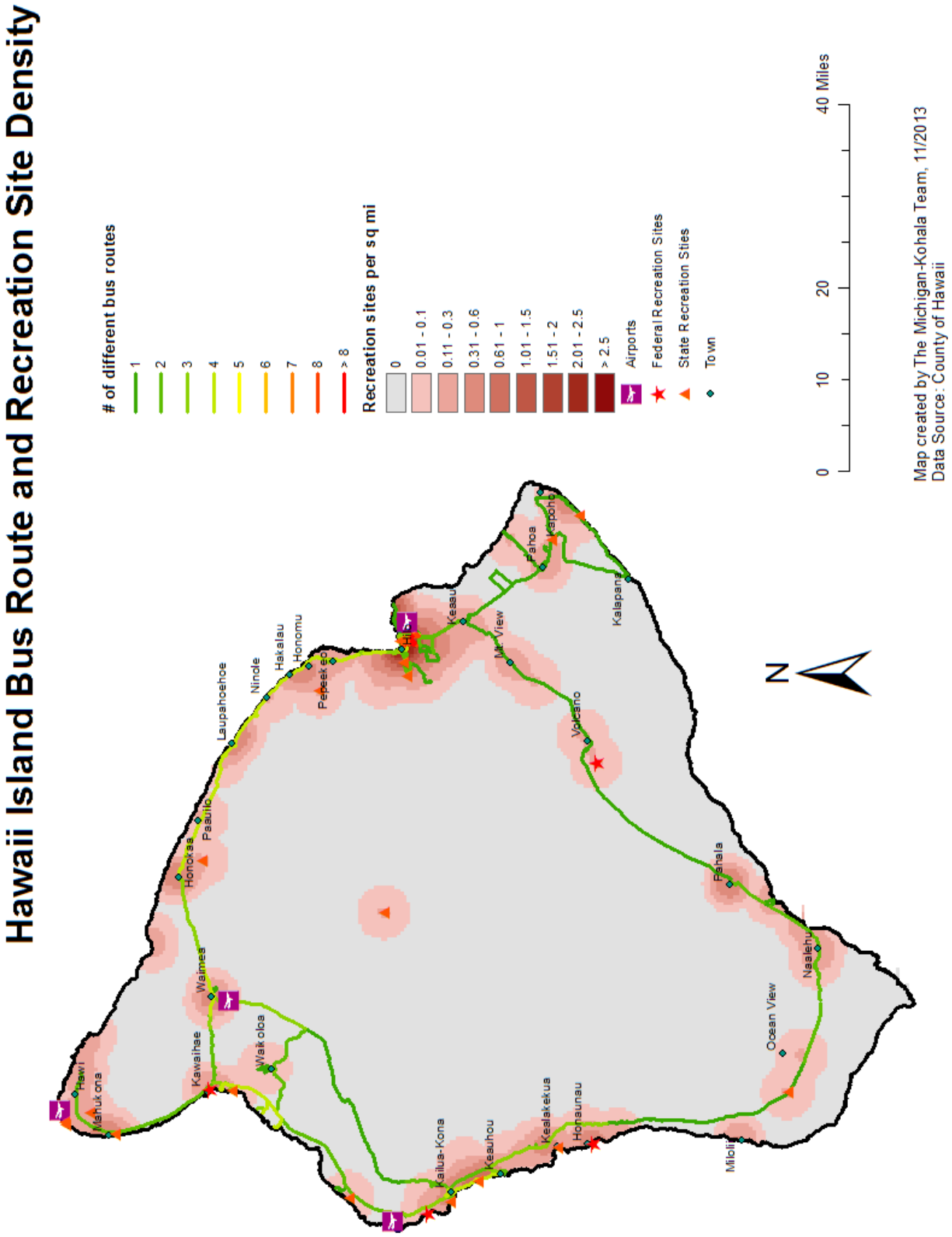
Recreation Area	**Hilo**	**Pahala**	**Honaunau**	**Kailua-Kona**
Bus route coverage	> 8	1	3	4
Recreation Area	**Kawaihae**	**Mahukona**	**Honakaa**	**Honomu**
Bus route coverage	3	2	4	4

It is important to note that the map of recreational hubs simply shows location of recreational sites. An analysis of the density of visitation would be more informative, but we are not able to get visitation data from recreation sites other than federal-level and state-level sites. The visitation data we have is presented below. All of the federal site data is actual 2013 data from the U.S. National Park Service. [75] The state park data is from the 2007 Hawai`i State Parks Survey. [76] The Survey estimates visitation data with its own methodology. Obviously it is not ideal to use estimated data and data from separate years, but this should at least provide some context for the map of recreational hubs since the federal-level and state-level recreation sites are labeled on the map.

Table 4-5: Annual Visitation of Federal and State Recreation Sites on Hawai`i Island

Federal and State Recreation Sites	Annual Visitations
Hawai`i Volcanoes National Park	1,583,209
Hapuna Beach State Recreation Area	514,300
Pu'uhonua o Hōnaunau National Historical Park	363,282
Kekaha Kai State Park	235,700
Old Kona Airport State Recreation Area	217,000
Wailuku River State Park	211,200
'Akaka Falls State Park	189,400
Kaloko-Honokohau National Historical Park	158,124
Kealakekua Bay State Historical Park	155,900
Wailoa River State Park	155,400
Puukohola Heiau National Historic Site	125,645
Kiholo State Park Reserve	76,300
Mauna Kea State Recreation Park	64,600
Lava Tree State Monument	44,400
Lapakahi State Historical Park	30,600
Manuka State Wayside Park	25,900
keolonahihi State Park	22,300
MacKenzie State Wayside	11,900
Kohala Historical Sites	9,800
Kalopa State Recreation Area	5,500

Figure 4-12


Hawaii Island Bus Route and Recreation Site Density
# of different bus routes
1
2
3
4
5
6
7
8
> 8
Recreation sites per sq mi
0
0.01 - 0.1
0.11 - 0.3
0.31 - 0.6
0.61 - 1
1.01 - 1.5
1.51 - 2
2.01 - 2.5
> 2.5
Airports
Federal Recreation Sites
State Recreation Sties
Town
0
10
20
40 Miles
N
Map created by The Michigan-Kohala Team, 11/2013
Data Source: County of Hawaii
Hawi
Kahuku ona
Kawaihae
Waimea
Waik oloa
Honokaa
Paauilo
Laupahoehoe
Ninole
Haxalau
Honomu
Pepeek eo
Hilo
Keaau
Mtn View
Pahoa
Kapoho
Kalapana
Volcano
Kailua-Kona
Keauhou
Kealakekua
Honaunau
Miloli
Pahala
Ocean View
Naalehu

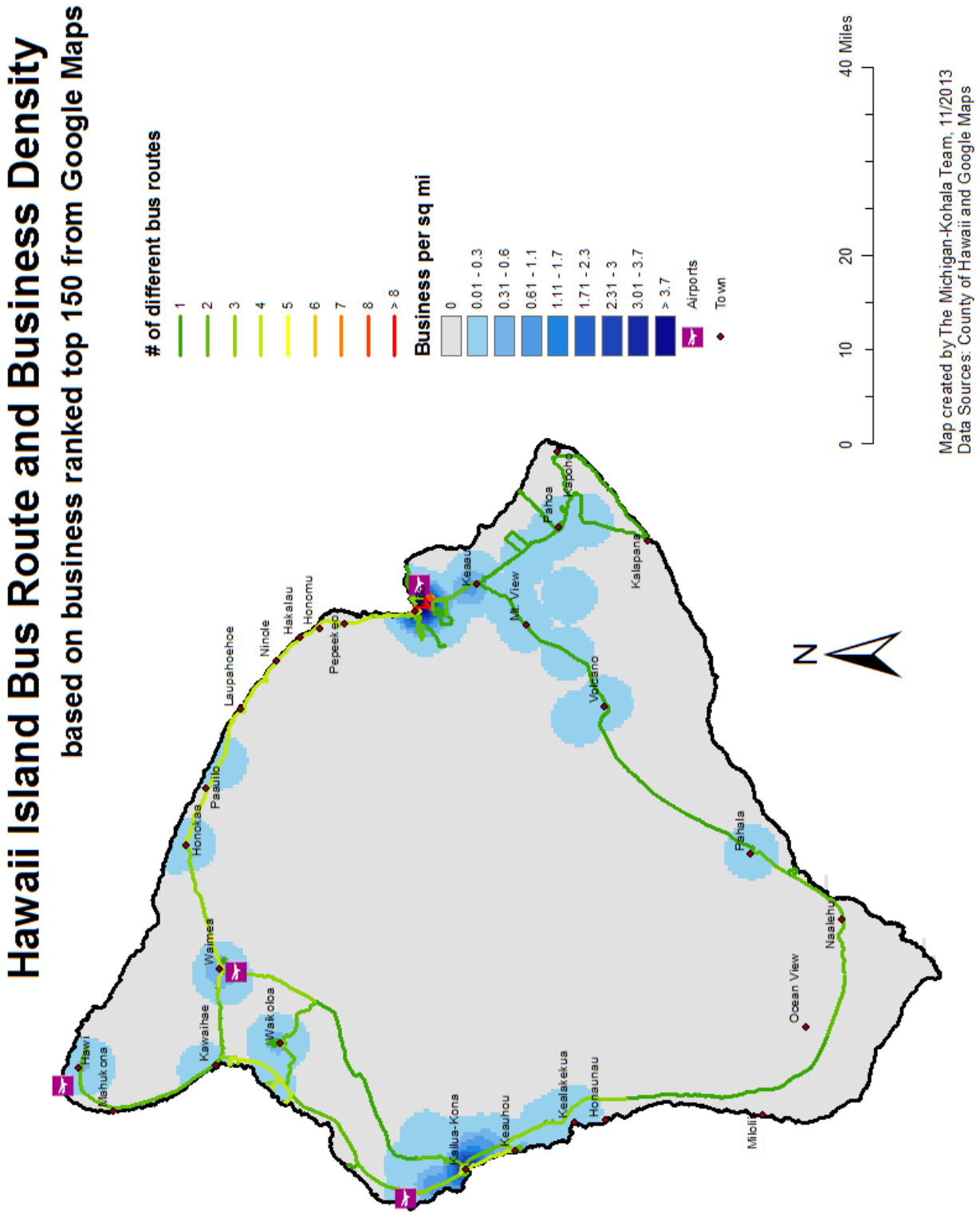
The map in Figure 4-13 shows bus routes compared to density of businesses within a given area. A large number of businesses are centered in and around Hilo, which is covered by more than eight bus routes and Kailua-Kona, which is covered by four bus routes.

Hawai`i Island has two primary airports, Hilo International Airport (ITO) and Kona International Airport at Keahole (KOA). These two airports serve as major hubs for arrival to and departure from Hawai`i Island. According to the Federal Aviation Administration (FAA), the enplanements (passenger boardings) of ITO and KOA in 2012 were 641,904 and 1,367,091 respectively.[77] Given the amount of passengers, it is necessary to study the public transit connectivity of the airports.

Currently, ITO is not covered by the Hawai`i County Mass Transit Agency Hele-On bus service. KOA is covered by two bus routes, which are the *Intra Kona* route and the *Pahala/Kona/South Kohala* route, but the number of buses involved is limited. These two routes each have only one bus going to KOA at 8:20 a.m. and two buses leaving from KOA at 8:30 a.m. and 4:50 p.m. every Monday to Saturday.[78] Apart from the very limited bus service, the airports are also accessible by car, taxi and shuttle.[79] [80] The alternative transportation approaches, however, have smaller capacity and are often more expensive. As a result, we think increasing Hele-On bus connectivity to the two primary airports should be considered in future bus route planning.

As a result of the analysis, we can see that the current mass transit system serves key areas of the island, especially business hubs, in terms of number of routes, but we cannot tell if those routes run frequently enough to meet demand. Overall, most recreation hubs and population clusters are served by multiple bus routes, except that Mauna Kea State Park is not accessible by bus, and Mountain View, Pahoa and Pahala are all only covered by one bus route. The bus route connectivity to the two major airports is limited as well. These findings are one important factor for evaluating overall network efficiency. Other considerations should include redundancy in routes, scheduling, and demand for inter-town and intra-town service. We examine technologies available for gathering data on these considerations in the OPTIMIZING PUBLIC TRANSIT WITH TECHNOLOGY SOLUTIONS section starting on page 47.

Figure 4-13


Hawaii Island Bus Route and Business Density
based on business ranked top 150 from Google Maps
# of different bus routes
1
2
3
4
5
6
7
8
> 8
Business per sq mi
0
0.01 - 0.3
0.31 - 0.6
0.61 - 1.1
1.11 - 1.7
1.71 - 2.3
2.31 - 3
3.01 - 3.7
> 3.7
Airports
Town
0
10
20
40 Miles
N
Map created by The Michigan-Kohala Team, 11/2013
Data Sources: County of Hawaii and Google Maps
Hawi
Kohala
Kawaihae
Waimea
Waikoloa
Honokaa
Paauilo
Laupahoehoe
Ninole
Hakalau
Honomu
Pepeekeo
Hilo
Keaau
Mt View
Pahoa
Kapoho
Kalapana
Volcano
Pahala
Naalehu
Ocean View
Miloli
Honaunau
Kealakekua
Kauhou
Kailua-Kona

LIMITATIONS OF ANALYSIS

Data acquisition is the major issue in creating accurate and useful maps and producing relevant analysis. Different recreation sites can generate vastly different annual numbers of visitors. For instance, Volcanoes National Park gets a lot more visitors than the much smaller Onekahakaha Beach Park in Hilo. We were able to get the annual number of visitors of national parks and state parks, but this data was lacking for most of smaller recreation sites (the annual visitor data does not exist as visitors are not tracked in many of these sites). National Parks and State Parks are labeled separately to better show those recreation sites on the Island for which we have visitation data.

Likewise, one business may employ 1,000 people, while another may employ only 10. The data of the number of employees for all businesses of the island was difficult to obtain. As a result, we developed the map of work hubs just based on their locations. In fact, getting locations of all the businesses was in itself also quite difficult, given the overall number of businesses is more than 20,000 with no single public database storing all of their locations. Instead, we chose to make estimations of work hub distributions based on the most popular businesses (based on Google Analytics), hoping the pattern of estimated work hubs on the map could more or less reflect the true pattern in reality.

Continuous updates are important to increase the accuracy all of the maps and should be undertaken as new data becomes available.

CREATING THESE MAPS

Data sources and contents, data processing approaches and map-making techniques are explained in the Appendix D.

5: MAUI COUNTY - A PUBLIC TRANSIT CASE STUDY

MAUI COUNTY PUBLIC TRANSIT

Maui County was chosen as a case study because of the similar rural nature of Maui and Hawai`i Island, relative to the other Hawaiian Islands. While Maui County encompasses four islands, only the island of Maui has a public transit system. The very first public bus service on Maui was started in 2002.[81] Today, the Maui Department of Transportation (DOT) runs the system in the County government, and the DOT essentially functions as the Mass Transit Agency on Maui. The Maui DOT also runs paratransit, which is a flexible transit service that involves demand response and is commonly used to transport ADA passengers. However, paratransit is outside of the realm of Hele-On and thusly not a focus of investigation in this report. There are a total of 13 fixed routes along with four routes that are designated as commuter service. All of the routes are contracted out to, and operated by, Roberts Hawaii. The non-commuter routes have standardized schedules that run throughout the day, leaving at regular intervals of 0.5, 1, or 1.5 hours. The commuter routes cater to the working schedules of resort employees, similar to some of the longer Hele-On routes. The fares are similar to Hele-On at $2 per ride, $4 per daily pass, and $45 for a monthly pass with discounts for students and seniors.[82] A similar system operational structure exists as well, with the management done by the government, but the day-to-day operation of the routes is contracted out.[83] A couple of basic differences between the Maui bus system and Hele-On are that Maui has bus stop signs more consistently, and the presentation of route maps and schedules are more readable (see Figures 5-1 and 5-2).[84]

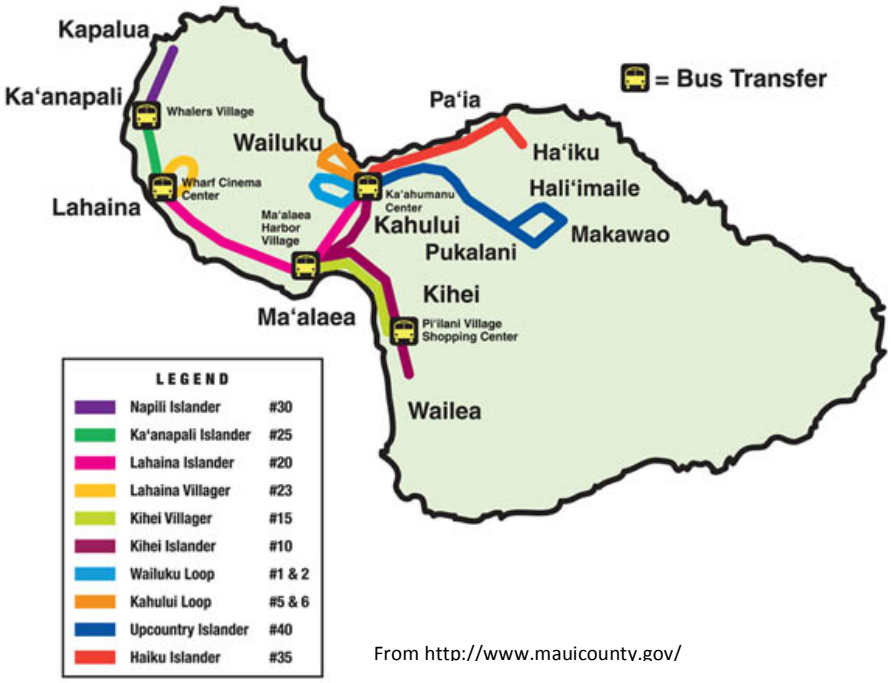
Figure 5-1: Maui Bus Schedule

WAILUKU LOOP ROUTE #1

Queen Ka'ahumanu Center	Maui Memorial Hospital	Maui Lani Parkway	Ka Hale A Ke Ola	State Office Building	Malama I Ke Ola Health Clinic	Wailuku Post Office	Piiholo Terrace	Makaala Dr. fronting Hale Mahaolu	Waiehu Heights	Hawaiiana Homes	Eha St. Fire Hall Back N Slave	Wailuku Community Center	Kanaloa Ave./ Little League Field	Queen Ka'ahumanu Center
6:30	6:37	6:39	6:47	6:52	6:55	6:58	7:03	7:08	7:11	7:12	7:13	7:15	7:21	7:30
7:30	7:37	7:39	7:47	7:52	7:55	7:58	8:03	8:08	8:11	8:12	8:13	8:15	8:21	8:30
8:30	8:37	8:39	8:47	8:52	8:55	8:58	9:03	9:08	9:11	9:12	9:13	9:15	9:21	9:30
9:30	9:37	9:39	9:47	9:52	9:55	9:58	10:03	10:08	10:11	10:12	10:13	10:15	10:21	10:30
10:30	10:37	10:39	10:47	10:52	10:55	10:58	11:03	11:08	11:11	11:12	11:13	11:15	11:21	11:30
11:30	11:37	11:39	11:47	11:52	11:55	11:58	12:03	12:08	12:11	12:12	12:13	12:15	12:21	12:30
12:30	12:37	12:39	12:47	12:52	12:55	12:58	1:03	1:08	1:11	1:12	1:13	1:15	1:21	1:30
1:30	1:37	1:39	1:47	1:52	1:55	1:58	2:03	2:08	2:11	2:12	2:13	2:15	2:21	2:30
2:30	2:37	2:39	2:47	2:52	2:55	2:58	3:03	3:08	3:11	3:12	3:13	3:15	3:21	3:30
3:30	3:37	3:39	3:47	3:52	3:55	3:58	4:03	4:08	4:11	4:12	4:13	4:15	4:21	4:30
4:30	4:37	4:39	4:47	4:52	4:55	4:58	5:03	5:08	5:11	5:12	5:13	5:15	5:21	5:30
5:30	5:37	5:39	5:47	5:52	5:55	5:58	6:03	6:08	6:11	6:12	6:13	6:15	6:21	6:30
6:30	6:37	6:39	6:47	6:52	6:55	6:58	7:03	7:08	7:11	7:12	7:13	7:15	7:21	7:30
7:30	7:37	7:39	7:47	7:52	7:55	7:58	8:03	8:08	8:11	8:12	8:13	8:15	8:21	8:30
8:30	8:37	8:39	8:47	8:52	8:55	8:58	9:03	9:08	9:11	9:12	9:13	9:15	9:21	9:30

From http://www.mauicounty.gov

Figure 5-2: Map of Maui Bus System



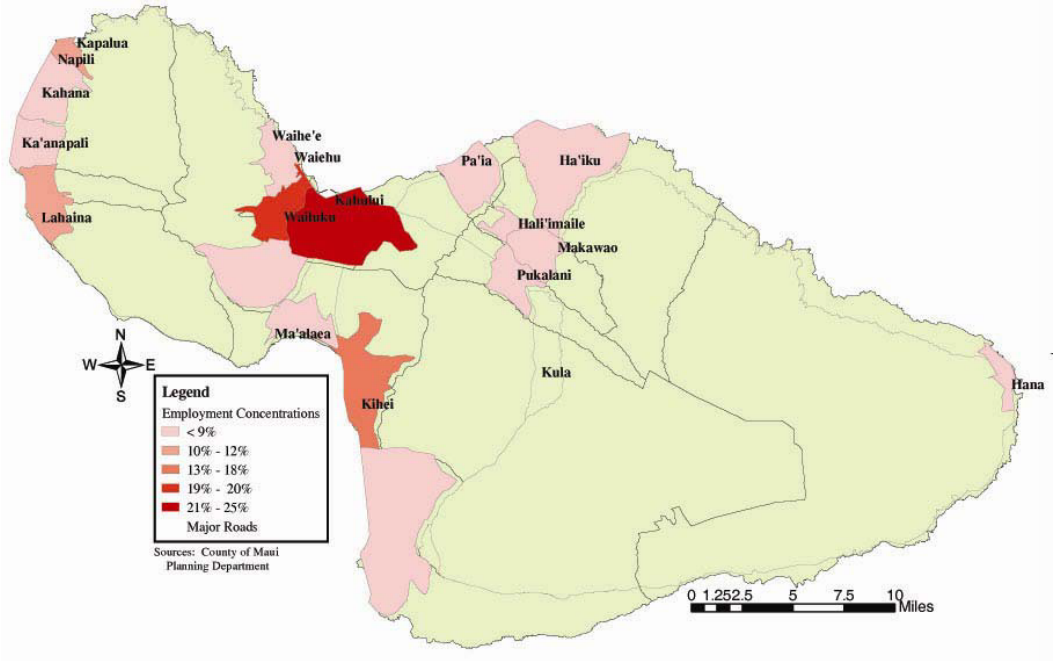
From http://www.mauicounty.gov/

Most of Maui's route analysis and updates are now based on public feedback, which often comes through public hearings. The simplicity of the non-commuter route schedules, with regular intervals, is cited as a reason for not having pursued GPS technology.

MAUI COUNTY SHORT RANGE TRANSIT PLAN

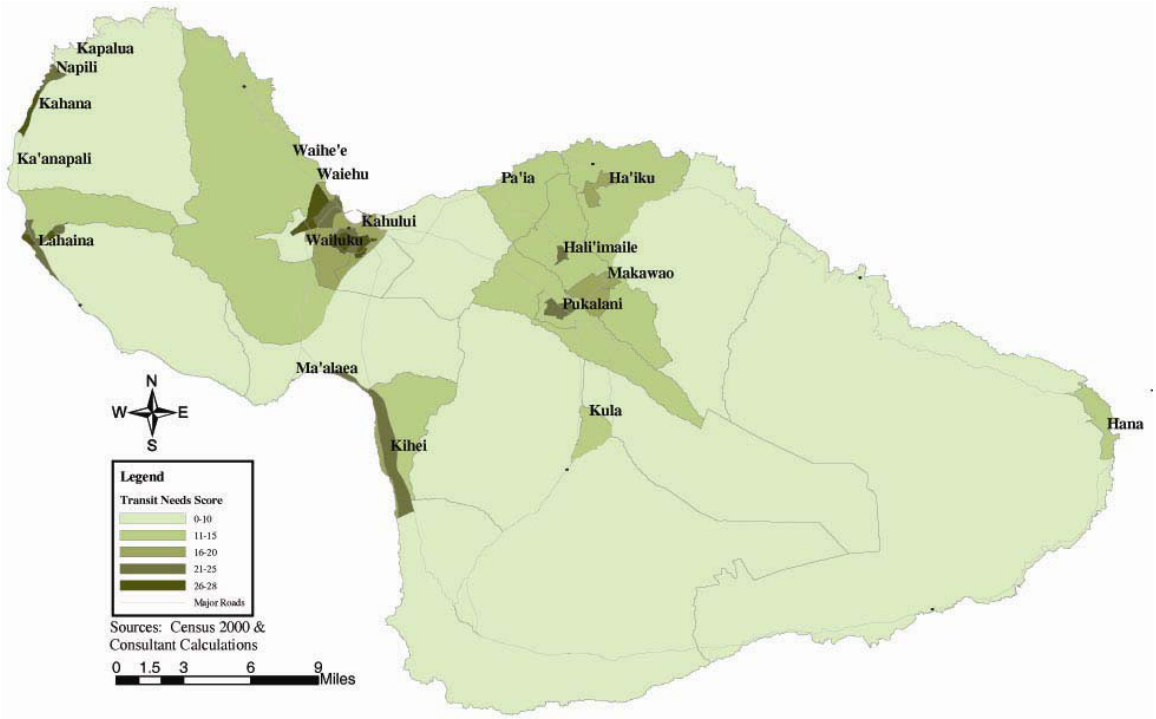
Maui County released a short-range transit plan in 2005. At this stage, the bus system was still in relative infancy with three routes run by Roberts Hawaii and only six fixed routes in total. As a result, much of this transit plan focused on planning and implementing expansions to their services. The report was prepared by Urbitran Associates, which was a consulting firm that specializes in urban transit planning, but has since been bought out by AECOM.[85,86] In order to identify areas of need for bus service, a scoring system was used with demographic variables to create a "transit needs index." The variables considered were: 1) population density; 2) employment density; 3) median household income; 4) disability status; 5) age. Some maps were provided for each of these, including an Employment Density map (see Figure 5-3).

Figure 5-3: Maui Employment Density Map[87]



Within each category, neighborhoods were scored in a range of 1-5. Summing up the scores then allowed for a map to be created with differing shades for ranges of transit needs scores (see Figure 5-4).

Figure 5-4: Maui Transit Need Map[88]



Other considerations were made for major destinations ranging from shopping and recreation to senior citizen centers, hotels, and medical facilities. A proactive stakeholder engagement strategy was used as well, including interviews, drop-in sessions with passengers and drivers, public workshops, and comment forms.[89]

As for technological recommendations, one key suggestion was for ridership data to be collected via some sort of counter system, which would allow for more effective tracking; this includes breaking down data by route, time of day, trip, and passenger type. This information would be valuable for future route and system planning along with analyzing usage of current routes. Along those lines, Urbitran recommended replacing the manual fare boxes with an electronic fare payment system to improve system efficiency. Other recommendations for future additions to the public transit system were Automatic Vehicle Location (AVL) and real-time public information and displays, or Traveler Information Systems (TIS). It is important to note that these suggestions were made in January of 2005. While none of these upgrades have been made, most of them are being investigated by the County government.

TECHNOLOGY CURRENTLY EMPLOYED BY MAUI

A couple of technologies that are currently used by Maui are Geographic Information Systems (GIS) and Google Transit. From speaking to one of the GIS specialists in the Maui government, the initial development of the GIS route maps required "a good amount of effort," while making updates is relatively easy. One of the lessons learned by Maui in developing GIS maps is that it is particularly helpful to have people working on the GIS aspects who understand the transit side as well as people who understand the GIS side working on the transit aspects, for quality's sake.[90]

Camera systems are also currently in use, which have helped police investigating incidents such as vandalism. While they did not purchase the full GPS option that came along with the cameras, they do get warnings for events such as accidents or speeding. While current ridership data collection is done manually, there have been talks to move towards a technological solution for such information gathering. Reasons cited for deciding to look into this include efficiency on the buses, as well as allowing for better management of the system. The County government is also looking into the acquisition of GPS.[91]

COMPARING HAWAI`I AND MAUI

Based on the data, Maui has a larger bus system than Hawai`i Island. The ridership is approximately double that of Hawai`i, and it is growing at a faster rate as well (see the Table 5-1).

Table 5-1: Hawai'i and Maui Ridership (in millions)

Year	Hawai`i Ridership[92]	Maui Ridership[93]
2012	1.32	2.7
2011	1.15	2.3
2010	1.06	2.14
2009	0.91	2.01
2008	0.82	1.5
2007	0.73	Not available
2006	0.71	Not available

Correspondingly, Maui spends much more on its bus system than Hawai`i, and this gap grows even larger when viewed on a per resident basis (See Table 5). The population data shown is for 2010, but the operational budgets used were the actual budgets for 2012 in order to match up with the most recent ridership data available. The budget number used for Maui does not include paratransit funding in order to allow for a more accurate comparison. The source for the budget data comes from the 2014 operating budgets for each county. Within these documents, actual budgets for 2012 were used for the purpose of this analysis. Both budgets are actual, as opposed to proposed, budget numbers, and they are operational, as opposed to capital expenditures. This allows for a more accurate measurement across the transit agencies that would not be swayed by one agency or the other making significant investments in increasing their vehicle fleets. Another conclusion that can be drawn is the Maui system has a passenger board more frequently in general than the Hawai`i system, and a likely explanation for this is that Hele-On has a greater portion of long, commuter-type routes. Additionally, Maui spends over four times more per vehicle-mile traveled, meaning their system may not be as efficient, although the conclusion cannot necessarily be drawn that they spend more per passenger-mile traveled.

Table 5-2: Hawai'i and Maui Transit Data Comparison

	Hawai`i County	Maui County
Population	189,191[94]	144,444[95]
Transit Operational Spending	$2,765,720[96]	$6,977,500[97]
Per Capita Expenses	$14.62	$48.31
Ridership (# of Boardings)	1,315,222[98]	2,703,411[99]
Cost per Rider	$2.10	$2.58
Cost per Vehicle-Mile	$1.04	$4.27
Miles per Boarding	2.021	0.605

CONCLUSION

Obviously, differences do exist between the two islands, but because of the similarities, some of what has been successfully utilized on Maui can also be applied on Hawai`i Island, and lessons that Maui has learned along the way should be taken advantage of by Hele-On. Some simple upgrades to Hele-On that could be made are improving the visual appeal and clarity of route maps and schedules. In looking to expand service, creating an objective scoring system could help with the ideal placement of routes in order to maximize societal benefit and minimize costs. Since Hele-On is much more mature today than Maui's system was at the time of the Short Range Transit Plan, perhaps they can use that strategy in combination with any requests for additional service in order to minimize the amount of time that must be spent analyzing areas into which expanding service would not yield significant benefits. In terms of technology, Maui is not a leader amongst public transit agencies, but they have been at least somewhat innovative with their maps and Google Transit, and Maui is looking to invest in additional technology solutions to improve the efficiency of their system. Lastly, Maui outspends Hele-On on its bus system and has over double the ridership. Overall, the emphasis on public transit appears to be more significant on Maui.

6: THE CASE FOR IMPROVING THE TRANSPORTATION INFRASTRUCTURE OF HAWAI`I ISLAND

OVERCOMING THE TRANSPORTATION CHALLENGES

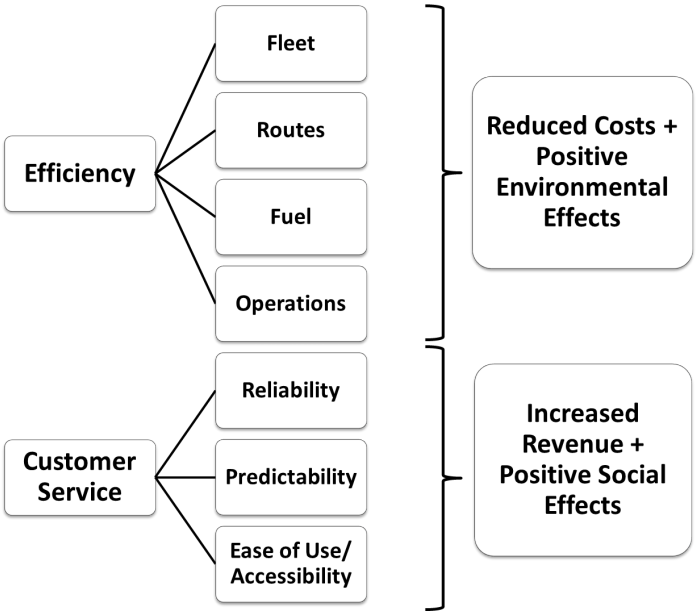
Transportation on Hawai`i Island is complicated and presents great challenges. There is rising and more complex demand for public transit service, operational costs are increasing, and resources are limited. In recent years, the Mass Transit Agency (MTA) has persistently worked towards expanding its Hele-On services and providing residents with suitable transportation options and an improved experience. However, the Agency still faces many challenges to expand while maintaining high quality service. At the same time the Island's traffic is getting worse according to locals, fuel expenses are a huge burden and vehicle carbon emissions are naturally increasing, as many people commute alone in their personal vehicles.

In the following sections we will evaluate a number of alternatives in order to provide some recommendations for dealing with these issues. In Section 6 we will focus on technology investments for the Hele-On public transportation system. In Section 7, we will discuss private sector investments that could provide alternative, cost-effective ways to commute on Hawai`i Island.

THE TECHNOLOGY VALUE PROPOSITION FOR HELE-ON

We have identified two overarching areas of opportunity that can facilitate the transition to a more economically, socially and environmentally sustainable mass transit system for Hawai`i Island. The following graphic introduces these two areas, the different segments in which they may be targeted, and the potential benefits they could provide. We believe that focusing on employing technologies that improve the efficiency of the current system and also increase customer service offerings will help the MTA achieve their goals of expansion, while minimizing costs and maintaining their high level of service.

Figure 6-1: Areas of Opportunity for Implementing Technology



In Section 7, we will also explore how rural mass transit agencies across the United States are implementing this technology to enhance their operations. We will go through available technologies and how they can benefit Hawai`i's Hele-On system, and analyze two rural transit case studies in which some of these technologies have been applied successfully. Finally, we will determine which of the analyzed technologies will have the biggest potential positive impact for the County of Hawai`i Mass Transit Agency, Hele-On and its passengers and provide an overview of potential vendors.

PRIVATE INVESTMENTS IN TRANSIT INFRASTRUCTURE OF HAWAI`I ISLAND

While public transit remains a key issue for the future growth and mobility of the Hawai`i County, our analysis has shown that a substantial majority of riders hail from low-income communities, forgoing automobile transportation due to its high cost of consumption relative to income. For this reason, we believe there is a great need for private investments in innovative alternative modes of transportation that serve those that do not use the public transit system. Additionally, alternative ridesharing networks or vanpool systems targeted towards middle-income residents and (possibly) tourists offer commuter incentives beyond simply the cost of travel.

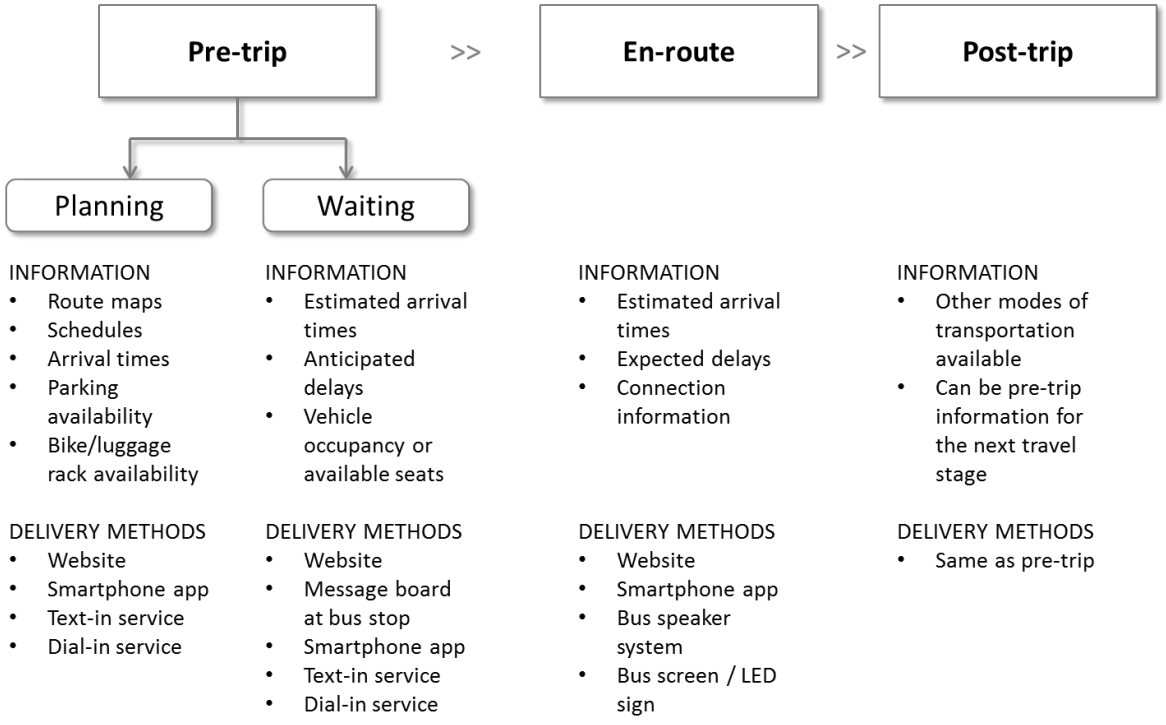
Section 8 outlines our analysis of ridesharing and vanpool networks and provides our suggestions for best practices for implementing them on Hawai`i Island. We weigh the merits of a) introducing an existing rideshare network onto the island; b) establishing a public-private partnership to create a rideshare network unique to the island; or c) alternative frameworks for implementing a vanpool network. In addition, we discuss possible funding channels, as well as offer a possible business model that examines how uniquely partnered rideshare networks might function on Hawai`i Island.

7: OPTIMIZING PUBLIC TRANSIT WITH TECHNOLOGY SOLUTIONS

TECHNOLOGY IN MASS TRANSIT

Technology has been used in multiple forms and for various purposes related to public transportation. There are three stages of trip. For each of these stages, the customer requires different information, and this information should be delivered using different methods. The following graphic illustrates this process and the different ways in which information can be delivered to the passenger.

Figure 7-1: Stages of Transportation and Information Delivery



Similarly real-time dynamic passenger information systems depend on three main stages: data collection, data integration and analysis, and the delivery of the information to passengers. Effective systems rely on three main pieces of information: 1) real-time vehicle location; 2) GIS maps; and 3) information about traffic conditions and delays.[100] Being aware of the specific information requirements, as well as the appropriate methods of information distribution based on what resources customers have available to them, is an important aspect of incorporating technology into public transportation. In the case of Hawai`i Island, it will be important to keep in mind the types of technology in which people actually have access. For example, according to a survey performed by Kanu Hawai`i, out of a sample of 100 people only around 30 use a

"smartphone"; therefore smartphone apps are currently not an ideal method of communication in Hawai`i.[101]

EXISTING TECHNOLOGY OPTIONS AND THEIR BENEFITS

There are many Intelligent Transportation System (ITS) technologies that have successfully penetrated the public transportation market, but not all are currently used in rural public transit. A 2009 national survey of rural transit agencies investigated technology use, obtaining responses from 451 different agencies across 45 states. The survey analyzed the technologies being used, as well as the technology's purpose and benefits.[102] A summary table of the identified technologies is included below:

Table 7-1: Available Technologies

Technology Name	Brief Description	Selected Benefits
Automatic Vehicle Location (AVL)	Tracking of vehicle location	Vehicle fuel efficiency; safety/security.
Computer Automated Scheduling & Dispatch (CASD) Software	Software package that helps automate scheduling and dispatch, particularly for demand response service	Operational efficiency; reporting/record keeping
Geographic Information Systems (GIS)	Spatial data containing various information; often required for other technologies	Planning/scheduling; maps
Mobile Data Terminals (MDTs)	Devices with screens that allow for communication and data transfer/display	Vehicle status information; reliable communication
Electronic Fare Payment (EFP)	Collection and processing of fares is done electronically, often using cards of some form	Ridership data collection; ease of fare collection; passenger convenience
Traveler Information Systems (TIS)	A wide range of technologies that deliver information to passengers	Passenger convenience
Google Transit	Schedule is available through Google Maps and has trip planner capabilities	Passenger convenience; live updates can be incorporated

There are a wide variety of benefits that can be garnered from ITS technologies. In general, some benefits of implementing ITS in Hawai`i include operational efficiency, economic productivity, a reduction in energy use and environmental impacts, convenience and comfort for users through information availability and awareness, and safety and security through improved driving behavior.[103] More specific benefits associated with certain technology types will be discussed below.

AUTOMATIC VEHICLE LOCATION

One relatively common technology is Automatic Vehicle Location (AVL). The specific method can vary, but the most common one uses Global Positioning System (GPS) technology, which requires on-vehicle technology to determine the location of each vehicle.[104] Sometimes satellite-based AVL systems are not available in rural areas, so this could, but does not necessarily, present an obstacle for Hele-On.[105] The reported purposes of AVL include dispatching, service quality, safety, customer information, scheduling, and communication, among others. One of the related benefits of AVL is that emergency response times are reduced.[106,107] AVL also allows transit agencies to monitor their vehicles to ensure they are on-schedule, which can help with planning as well as dealing with customer grievances.[108] Beyond simply dealing with complaints, customer relations are often improved as well for agencies that add AVL technology.[109] In terms of financials, companies that use GPS technology save an average of $5,484 per employee per year. Furthermore, the installation of GPS systems resulted in a reduction in fuel costs by 13.2% on average, and the majority of these reductions were through minimizing speeding and time spent idling.[110] Beyond these benefits, AVL can facilitate the implementation of other technologies, as the data collected can be used for many different purposes.

COMPUTER-AIDED SCHEDULING AND DISPATCH

Another commonly used technology is Computer-Aided Scheduling and Dispatch (CASD) software. These packages vary in exactly what they offer, but generally they streamline operations by automating a transit agency's scheduling and dispatch. This is particularly useful for demand-response service, which could be useful if the Hawai`i County Mass Transit Agency decides to pursue vanpool networks (which we will discuss in Section 7). The primary uses, however, are for reporting and record keeping, as well as scheduling.[111]

GEOGRAPHIC INFORMATION SYSTEMS

Geographic Information Systems (GIS) are another application of technology commonly used within rural transport. While GIS has many different applications, the two most common uses of GIS are for scheduling and operations. GIS can be useful for Hele-On because it can assist in the management and communication of large amounts of collected data through GPS or other methods, and it can do so in a visually appealing manner like a detailed map. It is also helpful as a planning tool since it can include demographic, economic, and road network data that can improve travel demand modeling.[112]

(Source: US DOT)

MOBILE DATA TERMINALS

Mobile Data Terminals (MDTs) allow for non-vocal communication between vehicle drivers and the transit agency. They are installed in the vehicles and can communicate information such as vehicle location and performance and passenger counts. Because MDTs rely on the collection of

a number of types of data, they are often integrated with other forms of technology. For example, in order to communicate vehicle location, MDTs would need to be integrated with Automatic Vehicle Location (AVL). Similarly, integration between MDTs and Electronic Fare Payment (EFP) systems would allow for the communication of passenger counts. The primary uses of MDTs are to identify vehicle location or passenger boarding and drop-off. MDTs can also relay information about a specific vehicle's mechanical status, which is useful to determine when preventative maintenance is necessary.[113] Additionally, they are generally a more reliable form of communication than voice, which can be particularly useful on Hawai`i where there are gaps in cell phone coverage.[114]

ELECTRONIC FARE PAYMENT

There are multiple varieties of Electronic Fare Payment (EFP) systems, but they all assist with both the collection and processing of fare payments and can provide Automated Passenger Counting (APC) and other trip information. Oftentimes they use cards or tickets of some form, which use a magnetic stripe, bar code, or Radio Frequency Identification (RFID) technology. RFID technology allows for information to be communicated by simply placing the card near a sensor, and it is often referred to as smart card technology. In the survey, all of the agencies that use EFP reported using magnetic stripe cards or tickets, while 25% also use smart cards and 12% use barcodes.[115] EFP systems eliminate the driver's responsibility of handling cash and the corresponding losses that come with the task. Additionally, ridership can be automatically tracked, and when integrated with an AVL system the ridership data can be location-specific for boarding. Boarding speed is increased as well, which can improve convenience for passengers, and result in increased satisfaction and ridership through increased customer loyalty.[116]

(Source: Lehman Center)

TRAVELER INFORMATION SYSTEMS

Traveler Information Systems (TIS) encompass a wide range of technologies that deliver information to passengers. These can be divided up by the different stages of a trip, previously discussed. Pre-trip information can be made available to users via the internet or phone, and should include trip planning tools, as well as both static and real-time information related to bus routes and schedules. During the trip, both variable message signs and audible announcements can be employed. While mobile telephone companies claim to have cellular phone coverage almost everywhere on the entire island, we realize that this is not true in all parts of the island as there are gaps due to geographic characteristics. However, diversifying the modes of communication in which the information is delivered can solve this problem and reach more people. The primary benefit of TIS is to improve service quality and passenger experience through predictability, reliability and ease of use. For example, an experiment at a bus station in

London found that waiting times were perceived to be lower by passengers simply by providing real time information about bus arrivals at the stop.[117] This provides further evidence that customer satisfaction could be improved by incorporating technology into Hele-On.[118]

HISTORIC ADOPTION BY RURAL TRANSIT AGENCIES

The Table 7-2 shows the usage rates of the previously discussed technologies amongst the rural public transit agencies that responded to the national survey we mentioned previously. Agencies that used one technology were more likely to use other technologies.[119]

Table 7-2: Current and Prospective Adoption Rates

Technology Type	Percent That Currently Use	Of Remaining, Percent Will Use In 5 Years
Automatic Vehicle Location (AVL)	6%	45%
Computer-Aided Scheduling and Delivery (CASD) Software	33%	46%
Geographic Information Systems (GIS)	25%	43%
Mobile Data Terminals (MDTs)	9%	31%
Electronic Fare Payment (EFP)	2%	32%
Traveler Information Systems (TIS)	4%	20%

While these rates may seem extremely low, it is important to note that the majority of the rural agencies surveyed are significantly smaller than the Hawai`i County Mass Transit Agency. Within the survey, the larger an agency was (measured by vehicle-hours of service, ridership, fleet size, or budget) the more likely they were to use technology. The adoption rates for the largest agencies included in the survey, which Hele-On far exceeds in each case, are shown in the table below.[120]

Table 7-3: Technology Adoption Rates

Technology	1,000,000+ Vehicle-Hours of Service	150,000+ Passenger Trips (Ridership)	20+ Vehicles in Fleet	$1.5 million+ Annual Budget
AVL	38%	40%	42%	38%
CASD	70%	47%	64%	55%
GIS	52%	51%	53%	55%
MDTs	26%	25%	30%	22%
EFP	5%	8%	2%	6%
TIS	7%	11%	5%	8%
Hawai`i values		*1.15 million*[121]	*56 vehicles*[122]	*~$3.5 million*[123]

A range of technology options exist, and each of them have different benefits, but when multiple options are incorporated together, additional benefits can be created that do not exist from the options by themselves. It is not uncommon for joint adoption of technologies to occur with AVL, GIS, and MDTs. Accordingly, it is not uncommon for transportation technology companies to offer multiple technology solutions in a bundled package as technologies are complementary to each other. As more technologies are properly incorporated, the value received from them is exponential.

GOOGLE TRANSIT

While it was not included in the survey of rural transit agencies, Google Transit is an easily achievable target for Hele-On. Incorporating Hele-On into Google Transit can provide benefits both to the Mass Transit Agency as well as current and potential future riders. Google Maps is the world's largest mapping website and is accessible in over forty languages. By including all of Hele-On's routes, riders will not have to pick and choose the best route on their own. Trip planning will be available through Google Maps, both on desktop and mobile devices, so passengers can simply input their starting point and desired ending point, as well as requested times of departure and/or arrival, and they will be provided with the public transit options that best meet their requirements.[124] This trip planner tool can even be incorporated into the Hele-On website. A mass transit agency in Virginia, Hampton Roads Transit, that began using Google Transit previously used 6-8 hours of employee time to update a new print transit schedule, which they would have to do for each route, often multiple times per year; with Google Transit, that task has been reduced to only a few minutes. They also improved their image through their association with Google.[125] The only drawback for Google Transit is that it is not designed to supply information about demand response service, a major service offering for many rural transit operators. Hawai`i County, however, relies on fixed-schedule buses, so we believe the system has a lot to gain from this relatively simple process.

Participating in Google Transit does not cost anything and the process to get started is simple. The requirements for participating in Google Transit are only that your public transit service operates fixed schedules and routes, and Hele-on satisfies these.[126]

The first step in implementation would be to format the Hele-On data in the format required by Google (specifications for this can be found on the cited website).[127] This will require time and/or resources, but is mostly of a one-time upfront investment, and future updates will be much less time-intensive. Additionally, there are open source tools available to expedite this process.[128] Examples of these feeds can be found on the cited website.[129] The Northwest Oregon Transit Alliance, which is made up of five different rural transit agencies, developed a web-based application to assist in the process of integrating rural transit agency routes and schedules with Google Transit because these agencies often do not have the resources available to hire external consultants for this purpose.[130] Once this data is created, it must be run through a validator, and then the routes can be previewed to make sure the data has been correctly interpreted. The next steps are to zip the data file and host the feed on a web server, from which Google will be

able to download it. At that point, the Mass Transit Agency will need to contact Google and sign-up for the partnership, a private preview will be setup and an online agreement will be made. Once everything is functioning satisfactorily, Google Transit will launch its Hele-On segment. While Hele-On would first need to be integrated with Google Transit, Google Transit has the ability to include Live Transit Updates as well.[131]

The Maui DOT reported that the process of integrating Google Transit was not at all difficult. All that was required was updating a spreadsheet and uploading it to Google.[132] Based on their experience, we estimate that the data conversion would cost $7,500. This would include the initial conversion, as well as the development of a web app that would allow for easy updates as routes change. If Google Transit were to require a new data feed specification, then this conversion could be worked on at an hourly rate of $95.[133] All in all, Google Transit is likely the most simple of all potential upgrades.

RURAL TRANSIT TECHNOLOGY CASE STUDIES

The purpose of this section is to demonstrate that the employment of technology has been useful in mass transit systems and specifically in rural situations, where population density is low and sparse. While we did not find specific case studies of island mass transit systems using this technology, we believe the cases we have developed present certain similarities to Hawai`i, which makes them pertinent to this report.

CASE STUDY 1: MODOC COUNTY, CALIFORNIA

IMPLEMENTATION:

Modoc County, a rural frontier county in California with fewer than six people per square mile, was a pioneer of rural transit agencies incorporating Intelligent Transportation System (ITS) tools. There were multiple tools installed in the system during this project, but the ones most relevant to Hele-On were Automatic Vehicle Location (AVL) and Electronic Fare Payment (EFP), as well as Google Transit for a trip planner tool. AVL/swipe cards allowed for automatic collection of fares as well as ridership data. Modoc County was the first rural area to attempt to incorporate Google Transit, and they did so successfully.

FINDINGS:

In order to get data in the proper format, Modoc County hired an external consultant, the Mary Jaffe Company. The process was a learning experience that could be used by fellow rural transit agencies, including Hele-On, in their own future implementation. Unavailability of high quality route maps and unreliability of internet access and speeds were obstacles encountered by Modoc County. Additionally, they found that it was important to make a contractor prove in the field that their technology can apply on a smaller scale than is typical, as opposed to simply taking the contractor's word for it. One particularly important comment was that "future rural

ITS projects should have clear, specific milestones that can be accomplished in six to nine months," which fits with the focus on short-term solutions.[134]

APPLICATION TO HAWAI`I COUNTY:

One significant difference between Modoc County's service and Hele-On is that there is a much larger emphasis on demand response transport in Modoc County. As a result, only the parts of the project that apply to fixed-route service were included in this analysis. An example of using multiple technologies was the combination of AVL and EFP to allow for automatic ridership data collection. Additionally, based on the cooperation between Modoc County and Google Transit, Google has revised its system to better allow for the incorporation of rural transit where trips are less frequent than hourly or even daily. This ensures that most of the issues have been worked out for Google Transit with regard to rural transit operators, so the process should be smoother for Hele-On. Still, a significant investment of some form, either time, new employee(s), or consultants may be necessary to get schedules in the proper data format for Google Transit.

CASE STUDY 2: POINCIANA, FLORIDA

IMPLEMENTATION:

A partnership between the Central Florida Regional Transportation Authority (LYNX) and Polk County Transit Services (PCTS) resulted in the implementation of a rural ITS demonstration project in Poinciana, FL from 2006-2007. The technologies deployed in this project that are particularly relevant for Hele-On were Automatic Vehicle Location (AVL), Geographic Information Systems (GIS), Global Positioning Systems (GPS), and Mobile Data Terminals (MDTs).

FINDINGS:

This project resulted in a number of impacts to the transit system. While there are multiple contributing factors to this, including linking a flex-route with the fixed-route system, overall fixed-route ridership increased 24% after implementation. Similarly, total transit ridership increased 27%. Additionally, customer and driver satisfaction were both improved as a result of the project.

Since it was a demonstration project, both LYNX and PCTS learned some important lessons along the way that can be used by future adopters of technology, including Hele-On. For procurement, it is crucial to make sure that the AVL supplier can use the transit operator's base maps. A small implementation issue, but important nonetheless, is that the GPS antenna needs to be a minimum distance away from the radio antenna to prevent interference (the specific distance depends on the technology employed). If possible, installing the GPS receiver and MDT in close proximity helps simplify and shorten the wiring process, but it is also important to make sure that the MDT is placed in a location that will prevent boarding passengers from damaging it

accidentally. Another lesson learned during implementation is that there needs to be a connection between the MDT and the vehicle's digital odometer in order to get the AVL system to function properly, and this process proved to be more complicated than had been anticipated. For operations, training was required for agency employees on the technology being implemented which increased costs of the agency. As an example, all operating employees took a two-hour training class on using the MDTs.

APPLICATION TO HAWAI`I COUNTY:

Similarly to Modoc County, demand response is a component of the transit service provided by these agencies, but it is not nearly as significant since there are still plenty of fixed routes that the agencies operate. Like Hawai`i County, a great deal of riders use the LYNX/PCTS systems to commute to work; 41% of those who completed a ridership survey claimed travel to work as a purpose for traveling via public transit. Additionally, there was a wide range of trip lengths reported, ranging from 0-15 minutes to over 2 hours. The survey also asked how the riders found out about the transit services. More than 40% responded that they had seen a transit vehicle on the street. Almost 30% stated they heard about the availability of transit services from a friend. While the lessons that LYNX and PCTS learned during implementation are simple, they apply in all settings and would be useful in making the future process smoother for Hele-On.

CUTTING EDGE RESEARCH

There is a great deal of relevant research related to new and/or cutting edge ideas for improving rural public transit through technology. One pilot program, called Bus Coming, uses a smartphone system integrated with Google Maps in Trinidad & Tobago and allows for wayside passengers to see how long until the bus arrives at their specific location, as opposed to how long until it gets to a certain stop.[135] This idea would be particularly useful to Hele-On, where there can be tens of miles between officially listed stops. Additionally, with some routes running service before sunrise, it would improve safety for passengers catching the bus in the middle of its route in the dark. Another similar idea is a system in which riders can digitally flag the bus, alerting the drivers that they are waiting for them.[136] This also would be particularly appropriate for Hele-On's long routes, especially when it is dark out and bus drivers have difficulty spotting passengers along the side of the road.

A number of other experiments use crowd-sourced data supplied by the passengers themselves. Crowdsourcing is becoming popular as a way in which companies or organizations can collect desired data or information through the collaboration of a large group of people who are willing to connect digitally through their phones or computers. This would overcome the lack of infrastructure present for obtaining real time vehicle location, as well as help deliver information to passengers. To get around this challenge, passengers' smartphones are used both to obtain data and to deliver information.[137] One example of using crowd-sourced data is Tiramisu, an Italian app that provides access to real-time arrival data for local public transit,

although it is currently only used in urban areas.[138] The Informed Rural Passenger project, which is a massive research project investigating technology use in rural transit, is being carried out by the dot.rural research center at the University of Aberdeen and has investigated using crowd-sourced data as well. This project has led to the development of GetThere, which is a real-time passenger information system that takes data from multiple sources and delivers information through multiple methods. Passengers are one of the sources for data, and all of the others used are open data sources. GetThere delivers information through web sites, SMS messages, and a smartphone app. Since cell phone service is unreliable in parts of rural Scotland, this flexibility in delivery method is crucial.[139] Even with this limited coverage, the pilot of GetThere was still successful at identifying bus locations. Other examples of data that can be crowd-sourced are occupancy levels as well as facilities present in the vehicle, such as if there is a restroom and if there are bike racks available. When dealing with crowd-sourced data some issues that arise include privacy and security, and the quality must be monitored as well.[140] Because there are similar infrastructure issues that must be overcome on Hawai`i Island, these crowd-sourced data methods could prove helpful.

CONCLUSIONS ABOUT TECHNOLOGY

There are multiple reasons why these technology solutions would be particularly beneficial when applied to Hawai`i Island. There is significant potential for operational efficiency improvements, which can result in fuel savings, route optimization and reduced maintenance cost. Collecting data on ridership, driver performance and commonly used stops can give the planning department full visibility of their system operations, which is necessary for determining the optimal number of routes and buses needed to serve Hele-On riders effectively, without redundancy. With little technology currently being used in Hele-On, the opportunity for efficiency improvements could be even larger.

Through reliability, predictability and clear communication, technology can help the customers as well. It can make current riders' experience a much more pleasant one and could also bring in new riders that are not fully aware of or do not yet trust the public transit system, boosting ridership and revenues and potentially reducing operational costs. While a smartphone can be useful for accessing data while away from home, not all people in Hawai`i currently use smartphones. However, passengers can still take advantage of technology solutions by either using the Internet on computers or by phone. Since the demand for public transit in Hawai`i County is often intermittent and related to work schedules, it is particularly important for passengers to know when their bus will be arriving because the next bus on the route may not come for many hours. Since travel times to mass transit stops tend to be longer in rural areas, having confidence in exactly when a bus will arrive can help passengers plan the appropriate amount of buffer time in order to catch it without arriving too early and wasting time.

Since expanding public transit service is commonly brought up at public meetings, doing it in the proper areas would likely be well perceived and adopted. We have identified key technologies

that we believe will be most beneficial for the County of Hawai`i Mass Transit Agency, the Hele-On bus system and its passengers.

KEY TECHNOLOGIES FOR HELE-ON

Automated Passenger Counting (APC): In order to thoroughly understand which routes are over or underserved and determine ideal routing, sophisticated ridership data is crucial. This data can provide valuable insight into demand patterns, passenger behavior, duration of trips, and other reference points to properly design a transit system that effectively serves the needs of its customers while maintaining operation costs low. Reliable data can determine optimal routes, sizing of the fleet vehicles for each route (i.e. a van versus a bus), and real time information about changes in demand that will allow easy and prompt adjustment. APC can be included with an Electronic Fare Payment (EFP) system or through an independent system of sensors at the bus doors.

Geographic Information Systems (GIS), Automatic Vehicle Location (AVL) and Mobile Data Terminals (MDT): These three technologies can have a positive impact on routing and fleet efficiency, as well as operator and vehicle performance; the greatest impact of these systems would be felt through simultaneous implementation, as they are complementary to one another. A mix of these can result in significant reductions in fuel and overhead costs. One of the key benefits these technologies provide is fleet visibility. Because Hele-On will be able to track its entire fleet at all times, routes and vehicles can be used and allocated optimally. Driver execution can also be tracked, increasing accountability. Finally, these technologies facilitate easier planning and more efficient operations.

Real-time Passenger Information (RTPI): A subset of general Traveler Information Systems (TIS), real time passenger information has potential to improve customer service and satisfaction, ultimately increasing ridership and willingness to pay. When a potential bus rider has access to information on bus routes and real-time arrival times, the stress of traveling in public transportation is significantly reduced. Having an easy-to-use mobile phone application, computer website, or text/call center that can provide this information will improve the rider's full experience and could attract new customers while making current ones even more loyal.

ANALYSIS OF POTENTIAL VENDORS

As in any growing market, there are multiple companies offering products and services for transportation management or optimization purposes. We performed extensive research on existing companies and their offerings. This analysis can serve as a tool for the Mass Transit Agency to determine which company might best fit Hele-On's requirements, while staying within the County's budget or making the case for extra funding to be raised via public or private investment. Aside from economic considerations, an ideal vendor should be able to provide multiple items from the 'Key Technologies for Hele-On' listed above and present customizable

solutions. Additional value will come from firms with products designed specifically for public transportation systems and previous experience with rural or island-based clients.

The following section will highlight the top transportation technology companies and describe their product and service offerings. It will analyze potential benefits and implementation costs, and list some examples of implementation or case studies. It is important to note that all implementation examples were provided by each vendor and results are self-proclaimed. Before any particular vendor is contracted, we suggest contact their customers to confirm their satisfaction with the vendor. It is equally important to note that while the companies provided costs of implementation, these are not official quotes and the price of their products or services will vary depending on each project and its customized solutions. These numbers serve as an approximation, but it will be essential for the County to contact the vendors directly to receive a real price offering. Cost calculations are based on a fleet of 56 vehicles (48 buses, 5 cutaway vans and 3 minivans).[141]

ACTSOFT

ActSoft[142] is a custom software development company based out of Tampa, Florida. The company specializes in tracking fleets and optimizing the system through timekeeping, dispatching and tracking forms. Its main fleet management product, CometFleet[143] focuses on providing tools to improve routing, reduce downtime, and cut costs. CometFleet is composed of a GPS tracking system and the company's Comet Suite applications to provide visibility of the fleet and create reports to identify improper use of vehicles or inefficient behavior.

POTENTIAL BENEFITS

- Reduced fuel and overhead costs
- Availability of location data for fleet vehicles at all times
- Identification of idle and stop times
- Can be used to improve routing and eliminate redundant routes
- Reduced downtime and unnecessary wear
- Scheduled maintenance alerts

POTENTIAL CONCERNS

- No analysis capabilities. Analysis would have to be performed by Hele-On or County
- No previous experience with work on islands
- Not designed specifically for mass transit systems
- More appropriate for fleet tracking and driver supervision
- Does not provide Traveler Information Systems

COSTS

ActSoft works on 24- and 36- month term contracts and a month-to-month payment. A one-time licensing fee of $100 is required and the monthly payments cover the equipment rental

and data monitoring and access. Hardware installation can be performed by the customer or through a referred installer. Installation services typically costs a total of around $125. However, installation is relatively simple and takes approximately 30 minutes per vehicle.

Price→ $23.99 per vehicle per month + licensing fee + installation costs

Approximate investment for Hele-On (for 3 years)→ $48,589

Additional resources needed→ Because ActSoft does not provide any analytics services, it would likely be necessary to hire a specialist to do the routing, fleet and passenger optimization analysis. The hiring and/or training of a Data Manager should also be taken into consideration.

EXAMPLES OF IMPLEMENTATION

STAR Transit is a demand response public transportation company for Kaufman and Rockwell Counties in Texas. STAR uses ActSoft's Comet Fleet software for mileage tracking, driver behavior monitoring, and maintenance reports and reminders. Since it installed the software, the company has increased fuel efficiency by 50% and is saving hundreds of dollars per month[144].

Floyd County Schools Transportation Department is in charge of transporting students safely for all school-related activities, as well as communicating with parents if any issues or concerns arise. ActSoft provided visibility of vehicle location and therefore reduced safety concerns and complaints from parents. The installation of this software allowed Floyd County Schools to improve their operation efficiency and to properly follow the location of dispatched buses and children[145]

CONTACT INFORMATION

http://www.actsoft.com/
(888) 732-6638

NEXTBUS

NextBus[146] is a real-time passenger information solutions provider that offers a GPS enabled website for mobile users to identify the nearest bus stops and provides up-to-the-minute arrival times. Information is made available through the Internet, SMS text or a phone call, which enables all types of users to access the service. NextBus currently serves over 135 transit agencies and more than 300 million riders every year.

POTENTIAL BENEFITS

- Interface is easy to use and allowed for easier planning and transportation
- Increased visibility of the transit system for passengers with live mapping of rider, stop and bus
- Automatic alarms help riders arrive to the stop on time

- Customized installation to meet passenger, management and budget needs
- Focused solely on public transportation systems
- Experience with many fleet sizes and broad client base
- Potentially low cost solution

POTENTIAL CONCERNS

- No focus on fleet optimization
- No focus on passenger or route tracking
- Does not solve most of Hele-On's needs on its own.
- Requires investment in other technologies, like GPS to get required data
- No previous experience on islands
- No previous experience in rural or dispersed areas
- Not very responsive, no contact phone number available

COSTS

Unfortunately, NextBus did not respond to our inquiries and therefore cost information is not available. However, on their website they claim having customizable options to fit any budget.

EXAMPLES OF IMPLEMENTATION

NextBus serves a broad range of transit systems in North America, from small towns and colleges to large cities. Some of its biggest successes include: **LA Metro, San Francisco's Municipal Transportation Agency, Chapel Hill Transit, and Massachusetts Institute of Technology** (MIT).

CONTACT INFORMATION

http://www.nextbus.com/

SYNCROMATICS

Based in Los Angeles, California, Syncromatics[147] is focused on providing Intelligent Transportation Systems (ITS). It serves fixed-route transit clients in university, municipal, and private markets and currently serves the entire fleet of the City of Los Angeles and has customers in 30 states in the United States.

Syncromatics' product and service line includes cloud hosting, transit dispatch, real-time bus tracking, transit reporting, stop annunciators, automated passenger counting and transit schedule performance reports.

POTENTIAL BENEFITS

- Real time passenger information, including arrival predictions

- Accessible information through multiple platforms: smartphone apps, text messaging, Interactive Voice Response (IVR) phone system
- Wayside LED signs
- Access to web-based tools for planners, dispatchers and executives
- On-time, ridership and management reports
- Includes Computer Aided Dispatch (CAD), Automated Vehicle Location- GPS (AVL), Automated Passenger Counting (APC), Automated Vehicle Annunciation System (AVA)

POTENTIAL CONCERNS

- No previous experience on islands
- No previous experience in rural or dispersed areas
- Strongly focused on dispatching and complex transit systems (emergency response), not necessarily at resource optimization

COSTS

Unfortunately, Syncromatics has not responded to our inquiries and therefore no cost data is available.

EXAMPLES OF IMPLEMENTATION

City of Los Angeles[148]: With incredibly varied traffic patterns, a large number of pedestrians, and regular special events, downtown LA was a highly unpredictable environment for transit buses. Syncromatics provided real-time operations tools to solve the multiple challenges this environment created. For this particular client and its needs, Syncromatics developed a new software program that allowed both dispatchers and drivers to identify the relative spacing of buses.

University of South Florida[149]: With a large and complex transit operation system, the University of Florida required an all-inclusive solution to their operation issues. Syncromatics provided a real-time passenger information system (RTPI), automated passenger counters (APC), mobile data terminals (MDT), and in-depth reporting and dispatching functions. This system has generated over 200,000 hits per month from students, faculty and staff.

CONTACT INFORMATION

http://www.syncromatics.com/
(310) 728-6997

TELETRAC

Teletrac[150] provides an array of services including asset location, diagnostics, fuel efficiency, safety, and compliance. Its Fleet Director software is aimed at fleet management issues and requires no up-front cost. They provide unlimited training and support as well as a lifetime guarantee on hardware. They have worked with more than 20,000 fleets around the world.

POTENTIAL BENEFITS

- Fleet and route optimization
- Improved communication with customers and reliability
- Reduced traffic violations, enhanced security and safety
- All-around business solution
- Customizable for public transportation systems
- Experience in the field

POTENTIAL CONCERNS

- No previous experience on islands
- No previous experience in rural or dispersed areas
- Less focus on rider experience

COSTS

Teletrac provides free installation, web training, lifetime warrantee and unlimited service. Equipment rent and subscription to their system requires two month down payment and a one-time $95.00 process fee.

Price→ $39.00 per vehicle per month + process fee

Approximate investment for Hele-On (for 3 years)→ $78,720

Additional resources needed→ Teletrac can help Hele-On with tracking and efficiency but they do not provide analysis or passenger information systems, so an additional investment would be required for those separately. Further, these costs are for their basic tracking software package, there are additional added value products that could be considered for more sophisticated hardware or services but would require additional investment.

EXAMPLES OF IMPLEMENTATION

A recent survey performed by Teletrac to all supported fleets using Fleet Director showed a 30% reduction in fuel consumption, a 15% reduction of overtime, a 12% reduction of unauthorized vehicle use and a 12% increase in productivity.

CONTACT INFORMATION

http://www.teletrac.com/
1-800-TELETRAC

TRAPEZE

Trapeze Group provides transportation solutions through technology, systems and services in North America. The “Transportation Solutions” department within the company focuses on public transportation management to improve service quality, control costs and optimize the fleet resource productivity.

Trapeze Group has experience working with small and dispersed fleets and offers customization options to serve diverse fleets' individual needs. Its product and service lines span from asset management and fuel efficiency to routing, ridership and operations analysis of current fleet.

BENEFITS

- Customizable solutions
- Increased productivity of fleet and operators
- Route optimization
- Visibility and accessibility for passenger through real time information
- On-the-bus technology for easy operation
- Driver-dispatcher communication
- Available customer care program

POTENTIAL CONCERNS

- Potentially requires large investment

COSTS

Unfortunately Trapeze Group has not yet provided pricing information to the team. The quote order is in place but we have not had any response.

EXAMPLES OF IMPLEMENTATION

Regina Transit is the public transportation system in Regina, Saskatchewan, Canada. The transit agency dealt with inefficiencies and problems with manual dispatching and recording. Dispatchers were lacking real time information and location status of their fleet. The Regina fleet consisted of 30 vehicles to serve 200,000 inhabitants and performed an average of 200 trips per day. After installing Trapeze system, weekday ridership increased by 16% and passengers per hour numbers increased from 2.96 to 3.0.

Kiwanis Transit (K-Transit) is a demand response transportation provider in Ontario, Canada that provides services in three rural townships and whose vehicles average over 450 kilometers during a single shift. K-Transit required detailed client history tracking and customizable reporting functions to provide accurate data to federal, provincial and municipal stakeholders. The chosen Trapeze solution automatically scheduled rides and maximized the number of passengers riding each vehicle through routing redesign and automated dispatching information.

CONTACT INFORMATION

http://www.trapezegroup.com/
(403) 777 3760 ext. 427

TSO MOBILE

TSO Mobile[151] focuses on Mobile Resource Management and logistics products and services. With headquarters in the US, Mexico, Colombia, Peru and Venezuela, it has worked on projects across North, Central and South America, as well as the Caribbean. TSO Mobile provides GPS vehicle tracking, dispatching tools, and other specialized products for public transportation systems.

TSO provides customized solutions depending on industry and size of fleet. It also provides a strong focus on customer satisfaction and passenger benefits. Public sector specific services include real-time GPS tracking, TSO public tracker for real-time information for passengers, arrival forecast, Automated Voice and Text Information Services (AVIS and ATIS), passenger counters, live video monitoring of buses, LED signs and annunciators, and public information displays and bus stops.

POTENTIAL BENEFITS

- Maximized productivity and reduced operational costs
- Improved dispatching
- Increased security
- Previous experience with rural or dispersed and low density areas
- Previous experience on island systems
- All-around and customizable business solution
- Focused on public transit systems
- Provides analytics/consulting services for optimization

POTENTIAL CONCERNS

- Requires large investment

COSTS

TSO Mobile provided an itemized quote that includes prices for all of the following systems: Automatic Vehicle Locator (AVL), Automated Passenger Counting (APC), Video Security, LED signs/annunciators, public information displays, Automatic Text and Voice Information Systems (ATIS and AVIS). They charge a total project management fee of 2% and a monthly services fee, which depends on the final installed systems (if all were installed, this fee would be $170 per unit). This price includes all on-site installation, training and unlimited service.

Price→ $7,797.32 per vehicle + project fee (equipment). $170 per vehicle per month (services).

Approximate investment for Hele-On
Up-front investment→ $445,210
Annual investment→ $114,240

Additional resources needed→ None. If anything, the County might choose not to install all options and the investment would be lower.

IMPLEMENTATION STATISTICS

From TSO Mobile Website:

- Over 30 hours per week can be saved thanks to the automation of operations.
- Over 30% increase in ridership can be achieved through proper dispatching and an efficient public transportation service.
- Over 10% reduction in costs annually can be achieved depending on the entity's size, operations and goals.

CONTACT INFORMATION

http://www.tsomobile.com/
1-877-477-2922

SUMMARY OF COMPANIES AND SERVICES

Figure 7-2: Analysis of Companies and Services

Company	Services							
	Automated Passenger Counting (APC)	Routing and Fleet Efficiency Optimization	Operator and Vehicle Performance	Real-time Passenger Information (RTPI)	Mobile Data Terminals (MDT)	Has Specific Service for Public Transport?	Has worked on Rural or Island Projects	
Actsoft		x	x					
NextBus				x		x		
Syncromatics	x	x		x	x	x		
Teletrac		x	x	x	x	x		
Trapeze	x	x	x	x	x	x	x	
TSO Mobile	x	x	x	x	x	x	x	

As shown in Figure 7-2, the companies reviewed in this research provide a wide array of services, and finding the best option for Hele-On to implement will depend on the costs of each and the availability of resources in the County of Hawai`i. If resources were not an issue, we believe TSO Mobile would be the best option. Their previous experience with island transportation systems was evident when talking to their sales representative. Options like Automated Voice and Text Information Services (AVIS and ATIS) are ideal for Hawai`i because a large part of the population does not own a “smartphone” or technology to use an “app”. For those that do use smartphones, an app is available as well. Finally, TSO Mobile provides

analytics and consulting services at no extra charge, which is essential in Hawai`i County where the staff is not specialized in that type of work.

CONCLUSIONS AND NEXT STEPS

After an extensive analysis of available technology options for improved transportation services, we have determined that there are many opportunities for the Hawai`i County Mass Transit Agency to invest in its future operations. Further, we realized that the value of a technology investment is exponential when several technologies are used together. The following were identified as the most beneficial technologies for the Hele-On transit system:

1. Automated Passenger Counting (APC) through Electronic Fare Payment (EFP) to determine ridership trends and optimize routes and pricing depending on capacity vs demand.
2. Geographic Information Systems (GIS)- to create and provide easy and appealing information on routes and schedules.
3. Automatic Vehicle Location (AVL)- to understand current operations and optimize route, fleet and driver performance.
4. Mobile Data Terminals (MDT)- to make the integration of technology systems easier and more seamless.
5. Real Time Passenger Information (RTPI)- to provide better predictability, reliability and service to passengers and improve their overall experience to increase ridership.

While Google Transit is not in this list, as it lies in a different category of technology, it can provide incredible benefits at a low cost and we believe it is the first important step the Mass Transit Agency should take.

We have identified three different stages of activities and investments for the County to consider. There are some easy and low-cost solutions that we recommend should be implemented right away, and some pricier but more impactful solutions for which additional funds must be procured.

IMMEDIATE SHORT TERM

- Google Transit: Low cost option with easy and fast implementation that can help passengers identify ideal routes, schedules, connections, etc. It will be necessary to develop a communication strategy to let users know of its availability once it is in place.
- Website enhancements for easier navigation.
- Develop clear route schedules and maps that can be seen on website without the need to download the file.

SHORT TO MEDIUM TERM

- Procure funding for significant technology investment. Tentative sources include: federal grants, private impact investment opportunities, and environmental or social impact foundations

MEDIUM TERM

- Make technology investment
  - Determine appropriate vendor and obtain a customized quotes
  - Determine new staff requirements and cost (if any)
  - Set project manager responsible for implementation

8: PRIVATE INVESTMENTS AND TRANSPORTATION ALTERNATIVES

OPPORTUNITY: BUILDING A RIDESHARE NETWORK

THE NEED FOR RIDESHARING NETWORKS IN HAWAI`I COUNTY

Ridesharing networks offer an alternative, inexpensive method of transportation that would be well suited for coordinating commuting across the County's dispersed and rural populations.

According to the American Automobile Association, in 2008 it cost the average American 54.1 cents per mile to drive, including gasoline, oil, maintenance, and vehicle depreciation; a 40-mile daily round trip would end up costing $21.64 per day, $454 monthly, or $5,453 annually.[152] These costs are increased substantially for Hawai`i, where gasoline prices average almost $0.80/gallon more than national levels.[153]

A German employer-based rideshare network (TwoGo) recently implemented trial runs of its service in Canada, the United States and Singapore between July 2011 and April 2013; the trial analyzed patterns of 22,000 employees, 8,500 of which registered with the network. In this two-year period, there were 36,000 matches, 400,000 miles eliminated, 88 kilotons of greenhouse gas emissions avoided, and $5 million realized in fuel savings, car maintenance and resale value.[154] A U.S-based service specializing in corporate and university partnerships, Zimride, had facilitated over 26,000 carpools, acquired 350,000 registered users, and saved users over $50 million in vehicle operating expenses within the two years since its inception.[155]

Ridesharing networks allow for greater cost sharing among users, reduced car maintenance costs, and could ease overall congestion on roads. As these networks penetrate the national market, rivalry among services is increasing and fees are becoming more cost-competitive between both networks as well as taxi services. UberX recently reduced fares to make them 10% lower than average taxi prices (base UberX fare of $7 plus $0.80-$3.80/mile),[156] while Lyft, an app created by Zimride, has maintained an average cost of $15 per hour with drivers keeping 80% of the total donations.[157][158][159]

In addition to lowered costs, rideshare networks allow for flexibility of unintended scheduling conflicts, work delays, and the reassurances of GPS-tracked reliability and sharing of information unparalleled by bus transit – each trip is specifically tailored to the needs of passenger and driver.

Commuters are realizing real benefits, reflected by the rapid expansion of regional and urban networks, increased capital investment funding, and increased average growth of up to 60% monthly.[160] Travelers are also attracted to the network by the sense of community, informality, and public good derived by users. Ridesharing networks are under consideration nationwide in

order to adequately address the unmet demand for lower-cost travel alternatives for middle-income residents. For this reason, we do not foresee that future implementation will adversely impact mass transit ridership on Hawai`i Island, which mainly relies on lower-income workers for a majority of its fare revenue.

The biggest challenges to implementation of these alternative systems remains the population density resulting from land use and residential planning, which has led to heavy reliance on existing cars for daily travel. To date, ridesharing networks have experienced success in dense urban areas, but their applicability to more rural situations is still questionable. We are unsure whether the County has the sheer number of coast-to-coast commuters necessary to facilitate a rideshare network (although shorter rides may have the population densities required to support the system). On the other hand, the 15% of islanders who carpool present a substantially larger proportion of potential ridesharers and vanpoolers than their mainland counterparts.

Currently, there is a small Shared Ride Taxi Program managed by the Mass Transit Agency, which charges approximately $2 per coupon for four miles, or two coupons ($4) for eight miles. The County reimburses the $2 to the driver for each coupon they submit. Many of the independent taxi drivers enrolling in the program cater to the elderly and disabled in Hilo. This system also has had some success in distributing coupons through the County Prosecutor's Office to bars to discourage drunk driving around the holiday season. However, participation is limited to an eight-mile radius on the Hilo side of the island, while west-coast taxi companies usually decline applications for permits because the returns are not as lucrative.[161] Additionally, passenger registration for this service is required beforehand, so it does not have the flexibility of a real-time demand-response rideshare network. The greatest potential impacts of ridesharing and realized cost savings depend on the ability of a newly created service to bring adequate long-distance ridership from residential clusters in Puna, Hilo, Waimea, and Ocean View-South Kona to the Kohala Coast and Kona. New networks are not meant to reduce travel time, but rather provide more cost-effective, flexible and community-oriented commuting alternatives.

BEST PRACTICES FOR RIDESHARING NETWORKS

We studied a variety of existing private global rideshare networks and synthesized a set of best practices and amenities that have allowed for their success. We determined that these networks have become increasingly popular in attracting ridership both domestically and abroad, because they offer the user a specific value proposition: avoiding the costs and congestion of individual daily commuting. Lyft now provides an estimated 30,000 rides per week,[162] while UberX has launched in 40 cities around the world in the last three years.[163] Such rapid success and expansion has not gone unnoticed – venture capital firms have realized that such networks could provide substantial returns on investment, and have heavily financed these networks with startup capital. Though each network varies in its marketing and branding strategies, the general design of these systems is quite similar:

TYPICAL COMPONENTS OF A RIDESHARING NETWORK

1) "Drivers" and "passengers" each create log-in accounts via smartphone, tablet or computer. In order to ensure driver safety and avoid insurance risks, security background checks are completed on all active account members before they are entered into the system. This process verifies that drivers have violation-free records and no criminal history.
2) Passengers log into their accounts when they would like to be picked up for a ride from a driver who has made plans to drive, and whose route coincides with the passenger. This is determined through GPS real-time tracking and coordination to select the most optimal route for the passenger to reach their destination. The passenger is presented with a variety of choices and can select the driver who best meets his criteria through Driver Ratings and Profile Information from past rides. The driver is then notified via the app on their smart device.
3) Upon arrival at the final destination, passengers either pay "suggested donations" to the driver based on their level of satisfaction with trip, or are charged a mileage fee directly to their account (which is connected to a working credit card). Factors incorporated into donation include distance, time of day, duration and location, with the company retaining a percentage of the donation.
4) Both driver and passenger have the option to leave a review or rating for each other, to boost their membership points within the rideshare network and expand opportunities for later rides.

OPTIMIZING FEATURES

- **Flexibility of scheduling:** The best systems allow drivers and passengers to make plans anywhere from a week in advance to ten minutes prior to departure. We also recommend the integration of calendar functionality to notify the user for friendly reminders for those that make their plans in advance.
- **Matching algorithm**: We recommend a system that allows the driver or rider to filter ride requests to a specific drop-off location or area (i.e. setting filter to only accept rides that end near your work). This technology was first utilized successfully by Sidecar in San Francisco.[164]
- **Integrated GPS**: GPS real-time synchronization and information tracking between Driver and Passenger allows the rider to receive up-to-the-minute details regarding departure, arrival and current status of the trip. Shared data alleviates uncertainty for both parties.
- **Cancellation and Damage Fees**: Regardless of whether donations are voluntary or mileage fees are mandatory, cancellation and damage fees (penalty payments from skipped rideshare arrangements or car damages) mitigate the risk of accident or inconvenience on the part of the driver or passenger.
- **Marketing promotions:** In order to build name recognition and ease skepticism within communities, many rideshare networks have organized promotional and philanthropic events and bargains upon initial expansion to a new coverage zone. UberX expansion

promotions include a first month of rides free of charge offered to new users, as well as promotional codes and sales partnerships with retail vendors like Stubhub and LivingSocial.[165]

- **Useful client services**: automatic fare-splitting, calculable greenhouse gas emissions saved, and account management.
- **Local partnerships:** There are a number of local taxi companies in Hilo and Kona, most of which do not operate for distances greater than nine miles (intra-town only). Rideshare networks can partner with these independent taxi companies and link licensed and insured drivers to customers – this can be mutually beneficial in allowing the networks to gain initial traction by exposure to taxi customers, while attracting new business to taxi services. This would be regulated under the authority of the Hawai`i Public Utilities Commission, and is already practiced with UberX in Honolulu.[166][167].
- **Long-term integration of ridesharing networks with other nearby transportation alternatives:** Existing software applications like Ridescout incorporate GPS real-time tracking and scheduling with bus, rail, taxi, Sidecar (rideshare) and bike sharing networks in close proximity. This would allow for users to assess the cheapest and most efficient nearby transportation options while simultaneously reducing uncertainty for these services (last-five-miles compatibility).[168] This implementation would be contingent upon GPS coordination and installation on an island-wide scale.

CONSIDERATIONS FOR ESTABLISHING A RIDESHARE NETWORK ON HAWAI`I ISLAND

The following section clarifies the regulations and policies essential for creating a viable environment for the network to thrive. In addition, the section outlines funding concerns and startup costs, steps for implementation, and possible barriers to overcome.

POLICIES IN EXISTENCE

In order to apply for grants, an individual, non-governmental organization or public entity must formalize a proposal to the Hawai`i Department of Transportation, who will subsequently evaluate the proposal before granting the request, or submitting to the federal Department of Transportation for prioritization.

EMPLOYER-RELATED SUBSIDIES

Employer-related subsidies can increase productivity by promoting commuter habits that reduce employee absenteeism and late arrivals, while saving on overhead costs associated with maintaining parking through the encouragement of carpools. Employees and businesses must be enrolled in the federal Transportation Incentive Program (TIP) in order to benefit from commuting incentives.

COMMUTER TAX BENEFITS PROGRAM

This program, which is introduced in the Ground Transportation on Hawai`i Island and Other Rural Localities section, reduces payroll taxes by allowing employees to use pre-tax dollars for

transport as subsidies for carpooling. It applies to work-related trips taken on a bus, rail, subway, ferry, subscription bus, shuttle, vanpool, or rideshare network. Employers can structure the benefits in three ways:[169]

- Provision of transit passes, vanpool vouchers or cash reimbursement directly to employees. Businesses can deduct up to $130 per month per employee for any qualified commuting subsidy as a normal business expense, nontaxable to the employee.
- Employers can set aside their employees' pre-tax income amount used for qualified commuting expenses, up to a maximum of $130 per month before payroll taxes; taxes are paid on this reduced amount of the employees' salary.
- Employers can pay both part of an employee's commuting costs, deducting that amount, then deduct the remaining cost up to $130 per month per employee from their salary before calculating taxes.

Businesses and regional authorities must ensure that tax benefits apply to user rideshare payments.

GUARANTEED RIDE HOME PROGRAM (GRHP)

This regionally based program exists for commuters who vanpool, carpool, bike, walk or take public transit – it exists as an emergency or contingency plan for getting home. Operated by the local transit authorities (Mass Transit Agency), it is relatively inexpensive to implement. For many businesses, participation in a GRHP is free for employers. The program requires employees to commute *alternatively* to work a minimum number of times each week, and in return allows a ride home either by taxi or rental car up to an annual ride limit (usually between two to eight rides). Payment for the ride is either reimbursed by the sponsoring agency or employer-paid to the transit provider in the form of a small annual base rate determined by size of the company work force. The sponsoring agency sets program eligibility criteria, allowable destinations and maximum distance, service hours, payment method, membership fees and program procedures.[170] Companies must register for the program on an individual basis, usually coordinated through the region's respective regional transit authority. An FTA study of regional GRHPs in 2006 revealed a median cost per claim of $36.95 and a median cost per registrant of $0.35; the average amount of time spent weekly to manage the program (per 100 participants) was only 15 minutes in rural areas.[171]

The benefits expand business service hours without increasing costs by allowing flexible or staggered work hours only available through increased access to transportation alternatives (such as ridesharing). Furthermore, businesses that actively participate in transportation planning initiatives have the opportunity to network with other businesses and entities with a stake, making them well positioned to voice their priorities. Other states (such as Maryland and Minnesota) have implemented their own state tax credit initiatives allowing businesses to claim a tax credit for a percentage of what employers have contributed towards commuting costs.

Either way, these federal subsidy programs offer substantial dividends to businesses that utilize them.[172]

This program is important to providing reliability and flexibility in extending contingency coverage for long-distance commuters. The successful implementation and desirability of the network relies on the strength of its service convenience and certainty, so this type of benefit could attract new ridership and substantial business registration. However, it is important not to overstate this program as a strong ridesharing incentive – most regional programs only offer a severely restricted annual ride limit. Additionally, Hawai`i County's geographic location and lack of state transportation demand management (TDM) initiatives will be a difficult obstacle to overcome in terms of adequate program funding. Funding for the program varies by region, but can either be supplemented with state and federal monies, or completely supported by the private sector or through grants from local organizations. Funding may prove difficult for Hawai`i County – most federal grants are only available for congestion mitigation initiatives in more dense areas, or programs addressing transit for the disabled.[173]

PARKING INCENTIVES

Preferential parking incentives may also be used to promote carpooling and ridesharing networks for work. This may include reduced fees for parking, or designated rideshare parking spaces located close to places of work.

STATE CAR-SHARING VEHICLE SURCHARGE TAX: HB1894 & SB2731

(Pending Final Review as of 1/31/14) [174]

These proposed bills, passed on first reading in both the Hawai`i House and Senate, require a vehicle surcharge tax (current amount undecided) to be levied upon all vehicles used by members of car-sharing organizations each month. Additionally, a $20 first-time registration fee also must be issued to the person who registers the vehicle. Currently, the definition "car-sharing organization" is too narrow, and specifying the term with regard to peer-to-peer ridesharing programs would have substantial implications moving forward into the future.

Official acknowledgement of the emerging car-share (rideshare) market as "a green transportation innovation that can significantly reduce vehicle miles traveled, oil imports, greenhouse gas emissions, and household transportation costs for residents"[175] could be instrumental in establishing a precedent for encouraging competition and development within the state, but the imposed tax could also be another way to discourage new users from registering vehicles with car-sharing organizations by treating them like a public utility.

In addition, the 2007 state legislature passed HB869, the *Energy Efficient Transportation Strategy* Act, signed into law as Act 254 – it requires strategic professional working groups to develop strategies that optimize energy usage in the transportation sector. It highlights carpool/vanpool programs, government subsidies and marketing campaigns as essential strategies in offering more choices in mode of travel.[176] While there is still a disconnect between

level of state governmental commitment/funding and actual prioritization, the past five years have seen forward steps in recognizing ridesharing as a viable entity moving into the future, which may coincide well with the timing for rollout of Requests for Proposals (RFPs) or setting up vendor contracts.

Together, these pieces of legislation could reduce economic and social uncertainty and set a standard that recognizes the ridesharing network as a functioning transportation entity, while fostering support from legislators by generating additional revenue for the state. However, in order to encourage expansion, there must be further legislative clarification whether or not these companies will be grouped into the same categories as existing public utilities, and elaborate on which services and practices will be allowed. In California, a September 2013 legislative ruling legally authorized ridesharing entities within the purview of the state public utility commission; the ruling was hailed as a success by existing Transportation Network Companies (TNCs), which could operate more freely without having to comply with the same restrictions as traditional transit.[177] If ridesharing companies are legally established with properly defined regulatory guidelines, it could be a major boon in attracting rideshare expansion to the county, and perhaps even expand the capacity for allocating tax incentives to employers and commuters as more revenue is generated from these enterprises.

NETWORK MANAGEMENT

TRANSPORTATION MANAGEMENT ASSOCIATIONS

Transportation Management Associations (TMAs) are nonprofit, member-controlled organizations that coordinate transportation, vanpool, and rideshare services between regional businesses – these coordinated regional authorities are established by a sponsoring agency, usually a state, regional or county transportation board, metropolitan planning organization (MPO), or regional Council of Governments (COG). Private enterprises that wish to join a TMA are accepted on an individual basis and are allowed to share the federally recognized benefits of commuter-oriented ridesharing and carpooling. This organization can be structured as follows:

- A Hawai`i County Transportation Management Association could be established by the County of Hawai`i and Mass Transit Agency with input from the Hawai`i County Economic Opportunity Council, the Energy Coordinator, the Planning & Economic Development Department, and the Research & Development division.
- Transportation planning within a TMA should be an inclusive process, considering the perspective of various stakeholders including, but not limited to: users, citizens/taxpayers, impacted residents, businesses, employees/workers, public officials, affected organizations/interest groups.
- Among the responsibilities of the TMA are commute trip reduction, commuter financial incentives, flextime support, parking management and brokerage, rideshare matching and vanpool coordination, shuttle services, special event transport management, and tourist transport management.[178]

- Regional or local governments, chambers of commerce, or developers of a major facility usually provide seed funding. TMAs are generally funded through member fees paid by businesses and government transportation grants.
- A Board of Directors may be necessary to oversee administrative responsibilities of the TMA – this Board should consist of members from the business community, transportation and economic development government officials at the County level, as well as Chamber of Commerce representatives from both Kailua- Kona and Hilo.

It is important to note that there is an inherent tradeoff involved. Establishment of a federally recognized Transportation Management Association (TMA) offers benefits for increasing the infrastructure around ridesharing, specifically for employees and commuters, as this type of arrangement makes Commuter Tax Benefits and the Guaranteed Ride Home Program available and much easier to facilitate. TMAs provide the organizational structure necessary to gauge potential ridership from alternative commuting programs, garner public interest around new network opportunities, and work cooperatively to identify new company registrants and apply for external funding. However, it may be much more difficult to establish a TMA in a rural county with a dispersed population distribution and limited accessibility to public services and utilities. Because TMAs rely on a structured public-private partnership with registered users stored and detailed in an online database, the county's high percentage of socially and technologically isolated communities (like Puna) may impede transition to such a system.

There are also tradeoffs as to which public entity should partially administer the ridesharing network. The Mass Transit Agency is already in existence, but would require additional staff members because the current staff must focus on operating the Hele-On bus systems. Any additional responsibilities would require at least two new coordinating positions in order to spearhead funding and oversight. While a Transportation Management Association or Metropolitan Planning Organization might be a better long-term option in terms of its broad capacity for coordination and outreach/participation among key officials and business leaders, there are no current authorities in existence in Hawai`i County – any effort to establish such an entity would require time and more capital than adding duties to the existing agency.

TMA budgetary data from 1998 showed that California TMAs averaged $140,833 in expenses (office operations, marketing and promotions, capital services, other services), while yielding $152,941 in revenue (member dues, grants and subsidies, service fees, developer funding agreements).[179]

There are venture capital firms that have invested in early financing rounds for existing TNCs. Many of the companies invest in seed, series a/b and growth stages of development; many of the companies also consult with a design, marketing, recruiting and engineering perspective with portfolio companies in order to maximize financial return. Refer to Appendix F for more information on investors and existing rideshare companies.

A complete list of national TMAs and their corresponding websites are listed in Appendix E.[180]

PUBLIC-PRIVATE PARTNERSHIPS (PPP OR P3)

Public-private partnerships (PPP or P3) represent a bright future for the funding of transportation projects and may prove advantageous to long-term ridesharing solutions for Hawai`i Island. These public-private partnerships make it possible for transit agencies or transportation projects to find integrative and comprehensive solutions without driving up fares. The agencies' main objective is not so much profits, but rather to address mandates from government to reduce congestion, air quality and greenhouse gas emissions. In a P3 agreement, projects are privately financed with the transit agency maintaining full or partial control of the project. The private partner will assume all or part of the financial risk in exchange for a share of potential profits.[181]

Public-private partnership agreements must clearly define Key Performance Indicators (KPIs), which serve as the basis for payment and ensuring that the partner is addressing the needs of the public agency. Partners should also have a history of demonstrable experience in providing technical support and efficient delivery or functionality in production.

ADVANTAGES OF P3 SYSTEM:[182]

- Risk Transfer – private partners assume responsibility for delivering at a fixed price by a predefined date.
- Accelerated Project Delivery – these agreements usually employ a design-build contract approach, as opposed to design-bid-build procurement process that often expands the timeline of the project.
- External Funding/Lower Operating Costs and Higher non-transit revenues – transit agencies shift financial burden to private partners, which allow for consistently low fares while both parties profit.
- Private Partner Networks – private partners can potentially improve and streamline rideshare networks by leveraging past experiences, established services, standard administrative tasks, business processes and connections.

DISADVANTAGES OF P3 SYSTEM:[183]

- Transit agency must cede certain elements of control in order to acquire adequate funding and other benefits; depends on which partner is interested in retaining primary authority.
- Risk Transfer – there are certain risks that private partners will not assume, including changes in law, and interference or approval by third-party governmental entities.
- Most P3 projects to date have been implemented for transit solutions and improvements, rather than establishment of new rideshare networks.

HAWAI`I PUBLIC UTILITIES COMMISSION

The Hawai`i Public Utilities Commission (HPUC) should be involved the establishment of a ridesharing network as regulatory authority. In order to attract private growth, investment and economic certainty of an existing network, the state should legally recognize ridesharing as a separate entity – this provides legitimacy to the shared economy, and thus allows the HPUC to

standardize a set of rules for transportation network companies (TNCs). As the national leader in peer-to-peer ridesharing networks, California has experienced rapid cultivation, expansion and adoption of various networks throughout the state, and as a result has recently become the first state to adopt standards for ridesharing networks. In order to acquire a license from the California Public Utility Commission, TNC services were mandated to provide a minimum of $1 million in insurance coverage, vehicle inspections, driver training programs, and a zero-tolerance drug and alcohol policy.[184]

RECOMMENDATIONS FOR AN EXISTING RIDESHARE NETWORK (TNC)

Existing ridesharing companies, like UberX and Lyft, have the flexibility and could work within the framework of an island environment, as they require only GPS technology, cars, community, and little additional capital. Administrative oversight and long-term recognition of these entities by the state public utility commission, an established Transportation Management Association, the state transportation office (Rural Transit Assistance Program), or Mass Transit Agency would be necessary to ensure growth and success into the future, if a public-private partnership is not sought out. However, UberX introduced their service to Oahu with a "soft launch" in 2013. The company is testing out promotional specials and experimenting with prices to meet an optimal demand for the island.

Because there are no existing TNCs on the island, we recommend that the County issue a Request for Proposal (RFP) to mainland companies if they wish to connect with s an existing service. We cannot say with certainty whether one peer-to-peer mobile service works more efficiently for this unique situation than another, so we should allow them to compete in a bidding process for procurement. The County can prioritize key attributes that they desire in a rideshare network (minimizing costs to user and public, service convenience/flexibility/ frequency, ease of administration, technological requirements, capital required, socially equitable, etc.) and let the TNCs compete. Appendix F provides a table with information on existing rideshare mobility providers for reference during the RFP process.

OPPORTUNITY: ESTABLISHING A VANPOOL NETWORK

Vanpool networks are an attractive transit alternative to establishing a rideshare network on Hawai`i Island. A vanpool network on Hawai`i Island would ostensibly serve long-distance commuters along a designated route with hubs at both ends. The Vanpool Hawai`i system originally implemented around Honolulu utilized a third-party provider to provide cost-efficient rides to both commuters and daily travelers. In order for this type of network to attract an adequate base of commuters, costs must be subsidized by federal policies while the vans must be flexible enough to reach individual homes as well as central nodes. However, this type of funding is not readily available; residents and businesses could look to private vendor VRide if they wish to procure vanpool services, which already serve the island.

VANPOOL NETWORK STRUCTURES

Federal policies have encouraged businesses to develop alternative methods of work commuting (Guaranteed Ride Home, Commuter Tax Benefits). As a result vanpool networks have been expanded in many regions in order to efficiently sustain a mobile working community. Company vanpool protocols have been shown to save on parking costs by decreasing the number of individual employee drivers, expand company recruitment options through better networking, reduce employee absenteeism, promote companies as employee-friendly, as well as reduce travel costs for workers.[185] There are three possible frameworks for coordination of employee vanpool systems:[186]

- Employer-sponsored or operated programs where vans are leased and insurance is obtained through the company's regular fleet policy.
- Third-party providers (such as VPSI Inc., LOTMA, or 2Plus) where the employer contracts with a private company or organization to provide the vanpool service – this includes purchasing or leasing the actual vans, vehicle liability and collision coverage, forming vanpool groups, program administration, marketing, and van maintenance.
- Individually owned and operated vanpools where the employee owns and maintains the van, coordinating daily operation of the vanpool. Rider fares cover the purchase and maintenance costs of the van.

Riders usually meet at a designated location (shopping center parking lot, church, park-and-ride location, etc.) – from there, vans can either have one or several pick-up and drop-off points. There are determined starting and ending nodes for both morning and evening commutes for all weekdays.[187] This could also be expanded to include commutes on weekend days.

BEST PRACTICES FOR VANPOOLING NETWORKS

The Transportation to Work toolkit[188] emphasizes Keys to Success for vanpool programs nationwide through comprehensive case studies. They have summarized that the strongest elements of successful systems include development of innovative partnerships, involvement of area employers, understanding the unique needs of communities, obtaining political support from local officials, emphasis on ease of use for businesses and commuters, as well as ensuring flexibility in guaranteed rides.

- Drivers workshops, background checks to ensure safe driving; reduced fees for drivers
- Optimum capacity for vans should be anywhere between 4-15 people, depending on route and travel demand. The minimum of four riders ensures that fares will be kept low due to shared cost.
- Timing of funding cycles can significantly affect start-up goals – county officials should consider the costs associated with promotional materials, outreach and partnership development.

- Employees and business owners should both be consulted when developing time/route schedules, even if the service is to be provided through a third party contract. This ensures that adequate attention is paid to meeting geographical transportation demand.
- Optional fuel card program and either monthly fares or flexible pay-as-you-go agreements that cover costs of the van, insurance, roadside assistance, and emergency rides. In a third party system, private companies will recruit the drivers.
- Online account and database which tracks daily van routes along a map

FUNDING A VANPOOL NETWORK

In the past, funding for Transportation Management Association (TMA) vanpool networks has been allocated via voter-approved sales taxes or federal grants from the Federal Transit Administration. While a majority of the funding goes towards administrative duties and oversight through state agencies, Metropolitan Planning Organizations (MPOs) or TMAs, most federal funding allows for up to 50% of the total allocations to be kept for the vanpool operations themselves. In addition, some states have their own Vanpool Investment Funds; Washington uses such a fund in order to enable regional TMAs to put vans into operation, with costs (fuel, maintenance, insurance) being recovered through fares and federal subsidization.[189] There are three primary channels of federal funding available for the County of Hawai`i to establish its own network, all enacted through the U.S. Department of Transportation's Safe Accountable Flexible Efficient Transportation Equity Act (SAFETEA-LU):

Keeping these funding channels available is essential if the County wishes to administer its own vanpool program. However, it is important to note that the Hawai`i County Economic Opportunity Council has had some recent difficulty with securing funding through the Job Access and Reverse Commute Program (discussed below) for an additional vanpool vehicle to take commuters from Ocean View to the major work hub along the Kohala Coast.[190] Actual monthly savings are still realized (between $120-$160 per month to the user), but there are currently only 1,600 estimated vanpoolers statewide.[191] The Hawai`i Department of Transportation currently only sets aside a small portion of funding through its Rural Transit Assistance Program for vanpool driver training scholarships, while responsibility has been ceded to a third party (VRide) for network operations. This, coupled with the state's discontinuation of the Vanpool Hawai`i program altogether, highlights the difficulties of subsidizing and prioritizing county transit efforts despite public interest in alternative commuter networks.

FORMULA GRANTS FOR OTHER THAN URBANIZED AREAS (SECTION 5311 GRANTS)[192]

Federal discretionary funding is also available to states for supporting public transportation in rural areas with populations of less than 50,000. These projects must demonstrate enhancement of accessibility to health care, shopping, education, and employment, and can improve existing systems, while encouraging the most efficient use of coordinated services and networks. The funding also seeks out support for private transportation providers in low-population areas. The federal share of capital expenses may not exceed 80%, while the share of

operating costs should not exceed 50%. Funding is apportioned by a formula using census information and analyzing land area, administered through the Federal Transit Authority. In 2012, there was $40.1 million appropriated to Hawai`i through these grants.

JOB ACCESS AND REVERSE COMMUTE PROGRAM (JARC SECTION 5316 FUNDS)[193]

This Federal Transit Authority-authorized program was established to address the transportation challenges faced by low-income workers seeking to obtain and maintain employment to moderate success. Eligible recipients are state and public entities, private nonprofits, and private operators, who are working to enhance mobility of these disadvantaged communities through transporting people to and from work. In 2007, there was $59.6 million allocated nationally, with 20% given to small urbanized areas and 20% apportioned for rural areas. Potential program candidates currently must apply individually to receive funding.

RECOMMENDATIONS

CREATING A RIDESHARE NETWORK ON HAWAI`I ISLAND

BUSINESS MODEL

We have developed the business model represented in Figure 8-1. The following section will discuss the key elements we have highlighted below.

Figure 8-1: Public-Private Partnership Rideshare Network Business Model

<table>
<tr><th>Key Partners</th><th>Key Activities</th><th>Value Propositions</th><th>Customer Relationships</th><th>Customer Segments</th></tr>
<tr><td>Value-Driven Investors

Independent Taxi Companies

Transit Authority</td><td>Acquiring funding and private investment

Platform, database, account development

GPS calibration & coordination

Application software development

Marketing & outreach</td><td>Connectivity, community, networking potential

Reduced cost of individual travel

Carpool engagement is friendly, safe, personalized, flexible</td><td>Same-side network effect (drivers and riders mutually beneficial)

Private partner-public agency intercoordination

Channels

Mobile Application

Online Calendar Automation

Website

Rideshare Board</td><td>County-wide commuters

Employers

Advertisers and Marketers

Tourists</td></tr>
<tr><td>Cost Structure

Development phase (GPS, ridematch platform, tech support, marketing)

Regional transit authority consolidation/administration

Cost of driving (gas, maintenance)</td><td>Key Resources

Technology infrastructure

Ridesharing Community

Mobile phones, tablets, Cloud-based support</td><td>Revenue Streams

Suggested minimum + per mile passenger donations

Advertising/promotional deals and events, partnerships with existing vendors

Existing commuter and business tax incentives

Possible partnerships with taxi companies</td><td colspan="2"></td></tr>
</table>

KEY PARTNERS

The network should be comprised of the following groups of suppliers and strategic partners:

1) A transit authority or Transportation Management Association is necessary for administrative coordination, daily functionality and management of an online account database of users. Within a public-private partnership (P3) framework, the public agency must cede a majority of its control to the private investor. Another possibility is for the private entity to engage in a partnership with the local university (University of Hawai`i at Hilo) to facilitate transportation for students, faculty and workers.
2) Value-driven entrepreneurs, like the Rideshare Company, Cubic, TwoGo and Trapeze will be necessary to finance initial startup costs of GPS, account and software development, technical support and marketing – as well as provide support and guidance to the necessary administrative agency.
3) Independent taxi companies could be subcontracted to build more of an initial client base while maintaining friendly relations and a mutually beneficial with this industry. This is more of a long-term goal, as taxi systems would have to be calibrated with GPS technology and ridesharing payment options in order for drivers to pick up multiple riders and split fares. Costs would also have to come down considerably.

KEY ACTIVITIES

A key advantage of the P3 structure over a traditional TNC company will be forgoing the tedious process of securing and sourcing funds, from venture capital groups as well as the federal funding sources mentioned above – this is essential in the earliest stages of development, where the most technical support and administrative coordination is needed. There may need to be some external sourcing of funding in order to partially cover the cost of compensation to the vendor, but usually the third party has the expertise to guide the agency in finding available financial assistance. In addition, the network must maintain platform and account development (keeping up a functioning and accessible database which screens users and provides feedback), GPS calibration and coordination between drivers and riders, application software development, and marketing/outreach to garner interest.

Marketing and outreach should account for a substantial portion of developing a consistent customer base. Press releases in local newspapers, emails to community groups, promotional deals broadcasted via radio, and in-person tabling in populous areas to disseminate information and greet potential riders.

KEY RESOURCES

The success of the network will rely on technology infrastructure (both through mobile and computer-based users and the interactive platform, which links them to rideshare information), an easy-to-use payment option linked to credit card information, the enthusiasm and network support of drivers and riders alike, and an accessible and attractive interface.

VALUE PROPOSITIONS

Ultimately, the rideshare networks should be marketed in a way that emphasizes connectivity and networking potential with the surrounding community (i.e. island pride and heritage in community). Additionally, ridesharing saves the cost of individual travel, while allowing commuters to engage and carpool in a friendly and safe environment with a personalized service. It should also be emphasized that drivers can actually make a profit based on distance and the number of carpoolers they select.

CUSTOMER RELATIONSHIPS

Same-side network effects exist where both drivers and riders benefit from a shared system. The business will benefit from increased usage and operation streamlining as the network expands and gets increasing exposure. There must also be a positive working relationship between private partner and public agency, where the responsibilities and duties of both parties are clearly defined prior to implementation.

CHANNELS

It is important to consider the way in which the network communicates and targets customer segments. It should rely on a functional mobile application, calendar automation (i.e. Google calendar notification), as well as a website for those without access to smart phones or tablets. A rideshare board might also be useful for residents with limited internet access in order for residents to either register for the service, or find out when rides are departing/entering their locale.

CUSTOMER SEGMENTS

Primarily this service will be targeted at island commuters and employers. Other prospective targets include tourists, university and high school students, university faculty and staff.

COST STRUCTURE

If the County opts to enter into agreement with a private vendor (via a public-private partnership), that vendor will cover operational expenses and technical support in exchange for compensation for fare revenue and software costs. For reference, a Regional Rideshare interface and online ridematching platform in the Los Angeles metropolitan area through the Trapeze Group's RidePro program cost a total of $208,929; the Riverside County Transportation Commission paid $81,553, while the national Mobile Source Air Pollution Reduction Review Committee (MSRC) covered $127,376, through the state of California's discretionary funds.[194]

From there, most of the cost is incurred upon the drivers, who would normally pay for gasoline and car maintenance from commuting anyway. The attractiveness of the network is the shared (reduced) cost of commuting through encouraged carpooling and accessibility to ride information.

REVENUE STREAMS

Because the system relies on "suggested" donations to the driver (average of $0.13/mile based on existing systems) to cover gas and car maintenance, actual revenue and ROI is difficult to determine. This system should provide a small percentage of the donation to go towards the network (20%), with additional sources coming from advertising or promotional deals. Additional partnerships with retail vendors (i.e. LivingSocial, StubHub, Groupon) could be utilized to entice new users to the network. Tax incentives for commuters may encourage more riders to pay for the system's use, as well as full cost recovery for drivers through a mechanized (or cash-based) payment plan. Most of the revenue is returned in the sale of the ridesharing software platform and coordination of technical guidance and support.

There are potential opportunities available for rideshare networks and independent island taxi companies to partner – Uber has already reached out to work with taxi and limo drivers to provide their service. This is a good way to reduce animosity and resentment between the two services, fueled by increased competition. However, partnership in this area may be slow, as taxi regulations are complex and based on entirely different business models developed pre-smartphone.

VENDOR OPTIONS FOR AN ISLAND P3-BASED NETWORK

Ultimately we recommend that a public agency partners with a private "product vendor" to develop a finance stream and organizational structure for individualized ridesharing network. We have completed a preliminary analysis on the following vendors for their suitability for a public-private partnership to develop a ridesharing network on Hawai`i Island.

THE TRAPEZE GROUP

The Trapeze Group claims to be "a company at the forefront of tackling global transportation challenges through technologically integrated solutions." The company provides end-to-end service programs from product innovation and development to solutions delivery and technical support. Most recently, they have acquired the assets of GreenRide, a suite of sustainable ridesharing solutions specializing in mobility management, demand response and software expertise. Trapeze offers the most comprehensive rideshare management online solutions package to date (through RidePro).[195] The capabilities of RidePro include:

- Automated ridematching, both individually or in batches
- Integration with social media enabled for individual networking
- Web site support to brand a public interface for the ridesharing service
- Commuter-recorded trips to support savings calculations and incentive programs (i.e. promotional drawings)
- Maintenance of contact with registrants while tracking program success through email and surveys
- Integrated vanpool matching software

THE RIDESHARE COMPANY

The Rideshare Company is a nonprofit organization offering interactive demand-oriented ridematching solutions and consulting, marketing strategies and fleet vehicular provisions for ridesharing and vanpooling programs. This company focuses on employees and brings together federal tax incentives, mass transit options, commuter incentives, and user tracking tools to deliver commuter services uniquely tailored to fit each business. Originating in the New York/New England region, the company has expanded their consulting services nationally to Washington, DC, Chicago and Los Angeles while procuring a General Services Administration contract that allows them to provide support directly to federal government agencies as well. The company places high emphasis on outreach, marketing, and education from conception to implementation in order to educate employers, commuters, state governments and NGOs while helping them optimize commuting alternatives.[196]

CUBIC TRANSPORTATION SYSTEMS

This global corporation provides integrated revenue management solutions within the mass transit industry. They assist with the design and delivery of technological services that provides the business model and fare payment infrastructure (gates, ticketing, smart card readers, back end or central systems for processing and reporting revenue). In addition, the company assumes responsibility in providing customer and software support as well as operations services. The company has delivered over 400 projects in 40 major markets on five continents.[197]

A UNIVERSITY RIDESHARE NETWORK

We recommend investigating the possibility of a ridesharing pilot project at the University of Hawai`i at Hilo to understand the benefits and barriers of this kind of network on Hawai`i Island.

University of Hawai'i at Hilo Campus (Source: hilo.hawaii.edu)

The success of ridesharing networks in attracting university students depends upon the proportion of automobile-reliant commuters at the school and the relative travel distances between their residences and campus. Further commuting distances from campus have traditionally been favorable for ridesharing, with larger universities often proving more successful at attracting new users to rideshare than their smaller, more campus-focused counterparts.[198] The University of Washington in Seattle (UW) campus, for example, registered 2,336 users through Zimride/Lyft on its launch date – the largest in Zimride history. Over six weeks later, there were 4,039 users (those who had logged onto the site). Zimride usually averages 1,500-2,000 campus users within the first year of its launch.[199] The success of the UW rideshare network may be attributed to its strategic communications campaign, based on results from student behavioral studies and focus group analyses. Furthermore, only 13% of undergraduate students live on campus, which indicates a strong demand for residence-to-campus service.[200] Commuter service emails and messages to those holding parking permits yielded statistically significant influence on user registration. It is unlikely that out-of-state university students at Hilo would rely on ridesharing to get from the local airport to campus, as the distance spans just four miles. However, out of the 4,100 undergraduate students, only 26% live on campus, so rideshare commuting to campus might be an option depending on user preferences – this number does not even take into account the university faculty and staff that may live further from campus and find carpooling an attractive option in getting to campus.[201]

Marketing and branding should account for a substantial portion of accumulating a critical mass of users essential for network functionality. Characteristics of past marketing campaigns have included extensive emails to target audiences (social clubs, parking permit holders), commuter-targeted tabling in student activities areas and parking lots to disseminate information, poster advertisements and added incentives (raffles for tablets and iPods, promotional deals with social media vendors like LivingSocial and StubHub). Once the network has attracted a broad base of consistent users, coordinators need to leverage their authority to incorporate larger campus groups and organizations in order to expand credibility and personal outreach for the network. Engagement from orientation is also recommended in order to familiarize students, while fostering a sense of community and security by emphasizing personal referencing and user recommendations/ratings.

The rideshare industry is highly competitive and as result is reluctant to disclose information about their revenues and costs. We were able to collect limited data from public records and by contacting the companies themselves. For example, Zimride (purchased in 2013 by Lyft) typically charges approximately $10,000/year to large universities for rideshare partnerships - major costs will be realized in the development phase, where initial technical and marketing capital is required to get the ridesharing platform up and running.[202]

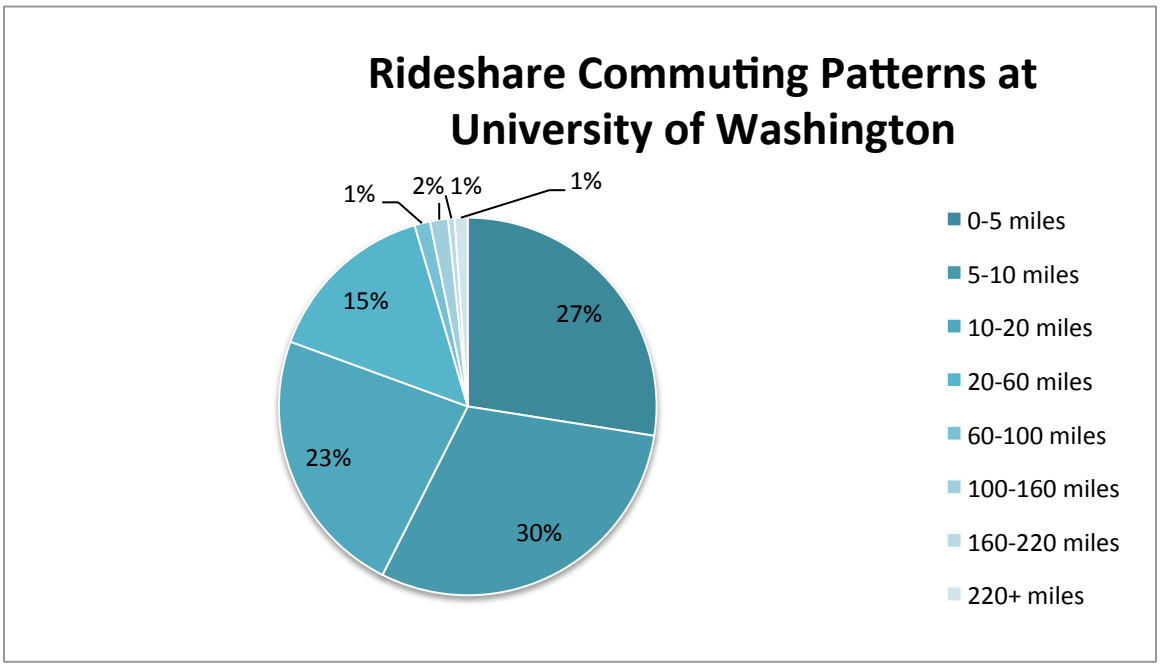
Students who are actively engaged in both environmental stewardship and campus-wide social groups have traditionally initiated project development. We connected with members of UH-Hilo's Students for Sustainability Committee, who do not currently work on commuting issues, but were interested in engaging in them in the future.

If the County wishes to pursue partnership with the University of Hawai`i -Hilo as a pilot project, information gathered from previous college networks suggest that UH should develop its own uniquely tailored and marketed rideshare network. It is important for the university to plan for the ability to change providers in the future without losing all prior market development; ridesharing platforms are still in their infancy and are still subject to market fluctuations and acquisitions by larger companies who may wish to diversify and re-prioritize their capabilities. Significant student involvement in the partnership process has also been a recurring theme of past implementation projects at the university level.[203]

UNIVERSITY RIDESHARE COMMUTING PATTERNS – A CURSORY GLANCE

Figure 8-2, below, indicates the success of ridesharing at attracting both short- and long-distance commuters at the University of Washington's Seattle campus between 2010 and 2014. There have been a total of 3,704 cumulative ride posts (approximately 8% of all campus students and faculty) since December 13, 2010, with 13 average ride matches per post.

Figure 8-2



The numbers reflect that the dense urban student population has utilized the network for a substantial majority of short distances rather than long distances; 26.6% of commutes were between 0-5 miles, while 29% of commutes were 5-10 miles, 22.4% of commutes were 10-20 miles, and 22% of commutes were longer than 20 miles. Despite the more substantial gains in cost-effectiveness from further driving distances, it appears that density and a higher number of potential commuters are a more significant factor behind rideshare usage than distance savings. This implies that the University of Hawai`i at Hilo could potentially benefit from a rideshare network despite short distances from town to campus.[204]

COMPARISON OF RIDESHARE OPTIONS

Table 8-1 provides an overview of the major decision points for moving forward with either an existing rideshare network, a newly developed network or a vanpool network.

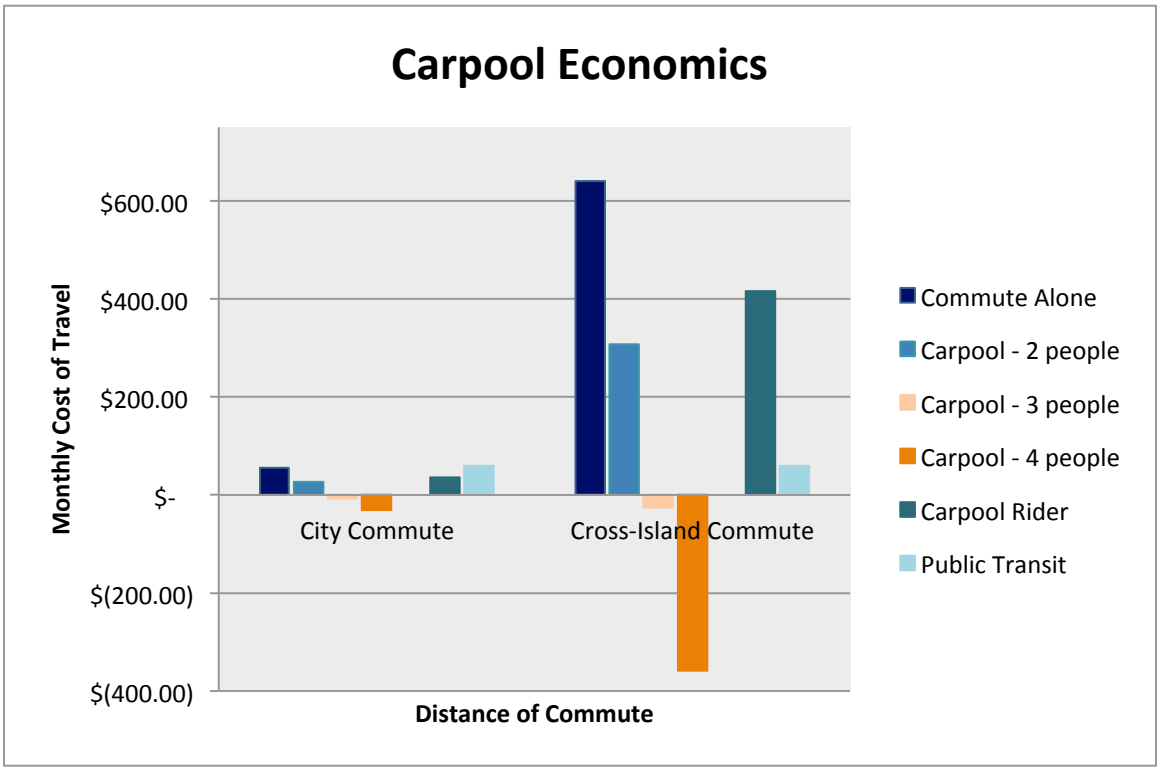
Table 8-1: Rideshare Options for Hawai'i Island

Criteria	Third Party Existing Rideshare Network (TNC)	Third Party Unique Rideshare Network (P3)	Vanpool Network
Cost for Average User	Optimal driver donation has been determined to be $0.13/mile with the company retaining a 20% fee.	Optimal driver donation has been determined to be $0.13/mile.	$141-164 per person/month (estimate specific to Vanpool Hawai'i)[205]
Capital Needed	Average cost to rollout service at the university level is approximately $10,000/year.[206]	Trapeze Group RidePro ridematching software cost a total of $208, 929; the Riverside County Transportation Commission paid $81,553, while the national Mobile Source Air Pollution Reduction Review Committee (MSRC) covered $127,376, through the state of California's discretionary funds.[207]	The average cost for a single carpool in Hawai`i is $1,300/ month for a 7-person van.[208] JobJet Iowa was initially funded by $146,000.[209]
Service Convenience	Optimal	Optimal	The van is assigned starting and ending nodes at the same time every working day. It lacks the flexibility of the rideshare networks, but maintains reliability.
Ease of Administration	TNCs are already in existence and easily transferable to new markets. However, a regional transit authority must be available to coordinate and regulate the TNC.	Development of a P3 is time-intensive and requires technical consulting to adopt a suitable model. However, longer term stability could make securing funding from external sources easier. Private vendors assume the administrative role, relieving the public agency of much of the burden.	There is no current MPO/TMA for the county. The statewide vanpool program was dropped in late 2010, so the commuter network is largely privately-managed. (Vride)
Availability of Technology	GPS user technology is readily available; the ridematching platform is provided by TNC.	Ridematching platform and technical support and GPS database provided by the company.	Software from VRide already implemented
Requirements	Cars, drivers, riders, mobile phone or tablet with GPS capability, ridematching platform and database with accessible account information	Ridematching platform and marketing/development depends on each unique situation, but could either be provided by the company or coordinating agency.	Van fleet provided either by third party provider or an employer. Database both online and via hard copy.

USER COST COMPARISONS

Figure 8-3 illustrates the monthly user costs associated with ridesharing and compares them to the cost of commuting alone and commuting via public transit. The chart also compares cost recovery for drivers based on how many passengers are served in the carpool and distance traveled daily (short city commutes of 10 miles and long intra-island commute of 160 miles). The economic returns from long-distance commuting are much more substantial in ridesharing than for shorter distances. Although the driver pays an average of $640/month for long-distance commuting on the island, that cost is cut almost in half by taking on one additional passenger ($332.80 returned to the driver), and fully recovered with additional profit by taking on two or three passengers (making $25.60 or $358.40 per month respectively). For shorter distances, the gains are more modest – the $40/month average cost of gasoline for a single commuter is recovered with the driver earning an additional $1.60 for two more riders and $22.40 for three more riders. (See Appendix G for more details on these calculations.) Despite these findings, the pilot project completed at the University of Washington clearly indicated that short-distance (<20 miles) commutes were the most heavily frequented routes of rideshare users, indicating that the potential of a loyal ridership community is more contingent upon a dense user base in which to draw, rather than relying on only long-distance commuters that live in more isolated neighborhoods.

Figure 8-3



THIRD PARTY EXISTING RIDESHARE NETWORKS (TNC)

ADVANTAGES

Existing Rideshare Networks provide quick entry into the marketplace. These heavily frequented and tested networks already have substantial technical expertise in developing efficient demand-responsive ridematching software. The networks also bring experience and guidance in community engagement and marketing, making them effective communicators with the practiced ability to promote new ridership and attract a wide variety of clientele across a social media landscape. Technical support is centralized and readily available, as is the capacity for organizational partnerships – Lyft, Zimride and UberX in particular have demonstrated a knack for partnering with universities, corporations or independent taxi providers in order to broaden their customer bases while cultivating mutually beneficial relationships with existing companies.

Service convenience (as included as a key performance criterion) refers to the flexibility, certainty, responsiveness, and reliability of the transportation system. Rideshare networks have near optimal service convenience due to the fact that the technology utilized is tailored to drivers picking up passengers along routes to be established ahead of time. They have proven to be used in cities as both commuting practices as well as established connection points between the workplace, larger transit hubs, and home.

Carpool savings to the user (driver or rider) naturally accrue over time, growing increasingly large depending upon number of users carpooling together. Carpool savings are generally much more substantial for longer commuting trips. As noted in User Cost Comparisons (above), drivers can recover their monthly spending on gasoline with just two more passengers, and can potentially earn over $350 per month with three additional passengers. Although the average cost to the passenger in said carpool may round out to about $416 per month, this is still lower than the $640/month standard commuter fare for the 160-mile round trip from Hilo to Kona.

Finally, as we mentioned in the section entitled “Characteristics of Hawai`i County Commuters,” residents of Hawai`i Island are already more prone to carpooling practices than their mainland counterparts. If these ridesharing networks are able to promote ridesharing as a community-strengthening culturally cohesive tool to network and support fellow Hawaiians, the companies may have a much more meaningful and long-lasting impact. The greatest chance for potential consumer impact on the island remains in long-distance commuting from residential clusters in Ocean View-South Kona, Puna, Hilo, and Waimea to work destinations along the Kohala Coast and Kona.

DISADVANTAGES

These ridesharing enterprises have recently become very popular and have begun to expand rapidly; this expansion, however, has been limited to populous urban centers and their surrounding suburbs. The ideal geographical arrangement for proven rideshare success has been a populous metropolitan setting; sprawling enough from the city center for substantial rider savings from carpool to be realized, yet dense enough to ensure a healthy supply of daily commuters. It is unclear whether the introduction of a rideshare network would attract a consistent customer base on Hawai`i Island given the region's mostly rural, geographically dispersed population. Until this point, the success of existing rideshare networks have hinged not only upon attractive cost savings to the user, but also upon the capacity for the existing infrastructure to support the network (both social and technological) – while mobile technological capabilities and Wi-Fi coverage seem fairly comprehensive on the island, population density for ridesharing commutes may not support regular ridership on a consistent basis. This, coupled with the networks' greater proven cost-effectiveness at a longer-distance scale, may be a moderate complication to island-wide success.

Another potential area of concern lies in the administrative oversight and regulation of these entities. In California, taxi providers resentful of the competitive pricing of rideshare transportation network companies (TNCs) lobbied against them, while investors remained uncertain of whether financial backing was in their best interest due to increasing economic discord. It was not until the California Public Utility Commission (PUC) officially recognized TNCs as a separate and legitimate entity that ridership and investment in the networks rapidly expanded – this essentially served as the PUC's assumption of responsibility for regulation and coordination of the networks.

Other than the Hawai`i County Mass Transit Agency (already focused on maintaining the Hele-On system), there is no clear transportation management authority, regional planning organization, or council agency with the resources necessary to oversee ridesharing expansion. Because the existing companies are emerging in a competitive market, many of the already established TNCs are in open competition both among themselves and with other industries (taxi, vanpool, transit), pay for themselves, and rely more on private investments and venture capital to keep expanding new features and services. This will require more burdensome regulation by an administrative authority going into the future (as opposed to a singular P3 network established in conjunction with an existing public agency). Establishment of a regional Transportation Management Authority that integrates mass transit with vanpool, rideshare, and taxi services could be costly – the national average annual budget for a TMA is priced at $200,000, generally from state appropriations.[210] However, the County is already geographically constrained, as an island while most of the TNC infrastructure is already web-based, making the current lack of a coordinated regional authority a minor issue. Expansion could be rolled out in conjunction with Oahu's UberX launch, and is not foreseen to require heavy-handed technological regulation or an extremely large professional staff presence on Hawai`i Island. Implementation could potentially be achieved with existing oversight from the state's Public

Utility Commission or through the Statewide Transportation Planning Office's Rural Transit Assistance Program, though the latter is probably unlikely.

TARGETED USER GROUPS

Due to the unlikelihood of last-mile travel for Hawai`i Island ridesharing (lack of cost-effectiveness of short-term travel), general reliance on normal business hours for a large commuter working base and relatively higher cost than mass transit, any rideshare network introduced on the Island will likely support middle-class professionals or company employees within a corporate partnership with a transportation network company. Ridesharing is unlikely to pull ridership away from mass transit due to the higher price of travel, and seems to be geared more towards riders that would otherwise drive themselves (i.e. those preferring the intimacy, flexibility and luxury afforded by automobile travel). The regularity of mass transit with regard to operating hours and predetermined bus routes ensures continued ridership by the same commuters and students who currently rely on Hele-On. Ridesharing networks will probably not gain much traction for lower-income families reliant on service sector shift labor due to these discrepancies.

INCENTIVES AND DISINCENTIVES

Federal subsidies for "alternative commuters" like the Commuter Tax Benefit Program, the Guaranteed Ride Home Program (GRHP), and the Job Access Reverse Commute (JARC) program are without an agency or representative body that can efficiently allocate these incentives to commuters and businesses on Hawai`i Island. The onus is on the partnering employer or enterprising individual to get in contact with the representative governing body to apply for tax credits or subsidies in exchange for provision of ridesharing commuter reliance.

The difficulties of securing these federal subsidies, combined with the lack of regional authority necessary to push for application of these incentives and make programs known to commuters, indicates that they have not been strong enough to encourage ridesharing practices on the Island. Additionally, it may be very expensive to implement the Guaranteed Ride Home Program due to the lengthy distances between work and residence for many islanders, and most federal funding is limited to congestion-prone service areas or targeted towards disabled populations.

This is not to say that tax benefits and commuter subsidies cannot significantly impact driving habits in the future – if state-directed legislation is any indication, Hawai`i might be seeing a significant push in rideshare and carpool efforts in the near future as potential energy savings are realized (see Policies in Existence – Carsharing Vehicle Surcharge Tax). Furthermore, if the County works to support regional transportation oversight beyond existing mass transit, it would create a more influential governing body in which to communicate the needs of its citizens to the state in order to apply for subsidies.

NEXT STEPS FOR EXPANSION OF AN EXISTING RIDESHARE NETWORK

Although the largest uncertainty remains in whether an existing and tested ridesharing service can attract adequate ridership given sprawling population dispersal, a formal governing entity must be established and federally recognized in order for the full range of capital investment and commuter incentive structures to be developed and cultivated.

A final criterion to be considered when comparing options for expansion is social equity, measuring both attractiveness and accessibility to the general public. While vanpool systems are utilized for commuters, the availability of technology must be assessed so that residents have the option to rideshare. We suggest that the County develop a population survey to gauge the potential popularity of the networks before implementation is considered. Such a survey should reach across a broad range of residents, from commuters to public officials, as well as employers and families. Such a survey could also be developed by University of Hawai`i -Hilo students in an effort to measure how students and faculty might respond to ridesharing as a means of alternative transportation in commuting to and from campus.

Looking into the future, it would be in Hawai`i County's best interest to either adopt a type of regional transportation management agency, planning organization or otherwise coordinate priorities between its Energy, Planning & Economic Development, Research & Development, Mass Transit departments and large-business employers to form a more cohesive approach to targeting sustainable transportation solutions. Currently, most ridesharing companies (TNCs) are regulated by state public utility commissions; to date, regulation typically entails ensuring that ridesharing networks are registered and approved, that rides facilitated between passengers and private drivers utilize the drivers' own vehicles, and that the companies maintain an insurance policy providing per-incident minimum coverage standards. The regulating entity might also seek to cultivate partnerships between local taxi companies and TNCs to avoid open hostility between competing businesses while allowing for incorporation of available network technology.

If the County does decide to go forward with an existing rideshare network, a Request for Proposal should be solicited to all existing national rideshare network vendors. This would encourage bidding by successful companies, allowing the networks to determine whether they might benefit from expansion into unique territory beyond the purview of traditional systems. If an ensuing partnership with the local university or with larger corporations is desired, Zimride (recently sold to Lyft) is recommended for its expertise in coordinating these partnerships at over 100 universities and 50 company offices.[211]

INDIVIDUAL PUBLIC-PRIVATE (P3) RIDESHARE NETWORK

ADVANTAGES

Transit-related public-private partnerships (P3) generally provide benefits in the form of risk transfer (the private software company assumes liability of service) while maintaining a proven

track record of reliability and technical support. Instead of wasting time and resources on outsourcing and bidding to existing ridesharing companies (TNCs) that may not see the demand as adequate for expanding their network to the Island, selecting a solutions-based vendor may provide accelerated project delivery through a fixed contract that forgoes the typical procurement process. The vendors are also familiar with ways to streamline operating costs through proven cash collection techniques, while helping the transit agency in maximizing new sources of revenue.

Generally, most regional public officials have favored P3s in an era where federal, state, and city resources are increasingly scarce. Initially expensive contract costs could relieve transit agencies of administrative and financial burdens, while it would be in the best interest of such vendors to streamline operations to keep attracting riders while keeping maintenance costs low. This could prove to be very attractive for Hawai`i County, where the Mass Transit Agency is already stretched thin in terms of financial and labor resources for oversight of the Hele-On system. It would also be highly unlikely for federal or state funding to be available for a coordinated county TMA in the future without clear assurance that the program will pay for itself. Additionally, a privately operated system unique to Hawai`i County would provide optimal reliability and flexibility in service, rather than a one-size-fits-all pre-existing rideshare model that has only demonstrated successful results in metropolitan regions. There is more sensitivity to branding and targeting selected groups, and private companies can work with the partnering public agency to help find external sources to supplement project compensation fees. More importantly, there is less sensitivity to potential company turnovers, acquisitions, or changes in company structure and ownership. Where TNCs might graft their existing network onto the Island, a unique P3 working in tandem with the County would require less oversight and foster a better relationship with existing residents and businesses.

A P3 system requires much more capital and more initial input from county officials – however, the benefits of such a system will be realized in the form of a more responsive and flexible rideshare network with a greater capacity for coordinating solutions to meet shifting transportation demands into the future. Compared to establishment of an existing rideshare network, a P3 structure could ultimately provide greater long-term stability for the island, with less dependence on uncertain future public funding.

DISADVANTAGES

The major distinction in choosing between implementation of an existing rideshare service or entering into a contract with a private vendor for an individualized network lies in the administrative oversight. While a P3 system might be lauded for its greater assumed role in managing the network almost in its entirety, the implication is that the public good (in this case, transit) has been transferred to a private entity. This could mean that the public becomes subject to the company's efforts to keep business costs low. The company could raise utility rates and fees over a period of time (for example, fare-raising of parking meters and private toll bridges in Chicago via Cubic Transportation Systems[212]), or similarly adjust costs based on

perceived market risks. Additionally, there are certain risks that private partners will not assume - including changes in regional law and interference or approval by third-party government entities – which could accordingly raise user costs.

The initial startup costs of operation for a P3 network are also much more expensive. Because each system is uniquely tailored to the geographical or infrastructure constraints of the project at hand, the coordinating public agency must pay for consultants to visit the island to make recommendations and decide exactly how an optimal rideshare network should be implemented (instead of relying on a pre-scripted format).

TARGETED USER GROUPS

Ridesharing networks on Hawai`i Island are speculated to attract the same demographic of ridership despite organizational structure, as user costs generated (at least in the beginning) would be relatively similar. P3 networks are expected to rely on middle-class commuting professionals or commuting university students and faculty for a majority of daily ridership.

INCENTIVES AND DISINCENTIVES

Again, many of the incentives offered for carpooling provide the same commuter and employer benefits for any rideshare network regardless of structure.

There is one possible innovation that may prove more feasible given a unique third-party rideshare system over a publicly administered expansion of a more rigid existing network. A former project consultant and current University of Michigan Sustainable Systems graduate student originally came to us with an idea that could provide an incentive for passengers to recruit each other for higher-occupancy carpooling. It applies the Game Theory as well as our User Cost findings for carpool – adding passengers to a carpool bring down costs for the driver until he breaks even, at which point adding additional riders would increase his own profit. While this provides an incentive for the driver to find people to take to work, the realized savings from a passenger standpoint may not be as apparent (though they do exist). Once the carpool exceeds the break-even point and a surplus is reached, some of the profit could be returned to the passengers in the form of cost subsidization, or simply a monthly payment. As more passengers are added to the carpool, the subsidy recovered by the riders increases with the profit. Although the concept was originally prescribed for public bus systems in India, the value might prove more beneficial for a private individualized rideshare network with the flexibility to both implement its own system and manage itself.[213] This is especially pertinent given the fact that most public buses operate at a loss without government subsidization.

NEXT STEPS FOR IMPLEMENTATION OF A P3-AGENCY PARTNERED RIDESHARE NETWORK

While it is not of paramount importance that a fully functioning agency be established to oversee, regulate and administer a P3 ridesharing entity, there should be a specified staff person (or persons) at the regional agency level to be tasked with coordinating the day-to-day

operations of the network. This person would work in accordance with the mutually agreed upon contract binding said agency with the private vendor. This staff member should also be charged with implementing and monitoring any additional policies enacted by the federal, state or local public agencies that may have an impact ridesharing practices. Again, any overseeing entity might want to focus attention on creating lasting, mutually beneficial relationships between said ridesharing service and local taxi companies in order to ease hostility and realize full potential of technology- and customer- sharing.

If the County wishes to proceed with implementation of an individualized rideshare network, this direction is relatively straightforward. There are a number of transportation technology vendors with a proven track record with significant investor backing – contacting a sales representative from one of these companies to obtain a quote would be the next logical step.

ISLAND-WIDE PRIVATE VANPOOL NETWORK

ADVANTAGES

Private vanpooling (with vans provided by a third party) has been the preferred network within the state due to lack of prioritization by the Hawai`i Department of Transportation, as evidenced by past budgetary cuts. The private VRide system is already in implementation, and its mapping tools and online surveys produce overviews of employee commuting patterns in order to establish travel nodes. The island is ideal in geography for vanpool commutes, where many large employers (e.g. resorts) draw from concentrated residential clusters (e.g. Hilo) and can pick up commuters along the way northward (via Waimea) and southward (via Puna, Ocean View) towards Kona and the Kohala coast. The existing network is entirely private – Vride both provides the vehicles and oversees the online registration database and mapping tools, while members sign up individually to drive and are reimbursed for fuel through “seat fees” by passengers.[214]

The organizational structure and technological infrastructure is already in place – commuters can create online accounts to immediately begin registering for existing vanpools on the Island, or even start their own vanpools. It is a federally recognized method of commuting, and requires no additional governmental oversight. Vanpooling can save long-distance commuters up to $4,000 a year (or more) in travel costs otherwise incurred through individual travel (assuming average monthly single-commuter cost of $640 from Hilo to Kona). Currently the system is not close to reaching full capacity, with most commuters relying on mass transit or individual vehicles for daily travel. Higher carpooling capacities into the future (as opposed to traditional rideshare) mean greater cost savings for the users.

Employer vanpools within the county are non-existent, but offer tax benefits to employers and employees as well as the additional savings in cost per mile.

DISADVANTAGES

While the network saves even more costs for riders and implementation has already been achieved, it only accounts for an insignificant fraction of daily travel for islanders. The driver is only reimbursed up until the point where his fuel costs are covered, and no more – while this is still an incentive for the driver to find willing vanpoolers, it still may not be worth the effort of receiving training and driving a large van back and forth across the island five times a week. Ridesharing services, in comparison, offer potential profits to the driver for his time and services.

The vanpool network still lacks the flexibility of mobile ridesharing and ridematching. Routes, though optimized to meet large concentrations of commuters, are still pre-determined and depart and arrive at specific nodes. Often times, riders in a vanpool might still find themselves having to drive just to reach the starting node, which may be more than ten miles away for those living on the interior of the island away from the hubs in Hilo or Kona. Furthermore, irregular shift hours between service-sector workers may hinder the effectiveness of filling employer-provided or VRide vans; if there is too much variation in the traveling times of workers within a single resort area, pre-determined vanpool route times may do little to meet the scheduling demands of the workers.

If the vans do reach full capacity and increase ridership, it could also divert riders from existing mass transit, which has traditionally been subsidized with county dollars to ensure that passengers do not have to pay more than a few dollars.

TARGETED USER GROUPS

To date, the few vans already transporting passengers on the island serve the handicapped and elderly in rural, isolated communities – these vans transport residents to city centers (mostly within Hilo) for shopping and health appointments. A more comprehensive vanpool system would ideally focus on transporting commuters and service-sector employees working consistent schedules to and from a starting node in Hilo to a final destination point along the Kohala Coast, possibly picking up riders along the way. While the cheaper user costs of vanpool make it a more attractive option for lower-income groups (around $150/person each month for a 7-9 person van),[215] the cheaper cost of vanpooling compared to ridesharing indicates that this service may be better suited for lower-income workers who have difficulty meeting scheduled bus routes, or cannot afford the luxury of driving their own vehicle or even ridesharing.

INCENTIVES AND DISINCENTIVES

There is already paratransit available on the island managed by the Hawai`i County Economic Opportunity Council (HCEOC) through a federal contract with the Department of Transportation. However, though they have applied for vehicle funding in the past through the Job Access Reverse Commute program (JARC), the state has been stalling in allocating the vehicles to the County for usage. Currently, this program only provides rides for the elderly and handicapped, although the HCEOC is waiting on a single van that will transport ALL commuters from Ocean

View to Kona for work purposes. Such difficulties with the reimbursement process suggest that although applications for funding through federal incentives are granted, the state's stalled implementation reflects a lack of prioritization when it comes to the island's transportation needs. Because of the difficulties associated with acquiring government funding, it is unlikely that public vanpool incentives are likely to induce new ridership, or even play a major role in vanpool development for some time. These issues may exacerbate if the County is to rely on federal subsidies for future vanpool programs – in 2011, the Hawai`i Department of Transportation cut vanpool subsidies entirely after 17 years, immediately raising user fees and eventually forcing Vanpool Hawai`i to sub-contract out to a private vendor (VRide) to head the program.[216] Such difficulties with implementing incentive programs also suggest the need for a stronger and more cohesive regional voice to represent county interests, reflecting the need for a planning organization, authority or council to facilitate and expedite grant proposals for new projects.

The VRide system, while allowing for riders to pay the driver to reimburse for the cost of gas, does not allow the driver to generate a profit of his own. Without adjusting this payment mechanism, there is little incentive for the driver to find more carpoolers beyond meeting fuel coverage costs – a mileage or time-oriented payment plan might be more suitable in allowing for the driver to earn extra money for his efforts in getting trained and driving the van daily.

NEXT STEPS FOR IMPLEMENTATION OF A PRIVATE VANPOOL NETWORK

There is already a state vanpool program (VRide), which offers its services to Hawai`i County, though it clearly has not been attainable for most of the island's residents. To remedy this while presenting the network as a cost-effective solution for many commuters, marketing and outreach campaigns should be expanded via radio and community newspapers. Forums could be held, accessible to both employers and employees, in which businesses can share employee travel information in order to gauge the effectiveness of partnering together to provide vanpool services. Employers should also be made more aware of the Commuter Tax Benefits available to the company should they opt with providing vanpool services to their employees. At the state level, the Department of Transportation could establish additional tax credits for employers who provide their own vans (Maryland, Georgia, Minnesota).

If vanpooling exposure and ridership increases on the island, the county should establish a point of contact within the state VRide office in order to bring in more vans.

9: APPENDICIES

- Appendix A: Project Plan and Hypothesis
- Appendix B: Sources of Information
- Appendix C: County of Hawai`i Financial Data
- Appendix D: Creating the Maps
- Appendix E: Transportation Management
- Appendix F: Existing Mobile Rideshare Providers
- Appendix G: The Economics of Carpooling
- Appendix H: University of Michigan Team Bios
- Appendix I: Masters Project Client
- Illustrations, Tables and Figures
- References

APPENDIX A: PROJECT PLAN AND HYPOTHESES

PROJECT PLAN

STAGE I: (MARCH – APRIL 2013)

Preliminary Research and Defining Testable Hypotheses

Following our preliminary research on Hawai`i Island and its public transit system, the team developed two hypotheses for reducing fossil fuel usage. The following hypotheses guided our onsite, background and best practices research:

1. Technological and communication upgrades to the current public transportation system will increase ridership and reduce personal vehicle use.

2. The introduction of car-share and ride-share services will reduce the number of personal vehicles used.

Metrics were subsequently selected in order to test the efficacy of determined hypotheses on reduction of overall Vehicle Miles Traveled (VMT) and reduced gasoline consumption.

STAGE II: (APRIL – MAY 2013)

Review of Hawai`i Island Transportation Infrastructure

In order to draft recommendations that are achievable and reflect the values of the community and all the stakeholders, the team completed further research to build a basic understanding of the local culture and stakeholder, the policy-making landscape, the available financial resources, the current transportation system, and the economics of the island.

STAGE III: (JUNE – JULY 2013)

Comparative Studies of Existing Regional Transportation Systems

The team performed a literature review to help broaden our knowledge of existing transportation systems and identify potential solutions through improvements to existing infrastructure or introduction of new practices.

STAGE IV: (JULY – AUGUST 2013)

Onsite Research and Meetings

The team traveled to Hawai`i Island to engage with project stakeholders directly. This trip ensured that we got some sense of the wants, needs, goals and objectives of those using and involved in the public transit system and energy sustainability on the island. (See Appendix B for a comprehensive list of all project participants and contributors.)

STAGE V: (SEPTEMBER 2013 – FEBRUARY 2014)

Data Analysis and Final Report

This process will require synthesizing Stage II and III research, as well as taking into account the concerns and attitudes of the commuters and employers (after meeting with key stakeholders) identified in Stage IV. We have prepared this report with our analysis and recommendations.

PROJECT HYPOTHESES

1. *Improvements in the current public transportation system will increase ridership and reduce personal vehicle use.*

   Tactics:
   a. Introduction of vanpools
      i. Will maximize efficient occupancy of vehicles
      ii. Allows for more frequent trips
   b. Redesign routes
      i. More direct and "express" trips
      ii. Clearly defined stops
      iii. Optimized times and peak hours
   c. Improve communication
      i. Major upgrade and redesign of web page: user-friendly, interactive and intuitive
      ii. Clear signs at designated bus stops
      iii. Clear and more intuitive route mapping (times, stops, etc.)
      iv. Major communication campaign when changes are implemented
      v. Web and mobile phone application with GPS tracking of buses and vans

2. *The introduction of car-share and ride-share services will reduce the number of personal vehicles used.*

   Tactics:
   a. Engage the business community
      i. Introduce rideshare or carpooling programs with employees
      ii. Implement car-share services in existing rental car agencies
      iii. Introduce rideshare service companies
   b. Develop coordination and communication tools
      i. Ride-share software
      ii. Web-based apps
      iii. Analog options

APPENDIX B: SOURCES OF INFORMATION

Our Master's Project team conducted interviews with a number of local stakeholders during our August 2013 trip to Hawai`i Island. These interviews helped us understand the culture, political, economic, and social dynamics present on Hawai`i Island. We focused on methods and patterns of transit on the island and connected with interviewees about the professional work in the transportation sector, as well as their personal experiences getting around the island. The team spoke with the following individuals:

- Tina Clothier – Peoples Advocacy for Trails Hawai`i
- Elizabeth Cole – The Kohala Center
- Kyle Datta – The Ulupono Initiative
- Laura Dierenfield – Queen Liliuokalani Trust
- Alex Frost – University of Hawai`i Manoa
- Tiffany Kai – Hawai`i County Mass Transit Agency
- Jay Kimura – Hawai`i County Economic Opportunity Council
- Wally Lau – Office of the Mayor
- Ray L'Heureux – Hawai`i State Department of Education
- Margaret Masunaga – Hawai`i County Department of Planning
- Laverne Omori – Hawai`i County Department of Research and Development
- Will Rolston – Hawai`i County Energy Coordinator
- Sharon Sakai – Kohala Coast Resort Association
- Jonathan Wong – University of Hawai`i Hilo
- Miles Yoshioka - Hawai`i Island Chamber of Commerce

We'd also like to acknowledge and give thanks to the following transportation experts for their support, guidance, and advice in helping us complete this report:

- Alissa Altmann – Customer Care, VRide
- Sara Brydges – Rideshare Coordinator, University of Washington
- Nelson Chan - Survey Researcher, UC-Berkeley Institute of Transportation Studies
- Adithya Dahagama – Graduate Student, University of Michigan School of Natural Resources & Environment
- Ryan Fujii – Programming Section Manager, Statewide Transportation Planning Office, Hawai`i Department of Transportation

- Celeste Gilman – Commute Options Manager, Transportation Services at the University of Washington
- Jonathan Levine – Taubman School of Architecture and Regional Planning, University of Michigan
- Carol Norton – Program Manager, Center for Environmental Policy & Management, University of Louisville
- Bill Medeiros –GISP Geographic Services Manager, Maui County Government
- Olin Lagon – Kanu Hawai`i
- Jo Anne Johnson – Director of Department of Transportation, Maui County Government
- David Parsons – Hawai`i Public Utilities Commission
- Marc Takamori - Deputy Director of Department of Transportation, Maui County Government

NOTE: We spoke with the above listed, but this does not constitute any endorsement by them or the agencies, businesses and organizations they represent.

APPENDIX C: COUNTY OF HAWAI`I FINANCIAL DATA

Table 9-1

County of Hawai'i Mass Transit Expenditures and Revenue					
General Fund					
Account Description	**FY 2010-11 Actuals**	**FY 2011-12 Estimate**	**FY 2012-13 Estimate**	**FY 2013-14 Estimate**	**FY 2014-15 Estimate**
Mass Transit - S&W	$ 329,217.68	$ 359,700.00	$ 344,553.00	$ 359,700.00	$ 359,700.00
Mass Transit - OCE	$ 2,741,181.00	$ 846,799.00	$ 902,199.00	$ 1,447,699.00	$ 1,302,199.00
Mass Transit - Equipt	$ 199,999.31	$ 300,000.00	$ 200,000.00	$ 200,000.00	$ 200,000.00
Taxicab Investigation	$ 29,249.82	$ 29,000.00	$ 29,000.00	$ 29,000.00	$ 29,000.00
Rural Transit Assist Pgm	$ 10,863.39	$ 20,000.00	$ 10,500.00	$ 10,500.00	$ 10,500.00
Sec 5309 Capital Grant	$ 36,230.00	$ -	$ -	$ -	$ -
Sec 5309 Capital Grt 05-06	$ 1,279,707.01	$ 1,500,000.00	$ -	$ -	$ -
Job Access & Reverse Commute	$ 312,716.00	$ -	$ 62,305.00	$ -	$ -
Sec 5311 Non-Urbanized Formula	$ 21,305.00	$ -	$ -	$ -	$ -
Sec 5309 Captial Grt FY12-13	$ -	$ -	$ 1,000,000.00	$ 1,000,000.00	$ 1,000,000.00
New Freedom Funds	$ -	$ -	$ 52,255.00	$ -	$ -
Fed Transit Admin	$ 973,632.61	$ 900,000.00	$ -	$ -	$ -
Fed Transit Admin FY12-13	$ -	$ -	$ 700,000.00	$ 700,000.00	$ 700,000.00
General Fund Expenditures	***$ 5,934,101.82***	***$ 3,955,499.00***	***$ 3,300,812.00***	***$ 3,746,899.00***	***$ 3,601,399.00***
Highway Fund (020)					
Account Description	**FY 2010-11 Actuals**	**FY 2011-12 Estimate**	**FY 2012-13 Estimate**	**FY 2013-14 Estimate**	**FY 2014-15 Estimate**
Hwy Mass Transit OCE	$ 943,892.00	$ 4,044,593.00	$ 4,845,250.00	$ 4,345,250.00	$ 4,445,250.00
Highway Fund Expenditures	***$ 943,892.00***	***$ 4,044,593.00***	***$ 4,845,250.00***	***$ 4,345,250.00***	***$ 4,445,250.00***
FY 2010 -11 Revenues	**General Fund**	**Highway Fund**			
HWYS: PUBIC TRANSPORTATION					
Mass Transportation Agency	$ 3,300,812.00	$ 4,845,250.00			
Public Transportation Revenues	***$ 8,146,062.00***				
			Source: County of Hawai'I Operating Budget FY 2012-2013		

APPENDIX D: CREATING THE MAPS

Data sources and contents, data processing approaches and map making techniques are explained in the following appendix.

Data sources and contents

Bus Routes

Bus route data is from the County of Hawai`i in Shapefile format. Each bus route is a polyline with its name.

Recreation

Recreation data is from the County of Hawai`i in Shapefile format. Recreation sites are from three different layers according to its level: federal level recreation sites such as Hawai`i Volcanoes National Park; state level recreation sites such as Kekaha Kai State Park; county level recreation sites such as Keokea Beach Park.

Work hubs

Employers' addresses are found online and then geocoded into Shapefile.

Census

We obtained spatial census data from the U.S. Census Bureau in the form of TIGER/Line® Shapefiles pre-joined with Demographic Data,[217] where Hawai`i Island is divided into 8,888 census blocks. Each census block has its own population data.

Spatial data processing

Recreation data processing

We merged all of the 179 recreation sites into one file and calculated its density using Kernel Density tool in ArcGIS 10. This tool calculates the density of features in a neighborhood around those features. In other words, it smoothes out the information represented by a collection of points in a way that is more visually pleasing and understandable because it is often easier to look at a raster with a stretched color ramp than it is to look at blobs of points, especially when the points cover up large areas of the map.[218] It also shows areas where POI (Points of Interest, "recreation sites" in this case) are clustered (i.e. have a high density).

Work hubs data processing

First, we put all of the employer's addresses that were found into a Microsoft Excel table with the four columns: "name," "address," "city," and "state." Then, we performed geocoding in ArcGIS 10. Geocoding is the process of transforming street addresses and/or zip codes (like 440 Church St., Ann Arbor, MI 48105) into associated geographic coordinates (often expressed as

latitude and longitude, like 42.277658,-83.736595). Finally, we calculated the kernel density based on the geocoding results.

Census data processing

We calculated population density in each census block by dividing population by its corresponding census block area.

Data visualization

There are a total of 19 bus routes and we presented them in different colors. Some of them are overlapped with each other, which makes it hard to display. As a result, the overlapped routes were offset slightly in order to be able to see all of them.

Density of recreation sites, employers and population are presented on the maps as well. Individual federal recreation sites are also presented, and road centerlines and airports are displayed as reference data.

APPENDIX E: TRANSPORTATION MANAGEMENT

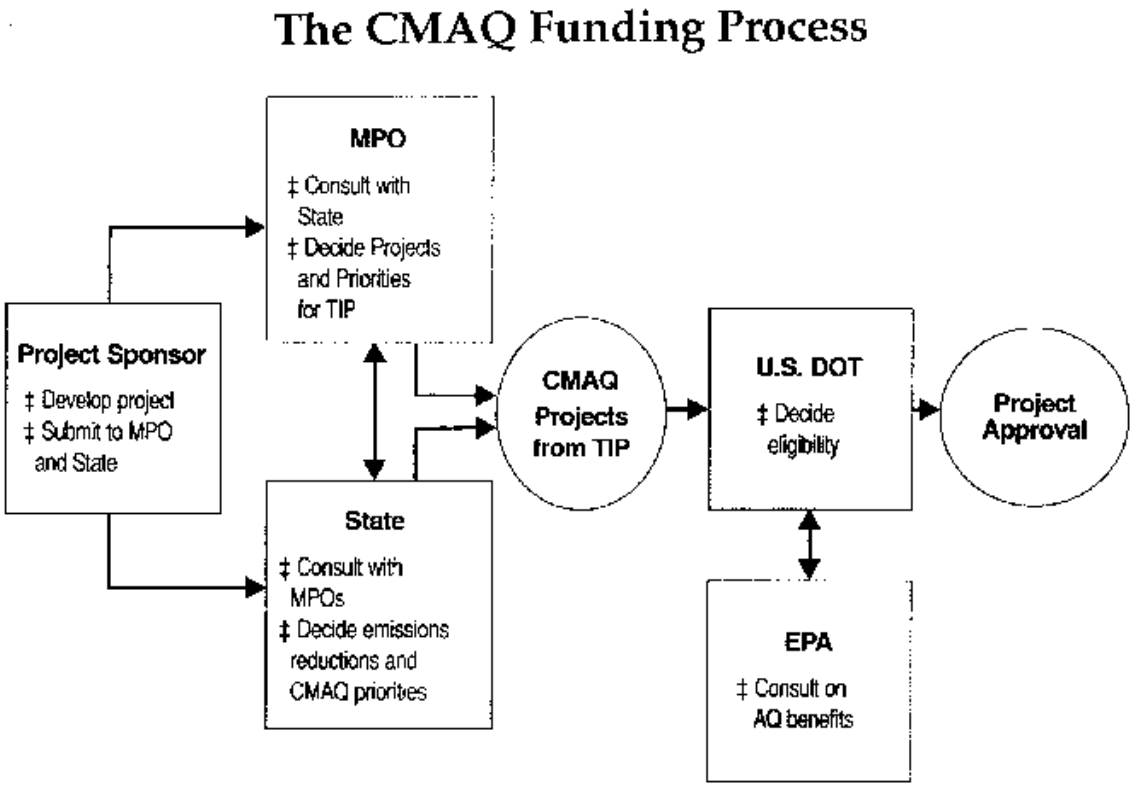
Table 9-2: Existing Transportation Management Associations[219]

LOCATION	SPONSORING AGENCY	TYPE OF AGENCY	CONTACT INFO	WEBSITE
Atlanta, GA	Commuter Connections, Atlanta Regional Commission	MPO, Rideshare	87-RIDEFIND	www.commuteconnections.com
Albany, NY	Capital District Commuter Register	Transit Agency, Rideshare	518-458-2164	www.commuter-register.org
Augusta, ME	Go Augusta	Rideshare	800-280-RIDE	www.goaugusta.org
Birmingham, AL	CommuteSmart Rideshare	Rideshare	800-826-RIDE	www.commutesmartrideshare.com
Contra Costa County, CA	Contra Costa CountyCommute Alternative Network	Public consortium	800-215-3035	www.traks.org/incentive/guarantee/incentive.html
Denver, CO	Ride Arrangers	Rideshare, COG	303-455-1000	www.drcog.org/ridearrangers/
Detroit, MI	Southeast Michigan Council of Governments	COG	313-961-4266	www.semcog.org/index.html
Houston, TX	METROVan	Rideshare	713-224-RIDE	www.hou-metro.harris.tx.us/METVAN.HTM
Kansas City, MO	Mid-America Regional Council	Rideshare, COG	816-842-RIDE	Rideshare.marc.org
Las Vegas, NV	Regional Transportation Commission	MPO	702-228-RIDE	www.catride.com/catmatch

Long Island, NY	Long Island Ridesharing	Rideshare	631-737-CARS	www.737cars.com
Miami, FL	South Florida Commuter Services	Rideshare	973-267-7600	www.transpotions.org
Twin Cities, MN	Metro Council	MPO, Transit Agency	651-602-1602	www.metrocommuterservices.org/index.asp
Morris County, NJ	TransOptions	Rideshare	973-267-7600	www.transoptions.org
Nashville, TN	Regional Transportation Authority	MPO, Transit Agency	615-862-8833	www.rta-ride.org/ridehome/ridepolicy/htm
New Hampshire	New Hampshire DOT	State DOT	800-462-8707	www.state.nh.us/dot/rideshare
New Haven, CT	Rideworks	Rideshare	800-ALL-RIDE	www.rideworks.com
New York, NY	Commuter Link	Rideshare	718-886-1343	www.commuterlink.com
Phoenix, AZ	Valley Metro	Transit Agency	602-262-7242	www.valleymetro.maricopa.gov
Portland, ME	RideShare	Rideshare	800-280-RIDE	www.ridesharemaine.org
Rhode Island	RI Public Transit Authority	Transit Agency	888-88-RIPTA	www.ripta.com
San Diego, CA	San Diego Commute	Rideshare, COG	800-COMMUTE	www.sdcommute.com/van_pool.html

San Francisco Bay Area, CA	RIDES for Bay Area Commuters	Rideshare	800-755-POOL	www.rides.org
San Mateo County, CA	Peninsula Traffic Congestion Relief Alliance	Public-private Assoc.	650-994-7924	www.commute.org
Seattle, WA	Metro Rideshare Operations	County	206-625-4500	Transit.metrokc.gov/van_car/vancar.html
Stamford, CT	Metropool	Rideshare	800-346-3743	www.metropool.com
Tallahassee, FL	Commuter Services of North Florida	Rideshare	973-267-7600	Tmi.cob.fsu.edu/commute
Tampa, FL	Bay Area Commuter Services	Rideshare	813-282-8200	www.tampabayrideshare.org
Vermont	Vermont Public Transit Authority	Transit Agency	800-685-RIDE	www.vpta.net
Vermont & New Hampshire	Upper Valley Rideshare	Rideshare, COG	802-745-RIDE	www.uppervalleyrideshare.com//uvrs.grh.html
Washington, DC	Commuter Connections	MPO	800-745-RIDE	www.mwcog.org/commuter
Windsor, CT	The RideShare Company	Rideshare	800-972-3279	www.rideshare.com

Figure 9-1[220]



APPENDIX F: EXISTING MOBILE RIDESHARE PROVIDERS

Table 9-3: Existing Mobile Rideshare Providers[221]

Provider	Location	Services Provided	Sustainability	Investors	Additional Notes
Carma (car.ma)	HQ in Cork, Ireland; Serves Ireland, Norway, U.S. (Austin, D.C., San Francisco)	Real-time shared car trips; automatic payment from rider based on distance traveled	SOS funded $10M over several years, each time investing larger amounts	Venture capital funding from SOSVentures	In October 2011, began a real-time ridesharing pilot in Arlington and released a real-time information and management system for vanpool operation rolled out by VPSI
Carpooling.com	Founded in Germany. Serving 40 countries, mostly European	Detailed user profiles, with info about where they want to meet and what they are willing to pay; multimodal platform also integrating bus, train, plane	Yes, been around for 15 years in Europe	Earlybird Venture Capital, Daimler	Over 5 million registered users, 50 million people transported since launch. 1.3 million people carpooling each month. 1 million downloads of mobile apps
Hailo (hailocab.com)	Started in London and also serves selected cities in North America, Europe and Asia	Flags licensed taxis through mobile devices and pays automatically by registered card on account, or pay driver directly.	Yes, Hailo has carried 8.5 million passengers and grown to annualized sales of well over $100M	Union Square Ventures, Accel Partners, Wellington Partners, Atomico Ventures, and Sir Richard Branson	A Hailo is taken every four seconds by tens of thousands of drivers and hundreds of thousands of passengers
Lyft (lyft.me)	Started in San Francisco; currently serves 17 major U.S. cities, with plans for further domestic and international expansion	Peer-to-peer ridesharing via smartphones and required Facebook accounts. Payment system via donation from passengers	Yes, for now and will probably be spun-off like Zimride. Lyft has more than 100,000 registered users and facilitates more than 30,000 rides per week within first year	Andreeson Horowitz	The service has more than 300 drivers in San Francisco along, who report earning as much as $30 to $35 an hour. As of the summer of 2013, Lyft had raised more venture funding than any other peer-to-peer ridesharing or app-based car service

Provider	Location	Services Provided	Sustainability	Investors	Additional Notes
NuRide (nuride.com)	Connecticut-based; also available in Massachusetts, Hampton Roads, San Antonio, Houston, DC	Rewards program for alternative commute trips tracked through Nuride software. Include trips via bike, carpool, transit, telework	Yes, NuRide has been in business for 12 years and continues to be supported by several state/local governments	Funded by state and local gov't where they operate	Focusing on rewarding trip logging. No payment/money needed for rides. Incentive through rewards for tracked trips
RelayRides (relayrides.com)	Service launched in Boston in summer 2010 and expanded nation-wide in 2012	A peer-to-peer carsharing service, allowing private car-owners to rent out vehicles via an online interface. Car owners can set their own prices, and the company takes 25%.	Unknown. Onstar partnership with GM cancelled in Sept. 2013 to focus on long duration car rentals	Received $19M in funding from GM Ventures, Google Ventures and others	Focusing more on driver eligibility requirements
RideScout (ridescout.com)	An Austin startup which later expanded to DC	RideScout is a free mobile app that provides real-time information on all available ride options, including both rail, taxis, bikeshare, car2go, Sidecar and more	Unknown. Working on online marketing ad co-marketing with the carsharing service Car2Go	Funded by employees' friends and family as well as angel investors	RideScout is a mobile app that aggregates all of the ride options available to a user. It is not a service provider, instead a clearinghouse of sorts
Sidecar	San Francisco, CA	Sidecar's smartphone app matches people in their own car with people nearby for shared rides	Yes, it's in over 60 metro regions in the country	Investors include Lightspeed Ventures, Google Ventures and others	All drivers are pre-vetted for safety, all rides are GPS tracked and everyone who rides is covered by $1 million dollar insurance policy
Uber	Started in San Francisco and is currently rolling out UberX rideshare network in most major U.S. cities and Honolulu	Independent ridesharing network with a mobile app which connects passengers with drivers of vehicles for ridesharing and pickup services	Yes, founded in 2009 and is in over 50 cities worldwide	Lowercase Capital, First Round Capital, Benchmark, Goldman Sachs, Menlo, Google Ventures	

APPENDIX G: THE ECONOMICS OF CARPOOLING

Table 9-4: Long Distance Intra-Island Commuting

	Daily			Monthly		
	Costs	Revenue	Total	Costs	Revenue	Total
Commute Alone	$32.00		($32.00)	$640.00		($640.00)
Carpool - 2 people						
Driver	$32.00	$16.64	($15.36)	$640.00	$332.80	($307.20)
Carpool Service		$4.16	$4.16		$83.20	$83.20
Carpool - 3 people						
Driver	$32.00	$33.28	$1.28	$640.00	$665.60	$25.60
Carpool Service		$8.32	$8.32		$166.40	$166.40
Carpool - 4 people						
Driver	$32.00	$49.92	$17.92	$640.00	$998.40	$358.40
Carpool Service		$12.48	$12.48		$249.60	$249.60
Carpool Riders	$20.80		($20.80)	$416.00		($416.00)
Public Transit				$60.00		($60.00)

Assumptions

Cost of gas:	$4.00/gallon
Fuel efficiency:	20 miles/gallon
Distance traveled:	160 miles (roundtrip - Hilo to Kona)
Gallons used:	Distance/Efficiency = 8 gallons
Days traveled:	20 days in a month
Rider fee:	$0.13/mile paid to drive
Carpool service fee:	20% of the fee paid by the rider

Table 9-5: Short Distance City Commuting

	Daily			Monthly		
	Costs	Revenue	Total	Costs	Revenue	Total
Commute Alone	$2.00		($2.00)	$56.00		($56.00)
Carpool - 2 people						
Driver	$2.00	$1.04	($0.96)	$56.00	$29.12	($26.88)
Carpool Service		$0.26	$0.26		$7.28	$7.28
Carpool - 3 people						
Driver	$2.00	$2.08	$0.08	$56.00	$58.24	$2.24
Carpool Service		$0.52	$0.52		$14.56	$14.56
Carpool - 4 people						
Driver	$2.00	$3.12	$1.12	$56.00	$87.36	$31.36
Carpool Service		$0.78	$0.78		$21.84	$21.84
Carpool Riders	$1.30		($1.30)	$36.40		($36.40)
Public Transit				$60.00		($60.00)

Assumptions

Cost of gas:	$4.00/gallon
Fuel efficiency:	20 miles/gallon
Distance traveled:	10 miles (intra-Hilo or Kona)
Gallons used:	Distance/Efficiency = 0.5 gallons
Days traveled:	20 days (work commute) + 8 days (non-regular travel)
Rider fee:	$0.13/mile paid to drive
Carpool service fee:	20% of the fee paid by the rider

APPENDIX H: UNIVERSTY OF MICHIGAN TEAM BIOGRAPHIES

Jonas Epstein is a 2nd-year MS student in the Environmental Policy & Planning track in the School of Natural Resources and Environment and the University of Michigan. He originally hails from Maryland and graduated from Bucknell University in 2011 majoring in Economics and Environmental Studies. Jonas has past work experience in ecosystem services valuation for the U.S. Department of Transportation (working under the Assistant Secretary for Transportation Policy), environmental cost-benefit analyses, and has completed extensive research analyzing economic impacts resulting from agricultural conservation, stormwater management, and wastewater treatment initiatives in the Chesapeake Bay watershed. He would like to hone his policy skills in order to develop a lifelong career in land use/urban planning and natural resource management.

Maite Madrazo is a 2nd year dual-degree MS/MBA student at the University of Michigan School of Natural Resources and Environment and the Stephen M. Ross School of Business. She is in the Sustainable Systems track. Maite is from Mexico City and has a Bachelor's in Mechanical and Electrical Engineering. Previous to coming to the University of Michigan, she worked in renewable energy project development with Potencia Industrial S.A., where she coordinated a 20MW wind power project in northern Baja California, Mexico; oversaw small-wind turbine manufacturing, sales and projects; and started the development of a mini-hydroelectric plant. Maite is passionate about creating social and environmental impact by transitioning to clean and renewable energy sources and improving energy efficiency.

Trevor McManamon is a2nd year dual MS student between the University of Michigan's School of Natural Resources and Environment and the School of Engineering, studying Sustainable Systems and Energy Systems Engineering. He grew up in San Jose, CA and majored in Chemistry and minored in Earth Sciences at Boston University, graduating in December 2011. Trevor has internship experience at the environmental research consultancy AltaTerra Research Network and at the concentrated solar power startup Combined Power. Trevor is passionate about contributing towards climate change mitigation and is hoping to enter the renewable energy sector upon graduation in May of 2015.

Daphne Medina is a 3rd year student at the University of Michigan's Erb Institute for Sustainable Global Enterprise, working toward a dual degree MS/MBA at the School of Natural Resources and Environment and the Stephen M. Ross School of Business. She joined the program after four years working at Environmental Defense Fund on green business practices in the Corporate Partnerships Program and on catch shares fishery management in the Oceans Program. Daphne is currently pursing a career in corporate social responsibility focused on incorporating sustainability into all aspects of corporate strategy in order to create a greener and more equitable global economy. Hailing from Boston, she attended Boston University, graduating with BA in Political Science

Xiaofei Wen is a 2nd year MS student in the Environmental Informatics track in the School of Natural Resources and Environment and the University of Michigan. He is from China and majored in Remote Sensing Science and Technology at Wuhan University, graduating in June 2012. Xiaofei has research experience of information extraction using remote sensing imagery and GIS modeling. Xiaofei is passionate about applying his expertise of spatial analysis to support the decision making of environmental & urban planning challenges in his future career.

APPENDIX I: MASTERS PROJECT CLIENT

From http://www.kohalacenter.org:

"The Kohala Center is an independent, not-for-profit, community-based center for research, conservation, and education. The Kohala Center was established in direct response to the request of island residents and island leaders to create greater educational and employment opportunities by caring for—and celebrating—Hawai'i Island's natural and cultural landscape.

The sheer diversity of Hawai'i Island's ecosystems and climate zones makes the island a model *of* the planet. Furthermore, the island's root culture is embedded in knowledge of the natural world and excels in natural resource management practices. In this remarkable local context, the island becomes a model *for* the planet whenever island communities successfully address contemporary challenges at the intersection of human and natural systems.

By focusing on the needs of island residents and the research interests of our university and agency partners, three core areas of work have emerged: energy self-reliance, food self-reliance, and ecosystem health. These areas of work involve basic and applied research, policy research, conservation and restoration initiatives, public outreach and education – all carried out through local, regional, national, and international partnerships. Through these partnerships and by recognizing that we work in a model environment, we help communities on the island, in the Pacific, and around the world thrive—ecologically, economically, culturally, and socially.

In addition, we have committed ourselves to supporting K-12 education, so that island youth can assume the knowledge-rich jobs that The Kohala Center and its partners are creating. Our work has generated, for example, the further need for ecologists, conservation biologists, economists, fence builders, archivists, agronomists, hydrologists, expert cultural practitioners, environmental educators, ethnographers, landscape architects, community organizers, writers, editors, geographic information scientists, cultural historians, engineers, geographers, media relations professionals, field managers, grant managers, and information technology specialists, among others.

We also support the development of island scholars, so that those from Hawai'i can lead educational and research institutions in Hawai'i and around the world. Toward this end, we created the Mellon-Hawai'i Doctoral and Postdoctoral Fellowship Program in collaboration with The Andrew W. Mellon Foundation and Kamehameha Schools.

Our mission: to respectfully engage the Island of Hawai'i as a living model for humanity.

Our vision: a state of *pono*, in which individuals realize their potential, contributing their very best to one another, to the community, and to the *ʻāina* (the land) itself, in exchange for a meaningful and happy life. “

ILLUSTRATIONS, TABLES, AND FIGURES

ILLUSTRATIONS

Front Cover: Photo at Akaka Falls State Park by Daphne Medina. All rights reserved.

Page 35: http://hawaiicountymayor.com/wp-content/uploads/2011/06/doubledecker-bus.jpg

Page 53: http://www.pcb.its.dot.gov/factsheets/comm/images/comm4.jpg

Page 54: http://floridaapts.lctr.org/images/GFIfarebox.jpG

Page 88: http://hilo.hawaii.edu/alumni/images/faderimages/10720121319110000000.jpg

TABLES

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REFERENCES

[1] "The Official U.S. Government Source for Fuel Economy Information." *Fuel Economy*. U.S. Department of Energy, 2013. Web. 11 Apr. 2013. <http://www.fueleconomy.gov/>.

[2] "Hawai`i : State Profile and Energy Estimates." U.S. Energy Information Administration, 2013. Web. 11 Apr. 2013. <http://www.eia.gov>.

[3] Cooke, Christopher P., and David C. Parsons. *County of Hawai'i Energy Sustainability Plan: Five Year Roadmap*. Rep. Kohala Center, 6 Dec. 2012. Web. <http://www.kohalacenter.org/pdf/energy/CoH_EnergySustainabilityProgram_Final.pdf>.

[4] "Hawai`i : State Profile and Energy Estimates." U.S. Energy Information Administration, 2013. Web. 11 Apr. 2013. <http://www.eia.gov>.

[5] " 2012 American Community Survey 1-Year Estimates." *American FactFinder* . United States Census Bureau., 2013. Web. 1 Nov. 2013. <http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_DP03>.

[6] *Ibid.*

[7] "Island of Hawai`i." *Google Maps*. Google, 2014. Web. 30 Jan. 2014. <https://www.google.com/maps/preview/place/Island%2Bof%2BHawai%25E2%2580%2598i/%4019.5896792%2C-155.434294%2C9z/data%3D%213m1%214b1%214m2%213m1%211s0x7953e7c1c5f73a59%3A0x1455a492f9d78134>.

[8] "Interview with Tiffany Kai, Mass Transit Administrator." Personal interview. 20 Aug. 2013.

[9] Miller, Erin. "New Saddle Road Connector to Open Sept. 7." *Hawai`i Tribune Herald*. Stephens Media LLC, 22 Aug. 2013. Web. 8 Nov. 2013. <http://hawaiitribune-herald.com/sections/news/local-news/new-saddle-road-connector-open-sept-7.html>.

[10] "Hawai`i Island." *Google Maps*. Google, 2013. Web. 8 Nov. 2013. <http://maps.google.com/>.

[11] Hosen, Kenneth I., and S. Bennett Powell. *Innovative Rural Transit Services*. Rep. no. TCRP Synthesis 94. Transportation Research Board, 2011. Web. <http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_94.pdf>.

[12] Cooke, Christopher P., and David C. Parsons. *County of Hawai'i Energy Sustainability Plan: Five Year Roadmap*. Rep. Kohala Center, 6 Dec. 2012. Web. <http://www.kohalacenter.org/pdf/energy/CoH_EnergySustainabilityProgram_Final.pdf>.

[13] *Ibid.*

[14] "Interview with Tiffany Kai, Mass Transit Administrator." Personal interview. 20 Aug. 2013.

[15] Crawford, Nancy E. *Comprehensive Annual Financial Report FY 2011*. Rep. County of Hawai'i, 27 Dec. 2011. Web. <http://records.co.hawaii.hi.us/Weblink8/1/doc/58499/Electronic.aspx>.

[16] 2011 Rural NTD Database. 15 Feb. 2013. Raw data. National Transportation Database, n.p.

[17] "The Official U.S. Government Source for Fuel Economy Information." *Fuel Economy*. U.S. Department of Energy, 2013. Web. 11 Apr. 2013. <http://www.fueleconomy.gov/>.

[18] "Hawai`i : State Profile and Energy Estimates." U.S. Energy Information Administration, 2013. Web. 11 Apr. 2013. <http://www.eia.gov>.

[19] Cooke, Christopher P., and David C. Parsons. *County of Hawai'i Energy Sustainability Plan: Five Year Roadmap*. Rep. Kohala Center, 6 Dec. 2012. Web. <http://www.kohalacenter.org/pdf/energy/CoH_EnergySustainabilityProgram_Final.pdf>.

[20] "Hawai`i: State Profile and Energy Estimates." U.S. Energy Information Administration, 2013. Web. 11 Apr. 2013. <http://www.eia.gov>.

[21] Cooke, Christopher P., and David C. Parsons. *County of Hawai'i Energy Sustainability Plan: Five Year Roadmap*. Rep. Kohala Center, 6 Dec. 2012. Web. <http://www.kohalacenter.org/pdf/energy/CoH_EnergySustainabilityProgram_Final.pdf>.

[22] " 2012 American Community Survey 1-Year Estimates." *American FactFinder*. United States Census Bureau., 2013. Web. 1 Nov. 2013. <http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_DP03>.

[23] *Ibid.*

[24] *The Hawaiian Islands*. Hawaii Visitors and Convention Bureau, 2013. Web. 11 Nov. 2013. <http://www.hvcb.org/schoolreport/eightmajorislands.htm>.

[25] "Hawai`i Island." *Google Maps*. Google, 2013. Web. 8 Nov. 2013. <http://maps.google.com/>.

[26] Doughty, Andrew, and Leona Boyd. *Hawaii, the Big Island Revealed: The Ultimate Guidebook*. Lihu'e, Hawai'i: Wizard Publications, 2011. Print.

[27] *Hawaii Island Weather Forecast & Report:*. Hawaii's Official Tourism Site, 2013. Web. 11 Nov. 2013. <http://www.gohawaii.com/big-island/about/weather>.

[28] *Ibid.*

[29] *State of Hawai'i Elected Officials*. Hawaii.gov, 2013. Web. 11 Nov. 2013. <https://portal.ehawaii.gov/government/elected-officials/>.

[30] *Governor of the State of Hawai`i*. Hawaii.gov, 2013. Web. 11 Nov. 2013. <http://governor.hawaii.gov/>.

[31] *Lt. Governor of the State of Hawai`i*. Hawaii.gov, 2013. Web. 11 Nov. 2013. <http://ltgov.hawaii.gov/>.

[32] *House of Representatives of the State of Hawaii.* Hawaii.gov, 2013. Web. 11 Nov. 2013. < http://www.capitol.hawaii.gov/members/legislators.aspx?chamber=H/>.

[33] *Senate of the State of Hawai`i*. Hawaii.gov, 2013. Web. 11 Nov. 2013. <http://www.capitol.hawaii.gov/members/legislators.aspx?chamber=S/>

[34] *County of Hawaii - Council*. County of Hawai'i, 2013. Web. 10 Nov. 2013. <http://www.hawaiicounty.gov/council/>.

[35] "Early History." *The History of Sugar Plantations in Hawaii*. Grovefarm.org, 2012. Web. 10 Nov. 2013. <http://grovefarm.org/kauai-history/>.

[36] Goldberg, Carey. "As Sugar Fades, Hawaii Seeks a New Cash Crop." *The New York Times*. The New York Times, 09 Aug. 1996. Web. 10 Nov. 2013. <http://www.nytimes.com/1996/08/09/us/as-sugar-fades-hawaii-seeks-a-new-cash-crop.html?pagewanted=all>.

[37] *Hawaii Agricultural Exports*. United States Department of Agriculture, 2013. Web. 10 Nov. 2013. <http://www.nass.usda.gov/Statistics_by_State/Hawaii/Publications/Annual_Statistical_Bulletin/stat11-88.pdf>.

[38] "How Important Is Agriculture Today?" *State of Hawaii Department of Agriculture*. State of Hawaii Department of Agriculture, 2013. Web. 10 Nov. 2013. <http://hdoa.hawaii.gov/blog/ag-resources/how-important-is-agriculture-today/>.

[39] *2012 Annual Visitor Research Report*. Rep. Hawaii Tourism Authority, 2013. Web. 10 Nov. 2013. <http://files.hawaii.gov/dbedt/visitor/visitor-research/2012-annual-visitor.pdf>.

[40] *Ibid.*

[41] "Interview with Sharon Sakai, Kohala-Kona Resort Association." Personal interview. 19 Aug. 2013.

[42] "Interview with Tiffany Kai, Mass Transit Administrator." Personal interview. 20 Aug. 2013.

[43] "2010 Census." *2010 Census*. U.S. Census Bureau, 2013. Web. 8 Nov. 2013. <http://www.census.gov/2010census/>.

[44] " 2012 American Community Survey 1-Year Estimates." *American FactFinder* . United States Census Bureau., 2013. Web. 1 Nov. 2013. <http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_DP03>.

[45] Mattson, Jeremy. *2013 Rural Transit Fact Book*. Rep. National Center for Transit Research, July 2013. Web. <http://www.surtc.org/transitfactbook/downloads/2013_rural_transit_fact_book.pdf>.

[46] *Public Transit in Rural Communities*. AARP, 2012. Web. <http://www.aarp.org/content/dam/aarp/livable-communities/act/transportation/public-transit-in-rural-communities-aarp.pdf>.

[47] Mattson, Jeremy. *2013 Rural Transit Fact Book*. Rep. National Center for Transit Research, July 2013. Web. <http://www.surtc.org/transitfactbook/downloads/2013_rural_transit_fact_book.pdf>.

[48] Ripplinger, David, Elvis Ndembe, and Jill Hough. *2011 Transit and Livability Report*. Rep. North Dakota State University: Upper Great Plains Transportation Institute, Dec. 2012. Web. <http://www.ugpti.org/pubs/pdf/DP262.pdf>.

[49] 2011 Rural NTD Database. 15 Feb. 2013. Raw data. National Transportation Database, n.p.

[50] Mattson, Jeremy. *2013 Rural Transit Fact Book*. Rep. National Center for Transit Research, July 2013. Web. <http://www.surtc.org/transitfactbook/downloads/2013_rural_transit_fact_book.pdf>.

[51] 2011 Rural NTD Database. 15 Feb. 2013. Raw data. National Transportation Database, n.p.

[52] *Ibid.*

[53] Mattson, Jeremy. *2013 Rural Transit Fact Book*. Rep. National Center for Transit Research, July 2013. Web. <http://www.surtc.org/transitfactbook/downloads/2013_rural_transit_fact_book.pdf>.

[54] "Commuter Tax Benefits | National Center for Transit Research." *National Center for Transit Research*. National Center for Transit Research, 2013. Web. 29 Jan. 2014. <http://www.nctr.usf.edu/programs/clearinghouse/commutebenefits/>.

[55] "Employer's Tax Guide to Fringe Benefits." *Internal Revenue Service*. U.S. Department of Treasury, 2014. Web. <http://www.irs.gov/pub/irs-pdf/p15b.pdf>.

[56] "Commuter Benefits." *Wageworks*. Wageworks, 2014. Web. 20 Feb. 2014. <https://www.wageworks.com/employees/benefits/commuter.aspx>.

[57] Hosen, Kenneth I., and S. Bennett Powell. *Innovative Rural Transit Services*. Rep. no. TCRP Synthesis 94. Transportation Research Board, 2011. Web. <http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_94.pdf>.

[58] Doughty, Andrew, and Leona Boyd. *Hawai`i , the Big Island Revealed: The Ultimate Guidebook*. Lihu'e, Hawai'i: Wizard Publications, 2011. Print.

[59] *History of Hawai`i Consolidated Railroad*. Laupahoehoe Train Museum, 2013. Web. 8 Nov. 2013. <http://www.thetrainmuseum.com/history.html>.

[60] "Hawai`i Island." *Google Maps*. Google, 2013. Web. 8 Nov. 2013. <http://maps.google.com/>.

[61] "Interview with Tiffany Kai, Mass Transit Administrator." Personal interview. 20 Aug. 2013.

[62] Miller, Erin. "New Saddle Road Connector to Open Sept. 7." *Hawai`i Tribune Herald*. Stephens Media LLC, 22 Aug. 2013. Web. 8 Nov. 2013. <http://hawaiitribune-herald.com/sections/news/local-news/new-saddle-road-connector-open-sept-7.html>.

[63] "Hawai`i Island." *Google Maps*. Google, 2013. Web. 8 Nov. 2013. <http://maps.google.com/>.

[64] *Ibid.*

[65] Doughty, Andrew, and Leona Boyd. *Hawai`i , the Big Island Revealed: The Ultimate Guidebook*. Lihu'e, Hawai'i: Wizard Publications, 2011. Print.

[66] Cooke, Christopher P., and David C. Parsons. *County of Hawai'i Energy Sustainability Plan: Five Year Roadmap*. Rep. Kohala Center, 6 Dec. 2012. Web. <http://www.kohalacenter.org/pdf/energy/CoH_EnergySustainabilityProgram_Final.pdf>.

[67] "Hawai'i County Mass Transit Agency — Hele-On Bus." *Hawai'i County Mass Transit Agency — Hele-On Bus*. County of Hawai'i, 2013. Web. 30 Jan. 2014. <http://heleonbus.org/>.

[68] "Interview with Tiffany Kai, Mass Transit Administrator." Personal interview. 20 Aug. 2013.

[69] Crawford, Nancy E. *Comprehensive Annual Financial Report FY 2011*. Rep. County of Hawai'i, 27 Dec. 2011. Web. <http://records.co.hawaii.hi.us/Weblink8/1/doc/58499/Electronic.aspx>.

[70] "Interview with Tiffany Kai, Mass Transit Administrator." Personal interview. 20 Aug. 2013.

[71] Crawford, Nancy E. *Comprehensive Annual Financial Report FY 2011*. Rep. County of Hawai'i, 27 Dec. 2011. Web. <http://records.co.hawaii.hi.us/Weblink8/1/doc/58499/Electronic.aspx>.

[72] 2011 Rural NTD Database. 15 Feb. 2013. Raw data. National Transportation Database, n.p.

[73] "Bus Schedules & Maps." Hele-On Bus Hawai'i County Mass Transit Agency. N.p., n.d. Web. 26 Feb. 2014.

[74] "Big Island Feature." *Top Things to Do on the Big Island*. N.p., n.d. Web. 26 Jan. 2014. <http://www.fodors.com/world/north-america/usa/hawaii/big-island/feature_30006.html>.

[75] "Annual Recreation Visitation by Park Type or Region For: 2013." U.S. National Park Service. N.p., n.d. Web. 26 Feb. 2014.

[76] 2007 Hawai'i State Parks Survey. N.p.: Hawaii Tourism Authority, Dec. 2007. PDF.

[77] "Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports." Federal Aviation Administration. Federal Aviation Administration, 31 Oct. 2013. Web. 07 Feb. 2014. http://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/

[78] "Bus Schedules & Maps." Hele-On Bus Hawai'i County Mass Transit Agency. Hawai'i County Mass Transit Agency, n.d. Web. 07 Feb. 2014. http://www.heleonbus.org/schedules-and-maps

[79] "Ground Transportation." Hilo International Airport. N.p., n.d. Web. 07 Feb. 2014. http://hawaii.gov/ito/ground-transportation

[80] "Ground Transportation." Kona International Airport at Keahole. N.p., n.d. Web. 07 Feb. 2014. http://hawaii.gov/koa/ground-transportation

[81] Bernardo, Rosemarie. "Joint Venture to Start Maui Bus Service." *Honolulu Star-Bulletin Hawaii News*. Honolulu Star-Bulletin, 23 Aug. 2002. Web. 30 Jan. 2014. <http://archives.starbulletin.com/2002/08/23/news/story4.html>.

[82] "Maui Bus Service." *Maui County, HI*. County of Maui, 2013. Web. 30 Jan. 2014. <http://www.mauicounty.gov/index.aspx?NID=605>.

[83] *Ibid.*

[84] *Ibid.*

[85] *Ibid.*

[86] "MTA Names New Construction Head As AECOM Buys His Former Firm - ENR | McGraw-Hill Construction." *ENR.com*. ENR.com, 01 Aug. 2008. Web. 30 Jan. 2014. <http://enr.construction.com/news/transportation/archives/080801a.asp>.

[87] Urbitran Associates. *County of Maui Short Range Transit Plan*. Rep. County of Maui, 2005. Web. <http://www.mauicounty.gov/documents/21/srtp.PDF>.

[88] *Ibid.*

[89] "Maui Bus Service." *Maui County, HI*. County of Maui, 2013. Web. 30 Jan. 2014. <http://www.mauicounty.gov/index.aspx?NID=605>.

[90] Interview with Bill Medeiros, Maui GISP Geographic Services Manager." Personal interview. 17 Jan. 2014.

[91] Interview with Jo Anne Johnson, Maui County Department of Transportation Director, and Marc Takamori, Maui County Department of Transportation Deputy Director." Personal interview. 23 Jan. 2014

[92] Crawford, Nancy E. *Comprehensive Annual Financial Report FY 2012*. Rep. County of Hawai'i, 30 Jun. 2012. Web. <http://records.co.hawaii.hi.us/Weblink8/1/doc/63773/Electronic.aspx>.

[93] Agsalog, Danilo F. "Comprehensive Annual Financial Report." *County of Maui*. County of Maui, 30 June 2012. Web. 30 Jan. 2014. <http://www.co.maui.hi.us/documents/3/515/COMCAFRFY%202012_201301101533124039.pdf>.

[94] " 2012 American Community Survey 1-Year Estimates." *American FactFinder* . United States Census Bureau., 2013. Web. 1 Nov. 2013. <http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_DP03>.

[95] "Maui County General Plan 2030." *Maui County, HI*. Maui County, HI, 2013. Web. <http://www.co.maui.hi.us/documents/17/69/71/3828/Chapter%201_201304191329387793.pdf.>.

[96] "County of Hawaii - Operating Budget FY 2013-4." *County of Hawai'i*. County of Hawai'i, 2013. Web. 20 Feb. 2014. <http://records.co.hawaii.hi.us/weblink/DocView.aspx?id=792118>.

[97]"Transportation - Department Summary FY 2014." *County of Maui*. County of Maui, n.d. Web. <http://co.maui.hi.us/documents/50/51/3734/3735/3738/060-18-Transportation_201310041315295723.pdf>.

[98] "2012 NTD Data Tables." *2012 NTD Data Tables*. American Public Transportation Association, 2012. Web. 20 Feb. 2014. <http://www.apta.com/resources/statistics/Pages/NTDDataTables.aspx>.

[99] "2012 NTD Data Tables." *2012 NTD Data Tables*. American Public Transportation Association, 2012. Web. 20 Feb. 2014. <http://www.apta.com/resources/statistics/Pages/NTDDataTables.aspx>.

[100] Velaga, Nagendra R. et al., "Transport Poverty Meets the Digital Divide: Accessibility and Connectivity in Rural Communities," *Journal of Transport Geography*, Volume 21, March 2012.

[101] Interview with Olin Lagon, Kanu Hawai`i ." Personal interview. 17 Jan. 2014.

[102] Ripplinger, David and Bethany Brand-Sargent, "Technology Adoption by Small Urban and Rural Transit Agencies," Upper Great Plains Transportation Institute, North Dakota State University, June 2010.

[103] Information about Rural ITS, <http://www.ruralits.org/>. Accessed November 1, 2013.

[104] Ripplinger, David and Bethany Brand-Sargent, "Technology Adoption by Small Urban and Rural Transit Agencies," Upper Great Plains Transportation Institute, North Dakota State University, June 2010.

[105] Velaga, Nagendra R. et al., "Development of a Map-Matching Algorithm for Rural Passenger Information Systems through Mobile Phones and Crowd Sourcing," *Journal of Computing in Civil Engineering*, Volume 27, November 2013.

[106] Ripplinger, David and Bethany Brand-Sargent, "Technology Adoption by Small Urban and Rural Transit Agencies," Upper Great Plains Transportation Institute, North Dakota State University, June 2010.

[107] "Central Florida Regional Transportation Authority d.b.a. LYNX & Polk County Transit Services Rural Intelligent Transportation System Demonstration Project," U.S. Department of Transportation Federal Transit Administration, December 2010.

[108] Ripplinger, David and Bethany Brand-Sargent, "Technology Adoption by Small Urban and Rural Transit Agencies," Upper Great Plains Transportation Institute, North Dakota State University, June 2010.

[109] "Central Florida Regional Transportation Authority d.b.a. LYNX & Polk County Transit Services Rural Intelligent Transportation System Demonstration Project," U.S. Department of Transportation Federal Transit Administration, December 2010.

[110] Brown, David, "GPS Monitoring Keeps Buses on Track," Mass Transit, December 20, 2011, <http://www.masstransitmag.com/article/10453259/gps-monitoring-keeps-buses-on-track>. Accessed November 1, 2013.

[111] Ripplinger, David and Bethany Brand-Sargent, "Technology Adoption by Small Urban and Rural Transit Agencies," Upper Great Plains Transportation Institute, North Dakota State University, June 2010.

[112] *Ibid.*

[113] *Ibid.*

[114] "Central Florida Regional Transportation Authority d.b.a. LYNX & Polk County Transit Services Rural Intelligent Transportation System Demonstration Project," U.S. Department of Transportation Federal Transit Administration, December 2010.

[115] Ripplinger, David and Bethany Brand-Sargent, "Technology Adoption by Small Urban and Rural Transit Agencies," Upper Great Plains Transportation Institute, North Dakota State University, June 2010.

[116] *Ibid.*

[117] Edwards, Peter, et al., "A Rural Real-Time Passenger Information Ecosystem," 10th International Conference on Mobile Systems, June 2012.

[118] Ripplinger, David and Bethany Brand-Sargent, "Technology Adoption by Small Urban and Rural Transit Agencies," Upper Great Plains Transportation Institute, North Dakota State University, June 2010.

[119] *Ibid.*

[120] *Ibid.*

[121] Crawford, Nancy E. *Comprehensive Annual Financial Report FY 2011*. Rep. County of Hawai'i, 27 Dec. 2011. Web. <http://records.co.hawaii.hi.us/Weblink8/1/doc/58499/Electronic.aspx>.

[122] 2011 Rural NTD Database. 15 Feb. 2013. Raw data. National Transportation Database, n.p.

[123] *Operating Budget FY2012-13*. Rep. County of Hawai'i, 2012. Web. <http://records.co.hawaii.hi.us/Weblink8/DocView.aspx?id=770538>

[124] Google Transit Partner Program, <http://maps.google.com/help/maps/mapcontent/transit/index.html>. Accessed November 4, 2013.

[125] "Hampton Roads Transit improves customer service and enhances web marketing efforts with Transit in Google Maps, Analytics, YouTube, Gadgets, Calendar and Picasa," Google Case Study, 2008, < http://static.googleusercontent.com/external_content/untrusted_dlcp/maps.google.com/en/us/help/maps/mapcontent/transit/case_study_hampton_roads.pdf>. Accessed November 6, 2013.

[126] Google Transit Partner Program, <http://maps.google.com/help/maps/mapcontent/transit/index.html>. Accessed November 4, 2013.

[127] "General Transit Feed Specification Reference," Google Developers, <https://developers.google.com/transit/gtfs/reference?hl=en&csw=1>. Accessed November 4, 2013.

[128] Google Transit Partner Program, <http://maps.google.com/help/maps/mapcontent/transit/index.html>. Accessed November 4, 2013.

[129] "Google Transit Data Feed," Google, <https://code.google.com/p/googletransitdatafeed/wiki/PublicFeeds?hl=en>. Accessed November 4, 2013.

[130] Rahman, Mazedur, "Five Transit Agencies, One Goal: Big Savings through Partnership and Innovation," Institute of Transportation Engineers, <http://www.ite.org/Membersonly/techconference/2012/CB12C3301.pdf>. Accessed November 2, 2013.

[131] Google Transit Partner Program, <http://maps.google.com/help/maps/mapcontent/transit/index.html>. Accessed November 4, 2013.

[132] Interview with Jo Anne Johnson, Maui County Department of Transportation Director, and Marc Takamori, Maui County Department of Transportation Deputy Director." Personal interview. 23 Jan. 2014

[133] Interview with Olin Lagon, Kanu Hawai`i ." Personal interview. 17 Jan. 2014.

[134] Modoc County Transportation Commission, "Evolution of Intelligent Transportation Systems for Mobility Management and Coordination Serving California's Rural Frontier," U.S. Department of Transportation Federal Transit Administration, January 2012.

[135] Thompson, Arthur and Goodridge, Wayne, "Bus Coming: A Service for Tracking Buses in Rural Areas based on Passenger Locations," GEOProcessing 2012, The Fourth International Conference on Advanced Geographic Information Systems, Applications, and Services, January 30, 2012.

[136] Anderson, Ruth E., et al., "Experiences with a Transportation Information System that Uses Only GPS and SMS," International Conference on Information and Communication Technologies and Development, December 2010.

[137] Edwards, Peter, et al., "A Rural Real-Time Passenger Information Ecosystem," dot.rural Digital Economy Hub, University of Aberdeen, The International Conference on Mobile Systems, Applications, and Services, June 2012.

[138] Edwards, Peter, et al., "Building an Information Ecosystem for Public Transport in Rural Areas," Proceedings of Digital Engagement 2011, November 2011.

[139] Corsar, David, et al., "A Rural Passenger Information System Utilising Linked Data & The Crowd," Digital Futures 2012 The Third Annual Digital Economy All Hands Conference, October 2012.

[140] Edwards, Peter, et al., "Building an Information Ecosystem for Public Transport in Rural Areas," Proceedings of Digital Engagement 2011, November 2011.

[141] 2011 Rural NTD Database. 15 Feb. 2013. Raw data. National Transportation Database, n.p.

[142] "Actsoft." *Actsoft Website*. N.p., 2014. Web. 30 Jan. 2014. <http://www.actsoft.com/>.

[143] "Comet Fleet." *Actsoft Website*. N.p., 2014. Web. 30 Jan. 2014. <http://www.actsoft.com/ products/cometfleet/>.

[144] "Case Studies." *Actsoft Website*. N.p., 2014. Web. 30 Jan. 2014. <http://www.actsoft.com/ about/case-studies/>.

[145] *Ibid.*

[146] "NextBus: Real-Time Passenger Information Solutions." *Cubic CTS*. NextBus Inc., 2014. Web. 30 Jan. 2014. <http://cts.cubic.com/solutions/realtimepassengerinformation/nextbus%2Cinc.aspx>.

[147] "Transit Bus Tracking, CAD, Real-Time Passenger Information." *Syncromatics*. N.p., 2014. Web. 30 Jan. 2014. <http://www.syncromatics.com/>.

[148] "Case Study: LA DOT." *Syncromatics*. N.p., 2014. Web. 30 Jan. 2014. <http://www.syncromatics.com/company/casestudies?ladot/>

[149] "Case Study: USF." *Syncromatics*. N.p., 2014. Web. 30 Jan. 2014. <http://www.syncromatics.com/company/casestudies?usf/>

[150] "Teletrac GPS Fleet Tracking Software." *Teletrac ®| GPS Fleet Tracking*. N.p., 2014. Web. 30 Jan. 2014. <http://www.teletrac.com/>.

[151] "Real Time Fleet Tracking, Management and Logistics Solutions." *TSOMobile*. N.p., 2014. Web. 30 Jan. 2014. <http://www.tsomobile.com/index.html>.

[152] "AAA Reports Cost of Owning & Operating a New Vehicle Is Now 54.1 Cents Per Mile." *NewsRoom*. AAA, 4 Apr. 2008. Web. 11 Nov. 2013. http://newsroom.aaa.com/2008/04/aaa-reports-cost-of-owning-operating-a-new-vehicle-is-now-54-1-cents-per-mile/

[153] "Average Gas Prices in Hawai`i Fall 3.8 Cents per Gallon the past Week | Hawai`i 24/7 | Hawai`i 247.com | Hawai`i 's News Now – News, Weather, Sports from the Big Island." *Hawai`i 24/7 Media Releases*. N.p., 3 June 2013. Web. 11 Nov. 2013. http://www.hawaii247.com/2013/06/03/average-gas-prices-in-hawaii-fall-3-8-cents-per-gallon-the-past-week-2/

[154] Goldberg, Michael. "SAP's TwoGo App Combines Data, Design to Address Carpool Challenge." *Data Informed RSS*. Wellesley Information Services, 1 July 2013. Web. 11 Nov. 2013. http://data-informed.com/saps-twogo-app-combines-data-design-to-address-carpool-challenge/

[155]Empsom, Rip. "Zimride Nabs LinkedIn Design Lead, Brings Its Ridesharing Service To Mobile." *TechCrunch*. N.p., 5 Apr. 2012. Web. 20 Jan. 2014.

http://techcrunch.com/2012/04/05/zimride-goes-mobile/

[156] Tam, Donna. "Uber Cuts Ride-share Prices below Taxi Fares." *CNET News*. CBS Interactive, 12 June 2013. Web. 11 Nov. 2013. http://news.cnet.com/8301-1035_3-57588963-94/uber-cuts-ride-share-prices-below-taxi-fares/

[157] Almendrala, Anna. "Lyft Driver In Los Angeles Explains It All In Reddit AMA." *The Huffington Post*. TheHuffingtonPost.com, 23 Sept. 2013. Web. 11 Nov. 2013. http://www.huffingtonpost.com/2013/09/23/lyft-driver-reddit-ama_n_3976553.html

[158] Baker, Chris. "Is Lyft Too Cool to Go National? | Fast Company | Business Innovation."*Fast Company*. N.p., 2 July 2013. Web. 11 Nov. 2013. http://www.fastcompany.com/3013759/is-lyft-too-cool-to-go-national?utm_source=twitter

[159] "Lyft." *Lyft*. N.p., 2013. Web. 11 Nov. 2013. http://www.lyft.me/

[160] "My Ride Is Your Ride." *Sidecar*. N.p., n.d. Web. 11 Nov. 2013. http://www.side.cr/

[161] Kimura, Jay (2014, January 15). Interview by J. Epstein (phone). Hawai`i County Economic Opportunity Council. Hilo, HI.

[162] "Lyft Lifts $60 Million From Andreessen Horowitz, Gives 30,000 Rides A Week A Year After Launch." *TechCrunch*. N.p., 23 May 2013. Web. 11 Nov. 2013. http://techcrunch.com/2013/05/23/lyft-a16z/

[163] Tam, Donna. "Car-sharing Showdown: UberX Offers Free Rides in Lyft's New Cities."*CNET News*. CBS Interactive, 05 Sept. 2013. Web. 11 Nov. 2013. http://news.cnet.com/8301-1035_3-57601515-94/car-sharing-showdown-uberx-offers-free-rides-in-lyfts-new-cities/

[164] "My Ride Is Your Ride." *Sidecar*. N.p., n.d. Web. 11 Nov. 2013. http://www.side.cr/

[165] "Uberx." *Uber Blog*. N.p., 2013. Web. 11 Nov. 2013. http://blog.uber.com/tag/uberx/

[166] Ozawa, Ryan. "Uber 'Black Car' Service Arrives in Honolulu." *Hawai`i Blog RSS*. N.p., 16 July 2013. Web. 11 Nov. 2013. http://www.hawaiiweblog.com/2013/07/16/uber

[167] Genegabus, Jason. "Uber Provides Rides in Style." *Honolulu Hawai`i Calendar of Events Hawai`i Entertainment and Nightlife Honolulu Pulse RSS*. Star Advertiser, 1 Oct. 2013. Web. 11 Nov. 2013. http://www.honolulupulse.com/2013/10/in-the-mix-uber/

[168] "RideScout™." *RideScout™*. N.p., 2013. Web. 11 Nov. 2013. http://ridescoutapp.com/

[169] Internal Revenue Service. Employer's Tax Guide to Fringe Benefits. Washington, DC. http://www.irs.gov/publications/p15b/index.html

[170] "Transportation Toolkit for the Business Community." *Community Transportation Association of America*. N.p., Jan. 2012. Web. 11 Nov. 2013. http://web1.ctaa.org/webmodules/webarticles/articlefiles/13_GuaranteedRideHomePrograms.pdf

[171] United States. Department of Transportation. Federal Transit Administration. *Guaranteed Ride Home Programs: A Study of Program Characteristics, Utilization, and Cost*. By William Menczer. N.p., 19 May 2006. Web. http://www.fta.dot.gov/documents/Guaranteed_Ride_Home_Program_final_study_web.pdf

[172] "Transportation to Work: Toolkit for the Business Community." *Joblinks Employment Transportation*. N.p., 2012. Web. 11 Nov. 2013. http://web1.ctaa.org/webmodules/webarticles/anmviewer.asp?a=1442&z=75

[173] "Guaranteed Ride Home Program: Giving Peace of Mind to Commuters." Joblinks Employment Transportation, n.d. Web. http://web1.ctaa.org/webmodules/webarticles/articlefiles/GuaranteedRideHomePrograms.pdf

[174] United States. Cong. *Hawai`i State Legislature*. By Yamane, Aquino, Nakashima, Takayama, and Yamashita. 27th Cong. Cong HB1894/SB2731. N.p., 21 Jan. 2014. Web. http://www.capitol.hawaii.gov/measure_indiv.aspx?billtype=HB&billnumber=1894&year=2014

[175] United States. Cong. *Hawai`i State Legislature*. By Yamane, Aquino, Nakashima, Takayama, and Yamashita. 27th Cong. Cong HB1894/SB2731. N.p., 21 Jan. 2014. Web. http://www.capitol.hawaii.gov/measure_indiv.aspx?billtype=HB&billnumber=1894&year=2014

[176] Energy & Efficiency Transportation Strategies Working Group. *State of Hawai`i Energy Efficiency in Transportation Strategies Study - Phase I*. Rep. Hawai`i Energy Policy Forum, University of Hawai`i at Manoa, 15 Jan. 2008. Web. http://www.hawaiienergypolicy.hawaii.edu/programs-initiatives/transportation-options-efficiency/_downloads/act-254-final-report.pdf

[177] Snider, Brett. "Lyft and Sidecar Legal in California Under New Regulations." Weblog post. *FindLaw - California Case Law*. N.p., 20 Sept. 2013. Web. http://blogs.findlaw.com/california_case_law/2013/09/lyft-and-sidecar-legal-in-california-under-new-regulations.html

[178] "Online TDM Encyclopedia - Transportation Management Associations." *TDM Encyclopedia*. Victoria Transport Policy Institute, 15 Apr. 2011. Web. 11 Nov. 2013. http://www.vtpi.org/tdm/tdm44.htm

[179] Cervero, Robert, Chester Colby, Gordon Fielding, David Forkenbrock, Jose Gomez-Ibanez, Naomi Lede, William Millar, Steven Polzin, Sandra Rosenbloom, Lawrence Schulman, George Smerk, and Vukan Vuchic. "TDM." *Journal of Public Transportation* 104 (2007): n. pag. *Center for Urban Transportation Research*. National Center for Transit Research, 2007. Web. 11 Nov. 2013. http://www.nctr.usf.edu/jpt/pdf/JPT%2010-4.pdf

[180] "Carpool Incentive Programs." *Best Workplaces for Commuters*. U.S. Environmental Protection Agency Office of Air and Radiation, Nov. 2005. Web. 11 Nov. 2013. http://www.bestworkplaces.org/pdf/carpool_June07.pdf

[181] Cole, Matt. "Public-Private Partnerships: The Future of Transportation Funding Cubic CTS." *Public-Private Partnerships: The Future of Transportation Funding Cubic CTS*. Cubic Transportation Systems, 2013. Web. 11 Nov. 2013. http://cts.cubic.com/Publications/CubicBlog/tabid/531/ID/134/language/en-US/Public-Private-Partnerships-The-Future-of-Transportation-Funding.aspx

[182] Wei, Min. "What Are the Pros and Cons of a P3?" *What Are the Pros and Cons of a P3?*Cubic Transportation Systems, 2013. Web. 11 Nov. 2013. http://cts.cubic.com/Publications/CubicBlog/tabid/531/ID/94/categoryId/21/language/en-US/What-are-the-Pros-and-Cons-of-a-P3.aspx

[183] Wei, Min. "What Are the Pros and Cons of a P3?" *What Are the Pros and Cons of a P3?*Cubic Transportation Systems, 2013. Web. 11 Nov. 2013. http://cts.cubic.com/Publications/CubicBlog/tabid/531/ID/94/categoryId/21/language/en-US/What-are-the-Pros-and-Cons-of-a-P3.aspx

[184] Geron, Tomio. "California Becomes First State To Regulate Ridesharing Services Lyft, Sidecar, UberX." *Forbes*. Forbes Magazine, 19 Sept. 2013. Web. 11 Nov. 2013. http://www.forbes.com/sites/tomiogeron/2013/09/19/california-becomes-first-state-to-regulate-ridesharing-services-lyft-sidecar-uberx/

[185] "Investing in Vanpools." *Transportation Toolkit for the Business Community*. Joblinks Employment Transportation, Jan. 2012. Web. 11 Nov. 2013. http://web1.ctaa.org/webmodules/webarticles/articlefiles/InvestingInVanpools_8_2013.pdf

[186] "Innovative Vanpool Programs." *Transportation Toolkit for the Business Community*. Joblinks Employment Transportation, Jan. 2012. Web. 11 Nov. 2013. http://web1.ctaa.org/webmodules/webarticles/articlefiles/InnovativeVanpoolPrograms.pdf

[187] "VPSI Inc. - Vpsiinc.com." *VPSI Inc. - Vpsiinc.com*. N.p., 2013. Web. 11 Nov. 2013. http://www.vpsiinc.com/home/submenu.asp?MMID=1

[188] "Innovative Vanpool Programs." *Transportation Toolkit for the Business Community*. Joblinks Employment Transportation, Jan. 2012. Web. 11 Nov. 2013. http://web1.ctaa.org/webmodules/webarticles/articlefiles/InnovativeVanpoolPrograms.pdf

[189] "Innovative Vanpool Programs." *Transportation Toolkit for the Business Community*. Joblinks Employment Transportation, Jan. 2012. Web. 11 Nov. 2013. http://web1.ctaa.org/webmodules/webarticles/articlefiles/InnovativeVanpoolPrograms.pdf

[190] "Jay Kimura." Personal interview. 22 Aug. 2013.

[191] "Life Without Subsidies: Vanpool Hawaii Announces New Group Rate Hawaii Free Press." *Hawaii Free Press*. N.p., 22 June 2011. Web. 11 Nov. 2013. http://www.hawaiifreepress.com/ArticlesMain/tabid/56/ID/4529/Life-Without-Subsidies-Vanpool-Hawaii-Announces-New-Group-Rate.aspx

[192] "Formula Grants for Other than Urbanized Areas (5311)." *FTA-SAFETEA-LU*. U.S. Federal Transit Administration, 2013. Web. 11 Nov. 2013. http://www.fta.dot.gov/grants/13093_3555.html

[193] "Job Access and Reverse Commute Program (5316)." *FTA-SAFETEA-LU*. U.S. Federal Transit Administration, 2013. Web. 11 Nov. 2013. http://www.fta.dot.gov/grants/13093_3550.html

[194] "Regional Rideshare Database Enhancements." *Clean Transportation Funding from the MRSC*. Mobile Source Air Pollution Reduction Review Committee, n.d. Web. http://www.cleantransportationfunding.org/projects/view/regional_rideshare_database_enhancements

[195] "Welcome to Trapeze Group." *Passenger Transportation Software and Solutions*. N.p., 2013. Web. 11 Nov. 2013. http://www.trapezegroup.com/

[196] *The Rideshare Company*. *Our Products and Services and the Story of The Rideshare Company through the Years*. N.p., 2013. Web. http://www.rideshare.com/Customer-Content/WWW/CMS/files/TRC_White_Paper.pdf

[197] "Cubic CTS Home." *Cubic Transportation Systems*. N.p., 2013. Web. 11 Nov. 2013. http://cts.cubic.com/

[198] Norton, Carol. (2014, January 15). Interview by J. Epstein (phone). University of Louisville Committee of Sustainable Transportation, Louisville, KY.

[199] Curtis, Kate, Lindsey Grad, Chris Hoffer, Chris LaRoche, McKenna Morrigan, Emmett Nelson, and Dan Welch. *Project Zimtervention: 2011 Environmental Management Degree Certificate Program Keystone Project*. University of Washington Environmental Stewardship and Sustainability Office, 2011. Web. 20 Jan. 2014.

[200] "University of Hawaii - Hilo." *The College Board*. N.p., n.d. Web. 29 Jan. 2014. <http://www.collegeboard.org/>.

[201] *Ibid.*

[202] Tozzi, John, Stacy Perman, and Nick Leiber. "2009 Finalists: America's Best Young Entrepreneurs." *Bloomberg Businessweek*. Bloomberg News, 2009. Web. http://images.businessweek.com/ss/09/10/1009_entrepreneurs_25_and_under/26.htm

[203] Curtis, Kate, Lindsey Grad, Chris Hoffer, Chris LaRoche, McKenna Morrigan, Emmett Nelson, and Dan Welch. *Project Zimtervention: 2011 Environmental Management Degree Certificate Program Keystone Project*. University of Washington Environmental Stewardship and Sustainability Office, 2011. Web. 20 Jan. 2014.

[204] Brydges, Sara. "Reaching out to UW Transportation Services." E-mail interview. 20 Jan. 2014.

[205] Life Without Subsidies: Vanpool Hawai`i Announces New Group Rate Hawai`i Free Press." *Hawai`i Free Press*. N.p., 22 June 2011. Web. 11 Nov. 2013. http://www.hawaiifreepress.com/ArticlesMain/tabid/56/ID/4529/Life-Without-Subsidies-Vanpool-hawaii-Announces-New-Group-Rate.aspx

[206] Tozzi, John, Stacy Perman, and Nick Leiber. "2009 Finalists: America's Best Young Entrepreneurs." *Bloomberg Businessweek*. Bloomberg News, 2009. Web. http://images.businessweek.com/ss/09/10/1009_entrepreneurs_25_and_under/26.htm

[207] "Regional Rideshare Database Enhancements." *Clean Transportation Funding from the MRSC*. Mobile Source Air Pollution Reduction Review Committee, n.d. Web. http://www.cleantransportationfunding.org/projects/view/regional_rideshare_database_enhancements

[208] Life Without Subsidies: Vanpool Hawai`i Announces New Group Rate Hawai`i Free Press." *Hawai`i Free Press*. N.p., 22 June 2011. Web. 11 Nov. 2013. http://www.hawaiifreepress.com/ArticlesMain/tabid/56/ID/4529/Life-Without-Subsidies-Vanpool-hawaii-Announces-New-Group-Rate.aspx

[209] "Innovative Vanpool Programs." *Transportation Toolkit for the Business Community*. Joblinks Employment Transportation, Jan. 2012. Web. 11 Nov. 2013. http://web1.ctaa.org/webmodules/webarticles/articlefiles/InnovativeVanpoolPrograms.pdf

[210] Cervero, Robert, Chester Colby, Gordon Fielding, David Forkenbrock, Jose Gomez-Ibanez, Naomi Lede, William Millar, Steven Polzin, Sandra Rosenbloom, Lawrence Schulman, George Smerk, and Vukan Vuchic. "TDM." *Journal of Public Transportation* 104 (2007): n. pag. *Center for Urban Transportation Research*. National Center for Transit Research, 2007. Web. 11 Nov. 2013.

[211] "Carpool Solutions for University and Corporate Networks." *Zimride*. N.p., n.d. Web. 21 Jan. 2014. http://www.zimride.com/

[212] Prechtel, Jason. "Our Coming Public-Private CTA: How Much Will We Pay?" *Gapers Block*. N.p., 7 Feb. 2013. Web. http://gapersblock.com/mechanics/2013/02/07/our-coming-public-private-cta-how-much-will-we-pay/#.Ut6jkuMo5-U

[213] Puttagunta, Sudhakar, PhD, and Dahagama, Adithya.. *A Sustainable Fair Fare System for a Public Carrier*. N.p., 2012. Web. 21 Jan. 2014.

[214] "Alissa Altmann of Vride." E-mail interview. 24 Jan. 2014.

[215] "Life Without Subsidies: Vanpool Hawai`i Announces New Group Rate Hawai`i Free Press." *Hawai`i Free Press*. N.p., 22 June 2011. Web. 11 Nov. 2013. http://www.hawaiifreepress.com/ArticlesMain/tabid/56/ID/4529/Life-Without-Subsidies-Vanpool-hawaii-Announces-New-Group-Rate.aspx

[216] "Life Without Subsidies: Vanpool Hawai`i Announces New Group Rate Hawai`i Free Press." *Hawai`i Free Press*. N.p., 22 June 2011. Web. 11 Nov. 2013.

http://www.hawaiifreepress.com/ArticlesMain/tabid/56/ID/4529/Life-Without-Subsidies-Vanpool-hawaii-Announces-New-Group-Rate.aspx

[217] *TIGER/Line® with Demographic Data*. Accessed 11 Nov. 2013.

[218] Krause, Eric. "How Should I Interpret the Output of Density Tools?" *ArcGIS Resources*. N.p., 28 May 2013. Web. 11 Nov. 2013.

[219] "Online TDM Encyclopedia - Transportation Management Associations." *TDM Encyclopedia*. Victoria Transport Policy Institute, 15 Apr. 2011. Web. 11 Nov. 2013. http://www.vtpi.org/tdm/tdm44.htm

[220]U.S. Federal Highway Administration. U.S. Department of Transportation. *A Guide to the Congestion Mitigation and Air Quality Improvement Program*. *Intermodal Transportation Efficiency Act*. Bureau of Transportation Statistics, n.d. Web. 11 Nov. 2013. http://ntl.bts.gov/lib/9000/9300/9317/00489-f.gif

[221] "Shared Use Rideshare Mobility Service Providers." *Mwcog.org*. Metropolitan Washington Council of Governors, 2013. Web. 29 Jan. 2014. <https://www.mwcog.org/uploads/committee-documents/al1ZXlhb20140117155212.pdf>.