

SUSTAINABLE TRANSPORTATION FOR HSU STAKEHOLDERS: LOOKING  
INTO ACCESS AND BEHAVIOR

By

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## ABSTRACT

### SUSTAINABLE TRANSPORTATION FOR HSU STAKEHOLDERS: LOOKING INTO ACCESS AND BEHAVIOR

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Safe and affordable transportation to and from campus are not available to many members of the HSU community. This research seeks to understand how members of the campus community can access forms of transportation without relying on private automobiles. A critical component of this research is to understand specific ways in which members of the campus community can access sustainable forms of transportation without relying on private automobiles.

This research draws primarily on Icek Ajzen's (1991) *Theory of Planned Behavior* framework, to determine that choice of travel mode is based on decisions that are affected by attitude, subjective norms, and perceived behavioral control. I addressed the questions: What are the main geographic, economic, and sociocultural factors that limit transportation choice for students at HSU? What factors motivate individuals to use alternative modes of transportation when accessing campus facilities? What is HSU's role in advocating for safe bicycle and pedestrian infrastructure for students within broader sustainable transportation frameworks? This research will help inform new transportation planning to overcome barriers to safe and sustainable access to the HSU campus.

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## CHAPTER ONE: INTRODUCTION

### Background

When I first visited Humboldt State University (HSU), I found myself instantly admiring the Northern California redwood coast (see figure 1). I grew up and lived my whole life in Southern California, where it seems that everyone is moving non-stop, traffic congestion is unavoidable, and most of the year the weather is warm unlike Humboldt where it is cool and rainy. For my master's degree, I wanted to go to a university that focused on sustainability and HSU has long been dedicated to conserving resources, advocating for social responsibility, and reducing our society's overall carbon footprint. Although HSU is devoted to sustainability, the campus faces challenges similar to those of other universities in terms of managing transportation demands efficiently. These include a lack of infrastructure for commuting, limited access to public transportation, a lack of pedestrian safety, and negative perceptions of forms of transportation other than single-occupant vehicle use.

Commuting to the HSU campus without a private automobile is a challenge for many students. When I moved to Humboldt County, I had a hard time getting around outside of the university without a car. I decided to try out the public transportation, such as the Arcata & Mad River Transit (A&MRTS) and the Redwood Transit System (RTS). I found that the public transportation was not reliable because the buses would run infrequently or at times, the bus would not show up. Since Humboldt County has a much

smaller scale of public transportation, I had to adapt to using other forms of transportation to get around the area such as walking and cycling. The majority of Humboldt State University students are from the metropolitan areas such as Los Angeles and San Francisco. In Los Angeles, students from the area are able to travel in reliable form of public transit by using the Los Angeles Metro Rail by the Los Angeles County Metropolitan Transportation Authority (LACMTA). In San Francisco, the most common form of traveling throughout the area without a car is using the Bay Area Rapid Transit's (BART), which is an inexpensive, fast, and dependable form to get around by avoiding traffic.

Most HSU students live in off-campus housing (5,830 students) and commute to campus daily (City of Arcata Housing Element, 2019). Commuting to campus includes walking, biking, taking public transit and the most common form, driving a private automobile. In Humboldt County, the high cost of rent and the lack of available units near HSU are the biggest barriers for students to find walkable or bikeable housing, and as a result, many students require motorized (either public or private) transportation to come to campus. The North Coast Journal reported, "Students must provide credit histories, proof of monthly income that equals three times their rent or higher and a parent to cosign" (2016). With affordable housing being a barrier, students tend to live father away in nearby cities and depend on getting to campus by driving a private automobile.

Given the lack of affordable housing, the HSU administration should focus on making the campus more accessible for HSU student commuters by expanding the

offerings of public transportation programs and incentivizing changes in transportation behavior towards the use of forms of transportation other than single occupant vehicles.

### Research Questions

My goal for this thesis is to understand the specific ways in which individuals within the campus community can access campus facilities without reliance on a private automobile and how past and current behaviors play a role in individuals' behavioral intention and choices regarding transportation. To address this broader research agenda, I ask the following questions: (1) What are the main geographic, economic, and sociocultural factors that limit transportation choice for students at HSU? (2) What factors motivate individuals to use alternative modes of transportation when accessing campus facilities? (3) What is HSU's role in advocating for safe bicycle and pedestrian infrastructure for students within broader sustainable transportation frameworks?

In order to address my research questions, I used a socio-psychological framework to explore the relationship between travel access and behavioral intention within the HSU community. With a socio-psychological framework, I can look at a specific model to determine mobility, traffic behavior, and choice of travel. I drew primarily on Icek Ajzen's (1991) *Theory of Planned Behavior*, to investigate the behavioral intentions of the HSU administration in relationship to the limited sustainable transportation available for students at HSU. I investigated this relationship to understand at an institutional level the manner in which HSU is addressing underlying reasons

behind single-occupancy vehicle travel and sustainable transportation infrastructure in order to meet the broader goals of the 2016 Climate Action Plan (CAP).

The primary data for this study were derived from the HSU Parking market Demand Study conducted by Walker Consultants (2018). I analyzed the survey responses from HSU stakeholders (students, staff, and faculty), and how they differed from or supported the literature on sustainable transportation as an investment tool to achieve goals in economic development, quality of life, social equity, public health, and environmental sustainability. Additionally, I used geographic information systems (GIS) to map various socioeconomic variables related to transportation in Humboldt County, including the reported bike and pedestrian collisions from the years 2012-2017. I also conducted interviews with three participants, all sustainability advocates, who were concerned about the number of HSU stakeholders driving to campus. The three participants were chosen for their institutional role at the HSU campus, and in Humboldt County.

My research goal was to uncover what students are open to in terms of alternative transportation options to travel to and from campus. I suggested that students will not use alternative forms of transportation, unless HSU and the City of Arcata provide more support in the form of safer and more accessible routes that encourage individual behavioral changes. Figure 1 is a map of the Humboldt State University campus with an inset of Humboldt County. The red star represents the location of the university within the county. The city of Arcata has a total area of 11 square miles and 1.9 square miles or 17.25 percent is water (Census Bureau Report, 2010). In Humboldt County, “the built

environment reflects both adaptation to and the reshaping of the landscape, such as the placement of structures on ridges adjacent to creeks and sloughs; the use of raised walkways; and raised basements to minimize the intrusion of water” (City of Arcata Historic Context Statement, 2012: 6). A sustainable transportation planning approach is fundamental to not only university goals of sustainability, but essential to the wellbeing of the broader community.

### Dissemination of Research to Campus Community

This research provides an analysis of the state of transportation at HSU for the HSU Advisory Committee on Sustainability along with theoretical and empirical evidence, that can be used to promote sustainable transportation and encourage HSU commuters to change their transportation behaviors when accessing campus. The HSU Advisory Committee on Sustainability is responsible for recommending actions the campus can take to further the implementation of sustainability into the core focus areas of campus operations, academics, infrastructure, and engagement. On the HSU Advisory Committee on Sustainability website states the definition the committee uses for sustainability: “sustainability is the recognition that humanity is a part of the natural world, not separate from it, and that healthy social and economic systems depend on the resilience of ecological systems” (Humboldt State University, 2020). A critique of the definition of sustainability used by the HSU Advisory Committee on Sustainability is that it is missing a dedication to greenhouse gas (GHG) emissions reduction. If Humboldt State is truly dedicated to reducing greenhouse gas emissions, then there need to be

stronger efforts to promote more sustainable transportation choices and work with the community to increase the safety of roads for all community members. I hope this research will be a catalyst for expansion of the existing transportation programs at HSU to meet future demands for its stakeholders. My goal is to analyze how understanding a broader theory of planned behavior in conjunction with existing material conditions at HSU and the surrounding community can contribute to a more nuanced understanding of sustainable transportation for the campus and its community.

### Organization of Thesis

This thesis is organized as follows: I first begin with a chapter on the case of HSU and its context, summarizing background research and key factors related to transportation at HSU. I then go on with the literature review where I define sustainable transportation planning, focusing specifically on mobility and public transportation systems. For both of these forms of mobility, I apply the theory of planned behavior framework and discuss how each is limited or influenced at the HSU campus.

Next, I detail my methodology, which includes my sampling rationale and interview technique. I explain how I used GIS to analyze various socioeconomic variables in Humboldt County by documenting my input data, spatial operations, and underlying assumptions about geospatial analysis. In my results section, I then present the data derived from both the interviews and GIS analysis to address my research questions and provide insight into the relationship between sustainable transportation planning and Humboldt State University's sustainability goals.

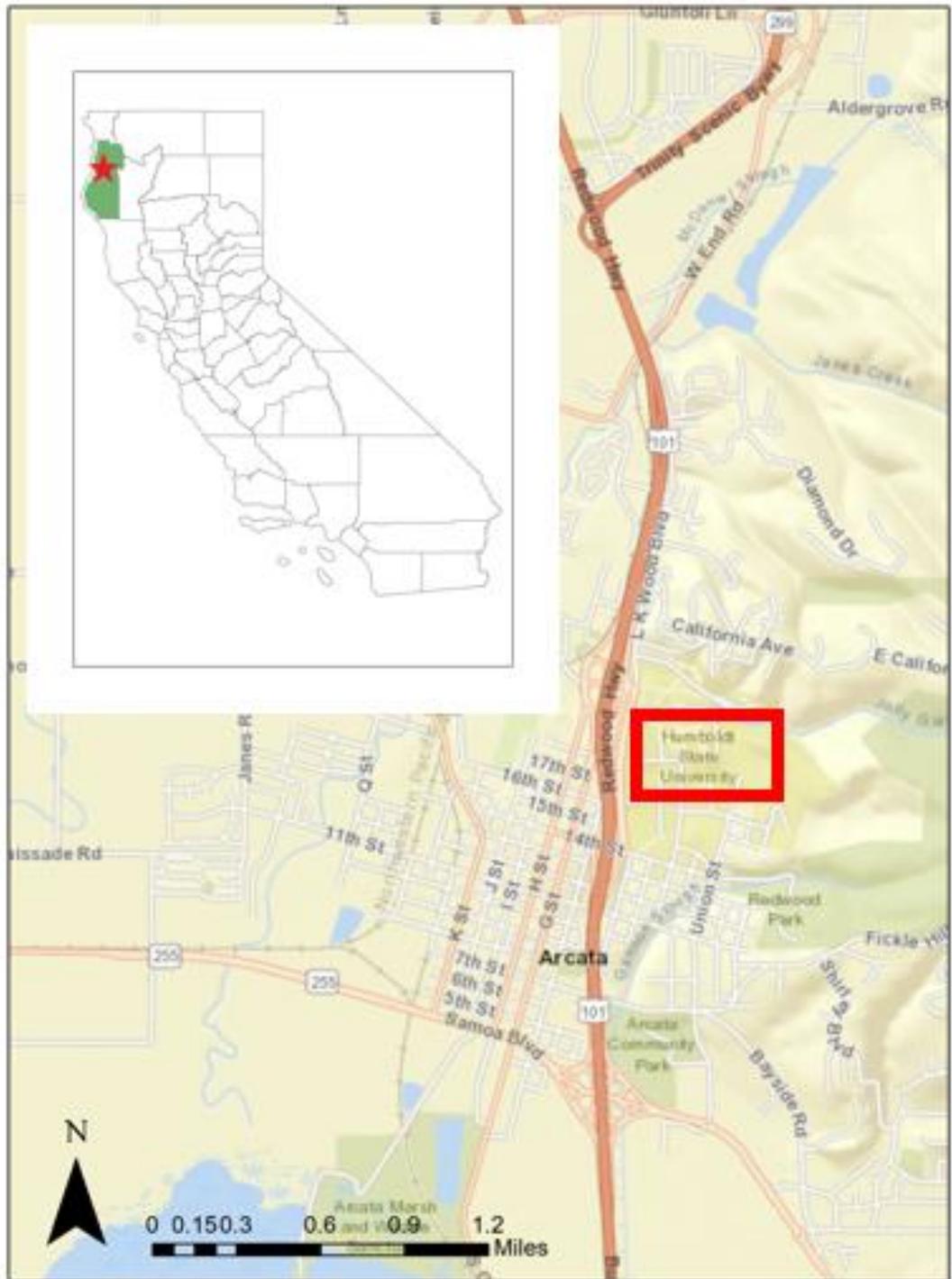


Figure 1: Location of the Humboldt State Campus. Map by Aneika Perez.

## CHAPTER TWO: HSU CASE AND CONTEXT

### Background

Humboldt State University is located in the City of Arcata, California. It is the northernmost campus of the California State University (CSU) system. The campus is situated on the hillside at the edge of the redwood forest and overlooking Humboldt Bay and the Pacific Ocean. With a population of just over 18,300, Arcata is considered rural, and its population shrinks and swells as university students come and go during the year. In 2016, there were 8,538 students attending the university, making Arcata an example of a “college town” (HSU Parking Market Demand Study, 2018, 8). Two nearby communities housing students are: (1) the City of Eureka, located on the shores of Humboldt Bay approximately 8.2 miles south of HSU; and (2) the unincorporated community of McKinleyville, located 5.2 miles north of Arcata.

### HSU Sustainability Profile

At Humboldt State, sustainability is recognized in the university’s vision and values. HSU presents itself as pursuing environmental responsibility in “...our mission, values, promotional materials, orientations, sustainability projects and hires, clubs, and even guest speakers” (Ray, 2015, 16). On campus, a wide range of students, staff, and faculty are involved in making campus more sustainable. They focus on energy, water, buildings, grounds and landscape, waste, and alternative transportation. As a green campus, HSU promotes sustainability through efforts such as the student-led Campus Center for Appropriate Technology (CCAT) and the Energy Independence Fund (HEIF),

which supports sustainability by implementing projects that are associated with energy efficiency. In addition, the campus location in a beautiful place with clean air, trees, and near the ocean, makes the university an attractive, literally “green” school. Humboldt State faculty, staff, and students are actively engaged in sustainability research. However, there is always room for improvement on sustainability. As HSU Environmental Studies professor, Sarah Jaquette Ray (2015) argues HSU is “green,” but that there is a long way to get the campus to become “truly green.” Jaquette Ray believes that HSU supports the campus by promoting sustainability values, courses, and the “green scene.” However, she insists that HSU needs improvement on knowledge production, decolonization in the classroom by centering work by non-white environmental thinkers, and requires a stronger narrative of the work done at the campus, in order to truly be a socially just green campus with environmentalist responsibility (29).

In 2016, Humboldt State University collaborated with other CSU’s in creating a Climate Action Plan (CAP) to guide and prioritize emissions reduction measures. HSU’s CAP sets course to present strategies to curb GHG emissions resulting from the university’s energy consumption, from indirect emissions from related activities such as business travel, student and employee commute, and solid waste disposal, and for integrating sustainability into academics and student life (Climate Action Plan, 2016). As Humboldt State has had a long commitment to sustainability one of the key goals was, “HSU is committed to reducing GHG emissions to 1990 levels, or below, by 2020” (Climate Action Plan, 2016). By working toward making campus more accessible for

students without cars, the HSU administration could demonstrate their commitment to a greener and more socially just sustainable campus.

In 2014, a survey done by the HSU Office of Sustainability included a series of questions to assess the commuting and parking practices of students, staff, and faculty at the university. It was found that the emissions created by commuting to the school were over 5,000 metric tons of CO<sub>2</sub> for the 2013-2014 academic year (HSU Office of Sustainability, 2014). According to the EPA equivalency calculator, 5,000 metric tons of CO<sub>2</sub> is equivalent to 652,620 gallons of gasoline consumed (EPA, 2019).

In 2019, it was estimated that nearly 7,774 students attended HSU, and many students lived in off-campus housing and routinely commuted to campus several times a week (City of Arcata Housing Element, 2019). One of the most common modes of transportation for students is driving. In the HSU Parking Market Demand Study, only about 4.46 percent of the participants (students, staff, and faculty) marked that the most important factor motivating their choice of transportation mode was sustainability.

### Sustainable Transportation Planning at HSU

A question central to sustainable transportation at HSU is whether campus commuters can access campus facilities without contributing to greenhouse gas emissions. The HSU Parking Market Demand Study conducted by HSU Facilities Management (Walker Consultants, 2018), recommended overall transportation system improvements to accommodate demand and improve sustainable commuter services to the university. HSU Facilities Management examined some of the barriers that the

university faces in attempting to shift towards more sustainable transportation: the location and topography of the university, the frequency and coverage of public transportation, and the location of housing compared to campus facilities.

#### Environmental Barriers at HSU

In Arcata, the average rain per year is forty to fifty inches (Houston, 2018). At HSU, seasonal rain showers impact commuters' ability to reach campus comfortably by bicycle, skateboard, and walking. People are less likely to walk when it is raining, snowing, icy, windy, or dark. Given the number of HSU commuters that originally come from mild climate regions in Southern California, consideration of weather as a determining factor for pedestrian behavior is important and designing infrastructure to accommodate pedestrian travel under all weather conditions is essential.

Travel and mobility are a challenge to many people in the HSU community largely due to the geographic location and topography of the area. HSU students, staff and faculty that live in neighboring communities encounter rolling terrain and steeply situated hillsides on their commute to HSU, which increases the chance that they will drive to the campus.

Both the local weather and the local terrain are environmental barriers that negatively correlate with individual decisions to walk to campus. Regardless of these barriers, the HSU Parking Marked Demand study (2018), found that approximately 50 percent of undergrads and graduate students, 30 percent of faculty, and 28 percent of staff were willing to commute to campus by walking, illustrating the need to take pedestrian

access seriously and consider ways to design pedestrian friendly infrastructure near and on campus.

### Bus Ridership at HSU

In Humboldt County, several bus companies serve demand for HSU riders including, Arcata and Mad River Transportation Service (A&MRTS), Redwood Transit Service (RTS), Willow Creek Intercity Service, Eureka Transit Service, and others serving southern Humboldt County. However, the HSU Parking Market Demand study respondents reported that most of these services are infrequent and travel times are long (69). Commuter routes extend as far north as Trinidad, south to Scotia, and east to Willow Creek.

HSU offers an unlimited-use transit pass called the JackPass to encourage mass transit and reduce fuel consumption by enabling students, staff, and faculty to travel to the university on Humboldt County bus systems. The JackPass, is valid on all local and regional bus lines such as the A&MRTS, Eureka Transit System, and Redwood Transit System. Students are offered the JackPass for free during the fall and spring semester. However, for faculty and staff the cost is \$60 per semester. A “single fare on these transit routes ranges from \$1.25 to \$5.50, and a monthly pass from \$30 to \$108” (Walker Consultants 2018:70). One of the survey questions in the HSU Parking Market Demand study asked, “How often have you ridden the bus to campus?”, A total of 74% of student respondents answered “never” and about 14% answered 1-3 days. For staff and faculty, the percentage riding the bus to the HSU campus is significantly lower at about 6% of

staff and 5% of faculty (Walker Consultants 2018:18). The reliance on automobiles as a primary mode of transportation has an impact on the shape of the university. Universities can be used as an example to mitigate their impact of transportation issues to other universities can influence actions to surrounding communities.

## CHAPTER THREE: LITERATURE REVIEW

Environmental impacts of transportation include air pollution, water pollution, polluted stormwater runoff, and GHG emissions (Tumlin, 2012). In 2017, transportation represented approximately 28.9 percent of total U.S. greenhouse gas (GHG) emissions (EPA, 2019). At global scale, GHG are a result of agriculture, land use, industry, transportation, electricity, and heat production. Out of this list of GHG producing industries, transportation aligns with individual daily choice, "...transportation touches all aspects of life in a city: economic development, quality of life, social equity, public health, and ecological sustainability (Tumlin, 2012, 2). The widespread use of private automobiles, and an increase of electric vehicles, most of which produce carbon dioxide emissions by combustion from petroleum-based products, has directly led to an increase in air pollution, and can pose direct health threats such as asthma attacks, heart disease, etc. to the general population (EPA, 2019). As cities continue to be developed in ways that rely on single-occupancy vehicle travel, emissions from transportation systems will continue to increase and significantly contribute to global climate change (Rodrigue, 2020).

Schiller et. al. (2010) define sustainable transportation by stating, "sustainable transportation aims at promoting better and healthier ways of meeting individual and community needs while reducing the social and environmental impacts of current mobility practice" (Schiller et al., 2010, xxii). These authors argue that a sustainable transportation system should: (1) meet the basic needs of individuals and societies, (2) be

affordable and operate efficiently, (3) and limit emissions and waste to within the planet's ability to maintain stable climate avoiding harms to human health and safety.

Author, Jean-Paul Rodrigue (2020), defines sustainable transportation as "...the capacity to support the mobility needs of a society in a manner that is the least damaging to the environment and does not impair the mobility needs of future generations."

Rodrigue advocates for sustainable transportation as a key factor in sustainable development, particularly where urban population growth is concerned. He argues for expanding public transportation infrastructure to accommodate the needs of the community.

Research suggests that sustainable transportation requires finding a balance between social equity, environment, and economy. With social equity, environment, and economy it determines that it is sustainable, but also the intersections of these three determinants solves these issues: "is it viable, equitable, and bearable?"(Tumlin, 2012). As mentioned earlier, research on the environmental impacts of transportation focuses on single occupant vehicle use.

Several studies illuminate commuter choices regarding university campus destinations. A study on sustainable transportation at the University of Kansas (KU), found that some of the determining factors for students who choose to commute by car over an alternative form of transportation were distance, ease of use, time, and weather (Fund et al., 2012). Another author, Wolf, argued that using well-designed initiative programs or campaigns to promote sustainable transportation alternatives could create

positive change in university stakeholders' commuting habits and transportation behavior (Wolf, 2009).

### Theory of Planned Behavior Framework

The success of promoting more sustainable commuting habits comes down to the ability to understand and influence individual behavior. Icek Ajzen (1991) argued that “concepts referring to behavioral dispositions, such as social attitude and personality trait, have played an important role in these attempts to predict and explain human behavior” (179). To predict behavior, Ajzen presented a theoretical model, the Theory of Planned Behavior (Figure 2).

Ajzen posited that behavior is a result of *intention*. The three determinants that make up intention are *attitude toward the behavior*, *subjective norm*, and *perceived behavioral control*. According to the theory of planned behavior, to influence an individual's behavior the three determinants must be favorable. In *attitude toward the behavior*, the individual has to think about whether the behavior performed will make a positive or negative contribution to their life. The *subjective norm* focuses on social factors that constrain individuals, such as social networks, beliefs, and rules which lead the individual to rely on what others think about performing the behavior. In *perceived behavioral control*, an individual has certain beliefs about their ability to perform the behavior. A positive with regard to the ability to complete all three determinants leads to intention. Today, the Theory of Planned Behavior is applied in marketing, such as when a consumer decides on a purchase by looking at ratings and reviews. When an individual

decides to purchase a new phone, for example, the person sees advertisements for the new phone and decides whether to buy or not based on three factors: (1) will the individuals friends and family support the purchase, (2) will it be easy to use the phone or not, and (3) whether the individual likes the phone.

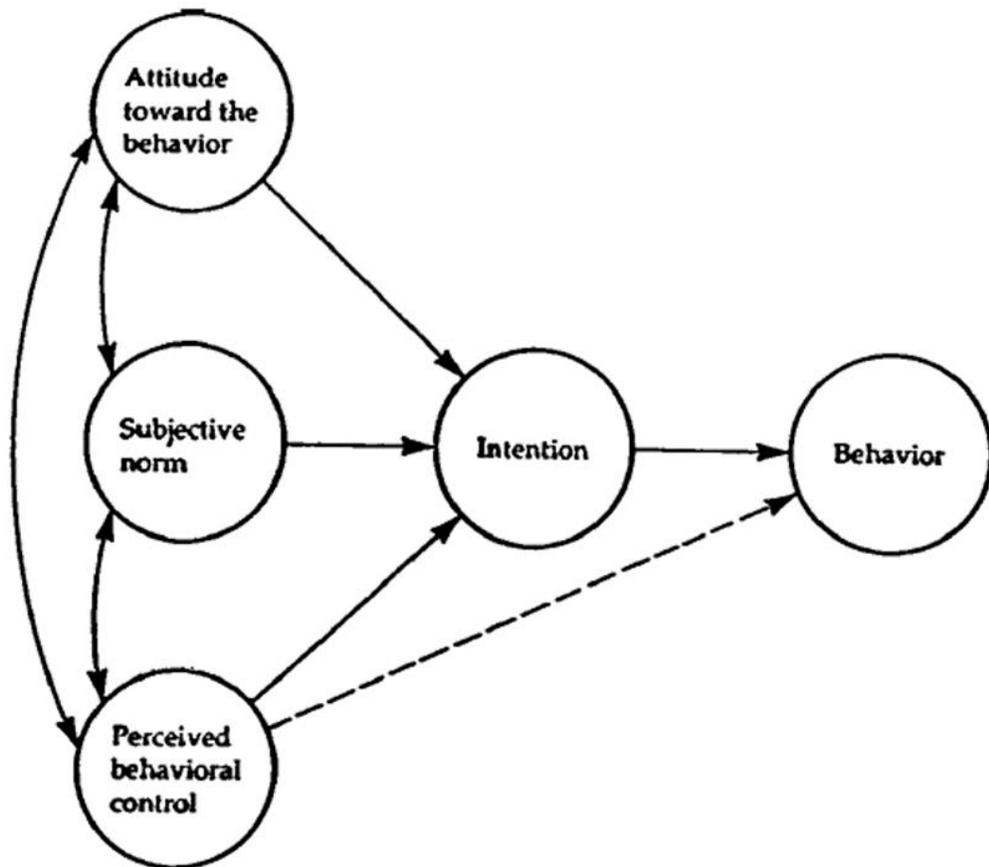
The Theory of Planned Behavior theoretical framework can be applied in the context of travel mode choice to understand how commuters travel to their destination (Sonja 2004). An attitude toward the behavior is formed when an individual makes a favorable or unfavorable evaluation or appraisal of the behavior in question. In a travel context, attitude can depend on how an individual may feel about using public transportation rather than a single-use vehicle. Subjective norms are defined as the perceived social pressure to perform or not to perform the behavior. In the travel context, a subjective norm could be whether an individual felt that people who are important to them would be supportive of them using public transportation instead of a private car. Perceived behavioral control refers to how difficult performing the behavior is within a broader context. In the travel context, perceived behavioral control could be the degree to which individuals feel using public transportation instead of a private car would be difficult or complicate everyday life (Sonja, 2004). Behavioral control is also linked with access to transportation systems and money to purchase fuel. By using the theory of planned behavioral framework, we can understand the determinants for individual travel mode choice and create interventions in order to change commuters' intentions and ultimately behaviors. In the context of institutional research, the Theory of Planned Behavior framework can be an excellent way to understand how broad measures and top-

down initiatives could ultimately influence the day-to-day behaviors of the people within the system.

While valuable, the Theory of Planned Behavior framework has a number of limitations. These limitations include: (1) assuming the individual has acquired the opportunity and resources to be successful in performing the behavior, regardless of the intention; (2) not accounting for other variables that factor into behavioral intention and motivation, such as fear, threat, mood, or past experience; (3) not taking into account environmental and economic factors that could influence an individual's intention to perform the behavior; (4) assuming that behavior is the result of a linear decision-making process, and not considering that it can change over time; and (5) not addressing the time frame between intent and behavioral action (LaMorte, 2019). Therefore, the Theory of Planned Behavior can help explain commuting behavior, but it is also important to consider that there are limitations to this framework.

Sonja (2004) argued that the Theory of Planned Behavior could be used to explain behavior related to transportation including modal choice (Sonja, 2004, 1). Sonja found that sociological and psychological factors contributed to which method of traveling individuals would choose. These factors include: "gender, age, occupation, working hours per week, income, education, main user or private car and means of transportation at their disposal" (Sonja, 2004, 2). In the research, choice of travel mode was a decision that could be affected through the three determinants of intention. A travel mode choice that can help determine the three intentions of the Theory of Planned Behavior is

walking. Walking can help understand the factors influencing the walking participation among the students at Humboldt State University.



**Figure 2: Icek Ajzen Theory of Planned Behavioral Structural Diagram. Figure from Icek Ajzen (1991).**

Walking as Transportation

*Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody.*

-Jane Jacobs, *The Death and Life of Great American Cities*

The Theory of Planned Behavior provides a good prediction of walking as a form of travel behavior and helps researchers to understand people who walk. Walking is not always seen as a mode of transportation. However, walking is essential for almost all trips and determines physical barriers and access to facilities of all kinds (Wigan, 1995). Walking is defined as traveling "...by foot for exercise or enjoyment or for reaching a specific location for some purpose (7). Some of the major factors that might influence or change the attitude towards walking as a mode of transportation include, information about the mode, its performance and impacts, and how it has a positive contribution to the person who is walking. Various studies of willingness to walk have identified weather, topography and as key environmental factors deterring walking.

#### Environmental Barriers to Sustainable Transportation

Montigney et al. (2012) examined the effects of weather on walking rates in nine cities and found that air temperature, sunlight, and precipitation all have a direct impact on walking behavior, suggesting that daily environment factors have significant impact on the desire to choose walking as a form of alternative transportation. McGinn et al. (2006), discussed additional barriers attributed to local weather in a study that analyzed the relationship between the natural environment and physical activity, suggesting that the prevalence of cold weather events such as precipitation, wind, and chilly air temperature negatively correlates with physical activity, such as walking. Montigney et

al. argued that the effects of "...air temperature, irradiation, and precipitation can be influenced to a certain extent through design, providing surfaces conducive to walking, by cleaning, by snow removal and by efficient drainage" (825). Therefore, proper planning and design of infrastructure can facilitate increased rates of walking.

### Pedestrian Actual and Perceived Safety

One of the biggest barriers for commuters to get to their destination by walking is the concern for safety. In the United States, pedestrians make up 11 percent of all car-related fatalities (Gottlieb, 2007). Cubukcu (2013) in analyzing what makes a neighborhood walkable concluded that to improve pedestrian safety changes were needed to land use designations, traffic, crime patterns, attention to comfort and accessibility. Additionally, Gottlieb (2007) argued that areas with frequent collisions involving pedestrians are the result of the way "...streets have been transformed into passageways, long and straight, with limited areas for walking compared to parking or flowing traffic..." (208).

Fundamentally, the auto-dominated landscapes common in American communities were not made for pedestrians. Gottlieb (2007) argues that in most places, "...pedestrians are not welcomed in environments where cars dominate" (207). Speck (2012) argues that cities are not walkable for two main reason: (1) a lack of protection and concern for the pedestrian and (2) a misunderstanding about what makes a city walkable and safe.

Sun et al. (2015), researched walking behavior of university students in Hong Kong, finding that walking behavior among students could be understood with the Theory of Planned Behavior framework and could potentially give information on walking interventions. They characterized the determinants in the Theory of Planned Behavior with example choices about pedestrian travel. The determinant attitude was characterized as, “For me to use walking as the main transport mode on campus for the next week would overall be: good or bad” (4). The subjective norm was presented as, “my friends in this university/other students within the university think(s) that I should or should not choose walking as the main travel mode over the next week on campus” (4). Finally, perceived behavioral control was framed as, “for me to walk as the main transport mode for the next week on campus would be: difficult or easy” (4). The study showed that all three determinants played a significant role in whether individuals intended to commute by walking, and according to Theory of Planned Behavior, intention explains the motivational factors that influence a behavior or the willingness to try to perform the behavior. Sun et. al. (2015) findings showed that only perceived behavior control had a large positive and statistically significant influence on participants’ walking intentions and was thus a significant contributor of walking behavior, whereas the determinants of attitude and subjective norm were less significant behavioral indicators. These results indicate that not only can public health practitioners and urban planners apply theory of planned behavior to develop walking promotion interventions for students at campuses, but that a focus on perceived behavioral control, or how easy or

difficult it is to walk as a form of transportation is key to sustainable transportation design. (Sun et. al., 2015)

City planner, Jeff Speck, argued that sidewalks are sacred and the key in supporting safety and ease for pedestrians (2012). Speck made two main arguments: making a sidewalk safe is based on sidewalk width and whether it is protected by a line of parked cars that form a barrier of steel between the pedestrian and the roadway; and that stripping a sidewalk of its protection in order to add bike lanes is sacrificing one form of non-motorized transportation for another. Tumlin (2012) suggested traffic calming measures to reduce the speeds or volumes of motorized traffic, and to help to significantly increase the safety of adjacent pedestrian routes. There are many methods to increase pedestrian safety by using traffic calming designs, including narrowing of lanes, vertical and horizontal deflections, and changes in texture on the roadway (Tumlin, 2012). While all these design elements physically alter the road to slow traffic, they also increase the perceived safety of a pedestrian route, which in the Theory of Planned Behavior, can impact all three of the determinants.

Being able to treat walking as another form of alternative transportation requires being able to suggest that travel time, distance, and frequency should be considered. Speck (2012) argued that the “general theory of walkability explains how, to be favored, a walk has to satisfy four main conditions: it must be useful, safe, comfortable, and interesting” (11). Each of these factors is essential and useful to encourage walking within a community. These factors are not just a nice idealistic notion, but rather a simple and practical solution to a problem that we face in society today that is undermining our

“...our nation’s economic competitiveness, public welfare, and environmental sustainability” (11). Walking is an active transportation mode with some associated safety, physical, and environmental barriers. In the next section I discuss the alternative mode of public transportation as a form of commuting.

### Public Transit and Bus Ridership

*Traffic congestion is caused by vehicles, not by people in themselves.*

-Jane Jacobs, *The Death and Life of Great American Cities*

In 2012, only 1.5 percent of all trips in the United State were made on public transportation (Speck, 2012). With traffic congestion and greenhouse gas emissions from single occupancy vehicles being a big issue in the United States, city planners advocate for public transportation ridership and highlight reliability. Reliability, or the perceived lack of reliability, is the primary reason many are not willing to switch to bus riding. Humes (2016) argued that buses tend to take longer because they are moving within the traffic pattern and also make numerous stops along a route. People who travel by car are unlikely to switch to bus riding to save time, unless buses have dedicated lanes that allow riders to bypass traffic congestion. Chen et. al. (2009) argued that the biggest challenge to enhance bus ridership is the real and perceived reliability of the system.

The main source of buses’ problems of reliability is delays. With buses there are two main causes of delay: (1) they stop much more frequently, so top speed matters less than the stops, and (2) they tends to be in situations that restrict their speed, including various kinds of congestion. Walker (2012) explained that there is a routine delay, a delay

that is a typical part of the operations of a transit line. He breaks down the three categories of routine delay: (1) traffic delay caused by the interference of other vehicles, (2) signal delay caused by required stops at signals, and (3) passenger stop delay caused by stops for passenger boarding and alighting. In most transit systems, the main focus should be on delay not speed because what is most important to overall reliability is how often the bus will stop or for how long. “Improving the reliability of bus service has the potential to increase the attractiveness of public transit to current and prospective riders” (Chen et. al., 2008, 724). Gottlieb (2007) argued that many metropolitan agencies, including Los Angeles, began to shift funding from bus to rail in recent years, cutting back on the number of buses in the streets, increasing fares, and reducing maintenance. But as a result, the active bus rider has to wait longer, sit in more crowded buses, and have longer trip times, thus reinforcing the idea of the unreliability of the system. Understanding service reliability is necessary to develop strategies that help transit agencies provide better services. The reliability of a network involves a combination of the routes, stops, punctuality of service, deviations from planned routes, and evenness of disruptions.

### Bus Stop Accessibility

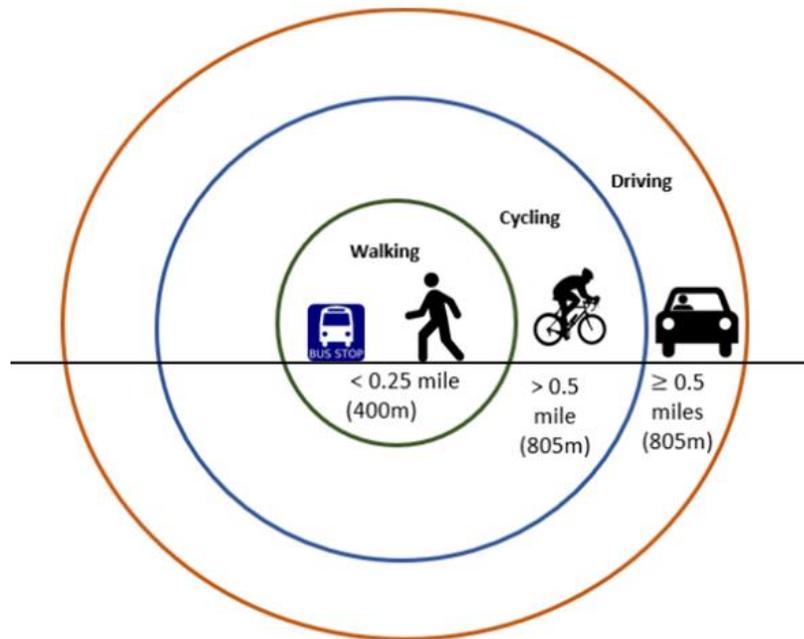
In a similar study, Salvo and Sabatini (2005) evaluated bus stop accessibility and concluded that access to public transportation access points is critical to increase participation in the network, stating that, “every transit begins and ends with pedestrian travel” (285). In addition to physical access, if people do not feel safe or comfortable

walking to the bus stops from their homes, then they are likely to choose to commute by car. “Bus stop access coverage is a critical measure for evaluating the stop location by estimating the covered area and populating lying within a suitable access distance from the bus stop” (Foda et al., 2010, 24).

The U.S. Department of Transportation Federal Highway Administration (2013) estimated the most people are willing to walk up to 0.5 mile to a bus stop. Corazza et. al. (2019) argued that accessibility to bus stops also should include demographic considerations about ridership, especially when discussing the accessibility in regard to elderly persons or people that are disabled. In addition, Tumlin (2012) suggested inclusion of comfort amenities at bus stops that encourage ridership. He suggests stops should be safe and clean, comfortable, easily identifiable, accessible, provide information, and be integrated with their surroundings. Furthermore, additional amenities that may be desirable for riders are public art, heating or air conditioning, area maps, and bike lockers.

Walker (2012), in looking more specifically at geographic coverage and bus stop distribution, argued that bus stops should be in multiple locations throughout the area within walking distance for pedestrian access, which encourages access to the transportation network within the flow of pedestrian activities. To encourage people to use buses, it is necessary to place bus stops with a walking distance of about one quarter mile (see figure 4). Foda et. al. (2010) drew similar conclusions, arguing that the average walking speed is about “...1.3 m/s, five minutes of walking is considered reasonable in

urban areas, which is about 400 meters in terms of walking distance” (24). To increase bus ridership, access to transit stops and the amenities of those stop is essential.



**Figure 3: Access Radii to bus stop. Figure by Jarrett Walker (2012).**

#### Buses and Theory of Planned Behavior

Travel mode is influenced by attitudes towards different forms of transportation. There is a perception that commuting by bus is for low-income and other marginalized people (Gottlieb, 2007). A study by Pew Research Center (2016), found that among the urban residents, 35% of African Americans and 27% of Hispanics are reported to take public transit at least once per week, as compared with 14% of white people (Deppen, 2018).

Although many people know that public transportation can help reduce air pollution, noise levels, ease traffic congestion, and fix parking problems, many people

continue to commute by private automobile. Bamberg et al. (2003), argued that frequency of past behavior is an indicator used to influence later action. For example, if a person takes the bus to commute daily, it eventually becomes a habit, so that "...little cognitive effort is required for continued execution of the behavior" (176).

Walker (2012) argued that one of the ways to change behavior towards bus ridership is by addressing "the seven demands of public transit." These seven demands that influence peoples' behavior to commute by bus are: (1) it takes me where I want to go; (2) it takes me when I want to go; (3) it is a good use of my time,;(4) it is a good use of my money;(5) it respects me in the level of safety, comfort, and amenity it provides; (6) I can trust it; (7) it gives me freedom to change my plan.

Each of these seven demands play a vital role for potential riders. Walker (2012) also noted the value of providing in-ride amenities such as reading lights, electrical outlets, phones, internet access, and other facilities that can enable a passenger to do something valuable during waiting time and the ride. Ajzen (1991) explained that to change the repeated performance of a behavior is to break the habit, and argued that researchers can learn about the factors that induce a person to engage in the behavior of interest (commuting by single-use vehicle) and to prompt another to create a new intention. Based on the research about bus ridership as a public transportation option, we can place this transportation option into the Theory of Planned Behavior.

## Key Findings

Throughout this section of the study, I looked over the researched literature that supported the Theory of Planned Behavior framework and applied it to transportation. Although Ajzen came up with the Theory of Planned Behavior, Sonja (2004) was the one who took the framework and applied it to transportation. With the Theory of Planned Behavior framework, it can help determine the decision of travel mode choice with the three determinants of intention. This framework can be easily applied to walking by predicting why people choose to walk. There are several factors that influence walking such as any environmental barriers, pedestrian actual and perceived safety. With public transit and bus ridership, the main issue with people refusing to use this form of transportation is reliability which can be a primary reason why people are not willing to use the bus. One thing that the researched literature is missing for my research is using other campuses are doing to solve transportation issues. I only focused on Humboldt's transportation data by using the HSU Parking Market Demand study.

Looking at the researched literature, there was evidence that the Theory of Planned Behavior can be used to identify why individuals choose to commute by car rather than a healthier form of transportation (i.e. walking). Sustainable forms of commuting should meet the goals of the three determinants of sustainable transportation that include social, environment, and economic. Environmental and safety barriers contribute to people avoiding walking as a form of transportation. The use of public transit is based on bus stop accessibility and perceptions towards buses.

These issues are pertinent to Humboldt State University which is experiencing high levels of its stakeholders traveling by car and seeks to address the challenge of increasing the level of walking or public transit. In the following research, I address the questions: (1) What are the main geographic, economic, and sociocultural factors that limit transportation choice for students at HSU? (2) What factors motivate individuals to use alternative modes of transportation when accessing campus facilities? (3) What is HSU's role in advocating for safe bicycle and pedestrian infrastructure for students within broader sustainable transportation frameworks? In the next section, I discuss the methods I used to conduct semi-structured interviews and geospatial analysis to address these questions.

## CHAPTER FOUR: METHODS AND METHODOLOGY

Research on access and behavior towards sustainable transportation can be addressed in many ways, and for this project, I used a combination of geographic information systems (GIS) to identify and analyze transportation networks at HSU and in the surrounding community and interviews with key stakeholders to understand administrative perspectives on Humboldt State planning for sustainable transportation. This mixed-method approach allowed me to understand the research questions from multiple analytical viewpoints. Using spatial analysis allowed me to identify the areas within the broader Humboldt community that are considered unsafe for pedestrians, evaluate the accessibility of bus stops, and illustrate the existing Arcata & Mad River Transit System (A&MRTS) routes in the City of Arcata. Qualitative analysis of interviews with key stakeholders allowed me to gain a broader understanding of institutional attitude towards transportation planning, constraints to making changes to the campus environment, and perspectives using the theory of planned behavior.

My initial entry point to design my research was the data and findings from Walker Consultants' Parking Market Demand Study at HSU (2018). Using the survey responses from the participants in the study, I analyzed current and future demand for parking, respondents' perception about other forms of transportation, and areas where most students were located and their challenge to commute to the HSU campus. With this study, I was able to identify: (1) what the university is doing to accommodate its stakeholders, (2) what the challenges are, and (3) alternative ways to meet the demand.

Through reading and assessing the study, I found how the university is approaching a sustainable plan for transportation – environmentally and financially. To do this it is necessary to minimize vehicle traffic on campus, introduce remote parking and pursue alternative transportation programming. Most HSU stakeholders will argue that there is more parking needed to solve the issue, however, the HSU Parking Market Demand study points out, the best thing to do is to decide to not build a parking structure on the main campus because this will not solve the parking issue, and instead add substantial debt and increase permit prices. A few additional recommendations the HSU Parking Market Demand study summarizes are that the university should raise prices for commuters, implement a shuttle-service to connect to remote lots to campus, and work with transit and local property owners to secure park-and-ride facilities in surrounding communities (Eureka and McKinleyville). To increase alternative forms of transportation, the study recommends enhancing understanding, education, and transparency around parking and commuter services by hiring a communications and marketing coordinator, building a social media presence, and issuing annual reports.

### GIS Interface & Spatial Data Analysis

My first objective in the spatial data analysis portion of my study was to identify the safety of non-motorized travel in Humboldt County. By doing so, I would be able to better understand the infrastructure-related context for the *attitude towards the behavior* from the Theory of Planned Behavior framework. By looking at the spatial analysis, it would identify the actual safety by looking at the number of accidents regarding the

issues towards commuting to the Humboldt State campus. For this, I obtained spatial data on Humboldt County's alternative transportation infrastructure and developed a geographic analysis showing potential opportunities and limitations for different modes of transportation to HSU.

Data layers were compiled and analyzed to create a visual representation of the transportation network. The spatial data gathered and modified for this research came from multiple geospatial data sources (Table 1). All spatial data, county boundaries, existing bike lanes and trails, bus routes, and commuting data were gathered and compiled into ArcMap for analysis.

Next, I used area-based distance measures to identify the parts of the community with walkable access to bus stops in the City of Arcata. The area-based measures were based on Corazza and Favaretto's (2019) study of urban mobility, in which they argued that the location of bus stops represents the connection between accessibility to walking and transit. Access to bus stops within distance of 400 meters is an acceptable range for high accessibility (Foda et al., 2010). Using these distance measures from existing bus stop access helped me to identify areas around Arcata that lack adequate access to transit stops. This analysis used a buffer operation to locate areas within Arcata that have reasonable access to bus stops, and then to overlay that on top of the official Arcata and Mad River Transit Map. I then visually analyzed the results to define the number of accessible bus stops in Arcata.

**Table 1: Geospatial Data Obtained for Analysis.**

<b>Spatial Data</b>	<b>Source/ Organization</b>	<b>Coordinate System/ Conversion</b>	<b>Reference</b>
U.S. States and Territories	National Weather Service	NAD 1983	<a href="https://www.weather.gov/gis/USStates">https://www.weather.gov/gis/USStates</a>
Humboldt County Boundary	Humboldt County GIS	NAD 1927 State Plane CA	<a href="http://humboldt.gov.org.276.GIS-Data-Download">http://humboldt.gov.org.276.GIS-Data-Download</a>
Humboldt County City Boundaries	Humboldt County GIS	NAD 1927 State Plane CA	<a href="http://humboldt.gov.org.276.GIS-Data-Download">http://humboldt.gov.org.276.GIS-Data-Download</a>
Existing Bike Lanes and Trails	Humboldt Powered Pathways/Rails to Trails Conservancy	NAD 1927 State Plane CA	<a href="http://humboldt.gov.org.276.GIS-Data-Download">http://humboldt.gov.org.276.GIS-Data-Download</a>
Major Roads	Humboldt County Community Development Services	NAD 1927 State Plane CA	<a href="http://humboldt.gov.org.276.GIS-Data-Download">http://humboldt.gov.org.276.GIS-Data-Download</a>
Bus Routes	Humboldt County GIS	NAD 1927 State Plane CA	<a href="http://humboldt.gov.org.276.GIS-Data-Download">http://humboldt.gov.org.276.GIS-Data-Download</a>
Bicycle and Pedestrian Collisions year 2013-2017	California Active Transportation Safety Information Pages	WGS 1984	<a href="http://catsip.berkeley.edu/resources/crash-data">http://catsip.berkeley.edu/resources/crash-data</a>

## Interviews and Qualitative Data Analysis

I conducted interviews using primarily open-ended questions that allowed respondents to provide detailed answers. During the interviews, I used a semi-structured, in-depth, flexible engagement interview style of questions. I chose to use interviews as a research method, because I wanted the research participants to share their views on sustainable transportation from the standpoint of people who help shape sustainability at HSU as an institution. Secor (2010) explained that interviews are often used to learn how “...certain practices, experiences, knowledges, or institutions work – or at least, how your participants talk about these things working” (199). For each interview participant, I provided an introduction explaining the purpose of my research, the goal of the interview, and what I planned to do with my research (see Appendix A). I had eight questions for each participant. Questions were based on the participant’s role to elucidate their view or perspective, identify barriers or concerns about other forms of transportation. I interviewed three people from Arcata CA. I chose to interview the three participants because I felt that their role in sustainable transportation planning was significant and could provide context towards the analysis.

I got in contact with three departments of transportation: HSU Facilities Management, HSU Advisory Committee of Sustainability, and the Coalition for Responsible Transportation Priorities. I sent e-mails describing who I am, my topic for my thesis, and asked if they would like to participate. I negotiated a date and time to do the interview. However, as I live in Southern California, I asked the participants if they

were comfortable interviewing by Zoom, phone call, or email. I recorded and took detailed notes of the interviews. Each interview lasted approximated 45-60 minutes.

After the interviews were completed, I began the process of analysis and interpretation of the responses collected. I first coded the transcript from each interview. According to Secor (2010), the purpose of coding is to find “themes, words, phrases, and interpretations are flagged within and across focus group and interview transcripts (199). After coding, I then analyzed the transcripts for patterns of conversation. My goal was to identify underlying themes or perceptions that each participant had.

In analyzing the interview data, I first looked at whether the perceptions of the people interviewed supported or differed from predominate themes in the literature. Following this, I analyzed patterns and themes that emerged in the conversation that were not mentioned in the research literature, indicating local variables that must be considered.

My goal was to analyze the issues of safety, accessibility and institutional perspectives using the Theory of Planned Behavior. In addressing safety, I wanted to be able to identify respondents’ attitudes towards actively commuting to the HSU campus. For example, according to the HSU Parking Market Demand study, walking to campus is an issue because the sidewalks on the way to the HSU campus are very narrow. In accessibility, I identified the subjective norm perspective by looking at the respondents’ perceptions on bus ridership and how it can affect potential riders. Institutional perspectives were linked to perceived behavioral control by looking at institutional

beliefs about being able to commute to the HSU campus other than in a single-occupant vehicle.

I report my results in two ways. First, I discuss the key themes that emerged from my research and link them to the interviewee responses and the literature review. I then look at spatial data to back up the interview responses and the researched literature and connect them to the Theory of Planned Behavior framework.

## CHAPTER FIVE: RESULTS AND DISCUSSION

The results chapter is broken into three distinct sections. In the first I investigate the issue of pedestrian safety and how the lack of safety can be perceived as a barrier for individuals walking to campus as a primary mode of transportation. The second provides the results of the bus stop accessibility analysis in Arcata. In the third section, I discuss the interview results and analyze institutional viewpoints on sustainable transportation.

### Sustainable Transportation at HSU

Schiller et al. (2010) defined sustainable transportation as meeting the basic mobility needs of individuals and not degrading the environment. Researching sustainable transportation in the context of HSU, I wanted to start out by asking professionals in the local community how they define the term. When asked, *in your own words, how would you define sustainable transportation?*, Each participant answered with a different definition. The sustainable campus administrator said,

“Sustainable transportation is utilizing non fossil fuel modes of transportation as a priority, there is a hierarchy of sustainable transportation; a pyramid where walking, biking, skateboarding, any non-motorized is at the bottom, following is a public transit as bus trains, etc., and the last resort is single-occupant vehicles.”

An administrator working for a nonprofit to help solve transportation issues in Humboldt County, gave an alternative definition, stating:

“I think of sustainability with the three factors looking at environmental dimension, as well as social and economic. To me, sustainable transportation would imply modes that are environmental[ly] responsible, socially responsible, and economic[ally] just. I usually don’t use the phrase sustainable transportation, I usually will say responsible transportation, but only because sustainability has many meanings to different people.”

While both participants highlight the importance of sustainable transportation, the latter response brought in social and economic dimensions that add complexity to thinking about what shifts need to take place for people to change their behavior.

### Barriers to Sustainable Transportation

The literature suggests perceived safety is one of the primary barriers to individuals making sustainable transportation choices. Because of this, I decided to ask the participants if they felt safety was the primary barrier to commuting to the university or within the city of Arcata. The participants all had different views on the kind of barriers that are stopping stakeholders from using alternative forms of transportation. This was reflective of the range of barriers that exist for HSU stakeholders.

When I asked participants, *what are some of the barriers HSU stakeholders face when trying to use an alternative form of transportation*, it became clear that there were other barriers beside just safety. The Director of Sustainability at HSU, who frequently walks to the campus said that “one of the barriers at HSU is the topography. It is challenging for students, faculty, and staff to bike to HSU.” In the research literature, I found that topography is a barrier to sustainable transportation behavior. Montigny et al. (2011) observes behavior in relation to weather and found a linkage between perception of conditions, the conditions themselves, and observable behavior.

However, the sustainable campus administrator had a different perception about real vs. perceived barriers at HSU, explaining that:

“We are a rural campus. There are certain external barriers which makes it hard for people to overcome. The available transportation options are limited. A perceived barrier is convenience to utilize alternative transportation to get to campus. A real barrier would be students who commute farther due to the difficulty of finding affordable housing in Arcata.”

The administrator for the non-profit also raised this point, stating, “there is an affordable housing shortage for students, faculty, and staff that is a big factor contributing to the amount of driving.” In similar research, Gottlieb (2007) found that sustainable transportation should be addressed through transit-oriented development, locating housing and commercial development near transit stops, and by considering equity such as linking affordable housing to transit stops. As a frequent bicycle commuter, he felt that each form of alternative transportation has a different barrier, stating:

“The big determinant for walking or biking is safety. The question is, how far are people willing to walk or bike? The other big determinant for transit is convenience, reliability, and cost. And actually, the cost for a bus is not much when you factor in all the maintenance, gas, insurance for a car.”

Humboldt County exceeds the national average on motor vehicle deaths (North Coast Journal, 2017). In the years 2009-2014, Eureka ranked among the top three spots for pedestrian death and injury rates for California Cities of similar size (Times Standard, 2017). At the time, Eureka was trying to find a balance between allowing for smooth driving for single occupancy vehicles and providing a safe pedestrian environment. Yet, in 2015-2016 the numbers of pedestrian deaths increased by 11% (Governors Highway Safety Association, 2016). The California Office of Traffic Safety found that Humboldt County had the second highest rate of pedestrian deaths and injuries of all counties in the state in the years 2010, 2011, 2012, and 2014 (Times Standard, 2017). The map below

(see figure 4), shows the type of accidents in Arcata from the years 2013-2017. The blue dots represent the bicycle accidents and the yellow dots represent the pedestrian accidents. The first thing I noticed in this map is the sheer number of accidents there were, 83 accidents in total. In ArcMap 10.6.1, I was able to label each dot with a number and add a halo around it to make it more noticeable. Also, I noticed that the number of accidents increased near the downtown area of Arcata. Another thing that was interesting is that many of these accidents occurred near the Humboldt State campus. This map supports the claim that in Arcata needs planning and infrastructure to support active transportation for its community. However, pedestrians need to be responsible and learn to cross the street at controlled intersections where signal lights or other control devices are present. The sustainable campus administrator mentioned this issue during the interview:

“Bicyclists and Pedestrians have rights but also responsibilities. They can make it harder for other active commuters if they don’t. For example, when a bicyclist or pedestrian does not stop at a stop sign. Drivers don’t expect bicyclists or pedestrians to do that. Whenever I bike, I stop and put my foot down the pedal to show other cars that I have stopped.”

Table 2, illustrates just a sample of the walking accidents that occurred in Arcata between 2013-2017. I focused on walking and not bicycle accidents because this was the mode of transportation that I reviewed in the literature. For this table, I wanted to look at a sample of where the accident occurred such as the street, the location, and the type of accident. What I noticed when I looked at this table is that most of the accidents happen at intersections. Some of the possible reasons why accidents occur at intersections

include vehicles that run red lights or stop signs, a failure to yield, speeding, left or right turns made against the crossing signal, crossing without a signal, and drivers or pedestrians who are intoxicated. Intersections must be designed, engineered, and constructed correctly in order to prevent accidents.

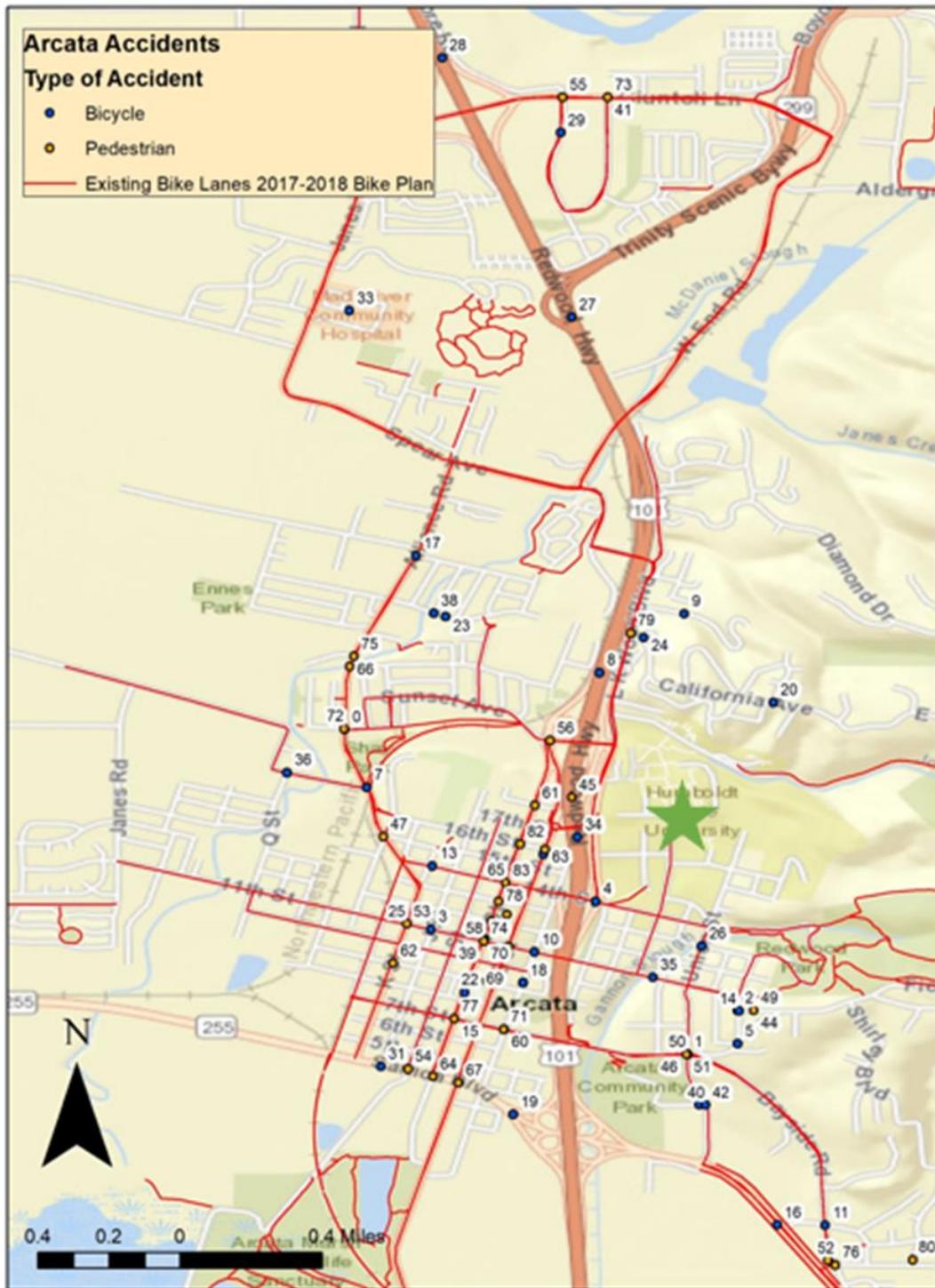


Figure 4: Arcata Pedestrian and Bicycle Accidents from the years 2013-2017. Map created by Aneika Perez.

**Table 2 Pedestrian Accidents Location in Arcata, CA.**

<b>Number</b>	<b>Street</b>	<b>Location</b>	<b>Type</b>
1	7 <sup>th</sup> Street & Union St	Intersection	Pedestrian
2	Bayview St & Park Ave	Intersection	Pedestrian
5	Bayview St & Hill St	Intersection	Pedestrian
11	Crescent Way & Bayside Rd	Intersection	Pedestrian
14	Bayview St and Park Ave	Intersection	Pedestrian
16	Samoa Blvd	Freeway	Pedestrian
21	Bayside Rd & Union St	Intersection	Pedestrian
37	Bayside Rd & Union St	Intersection	Pedestrian
40	Union St & Dr. Martin Luther King Jr Way	Intersection	Pedestrian
42	Union St & Dr. Martin Luther King Jr Way	Intersection	Pedestrian
44	Park Avenue	Street	Pedestrian
45	Redwood Hwy	Freeway	Pedestrian
46	Bayside Rd & Union St	Intersection	Pedestrian
49	Park Avenue	Street	Pedestrian
51	Bayside Rd & Union St	Intersection	Pedestrian
52	Bayside Rd & Buttermilk Ln	Intersection	Pedestrian
54	I St & Samoa Blvd	Intersection	Pedestrian
60	7 <sup>th</sup> St and F St	Intersection	Pedestrian
62	K St & 9 <sup>th</sup> St	Intersection	Pedestrian
64	H St & Samoa Blvd	Intersection	Pedestrian
67	G St & Samoa Blvd	Intersection	Pedestrian
71	7 <sup>th</sup> St and F St	Intersection	Pedestrian
73	Giuntoli Ln	Street	Pedestrian
75	Alliance Rd	Street	Pedestrian
76	Alliance Rd	Street	Pedestrian
77	7 <sup>th</sup> St & H St	Intersection	Pedestrian
79	LK Wood	Street	Pedestrian

Establishing a safe environment for pedestrians should be a priority because unlike other modes of transportation (i.e. cycling, driving, mass transit) at some point everyone is a pedestrian. In the HSU Parking Market Demand study, it showed that the reason why many pedestrians feel unsafe is due to a lack of road infrastructure and a proper engineering design. When designing and planning road infrastructure, many of the transportation planners "...design certain facilities for road users and other facilities for pedestrians. However, this approach to design does not take into account that the pedestrians and motorists will at some point have to interact with each other" (Emo, et al., 2011, 1745). When a pedestrian is feeling unsafe in an environment, it can impact their perception and behavior towards walking. For example, when a pedestrian is walking in an area where they feel unsafe, the individual increases their walking speed and level of stress (DeSilva, et al., 2017). Ensuring pedestrian safety for the HSU community is necessary to protect human life and because walking has additional benefits of providing exercise and improving health, as well as being a low carbon transportation mode.

When discussing barriers with participants, I thought it was necessary to ask about their perception of alternative transportation. When asked, what is your perception of public transit, both the director of sustainability and the administrator of the non-profit had consistent views. The director of sustainability, stated, "I love public transit! I seek out opportunities to take buses when I travel. There are so many benefits and it's a relaxing commute." The administrator for the non-profit contended, "I think Humboldt County has what is considered for the United States standards a pretty high functioning

rural transit system. Frankly, many rural areas don't have transit systems. Of course, the system doesn't function at a high enough level.”

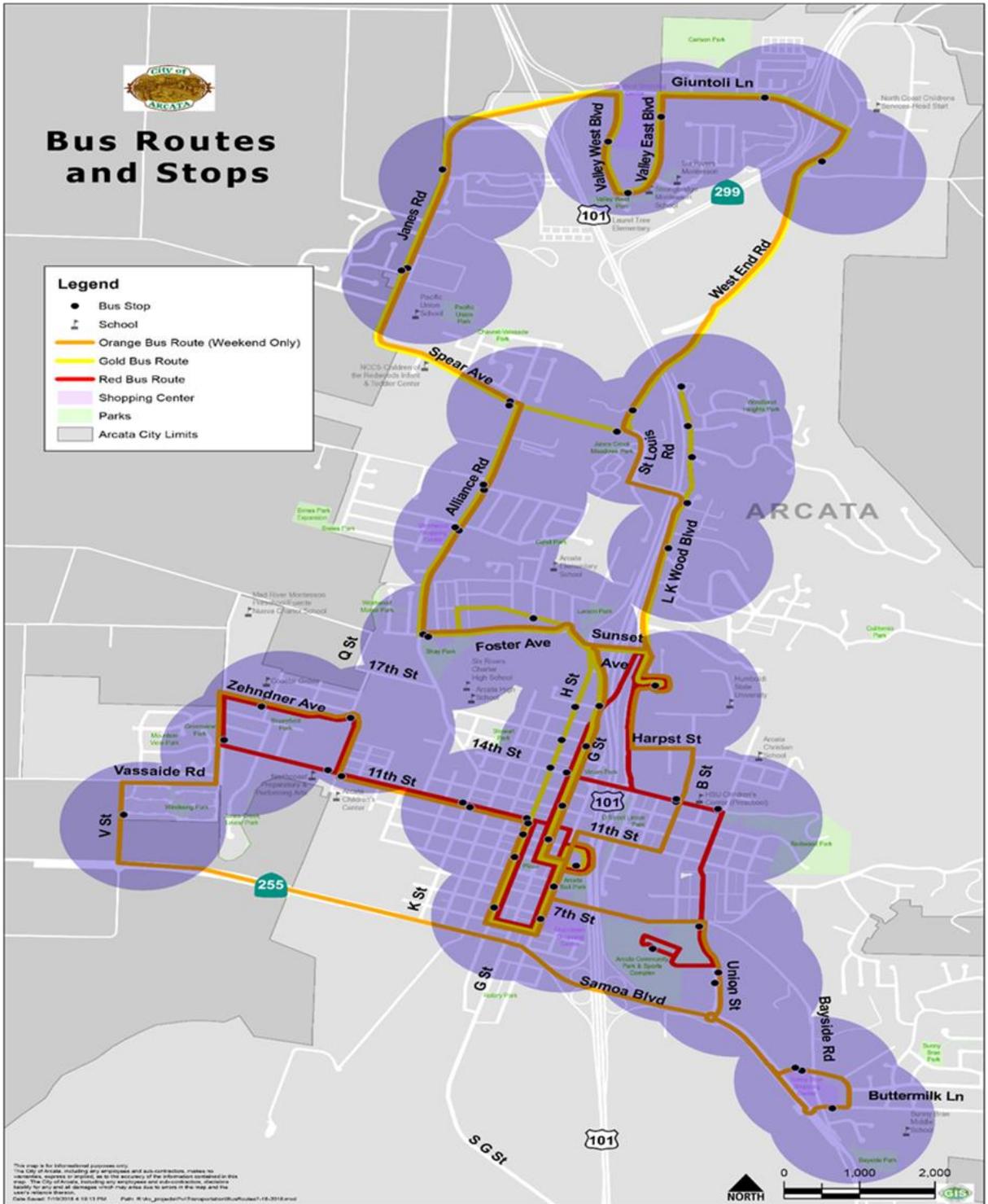
While these interviewees favor alternative transportation because they provided a positive outlook on their experiences, looking back at the HSU Parking Market Demand Study, many stakeholders from the study reported negative experiences using alternative transportation. About 41 percent argued that to change their behavior to change their commuting choice would be availability, and another 36 percent argued convenience, only 4percent answered that sustainability is an important factor.

#### Bus Stop Access and Theory of Planned Behavior

In the researched literature, bus stops are an important factor to contribute to bus ridership for current and potential riders. Foda et al. (2010), argued that with “... a transit trip [it ]begins and ends with pedestrian travel, access to a bus stop is considered a critical factor for assessing the accessibility of the stop location” (Foda et al., 2010, page 23). Salvo and Sabatini (2005) considered from a user's point of view, “...an ideal accessibility is one that allows visibility and easy access to the bus, is comfortable and convenient, provides clear information, and is safe” (Salvo and Sabatini, 2005, page 285). Throughout the literature, accessibility of bus stops is seen as critical to successful urban mass-transit systems. With regard to bus stop accessibility, it should be considered reasonable in urban areas, to have a bus stop within 400m of walking distance (REF). Accessibility to bus stops is necessary because transit stops affect the opportunity to use the public transport service (Salvo and Sabatini, 2005, 24).

The following map (see figure 5), by Arcata and Mad River Transit, represents the bus stops and bus routes in Arcata. In this map, I used a geospatial analysis to create 400m buffers to evaluate the distribution of the bus stops by estimating the covered area and population lying within a suitable access distance from the bus stop. In this research, I used GIS to identify all the pedestrian road networks that are within the bus stop access with a 400m access threshold. In addition, looking at Figure 5, there were a few additional things to consider. The Arcata and Mad River Transit bus system offers service Monday through Friday and limited weekend service. Many of the bus stops are in close proximity to each other but Tumlin (2012) argued that bus stops need to be in a certain distance from each other to be accessible to commuters from all parts of the city.

What is interesting about this map is that each of the bus stops is within a short distance of the others. It is recommended that bus stops should be spaced to minimize increasing the transit time travel. Corazza and Favaretto (2019) argued that bus stops are affected by factors that include (1) quality of the urban environment these facilities are located in, (2) the type of functions and operations associated with them, which dictate their “status” from simple bus marker to bus shelter. For bus stops to be comfortable, safe, and clean the National Association of City Transportation Officials recommends that bus stop planning and design involve including information for riders at the stop with route map and schedule, and installing adequate lighting to ensure personal safety and security. All these factors should be considered to influence behavior in bus stops and to encourage potential bus riders.



**Figure 5: Map of Bus Routes and Stops in Arcata with 400m Buffers. Base Map provided by the City of Arcata; buffer analysis overlay by Aneika Perez.**

## Actions and Steps Moving Forward at HSU

Education could be an avenue to increase the use of alternative forms of transportation by HSU stakeholders. When asked, *what type of actions is HSU undertaking to promote sustainable transportation?*, The sustainable campus administrator responded, “I am doing a lot of recruiting to find members for the Sustainability Advisory Committee at campus. I am doing a number of different types of outreach and activities to the bike share program.” He is highly involved in sustainability efforts on the HSU campus including promoting alternative forms of transportation by doing projects and working as the advisor for the Bicycle Learning Center (BLC) and Waste Reduction & Resource Awareness Program (WRRAP). He has been dedicated to making the HSU campus sustainable and facilitates climate action and resiliency planning.. I wanted to see what his reaction would be to a car free campus When asked, *what would a “car free” HSU campus look like*, he responded with enthusiasm,

“Wow! Wouldn’t that be amazing? I don’t think that will be happening in the coming decades at least. You won’t be able to eliminate cars entirely because of accessibility issues, and public transportation infrastructure needs to improve. But I can see things happening at the campus to reduce vehicles. Our campus is definitely exploring for new ideas.”

For the administrator of the non-profit who focuses on addressing transportation issues in Humboldt County, I thought it was necessary to ask what the Coalition is doing to help solve transportation problems. When asked, what types of actions the Coalition of Responsible Transportation Priorities is undertaking to address transportation issues in Humboldt County, he elaborated,

“We advocate primarily around infrastructure, planning, and policy. In addition, what we do is we engage in long term planning efforts, Such as a transportation plan, general plan, zoning plan and codes those kinds of things. We focus on infrastructure and land use development.”

In addition, with his expertise on transportation I asked, *what do you think HSU should do to encourage its stakeholders to use other forms of transportation other than the private automobile?* He was hesitant but responded,

“I would like to start with what HSU is doing correct. And something that HSU is doing right is the JackPass which provides a fare free public transit pass to all the students at HSU. But I would say HSU needs to give faculty and staff fare free passes or generally reduce the price because as of right now, they have to pay for a bus pass. Also, I would say parking is already a problem, but I think the university doesn’t manage parking in a way to discourage driving. When it comes to reducing driving, I think the main takeaway is to provide incentives and disincentives.”

The faculty member who is co-chair of the HSU Advisory Committee on Sustainability introduced a different approach on how to encourage HSU stakeholders to use alternative forms of transportation. She mentioned incentive programs as the best way to encourage people to use the bus. When asked, *do you think we need to invest in money in programs for sustainable transportation?*, She responded saying,

“Yes, I do! I know that the best thing to be done are incentives programs. For staff and faculty, an incentive to take public transit to work. For example, my mom who worked for the county of Sonoma, the incentive program there was if you promised to carpool, bike, or take public transit to work a certain percentage of your trips is entered to raffle that wins free tickets to movies, prizes, etc.”

I asked her *why is it important to make the school more sustainable?* She responded saying,

“Sustainability is important for the university because it is a way to recruit students. If we make arguments to the administration that involves anything doing

to be sustainable it can be used to recruit students since the past year there has been a decline in enrollment.”

### Actions of the Theory of Planned Behavior

Travel behavior is influenced by factors that include socio-economic and demographic needs and attitudes (Sonja, 2004). From the interview responses, I concluded that attitude towards travel behavior is influenced by: health and fitness, comfort, relaxation, freedom, time, environment, cost, and safety. If students at HSU don't have a physical disability and want to exercise, walking would be the best choice to commute to the campus with limiting factors being distance and the weather. From my personal experience, I would walk around Arcata whenever it wasn't raining and when I wanted to commute by getting exercise and not paying for transportation. The map generated from the accident data illustrates how Arcata is an unsafe environment for pedestrians is easy to come by with the frequency of accidents between cars and non-motorized modes of transportation.

To understand the subjective norm of planned travel behavior, throughout the researched literature and interview data I found that for people to use public transit or walk as a travel mode choice depends on who supports them to achieve this behavior. Family, friends, and partners can have an impact in supporting a person's behavioral changes towards choosing to walk or ride the bus than driving a single occupant vehicle. To change the subjective norm, HSU needs to make clear the prioritization of alternative modes of transportation. This could take the form of more information and education about alternative modes, and also changes to the environment that deprioritize

automobiles. This could include the removal of parking spots, car free zones, time-based constraints, and incentivizing carpooling. By deprioritizing the automobile influence in the environment, alternative modes of transportation more easily become the subject to the environment which can be part of the behavioral control because it makes it harder to drive.

In perceived behavioral control, factors that can limit sustainable transportation behavior include being in a hurry, traffic, weather, and the amount of weight an individual is carrying. Perceived behavioral control is really about the way the environment could be designed to support walking and public transit. This could include design that prioritizes the public in transit, such as covered stops and Wi-Fi enabled busses. On campus, this could include walking rest stations, more amenities such as food on campus, and umbrella share stations.

It is necessary to promote alternative forms of transportation at Humboldt State because the school is widely known to be a green campus and if all the HSU stakeholders are commuting to the campus in individual cars they are contributing to air pollution, noise levels, traffic congestion, and increasing parking problems. By advocating for and improving the frequency of more sustainable travel behaviors, they will eventually become a normalized part of campus life. For example, taking the bus to the HSU campus on a regular basis eventually becomes a habit in the sense that little cognitive effort is required for continued execution of the behavior (Bamberg, 2003). To increase sustainable transportation at HSU, it can be by adding incentive programs at the

university, increasing the safety network, and aim to find the behavior for stakeholders to allow

In this section, I have discussed the results of the geospatial analysis performed to show the need for sustainable transportation planning at HSU and analyzed my interview participants' responses by comparing them with the literature. I raised the issues of pedestrian safety and the perceived barrier of walking to campus by reviewing pedestrian accidents. By using GIS, I was able to analyze the number of pedestrian accidents that have occurred in Arcata within recent years.

From the interviews, I learned that there are administrators on campus that want to solve the transportation issues like the lack of parking and overflowed parking lots. One of the interviewees mentioned incentive programs that to encourage staff and faculty to use sustainable transportation alternatives when commuting to work.

When I looked at bus stop accessibility, I was surprised to see that most of the bus stops in Arcata are within a 400m buffer zone, which is accessible to most people who live in Arcata. However, as mentioned earlier, most students live in nearby communities such as Eureka and McKinleyville.

Overall, in this section I was able to look at the issues of pedestrian safety that can be a barrier for stakeholders to use an active form of transportation such as walking to the campus. For instance, I created a spatial map of the pedestrian accidents and then created a table to show the number of pedestrian accidents that have occurred in the years of 2013-2017 in Arcata. I then was able to create a spatial map that shows an analysis of bus stop accessibility in Arcata which shows that within 400m each bus stop is fairly

accessible, however, the Arcata and Mad River Transit offers services only Monday through Friday with limited hours. With the Theory of Planned Behavior, I found throughout the research that attitude can be based on health and fitness, relaxation, freedom, time, environment, cost, and safety. All of these factors that are based on attitude are influenced by Walker's (2012) Seven Demands of transit service which can be expectations and influence potential riders.

I believe additional research is needed to provide the basis for improved infrastructure, planning, and policy to make sustainable transportation at Humboldt County safe and accessible. In the next section, I present my recommendations and overall conclusions from my research.

## CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

At Humboldt State University, commuting to campus is an ongoing challenge. With accessibility and behavior being major factors, commuting to campus predominately consists of HSU stakeholders driving single occupancy vehicles. I hope this research will help to provide insights for the HSU Advisory Committee on Sustainability on encouraging HSU commuters to change their transportation behaviors. My aim for this research was to analyze sustainable transportation and to provide theoretical and empirical evidence to persuade HSU commuters to change their transportation behavior when traveling to campus. Throughout this research, I applied the Theory of Planned Behavior by Icek Ajzen (1991) as my theoretical framework. Applying this theory, I discussed how walking and public transit are limited at the HSU campus. I analyzed various socioeconomic variables in Humboldt County by using geographic information systems (GIS) to map out spatial data indicating how dangerous non-motorized forms of commuting are in Arcata and looking at areas where there is more access to bus stops which can be a big factor for people to start using the bus to the university.

In addition, I was able to apply interview-based qualitative analysis to understand broader institutional attitudes towards transportation planning. From this, I was able to answer my research questions: (1) What are the main geographic, economic, and sociocultural factors that limit transportation choice for students at HSU? (2) What factors motivate individuals to use alternative mode of transportation when accessing campus facilities? (3) What is HSU's role in advocating for safe bicycle and pedestrian

infrastructure for students within broader sustainable transportation frameworks? I found in this research that some of the factors that contribute to limiting choices for commuters to HSU are: environmental barriers, limited housing, and a negative perception of public transit in Humboldt County. In addition, some motivating factors that could encourage the HSU community to use alternative modes of transportation are incentive programs, health benefits, time, and accessibility. For example, by encouraging stakeholders to use walking as a travel mode choice it could benefit their health. HSU has a role in advocating for safety because the university committed to the 2016 Climate Action Plan and is recognized to be a sustainable school. As a result, I was able to discuss the key themes that emerged from my research and frame it to the theory of planned behavior.

The research provided evidence that safety and access are barriers to commuting in a more sustainable form. Many of the researchers argued that in order to make transportation sustainable, it should be able to meet individuals' and society's basic needs, be affordable and operate efficiently, and limit carbon emissions. Furthermore, in planning for sustainable transportation, it is necessary to have a balance between social, equity, and economy in order for it to be truly sustainable. In regard to barriers, the HSU Parking Market Demand study acknowledged that the location of the campus can impact students' ability to get to the campus. Montigny et al. (2012) concluded in their research on environmental barriers that it is necessary to provide the right infrastructure for commuting by walking for cold and wet weather climates such as in Humboldt County. Walker (2012) argued for changing the barriers to using public transit with the seven

demands of public transit. Lastly, research concludes that by providing incentives for the community, many individuals' behaviors towards sustainable transportation can change.

I recommend that additional research is necessary for cycling and carpooling. I focused on walking and public transit, because that was the form of commute I used in Humboldt County. There is much research on cycling and carpooling and current studies show that there are additional barriers and safety issues when it comes to commuting by cycling. Furthermore, I suggest that any future research on transportation at HSU assess the modes of transportation available to students, staff and faculty at HSU while considering that HSU is different from most campuses in its population, topography and climate – and how these factors create barriers to use of sustainable modes of transportation.

I believe my research will make a difference at the Humboldt State campus. I found it rather satisfying to do research on a topic that focuses on sustainability because that is what the HSU campus is known for. I hope this research will encourage future researchers to develop new ideas in transportation planning and find ways to overcome the barriers to sustainable transportation.

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## APPENDIX – INTERVIEW QUESTIONS

Hi, thank you for taking time to do this interview.

My name is Aneika Perez and I am a graduate student at Humboldt State University (HSU) in the Social Science – Environment and Community program. I am conducting research on sustainable transportation. Using a socio-psychological framework, this research explores the relationship between travel access and behavioral intention in Humboldt County, specifically within the HSU community.

The goal of this interview is to get your perceptions of sustainable transportation that you feel will be the most effective or ineffective for increasing awareness on minimizing the use of automobiles. The results of this research will assist the students/faculty/staff at HSU.

If you do not understand a question or term I am using, please let me know. I will define and explain any terms you may not understand.

Estimated interview time will take about 30-60 minutes.

Any questions before we start?

### **Interview Questions**

#### Participant #1

1. What role do you play on campus and in the HSU Sustainability committee?
2. In your own words, how would you define sustainable transportation?
3. What types of actions are HSU and the HSU Sustainability Committee undertaking to promote sustainable transportation?
4. What are some of the barriers HSU students/staff/faculty face when trying to use alternative forms of transportation?
5. In your view, how safe is bicycle commuting?

6. What would a “car-free” HSU campus look like?
7. How feasible is this?
8. Is there anything you would like to add? Questions?

Participant #2

1. What is your role on the HSU Sustainability committee?
2. How would you define sustainable transportation?
3. What types of actions is the Sustainability Committee focusing on for sustainable transportation?
4. What are some of the barriers HSU students/staff/faculty face when trying to use an alternative form of transportation?
5. In your opinion, what would eliminate or end these barriers?
6. What is your perception of public transit systems?
7. Do you think we need to invest in more money in programs for sustainable transportation?
8. Is there anything you would like to add? Questions?

Participant #3

1. What is your role for the coalition of responsible transportation priorities?
2. In your own words, how would you define sustainable transportation?
3. What is your perception of transit systems?
4. What types of actions is the CRTP doing to address transportation issues in Humboldt County?
5. What barriers, if any, keep people from commuting by other forms of sustainable transportation? (i.e. such as bicycling, walking, transit)
6. What do you think HSU should do to encourage its stakeholders to use other forms of transportation other than the private automobile?
7. Do you think we need to invest in more money in programs for sustainable transportation?
8. Anything you would like to add? Questions?