

# Promoting the use of the Public Bike Sharing System in Cuenca, Ecuador

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## Promoting the use of the Public Bike Sharing System in Cuenca, Ecuador

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## **Abstract**

A strategy of cities to combat the negative effects of urbanization, such as pollution and congestion, is to encourage biking. Due to an increase in population and car use in Cuenca, Ecuador, the transportation department, EMOV EP, is launching a bike share program to encourage cycling. The goal of our project was to assist EMOV EP in promoting the system by creating interconnected routes between bike-sharing stations for commuting, recreation, and self-guided tourism. We investigated potential uses of the system, perceptions of safety, points of interest, and strategies to address potential barriers to biking in Cuenca. Using this information, we determined criteria for selecting routes to create route maps. These were designed for EMOV EP to distribute via the web and the bike share app.

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## **Authorship**

**Zachary Ahrens** was responsible for the creation of the transportation prototype map, final transportation map, survey and interview analysis, and participated in physical testing of route choices. Worked along his group members in contributing an equal share of writing and editing in all sections of the report.

**Carl Aladin** was responsible for the creation of the recreation map, survey and interview analysis, and participated in physical testing of route choices. Worked along his group members in contributing an equal share of writing and editing in all sections of the report.

**Willard Murphy** was responsible for the general survey analysis. Worked along his group members and contributed an equal share of writing and editing in all sections of the report.

**H Mitchell Reid** was responsible for the creation of the “self-guided tour map, as well as the analysis of the interviews with bike shop employees. Additionally, H Mitchell Reid directed many of the meetings with our sponsor due to his Spanish abilities. Worked along his group members in contributing an equal share of writing and editing in all sections of the report.

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# 1 Introduction

Currently, 55% of the world's inhabitants live in urban areas, and this percentage is projected to increase to 68% by 2050 (United Nations, 2018). In developing countries around the world, fossil fuel-based transportation, primarily private automobiles, has come to dominate the means by which people travel (Girardet, 1996). The growing use of automobiles has significant environmental impacts. Cars release many types of emissions, including carbon dioxide, carbon monoxide, and nitrogen oxides, which seriously impact human health (Gringer, 2015). A study done in Austria, France, and Switzerland estimated that automobile emissions were responsible for over 25,000 cases of adult bronchitis, 290,000 cases of child bronchitis, 500,000 asthma attacks, and more than 16 million personal days of restricted activities per year (Künzli, 2000).

One of the ways that cities have attempted to combat the impacts associated with increased automobile usage is through the promotion of bicycling. In Europe, CO<sub>2</sub> emissions associated with riding a bike amount to about 21 grams per passenger per kilometer as opposed to cars which release 229 grams of CO<sub>2</sub> per passenger per kilometer (ECF, 2016). Not only does biking reduce air pollution, fewer people driving and increased use of cycling as a means of transportation also leads to less traffic congestion, fewer traffic accidents, lower demand for fuel, as well as health benefits to cyclists (Global Status Report, 2015, p. 8).

Cities have promoted bicycle usage through the creation of bike sharing programs. The implementation of bike sharing programs makes biking accessible to people that would normally take fossil fuel based forms of transportation (Bryce, 2016). Also, it has been shown that the more people biking in cities leads to better biking and walking infrastructure (Bryce, 2016). Furthermore, biking releases zero greenhouse gases and allows people to stay active on a consistent basis (Bryce, 2016). Successful bike sharing programs rely on features such as bike-friendly infrastructure, convenient docking station locations, and accessibility to safe routes that allow people to ride where they want and need to go (Small, 2017). Systems are more likely to fail when these factors are not addressed (Small, 2017).

Cuenca, Ecuador has experienced both rapid population growth and an increased reliance on automobiles over the past few decades. From 2011 to 2018, the population has increased from roughly 530,000 to above 600,000, an average increase of about 2% per year. If this trend continues, the city's population would exceed 1 million by the year 2050 ("The Population Development", 2017). Between 1992 and 2012 the percentage of car and taxi use as the primary form of transport has increased by 23% (Sander et al., 2015).

To address this growth in traffic and the environmental and health consequences, in Cuenca, Ecuador, the department of transportation *La Empresa Pública Municipal de Movilidad, Tránsito y Transporte* (EMOV EP) has coordinated the launch of a city-wide bike share system. With 240 bikes distributed between 20 stations around the city, EMOV EP is interested in finding ways that the bike share system will facilitate more widespread bike use among Cuenca residents, commuters, and tourists. EMOV EP would like to determine whether people are interested in the system, who will use this bike share system, what reasons will they use the system for, and what could change the public's outlook on cycling. Using this information, we established criteria for the purpose of selecting routes people would prefer to ride on.

The goal of our project was to create interconnected routes between existing bike-sharing stations that EMOV EP can use to promote biking, be it for transportation, recreation, or tourism. To achieve this goal, we first investigated how people in Cuenca would use the bike-sharing system, factors that influence their perceptions of safety, and places they are interested in riding. Secondly, we identified potential strategies to address the preferences and concerns towards biking in Cuenca. Lastly, we created 3 bike route maps for the purposes of efficient transportation, recreation, and tourism to accommodate potential user preferences.

## 2 Background

A bicycle sharing system is a public system in which there are bicycles available for use throughout a city for residents and tourists alike. People can use these bikes for short periods of time, often paying a usage fee on a monthly, daily, hourly, or “by-the-minute” basis (Tang, 2017). In most cases, these bikes are stored at a self-locking bike rack, or “docking station”, and are checked in or out through a phone application. Most successful bike share systems have several docking stations located throughout its host city (Tang, 2017).

Some bike share systems are owned and operated by private companies, but most are owned by public companies and are operated by private companies. For instance, Capital Bikeshare, in Washington, D.C., is publicly funded and publicly owned, but privately operated by Motivate, a firm that also operates Divvy in Chicago and Citibike in New York City (Klein, 2015). On the other hand, Citibike is a privately operated public-private partnership funded through sponsorships from Citibank and Mastercard (Baca, 2018).

Bike share programs are becoming increasingly prevalent in different cities around the world. These systems are mostly being implemented in cities such as New York City, London, and Barcelona, and typically consist of around 5,000 bikes with 250 docking stations (Yanocha, 2018). Bike share systems are being implemented in cities in developing countries as well. These include cities such as Quito, Nairobi, and New Delhi, with systems usually consisting of close to 500 bikes with around 25 stations (Yanocha, 2018).

The purpose of this chapter is to familiarize readers with some factors that influence the success of bike-sharing programs, the current state of transportation in Cuenca, and work that is being done to promote bicycling in the city.

### 2.1 Factors that Impact the Success of Bike Share Programs

There are many factors that can have significant effects on the overall success of a bike share program, including city characteristics, station locations, public transit, and route accessibility. Additionally, a primary deterrent to bicycle use is that people often perceive the activity as dangerous or unsafe (Pucher & Buehler, 2008). There are a few key characteristics that influence bicycle safety, including “bike-friendly infrastructure”, road conditions, traffic signals, and overall respect from drivers. For a city to have a successful bike share program, it must address some of these safety concerns.

#### City Characteristics

Successful bike share systems, such as those in London, New York City, Barcelona, and Montreal share similar characteristics (Ice Bike, 2016). One factor is related to the city’s environment, in terms of its terrain, climate, and cycling infrastructure. Hilly terrains can cause an uneven distribution of bikes. This is because the average user prefers to ride bikes downhill or on flat land rather than uphill (Mateo-Babiano, 2018). The climate of a city has a large part in determining the success of a bike share system. Case studies have shown that warm and dry weather encourages public bike sharing use, while humidity, rain, and strong wind reduce the usage of a bike share system (Mateo-Babiano, 2018). The cycling infrastructure of a city also plays a part in the usage of a bike share system. Easy access to bike lanes from the docking stations, as well as a complete network of bike lanes that connect popular destinations within the city have been shown to increase general bike use (Mateo-Babiano, 2018).

Another factor is related to population density. High population density can be a disincentive to own a car because of limited parking spaces and crowded streets, causing city residents to seek other modes of transportation, whether it be the bus, taxis, walking, or biking (Newton, 2010). London, New York City, Barcelona, and Montreal are densely populated, averaging close to 24,000 people per square mile (Wachs, 2010.).

Tourism plays a major role in a successful bike share system. London, New York City, Barcelona, and Montreal are widely-known tourist destinations. These four cities had almost 100 million tourists combined from November 2017 to November 2018 (O’Hare, 2019). Tourism can impact the usage of a bike share system because tourists want to explore the city that they are visiting. According to a 2013 study by USA Today, an

increasing amount of tourists would rather walk or ride bikes to see sights and places within a city rather than using other forms of public transportation or renting a car (McGee, 2013).

### **Bike Stations and Intermodality**

Intermodality can prove to be profitable for cities (Aslam, 2015). According to Merriam-Webster, intermodal is defined as: being or involving transportation by more than one form of carrier during a single journey. These “carriers” being bikes, cars, trucks, trains, or any other means of transportation (“Bikeways and Intermodality...”, 2013). To promote intermodal transport, cities have come up with some incentives to use bike sharing programs. An example is the implementation of a seamless fare collection for bike-share and bus usage (Aslam, 2015). Also, an interconnected network of bike-only paths and on-road bike lanes throughout a city increases the safety of bicyclists, while also decreasing their trip times and distances (“Bikeways and Intermodality...”, 2013).

To make the bike systems more clear and convenient for users, phone applications are often used. User-friendly maps and interfaces provide an easier means of connecting walking, biking, and public transportation (“Bikeways and Intermodality”, 2013). With a phone application, users can look at a map and see relative locations of bike stations, bus stations, train stations, airports or any other modes of public transport (Aslam, 2015). Cities that emphasize intermodality make sure that all forms of convenient transportation are connected in a logical way to increase comfort and ease of travel (“Bikeways and Intermodality”, 2013). This would also alleviate the process of having to walk the “last mile” to reach the destination (Griffin & Sener, 2016). The “last mile” is the idea that a form of public transportation drops someone off at a location where they still need to walk a substantial distance to reach the desired location (“Bikeways and Intermodality”, 2013).

### **Docking Station Locations**

In cities with large numbers of bicycle commuters, sufficient bike parking is a key influential factor in increased bike commuting (Buehler, 2012). Offering bicyclists safe, secure places to store their bikes near important areas such as universities, office buildings, city centers, and other high use facilities promotes bicycle transportation (Buehler, 2012). Bike sharing systems have attempted to address this need for sufficient parking by creating systems in which people can pay to use public bikes and docking stations in cities (Bike Sharing, 2013). This allows people to take bikes from large fleets that are parked at various stations and ride between them without worrying about parking or theft of their own personal bikes (Bike Sharing, 2013).

Relative locations of docking stations have a strong influence on the use of bike sharing systems (Goodyear, 2015). This means that choosing a good distribution of stations throughout cities is important. For example, systems that tend to overlook lower income neighborhoods are restricting the demographic of users and therefore limiting the overall use (Goodyear, 2015). The National Association of City Transportation Officials (NATCO) determined that the proper distribution of approximately 28 stations per square mile is the benchmark for easy accessibility (“Walkable station...”, 2015). An example of two cities where locations of docking stations were the main barriers and incentives to use bike sharing systems were Melbourne and Brisbane, Australia. 815 members of the systems as well as 60 non-members in the communities were surveyed to determine the motivations people chose to utilize or not utilize the systems (Fishman, Washington, Haworth, & Mazzei, 2014). Convenience and docking station locations were the main motivations for both groups (Fishman, Washington, Haworth, & Mazzei, 2014).

A study in Montreal showed that bike stations in the downtown areas are used at much higher rates and the availability of bikes at these stations can vary depending on time of day (Reynaud & Eluru, 2018). In the morning on weekdays, the availability of bikes at these stations are high because people are more inclined to take a bike into the downtown areas for work. This is the opposite for the evening because people take the bikes out of the downtown area to the outskirts of the city after work (Reynaud & Eluru, 2018). This study concluded that analysis of station activity is necessary to determine proper distributions of bikes at each station to maintain bike availability (Reynaud & Eluru, 2018).

A strategy used by the New York City and Boston bike share systems to incentivize more people to use their systems is to incorporate a feature in the bike sharing application that allows users and non-users to suggest

new locations of docking stations (BlueBike, 2018; CitiBike, 2018). This attempts to address the problem of insufficient docking station locations through personal feedback and recommendations (Goodyear, 2015).

### **Availability of Bike-Friendly Routes**

Choice of routes is something bike users must consider. The shortest routes in terms of travel time may not be the “safest routes” (Lu, Scott, & Dalumpines, 2018). A study in Hamilton, Ontario analyzed route choices and it showed that only 7% of bike share members chose the shortest routes based on distance (Lu, Scott, & Dalumpines, 2018). In addition, the study found that bike users tend to take minor roads with less traffic even though it may entail a longer distance (Lu, Scott, & Dalumpines, 2018). Minor roads are often the preference for bike users over major roads, but the slope of the route is also a key component in cyclist route choices. Cyclists in general do not like climbing hills greater than a 4% grade (Government of Canada, 2010), and a hill of over 5% grade is considered a “steep hill” (Winters, Brauer, Setton, & Teschke, 2010). In the Hamilton study, 92% of the most popular bike routes had grades of less than 6%, and 65% of routes had grades of 2% or less (Lu, Scott, & Dalumpines, 2018).

### **Cyclist Related Accidents**

In the United Kingdom, 71% of all reported bicycle injuries or deaths are attributed to driver/rider error, with “failure to look” by a car driver being responsible for 57% of all serious accidents (RoSPA, 2017). In Britain, safety hazards such as potholes and lack of protected bike lanes are stalling the growth of cycling and can result in bicycling injuries and traffic crashes. As of 2015, pedestrian and cyclist deaths average almost 50% of the total number of road traffic deaths worldwide (Global Status Report, 2015, p. 8). Some of the most frequently reported collisions occur when a motorist emerges or crosses in to the path of a cyclist when making a turn or a lane change. Another common bicycle accident is a result of the driver of a car opening their door into the path of a cyclist headed down the road. Additionally, auto drivers maneuvering recklessly due to being in a hurry are often common causes of bicycle accidents, accounting for roughly 17% of driver-cyclist incidents (RoSPA, 2017).

### **Bike-Friendly Infrastructure**

One of the most significant issues that cyclists face in urban areas is the danger associated with riding on the same roads as cars. One of the main defining characteristics of a city with high levels of bicycle transportation is bike lanes that aim to separate bicyclists from cars on the road (Pucher & Buehler, 2008). For example, countries such as the Netherlands and Denmark have found that bike-only paths and on-road bike lanes can significantly increase the safety of cyclists (“Bikeways and Intermodality...”, 2013). In Cuenca, city planners have incorporated two different types of bike lanes in some parts of the city; protected bike lanes that utilize physical dividers on the road to prevent cars from crossing in to the bike lane, and buffered bike lanes which use a painted buffer zones on the street to separate cars from cyclists. An example of protected bike lanes found in Cuenca can be seen in Figure 1.



Figure 1: Protected Bike Lane (Murphy, 2019)

## **Priority Traffic Signals**

Countries such as the Netherlands, Germany, and Denmark that have high numbers of bicyclists, have also found that intersection modifications and priority traffic signals make trips safer and more convenient for bicyclists in urban settings. In these countries, bike-only lanes often feed in to designated advanced waiting positions for cyclists at intersections, putting them safely away from the waiting cars. In addition, these countries often employ advanced traffic signals that give cyclists the green light before allowing cars to head in the same direction, as well as priority and early turn signals to keep cyclists moving (Pucher & Buehler, 2008).

## **Road Characteristics**

Characteristics of roads also play a large role in the safety of bicyclists. One characteristic that is very significant is the quality of the road surface. A study in Sweden found that defects and damage in the physical road surface contributed to almost half of all reported bicycle accidents (Nyberg, Björnstig, & Bygren, 1996). Defects in the road can include cracks, potholes, and unlevel curbs. Additionally, the steepness and construction material of a given road also affect safety. For example, steep downhill roads can cause bicyclists to lose control of their bikes. Similarly, roads that are constructed from cobblestones can also cause cyclists to lose control, as the cobbles can be jarring enough to disengage the cyclists' hands from their handlebars.

## **Respect from Drivers**

In a study done in Rio de Janeiro analyzing what it would take to convert users of public transport systems to bicycle commuters, over one third of all respondents surveyed expressed "lack of respect from drivers" as the main reason they would not bicycle (Reis RS, Hino AAF..., 2013). This is a sentiment that is shared by cyclists all across the world. Generally, cyclists believe that drivers do not respect them out on the road, usually by not giving them enough space, or by not respecting priority lane markings or traffic signals.

## **Safety in Numbers**

A concern for personal safety that keeps potential citizens from riding bikes is understandable, as countries with higher rates of cycling related injuries and deaths often have lower rates of bike use as a whole. The United States, for example, has a non-fatal cycling injury rate that is 30 times that of the Netherlands, while only 1% of all trips in the U.S are taken by bike, versus the 27% share of trips seen in the Netherlands. Additionally, research has found a phenomenon of "Safety in Numbers", in which cities or countries see an inverse relationship between the rates of cycling related injuries or fatalities and the rates of overall bike usage; as the overall cycling levels in any given city or country rise, the associated rates of injuries and fatalities fall (Jacobsen, 2003). This overall reduction in injuries associated with increased bike use seems counterintuitive at first, however researchers believe that when there are more bicyclists on the road, automobile drivers have to be more cognizant and aware of their surroundings (Jacobsen, 2003).

## 2.2 Modes of Transportation in Cuenca

As shown in Figure 2 below, cars are the main type of transportation used by the people in Cuenca, and shape most of the driving culture and environment on the roads. According to EMOV EP, there is an average of 2 to 3 cars per family living in Cuenca (Maria V. Hormazabal Andrade, EMOV EP, 01/2019).

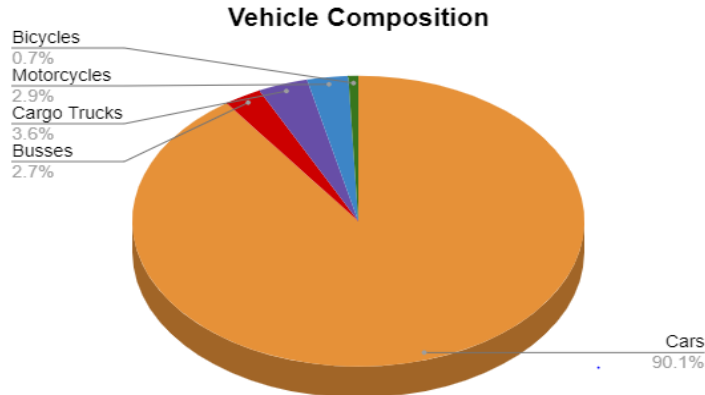


Figure 2: Cuenca Vehicle Composition (EMOV)

Cuenca currently has two types of public transportation: taxis and buses. Taxis are a quick and efficient way for intra-city travel. They are relatively inexpensive, ranging from \$2 to \$5 depending on the distance, and they can almost always be found on main roads throughout the day (CHL, 2017). Buses are the cheapest form of transit running from the middle to the outskirts of the city, with prices ranging from 25 to 30 cents per ride, while children, students, and people over the age of 65 only pay 12 cents (CHL, 2017).

In addition to buses and taxis, the city of Cuenca is developing two other means of public transportation: trams and bicycles. A tram system is already in place with its infrastructure set and built since October 2018 and is expected to be open for public use by March 2019 (CHL, 2018). Figure 3 and Figure 4 show picture a Tram and a map of the Tranvia routes, respectively.



Figure 3: Picture of Tram

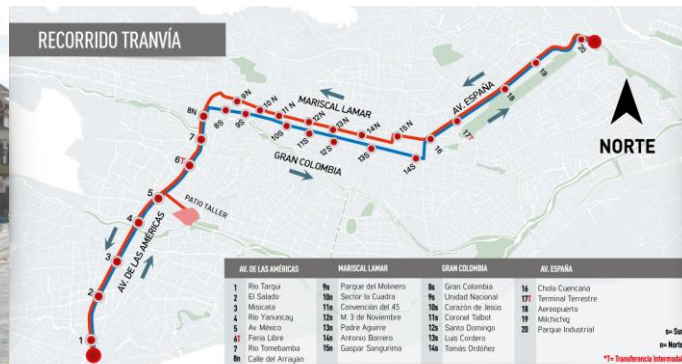


Figure 4: Map of Tranvia in Cuenca, Ecuador. “Mapas de Rutas y Paradas”, Retrieved from: Cuenca

In March 2019, there will be a city-wide bike sharing program that will allow people to use public bikes as an additional means of transportation in the city. Biking in Cuenca is not common and considered dangerous by most people due to driver inability to safely share the road (Discover Cuenca Ecuador, 2013). According to a 2017 study by Lacta Labs reported by Cuenca High Life, between 2 and 2.5% of the 600,000 population in Cuenca use bikes regularly, mostly for trips under 4 km, though another 7% would like to use a bike but choose not to because they feel unsafe (CHL, 2018). As of right now, there are some existing bike lanes on some of the main streets South of Río Tomebamba in Cuenca, however these bike lanes are disconnected.

With the city of Cuenca initiating the tram and bike systems, there is an opportunity to integrate these into the current forms of public transportation in buses and taxis. Bike stations located near bus stops is an example of linking these modes of transport. Creating an integrated transportation system in Cuenca may prove to be profitable, while increasing the convenience of travel for people (“Bikeways and Intermodality”, 2013).

### Bike Sharing Program Details

The bike system EMOV EP will be launching is called Bici Publica, and will offer 240 bicycles available to take from 20 stations distributed around the city (Bici Publica..., 2018). The station locations were determined by a study done by a company working with EMOV EP which analyzed many different possible locations throughout the city to place these bike stations (EMOV EP). 11 of the 20 stations were placed in “El Centro”, the Historic Center of Cuenca north of the Rio Tomebamba, while the other 9 stations were placed south of the Rio Tomebamba. Figure 5 below shows the final station locations decided on by EMOV EP.

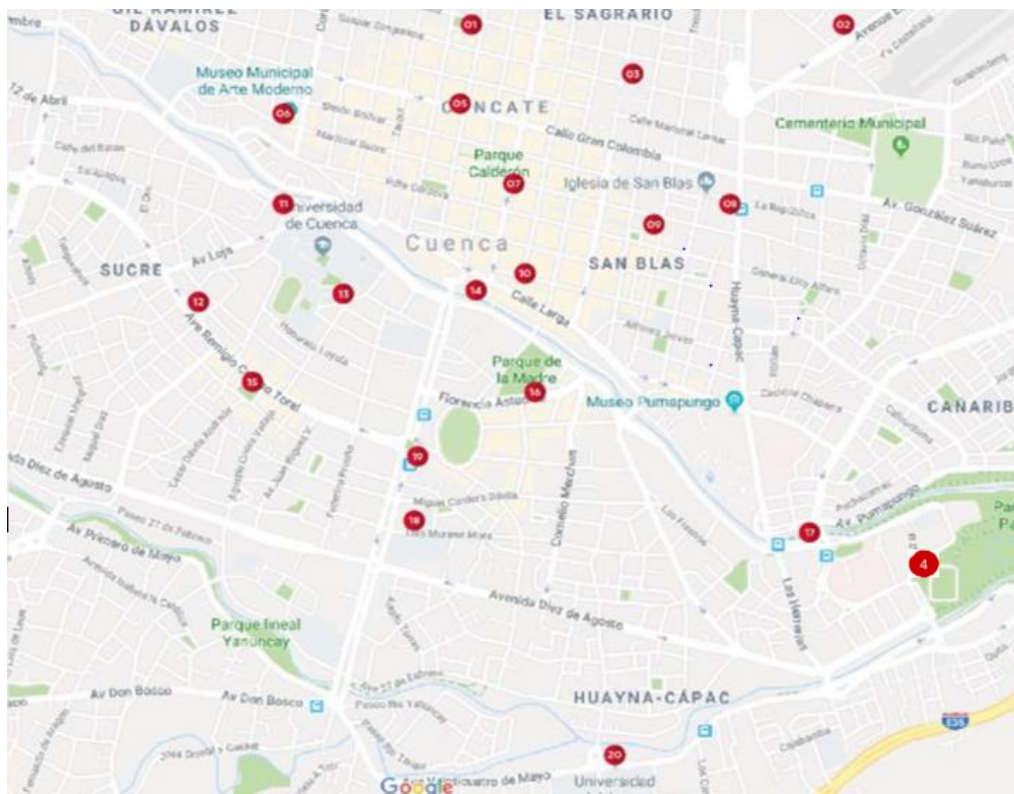


Figure 5: Map of Bike Share Stations in Cuenca, Ecuador. Retrieved from: EMOV EP

The logistics of the program are being handled by a private software company, P3GM, that has created an application that allows users to sign up for the bike sharing program, view the number of available bicycles at the stations, and pay for their trips. Through the application, P3GM will also be able to help EMOV EP track when people use bikes and where they go. Bike-share members, with exception to those with the day pass, will have a 30-minute time limit for each trip between stations. If a member uses it for longer than the time limit, they are charged with a fine. Appendix J shows a table with all the bike-share user costs and fees. Additionally, if there is a shortage of bikes at any station, it is planned that EMOV EP will have employees in place to monitor all of the stations and ensure an even distribution of available bicycles, as well as protection from damage or theft (EMOV EP).



## 2.3 Chapter Summary

There are several factors that contribute to successful bike sharing systems. Some of these factors include cycling infrastructure, tourism, availability of bike friendly routes, proper distribution of docking stations, and respect from drivers. This raised some questions about the feasibility and the overall potential of the new bike sharing program in Cuenca. Possible questions to consider for implementation of the system include:

- What are the current attitudes towards cycling as a form of transportation?
- Where do people want and need to go?
- What are the purposes that people would use the system?
- What can be done in Cuenca to encourage more bike use in general?

EMOV EP was seeking answers to questions such as these to help them promote the upcoming launch and overall success of Bici Pública. We set out to find the answers to these questions, and to determine how we could use this information to help us identify criteria for selecting safe bike routes throughout the city.

### 3 Methodology

The goal of our project was to create interconnected routes between existing bike-sharing stations that EMOV EP can use to promote biking, be it for transportation, recreation, or tourism. To achieve this goal, we:

1. Investigated how people in Cuenca might use the bike-sharing system, factors that influence their perceptions of safety, and places they are interested in riding
2. Identified strategies to address potential barriers to the use of the bike sharing system
3. Designed bike routes to accommodate potential user preferences

#### 3.1 Investigating how people in Cuenca would use the bike-sharing system, factors that influence their perceptions of safety, and places they are interested in riding.

We designed a survey to understand how potential bike share users might use the program, locations of interest, the routes they would choose, and more detailed information about what factors influence the perceptions of safety on a bike route. To understand the possible uses of the bike program and how people would interpret our questions, we conducted an initial survey at the University of Cuenca and surveyed 20 students. The initial survey can be found in Appendix A.

After the initial survey, we surveyed 102 participants at various locations around the city. We emphasized the collection of data from college students because they consume a large portion of the cycling population in Cuenca, so 40 of the 102 participants were students. To gather data from a wide variety of people around the city, the other locations we administered these surveys were Parque de la Madre, Calle Larga, Parque Yanuncay, Millenium Plaza, and Parque el Paraiso. Figure 6 is an image of Mitch conducting surveys at the University of Cuenca.



Figure 6: Mitch conducting surveys at the University

At the beginning of the surveys, we talked to the individuals about the details of EMOV's upcoming bike share program, informing them of the way the system will work and how much it will cost, as well as the locations of the bike share stations around the city. The survey covered the following topics:

1. Concerns about cycling in Cuenca
2. Reasons to use the system
3. Which specific bike share stations people would use
4. What destinations people would be interested in biking to
5. What factors influence individuals' perception of safety

The survey can be found in Appendix B.

### 3.2 Identifying strategies to address the preferences and concerns toward biking in Cuenca

To further investigate the issues identified in our surveys, we conducted interviews with 6 bike shop owners. The bike shops we interviewed were Monster Bike, Cikla, Podium, Cube, Base Extreme, and La Bici Tienda. The issues we aimed to highlight in these interviews included dangerous areas to ride bikes in Cuenca, how to navigate on a bike in el Centro, the main barriers to cycling in the city, and how cycling can be encouraged.

Dangerous areas to ride may be considered dangerous for various reasons. This is something we wanted to gain clarification on through speaking with the bike shop owners. We asked why some areas may be perceived to be dangerous, and where some of these areas are physically located in the city.

A goal of EMOV in the implementation of this bike share program is to promote cycling in el Centro. This led us to seek information on the current state of cycling in this area of Cuenca. We asked the bike shop owners about how cyclists should navigate and potential ways biking can be promoted in el Centro. The last portion of our interviews aimed to gain some insight on some barriers to using cycling as a form of transportation. Understanding some of the reasons why cycling is not popular in Cuenca may help identify some ways to address these barriers. We asked the bike shop owners if they had ideas to encourage bike use in the city to address the current barriers. See Appendix D for the interview questions and responses.

### 3.3 Designing safe bike routes for the purposes identified

Based on potential uses of the system, perceptions of safety, points of interest, and strategies to address potential barriers to biking in Cuenca, we designed multiple route maps that connect different stations and points of interest. Before designing routes, we established a criteria to determine the best trade-offs that each possible route entails. For example, roads with dedicated bike lanes had priority over roads without bike lanes because they are proven to be safer. On the other hand, roads without bike lanes that have dedicated bus lanes were avoided. Table 1 shows different qualities of routes, and the desirability we associated with each quality as it pertains to a preferred bike route. This is the criteria we used to weigh different options of potential bike routes.

<u>Qualities</u>	<u>Desirability</u>
Bike Lanes	Highest
Sufficient Space to Share the Road	Highest
Cyclist rides with traffic	High
Locations people are interested in riding	High
Shortest Distance	Medium
Roads with Bus Routes	Low
Steep Roads	Low
Roads with Dedicated Bus Lanes	Low
Roads along the tranvia	Low
High Crime Areas	Low
High traffic volumes	Low

Table 1: Criteria for Selecting Routes

The process for designing routes started with using Google Maps to outline route possibilities. Then, we physically tested these route possibilities ourselves to determine if other routes have more desirable qualities based on our criteria. The routes with the more desirable qualities were used in the final versions of our route maps.

Using Google Maps, we created 3 route maps for purposes which include:

- 1) Efficient transportation
- 2) Recreational routes
- 3) Self-guided bike tour

We used the same set of criteria to select the routes on all 3 of these maps to ensure that each map contained the safest possible routes.

- **Transportation Map**

The transportation map was created for people who would like to easily and quickly navigate between bike stations. Routes that have short trip times is important because every membership offered by this program, with exception to the day pass, has a 30-minute time limit for each trip. This map outlines ways to travel between stations quickly and safely.

- **Recreational Map**

This map was created for bike users who would like to bike recreationally. This map consists of safe, scenic routes that tourists and Cuencan citizens can take, leading to major points of interest between bike stations.

- **Self-Guided Bike Tour**

Using data gathered on places people would be interested in biking to, we created a self-guided bike tour that routes a safe path to specific points of interest that tourists might want to visit. Instead of specifically routing from individual stations to points of interest, this map consists of a long loop connecting a few main points of interest around the city. These points of interest include cathedrals, parks, and museums.

## 4 Findings

To create the route maps that we proposed, we learned about main concerns towards biking, purposes to use the system, popular locations to ride, dangerous areas, and possible route choices from our sample of 122 people. Learning about these concepts led us to 8 findings which helped us make informed decisions on which routes would be best for the maps we created.

- Finding #1: The primary concerns that people have regarding bicycling in Cuenca are general safety, disrespect from drivers, and high amounts of traffic.
- Finding #2: The main reasons that people in Cuenca would use the bike system are because “It's good for the environment”, “It is efficient and convenient”, “To reduce traffic”, and “for fun”.
- Finding #3: The main factors that influence the perception of safety when riding a bike in Cuenca are dangerous neighborhoods, lack of bike lanes, and high amounts of traffic.
- Finding #4: The proposed stations at Parque de la Madre, the University of Cuenca, and Parque Calderon are the most popular.
- Finding #5: 9 out of the 20 proposed bike stations are located in areas perceived as dangerous.
- Finding #6: Bike shop owners believe poor attitudes and a lack of respect from drivers towards bicyclists in Cuenca are the main barriers to bike use.
- Finding #7: Roads in the historic center have no bike lanes or paths, so it is not clear which routes would be preferred by potential bike share users.
- Finding #8: After testing a prototype of our transportation map, we determined that some of the routes we selected had better alternatives based on our criteria.

**Finding #1: The primary concerns that people have regarding bicycling in Cuenca are general safety, disrespect from drivers, and high amounts of traffic.**

In order for us to create routes that would appeal to the type of people we surveyed, it was important for us to understand the most common safety concerns related to riding a bike in the city. The following question was present in all versions of surveys we gave, including the initial survey we gave to students at the University of Cuenca:

3) ¿Qué te preocupa más al andar en bicicleta en Cuenca?  
(What worries you the most when riding a bicycle in Cuenca?)

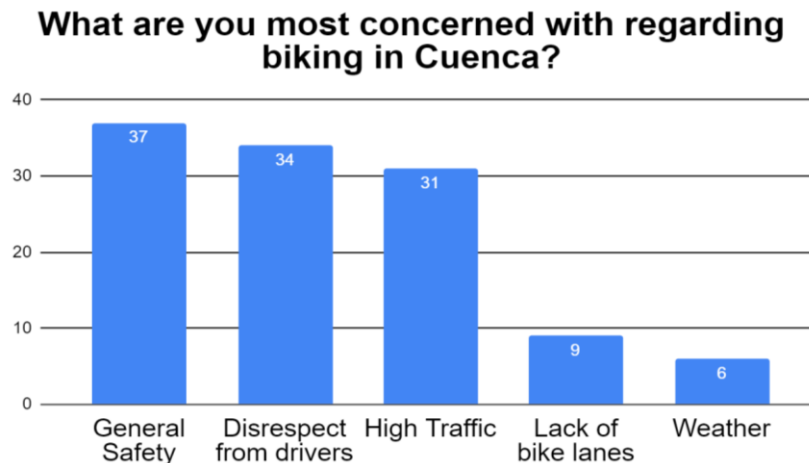


Figure 7: Main Worries Regarding Biking in Cuenca (n=122)

According to Figure 7, it is clear that the people we surveyed had three concerns that were more prevalent: general safety, disrespect from drivers, and high traffic

This information was very helpful to us in the creation of our maps, because it helped us understand some of the reasons people would be hesitant to ride a bike in Cuenca, and reinforced some of the ideas we gained from our background research. By creating maps that aimed to avoid situations that would cause users to feel these concerns, we hoped to encourage more people to actively utilize bikes to move around the city.

**Finding #2: The main reasons that people in Cuenca would use the bike system is because “It's good for the environment”, “It is efficient and convenient”, “To reduce traffic”, and “for fun”.**

Initially, we had thought about sorting our response data by the different types of cyclists that use bike share systems; commuters, workers, recreational riders, and tourists. In our initial survey that we gave to students at the University of Cuenca, we had a question that we believed would help us identify the different types of would-be riders we were surveying. The question was “Do you ride bicycles? If yes, why?”. When analyzing the responses from that initial survey, we realized that the people we were surveying didn't exactly respond how we expected them to. Instead of giving answers that we hoped would identify them based on the type of bike user they were, respondents understood the question to be asking why specifically they would ride bikes, and gave answers like “because it is good for the environment” and “to reduce traffic in the city”. Thus we could group the survey responders from this initial survey into four different groups based on the type of responses we got to this question. The four groups that we identified can be seen below. It is worth noting that users were able to put multiple reasons for their use of the program, in which case we counted them once for each reason they put.

Groups based on their reason for bike use:

- 1) Bueno para el medioambiente (Good for the environment)
- 2) Muy eficiente y conveniente (It is efficient and convenient)
- 3) Reducir el tráfico en la ciudad (To reduce traffic in the city)
- 4) Divertido (For fun)

Moving forward, we chose to analyze all of our data by sorting survey responders into one of these groups.

**Finding #3: The main factors that influence the perception of safety when riding a bike in Cuenca are dangerous neighborhoods, lack of bike lanes, and traffic.**

In order to create the route maps to address safety concerns, we conducted 122 surveys throughout the city, as well as 6 interviews of bike shop owners to find out how people perceive bike safety in Cuenca. Determining the different perceptions of safety told us what people thought to be the most dangerous factors when riding a bike on the road, as well as what elements people considered safe for riding bikes. The fourth question on our survey (Appendix B) lists nine things that commonly affect bike riding based on our initial survey, then asks the subject to choose three out of those nine that they think are the main factors they are most worried about when biking in Cuenca. The responses to this question shown in Figure 8 below shows that the main concerns were dangerous neighborhoods, lack of bike lanes, and lots of traffic.

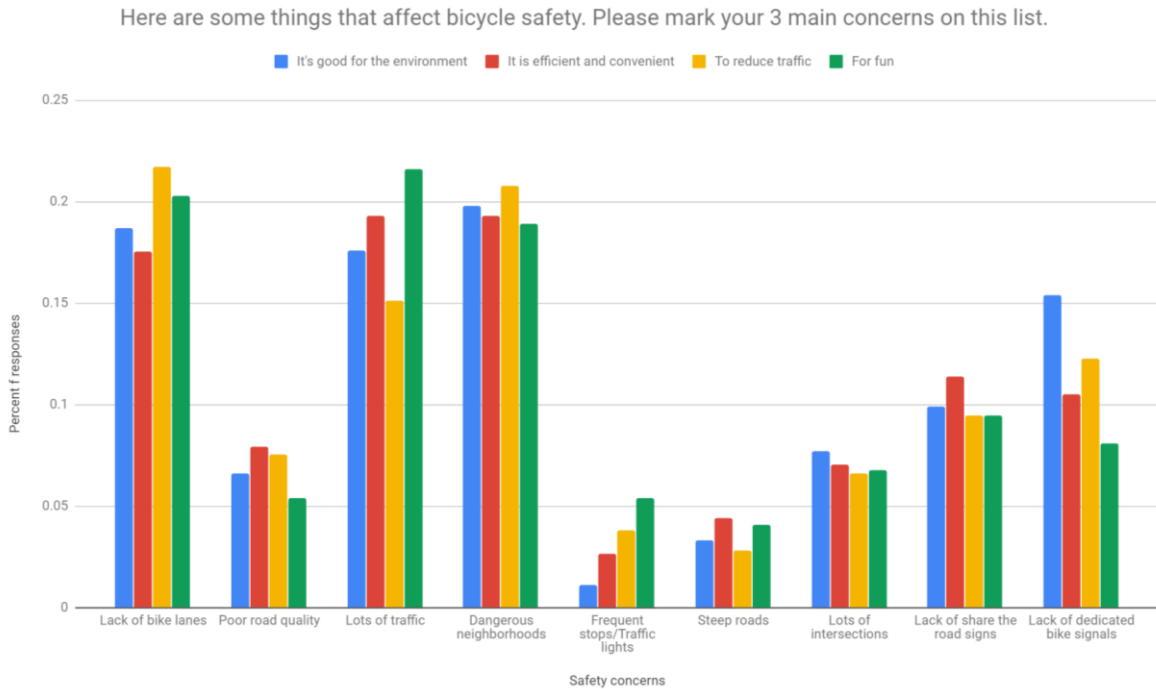


Figure 8: Factors that Affect Perceptions of Safety

**Finding #4: Of the current station locations, the stations at Parque de la Madre, the University of Cuenca, and Parque Calderon are the most popular**

In total, we asked 122 people, in both the preliminary survey of 20 university students and 102 from the main survey period, about what stations would be most useful to them. In result, the stations at Parque de la Madre, Parque Calderon, and the University of Cuenca were of high interest. Figure 9 shows the level of interest of each station based on the number of votes each station received. The station at Parque de la Madre (16) was the most popular response with 73 votes. The two stations at the University of Cuenca, 11 and 13, received 49 votes and 25 votes respectively, combining for 74 votes. The third most popular station location was Parque Calderon with 48 votes.

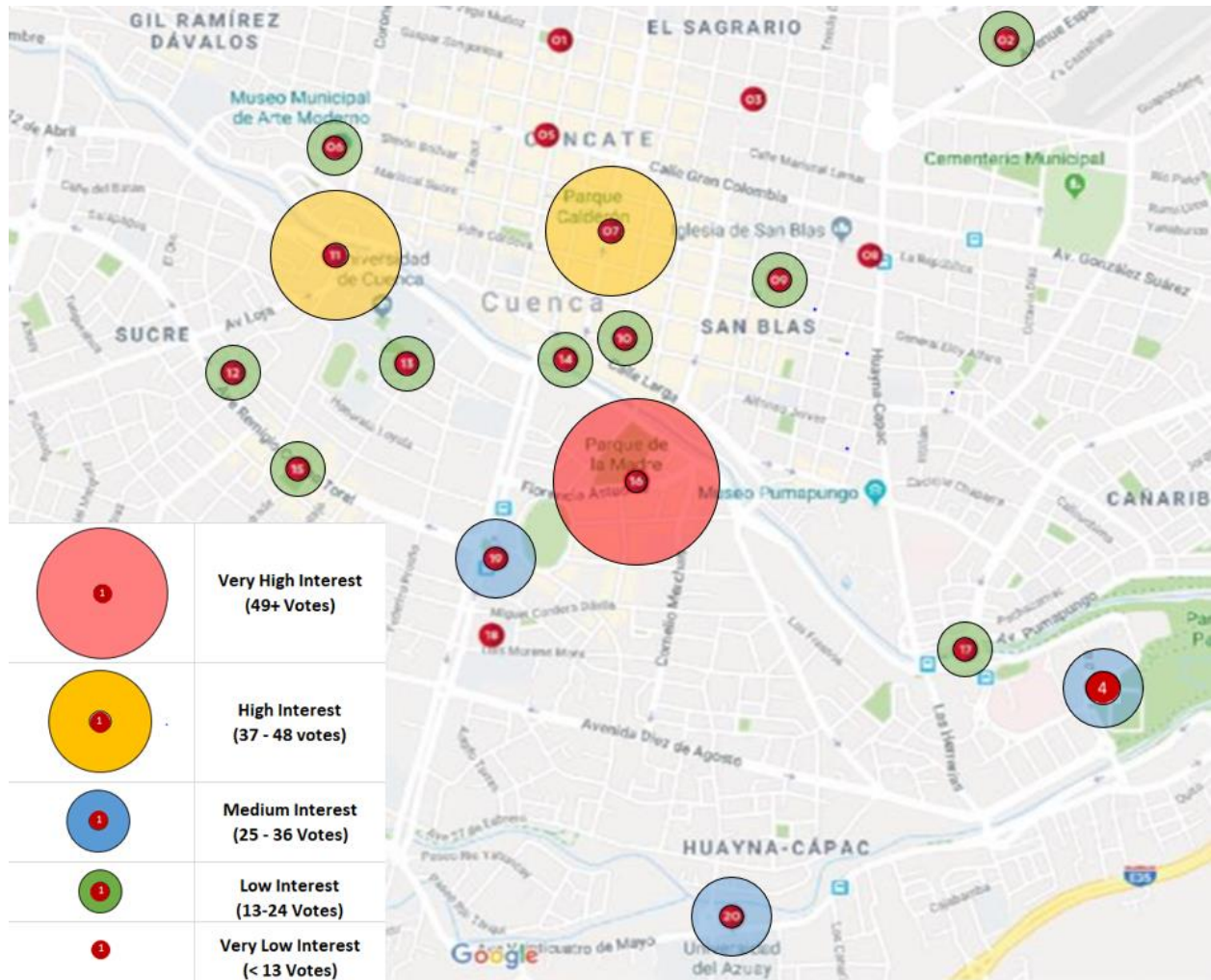


Figure 9: Most Useful Stations

We grouped the stations into categories based on the level of interest shown in the different station locations. The stations that were marked on at least 25 of the surveys were stations 4 (Parque El Paraiso), 7 (Parque Calderon), 11 (Universidad de Cuenca - Plazoleta El Farol), 16 (Parque de La Madre), 19 (Av. Solano - Estadio), and 20 (Universidad del Azuay). This information suggests that the system’s use may largely come from university students and people going to the local parks. Also, this analysis shows that proposed routes, should connect the points of high and medium interest because these will be the most used routes.

In addition to asking what existing stations users would use, we asked if they had recommendations for additional or alternative station locations. For reference, see question #8 in Appendix B. Figure 10 below shows a map of all of the recommended station locations indicated by potential bike share users responding to surveys. This information may be helpful to EMOV during the expansion of this program. According to these responses,



people would like future stations close to Cementerio Municipal, Parque Lineal Yanuncay, and Museo Pumapungo.

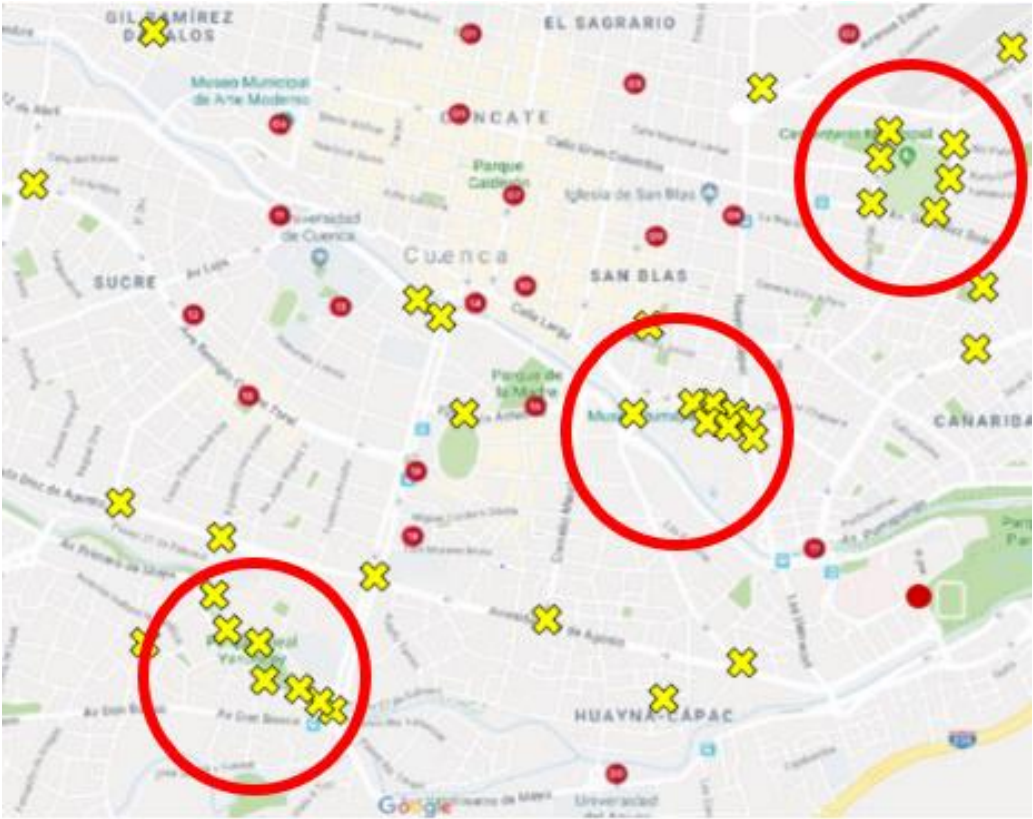


Figure 10: Suggested Station Locations

**Finding #5: 9 out of the 20 proposed bike stations are located in areas perceived as dangerous.**

Dangerous neighborhoods were a main concern of the people we surveyed, so we wanted to understand what people meant by this. It is possible that there are many reasons that people would believe a neighborhood is dangerous. From interviews with bike shop owners, we found that dangerous neighborhoods may be high crime areas, high traffic areas, or a mixture of both. We wanted to further investigate this idea by identifying some specific locations of dangerous areas. Most of the bike shop owners were quick to identify high crime areas, but did not have many ideas about the areas where most cyclist-related accidents happen. The circles on Figure 11 indicate the responses of areas with high likelihood of crime as perceived by the bike shop owners. Many of the areas contain bike stations, so in some instances, it is unavoidable to contradict our criteria by designing routes that pass through these areas.

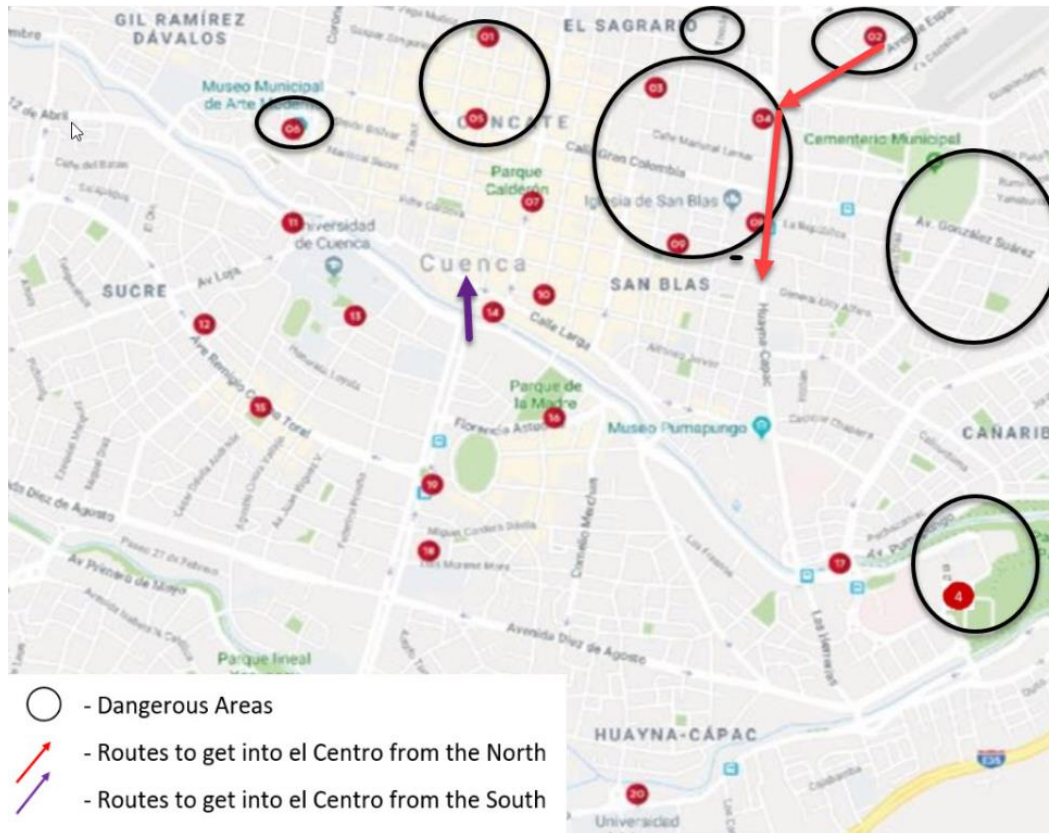


Figure 11: High Crime areas and Recommended Routes to get into el Centro

With regards to cyclist-related accidents, we reached out to EMOV and they provided us with data on cyclist-related accidents in Cuenca from 2016-2017. The points indicated on Figure 12 are the points where these accidents took place. By looking at the map, 8 of the 19 accidents in this time span happened around the airport, which is near Station 2, and is circled in orange. This indicates that it may be especially important for cyclists to be careful in this area. It is also an indication that this is an area people may not want to ride bikes, so we needed to find a fast, safe way to leave this area that leads into the rest of the city.

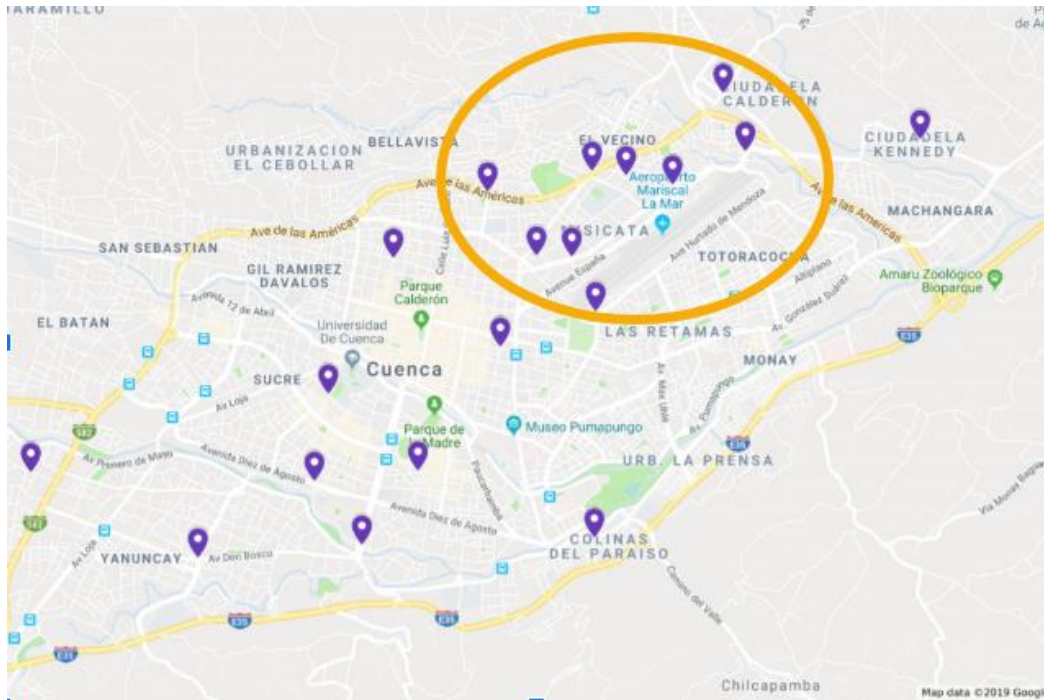


Figure 12: Cyclist Related Accidents

**Finding #6: Bike shop owners believe poor attitudes and a lack of respect from drivers towards bicyclists in Cuenca are the main barriers to bike use.**

According to bike shop owners, poor attitudes and lack of respect from drivers towards biking in Cuenca leads to a lack of cyclists. The bike shop owners generally say two main factors contribute to poor attitudes and lack of respect: Lots of traffic and lack of bike lanes. We asked if they had ideas on strategies that could improve the attitudes and respect towards cycling in Cuenca. Our interview subject at Cikla believed that one strategy is to build more bike lanes. He explained his logic:

“With no bike lanes, there are no bikers. If there are no bikers, the culture doesn’t change”

The bike shop owner at Monster Bikes also indicated that more bike lanes would incentivize more people to ride bikes in the city. As seen in the literature review, more bike infrastructure often leads to more people riding bikes. This also relates back to the “safety in numbers” idea that more people riding bikes in cities correlates with higher bike safety.

Bike shop owners believe lots of traffic and lack of bike lanes are even bigger issues in el Centro. Every interview subject said that riding a bike in el Centro is not recommended because of high traffic, narrow roads, and no bike infrastructure. We asked if they had any ideas about how to get into el Centro from the North and South directions. They all had the same recommendations for both directions, but highlighted the fact that there is no single route that is the “safest”. The directions they indicated are on Figure 11. We used these recommendations given by the owners in the creation of our route maps.

**Finding #7: Roads in the historic center have no bike lanes or paths, so it is not clear which routes would be preferred by potential bike share users.**

The layout and quality of the roads in el Centro are poor for bicycling based on our criteria for selecting safe roads. Since most of the bike stations are located in el Centro, we compared the different types of roads in el Centro to identify which roads would be most suitable for safe bicycling.

Roads with bus routes on them played a large role in determining safe routes. Based on our surveys, interviews, and personal observations, roads with buses lack sufficient space for cyclists, a quality that people in Cuenca would consider dangerous. Appendix G, a map from Alternatur Cuenca has all the ongoing bus routes in Cuenca. Most of the buses tend to flow across the city in the east and west directions. Based on the bus routes shown, we can identify which roads to avoid when creating our maps.

Figure 13 below is an example of 3 possible ways to travel between Station 7 and Station 1. Each path has different qualities which can make them more or less conducive to biking based on our criteria for selecting safe routes. For example, Routes 1 & 3 (highlighted in red and orange respectively) have parked cars on the side of the road in some areas, and contain bus routes, as opposed to route 2 (highlighted in green) which has no parking on the road, does not run along a bus route, and is shorter in terms of distance. Route 2 is the best route in this case based on the trade-offs compared to the other routes. Appendix K shows some images of different road qualities.

### Bici Pública

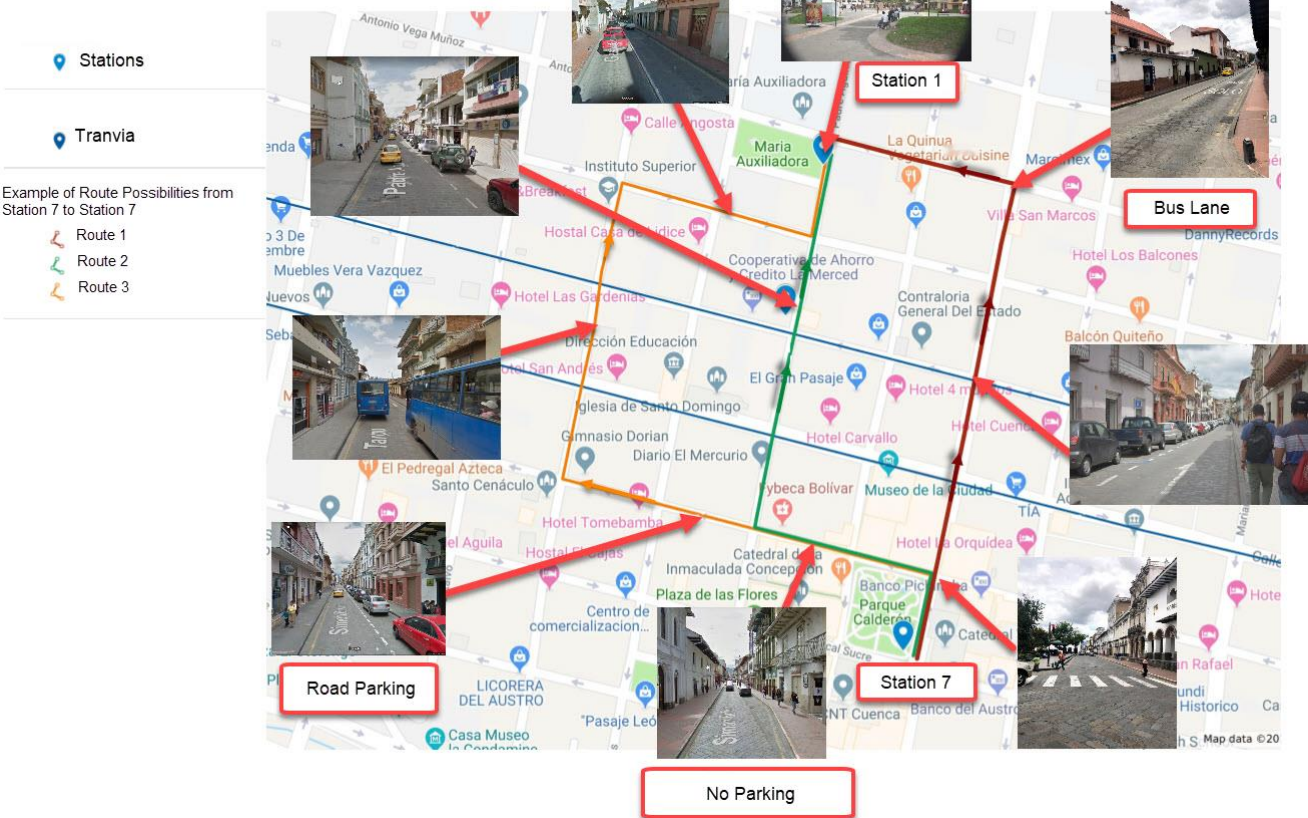


Figure 13: 3 Examples of Routes from Station 7 to Station 1

**Finding #8: After testing a prototype of our transportation map, we determined that some of the routes we selected had better alternatives based on our criteria.**

After understanding some of the possible trade-offs and alternatives different roads may include, we created a prototype for our transportation map based on our insights. The prototype was tested to look for better alternatives in order to make a more robust map. We found that many of the routes we tested were not best suited for cyclists because of factors relating to safety and convenience. For example, in Figure 13 we determined that Route 2 was the best because of sufficient space to share the road, no buses, and shortest distance. The transportation map prototype (Figure 14) contains some routes highlighted in red to indicate the roads that we changed.

After identifying the routes on our prototype that did not correspond to our criteria, we found alternatives to them and created a more refined final transportation map. A limitation we had in the creation of our transportation map was the fact that we did not have enough time to do many iterations of selecting routes. This would have allowed us to create a better final product. The final transportation map (Figure 15) contains some roads highlighted in green to indicate the alternative routes selected. Appendix M contains the final transportation map and some detailed images of specific roads on the map.

**Bici Pública**

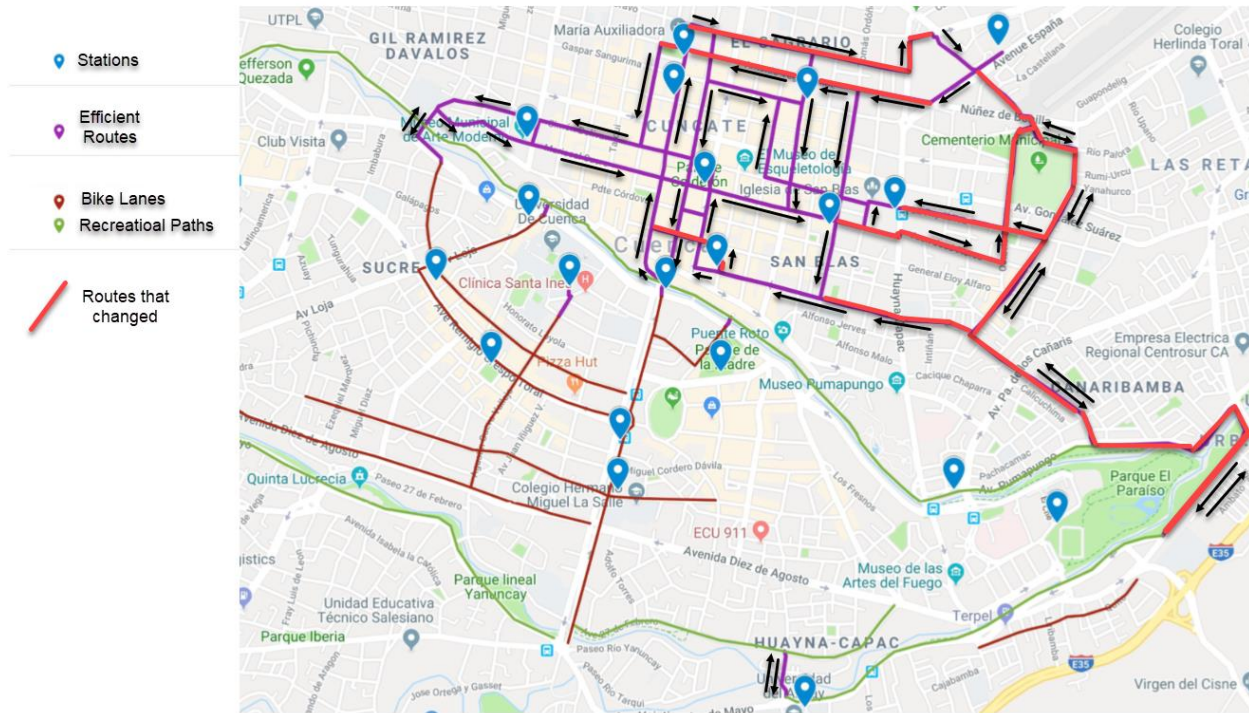


Figure 14: Transportation Map Prototype

# Bici Pública

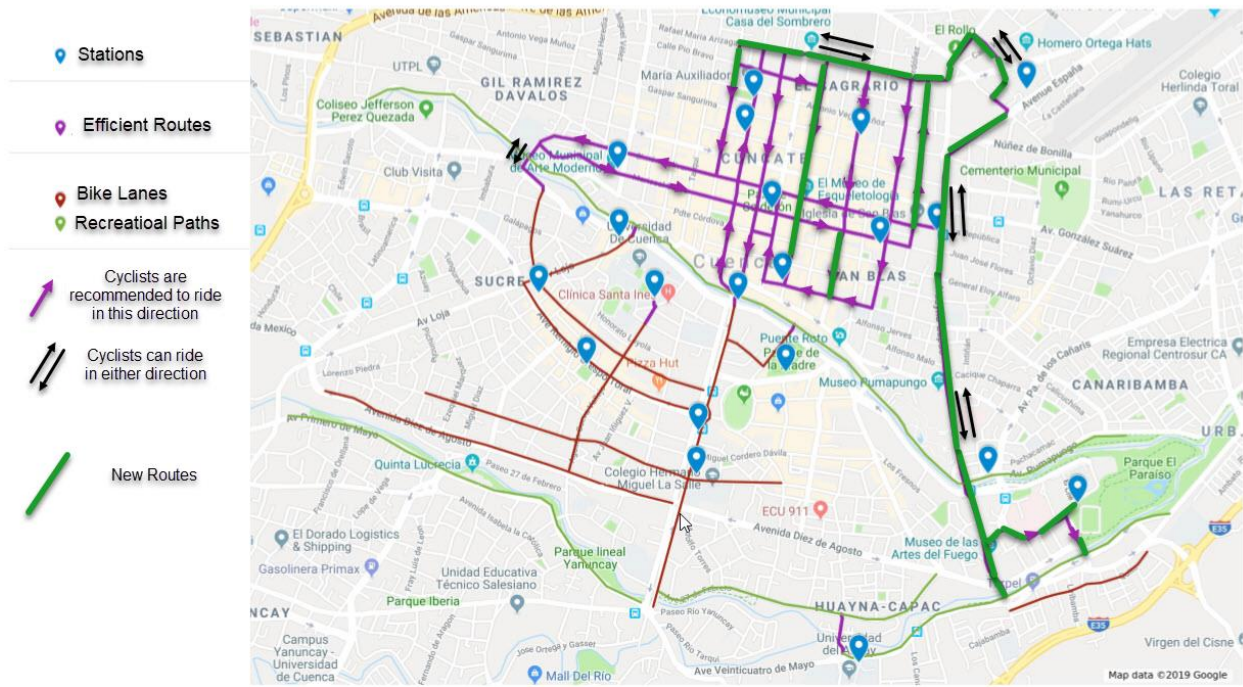


Figure 15: Final Transportation Map with New routes

Deciding on alternate routes for our transportation map also helped us create our recreational map and self-guided tour. Recreational routes include all bike lanes and paths, and connect recreational attractions such as parks and museums. Figure 16 shows the recreation map. Our recreational map also includes a loop (shown in navy blue) connecting the paths that run along Rio Tomebamba and Rio Yanuncay. The routes without bike lanes (shown in orange) on the recreation map were designed to resemble the routes chosen in our transportation map because they are safest based on our criteria. Appendix N contains more detailed versions of the recreation map.

## Bici Pública

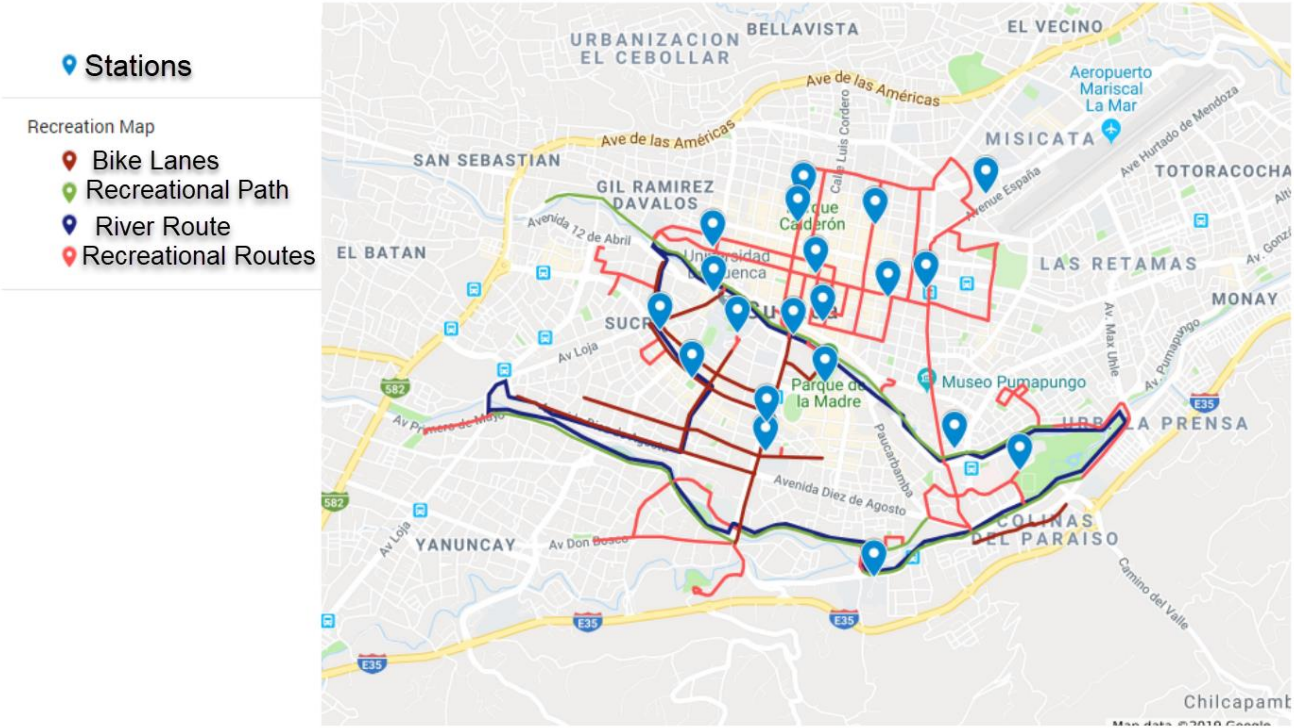


Figure 16: Recreation Map

In addition to the recreational map, we decided to make a self-guided tour that allows the user to travel on a continuous loop with 4 stops at popular locations along the way. Figure 17 is the self-guided tour which was also designed to resemble the routes we chose in our transportation map. We designed it so that all four stops along the tour corresponded with bike share stations, so that users could lock up their bikes while they went and checked out some of the recommended activities. The tour highlights some of Cuenca's most popular tourist locations, such as Parque de la Madre, Parque Calderon, and Museo Pumapungo.

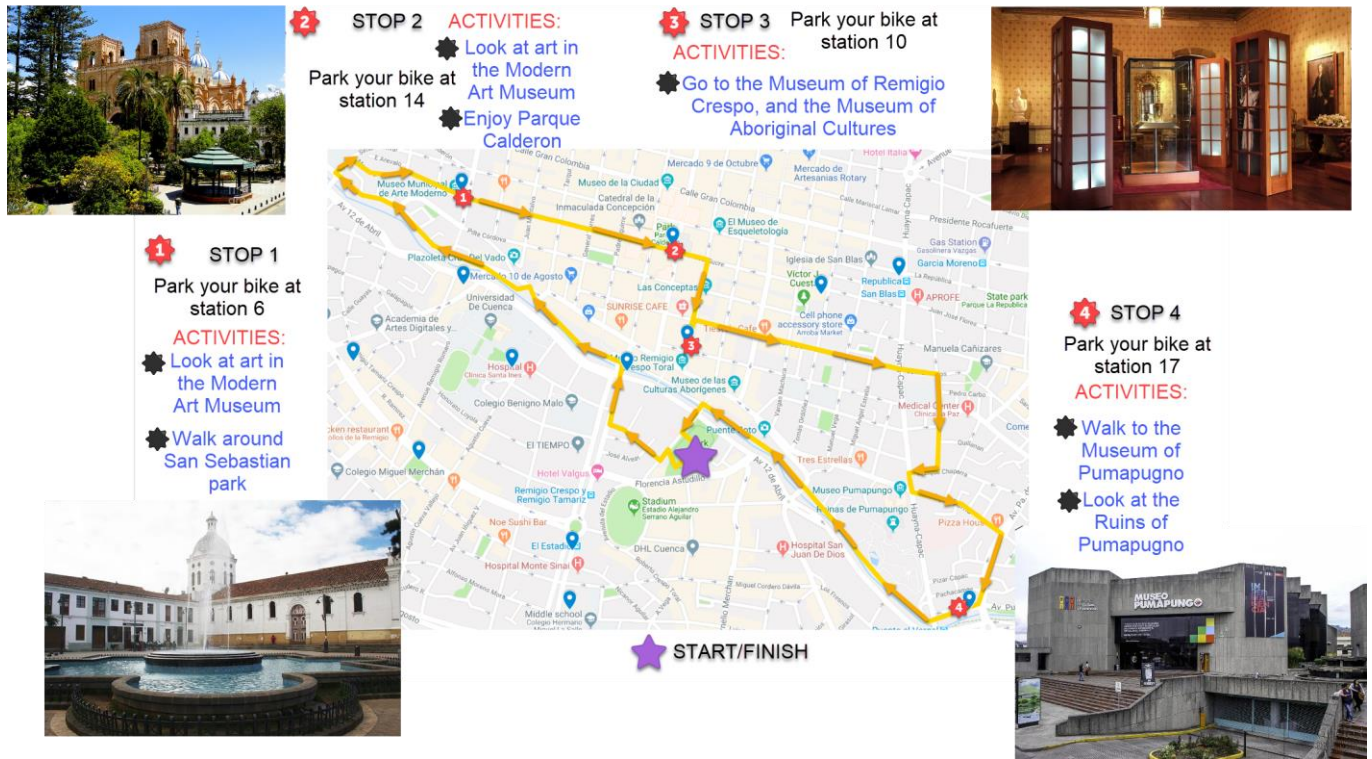


Figure 17: Self-Guided Tour



## 5 Recommendations

This purpose of this chapter is to discuss our recommendations for EMOV EP to promote the use of the upcoming bike sharing program as well as improve the attitudes and respect towards cycling in Cuenca. The three main topics covered address:

- 1) Recommendation for establishing bike routes
- 2) Recommendations for expanding the bike sharing system
- 3) Recommendation for potential ways to promote general bike use in Cuenca

### 5.1 Recommendation for establishing bike routes

**Recommendation 1:** We recommend that EMOV EP determines if the criteria we created is one they would like to use, if not, they may alter it or use a different criteria to choose routes.

In order to choose routes that are best suited for the people in Cuenca, it is necessary for EMOV EP to weigh different options of possible routes. The routes we designed are the safest and most practical based on the criteria we determined through data gathering and observation. Understanding the criteria that we determined for creating our routes would help EMOV EP create a criteria of their own to accommodate the preferences of EMOV EP and bike share users. Detailed route maps can be used as a way to identify some of the qualities different routes may entail. Specific roads may have pictures or descriptions and associated levels of safety. For a potential user who does not have a great idea about how to navigate on a bike in the city, route maps can be provided as a reference that may influence them to use the bike share system.

### 5.2 Recommendations for expanding the bike sharing system

**Recommendation 2:** We recommend EMOV EP track user data on route choices to make improvements to the route maps using this data.

EMOV EP has a phone application that will release at the time of the bike share launch. They have made it known that they would like to have maps as a feature in the app, either as fully interactive maps or just images of the maps. Also, EMOV EP has shared that because of GPS systems within the bikes and users' phones, they are able to track the routes that people actually take between destinations within the app. We suggest that EMOV EP track this data because it will allow them to compare the most used routes with the suggested routes, investigate why people are taking these routes, and make changes to the different route maps.

**Recommendation 3:** We recommend that EMOV EP uses the bike share application to gather information from users on possible preferred locations for additional bike share stations.

With the station locations set and with the commencement of the program in March 2019, we recommend EMOV EP collect data on where to add additional stations for the purpose of expanding the bike share program. Through the usage of the bike share application, EMOV EP can track users and collect information on how many bicycles there are at each station and which stations are being used the most at specific times throughout the day. EMOV EP will then be able to assess how many bikes any station might need based on its popularity. Since some stations have more bikes than others, gathering this information will also help EMOV EP determine how many bikes are needed for any additional stations they decide to build. Some stations near main points of interests or stations with high usage rates might need additional bikes. Additionally, by creating new station locations at different points around the city, EMOV EP may be creating opportunities for new demographics of users to have access to the bike sharing program.

Boston's Blue Bike and New York City's Citi Bike bike-sharing programs both have a feature on their bike share application allowing users to suggest new station locations in places they are interested in riding (BlueBike, 2018; CitiBike, 2018). We recommend that EMOV EP utilize this type of feature for the purpose of understanding popular locations where there is not currently a station. Based on our findings from the surveys we conducted, we were able to locate where people would recommend EMOV EP to build additional bike

stations. We recommend EMOV EP analyze these locations and position the stations based on where many people suggested.

### **5.3 Recommendation for potential ways to promote general bike use in Cuenca**

**Recommendation 4:** We recommend that EMOV EP create more bike lanes and bicycle infrastructure throughout Cuenca to promote bike usage.

For bicycles to experience an increased amount of usage in Cuenca, our research suggests that it is vital for EMOV EP to work to create more bike lanes and bicycle-friendly infrastructure in the city moving forward. EMOV EP has already made some good progress with implementing bike lanes on some of the more popular roads in Cuenca south of Rio Tomebamba, however, there are two ways that the current work falls short. First, most of the bike lanes south of Rio Tomebamba in Cuenca are disconnected. This means that while bike users have a safe and convenient way to travel on some of the major roads, they still are required to spend some time navigating on streets with no bike lanes. Our research gathered through surveying the public in Cuenca, as well as knowledge attained from our literature review, shows that the presence of bike lanes is one of the key features that contribute to the overall amount of bike usage in a given city. If EMOV EP were to connect all of the existing bike lanes that are already in place in the Southern part of the city, there would potentially be an increased number of bikes being used to travel around Cuenca.

Building on the need to further connect the existing bike lanes in Cuenca, the second part of this recommendation to EMOV EP is to add new bike lanes to the parts of the city North of the river. Sources from our literature review show that there is a clear inverse relationship between the overall number of bike users in a city and the amount of bicycle-related accidents that are present in the same city; As the number of bikes on the road increases, the overall number of bike-related accidents decreases (Jacobsen, 2003). When asked about promoting bike use in Cuenca, an employee from Cikla said “With no bike lanes, there are no bikers. If there are no bikers, the culture doesn’t change”. This sentiment of “safety in numbers” was echoed in our interviews with bike shop workers in Cuenca as many of them agreed that the best way for the existing culture to change its views on cyclists is by getting more cyclists out on the roads.

## 6 Conclusion

Like many developing cities around the world, Cuenca, Ecuador experiences issues such as pollution, traffic congestion, accidents, high fuel demands, and poor personal health. Increased bicycle use has been shown as a successful way to address some of these issues, however, there are some factors in Cuenca that are acting as barriers for bicycles to be seen as a viable way to combat these issues of developing cities. It is clear from research gathered from the public that attitudes toward bike use in the city should be changed for bicycles to see an increased usage. One of the potential ways to accomplish this is simply by getting more bike users on the roads. The implementation of Bici Publica may prove to be an integral piece in promoting biking as an alternate mode of transportation and increasing bike use. Using the resources we have created, EMOV EP can incentivize people to use the system by showing safe and convenient ways to travel by bicycle around the city. This may contribute to an increase in bike users, which has the potential to promote the overall development and sustainability of Cuenca.

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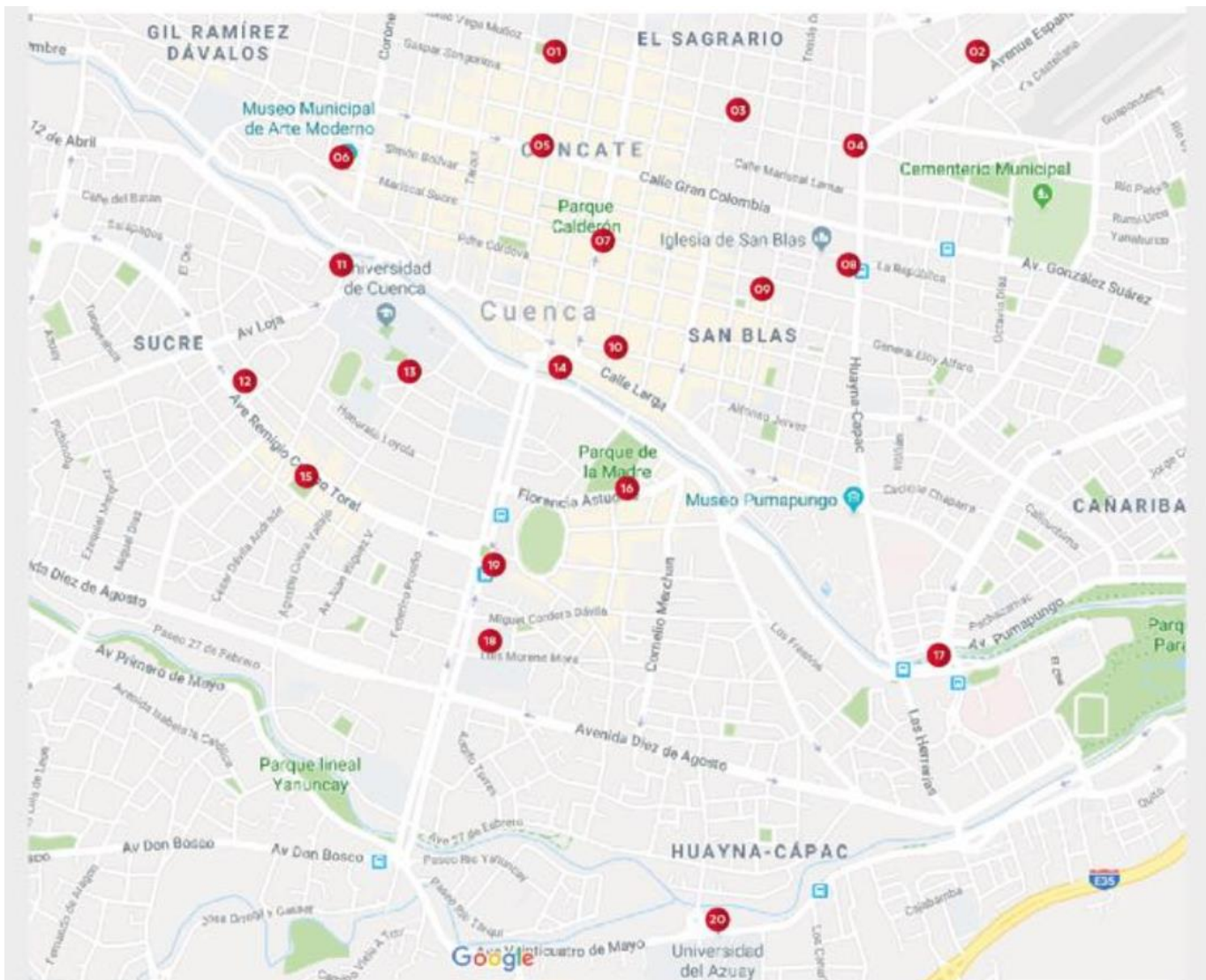
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## Appendix A (Initial Survey)

1. Do you ride bicycles? If yes, why?
2. Are you aware of the upcoming bike-sharing program by EMOV? Circle your answer
  - Yes
  - No
3. Please look at the map to answer the following questions
4. Based on the locations of these stations, do you believe this system would be useful to you? Why or why not?
5. Mark some of your main points of interest on the map.
6. Which stations would be most convenient for you to use?
7. What would you be most worried about when riding a bike in Cuenca?



## Appendix B

(Main Survey - English)

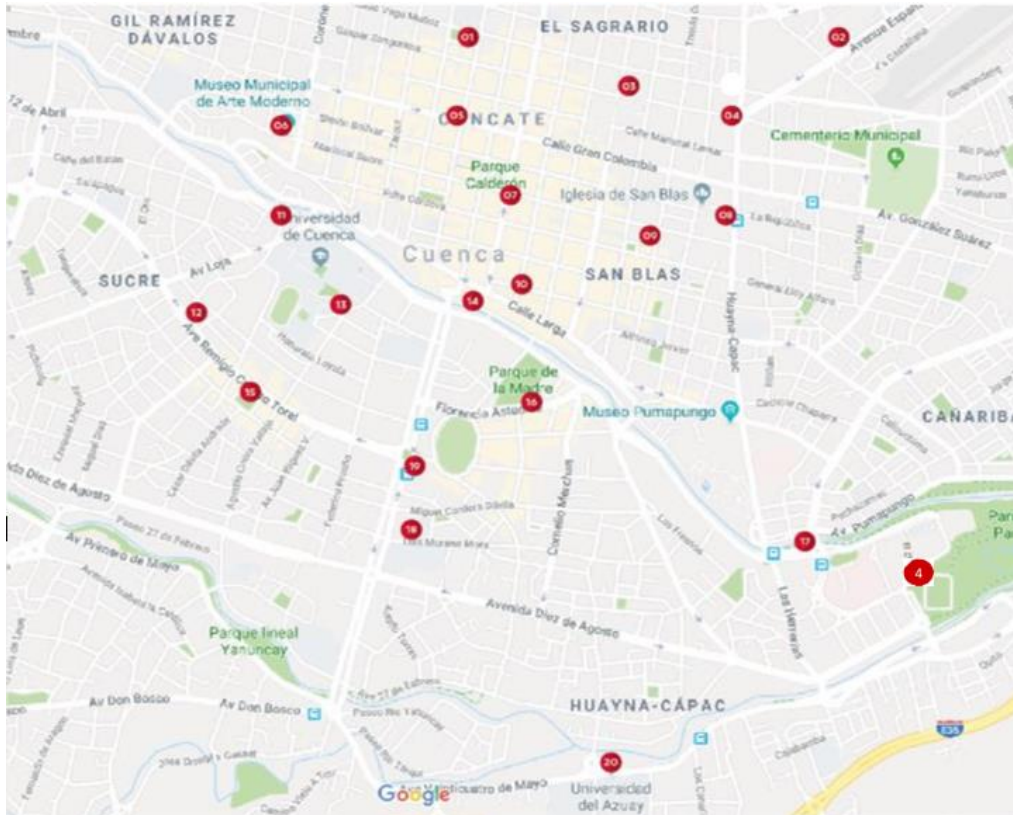
1. Do you ride bikes? If yes, why? If no, why don't you ride bikes?
  
2. Do you know about the new bike sharing program by EMOV? Mark your answer
  - Yes
  - No
3. What worries you the most about riding a bike in Cuenca?
  
4. Here are some factors that affect bike safety. Please mark your top 3 worries on this list.
  - Lack of bike lanes \_\_
  - Bad road quality \_\_
  - Lots of traffic\_\_
  - Dangerous neighborhoods \_\_
  - Frequent traffic signals \_\_
  - Steep roads \_\_
  - Intersections \_\_
  - Lack of share the road signs \_\_
  - Lack of dedicated bike signals \_\_
5. What are some qualities of roads you prefer on a bike route? Why?
  
6. Are there roads you would like to avoid when riding a bike? If so, please indicate these roads.

Continue to the next page



Appendix B cont.

Please look at the map to answer the following questions.



7. Which stations are most convenient for you to use? Please circle these stations on the map. If you wish, indicate possible routes you would take between these stations.
8. Do you have any suggestions for locations of other possible station locations? Please mark these locations with an X.
9. Where would you ride on a bike? For example, museums, parks, commercial centers, cathedrals, home, work, etc.
10. Based on the locations of the stations, do you believe the system would be useful?
  - Yes
  - No
11. Why would you use the system?
  - It is good for the environment
  - It is efficient and convenient
  - To reduce traffic in the city
  - For Fun
  - I would not use the system

## Appendix C

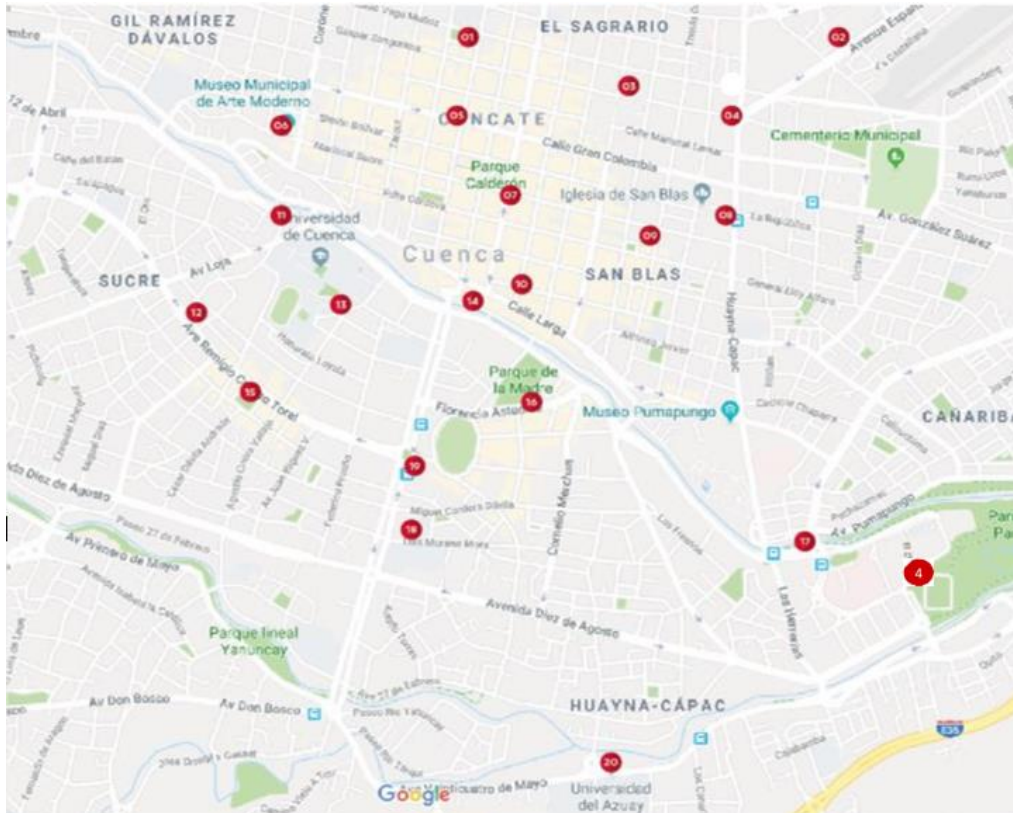
### Main Survey (Spanish)

1. ¿Montas bicicletas? ¿Si es así por qué? Si no, ¿por qué no andas en bicicleta?
2. ¿Conoce el nuevo programa de compartir de bicicletas de EMOV? Marca tu respuesta
  - Si
  - No
3. ¿Qué te preocupa más al andar en bicicleta en Cuenca?
4. Aquí hay algunas cosas que afectan la seguridad de la bicicleta. Por favor, marque sus 3 preocupaciones principales en esta lista.
  - Falta de ciclovías \_\_\_
  - Mala calidad de las calles \_\_\_
  - Mucho trafico\_\_\_
  - Barrios peligrosos \_\_\_
  - Señales de paro frecuentes / señales de tráfico \_\_\_
  - Caminos escarpados \_\_\_
  - Un montón de carreteras que se cruzan \_\_\_
  - Falta de las señales sobre compartir las calles \_\_\_
  - Falta de señales de bicicleta dedicadas \_\_\_
5. ¿Cuáles son algunas cualidades de las calles que prefieres en una ruta en bicicleta? ¿Por Qué?
6. ¿Hay calles que te gustaría evitar cuando montas en bicicleta en Cuenca? En caso afirmativo, por favor indique las calles.

Continuar de Vuelta

Appendix C cont.

Por favor mira el mapa para responder las siguientes preguntas.



7. ¿Qué estaciones serían las más convenientes para usted usar? Por favor indique con un círculo las estaciones en el mapa. Si lo desea, indique las rutas que tomará entre las estaciones que elija.
8. ¿Tiene surgencias para otros lugares donde deben haber estaciones? Por favor, indique con una "X" los lugares en el mapa.
9. ¿A dónde irías en estas bicicletas? Por ejemplo, museos, parques, centros comerciales, catedrales, hogar, trabajo, etc.
10. Según la ubicación de estas estaciones, ¿cree que este sistema le sería útil?
  - Sí
  - No
11. ¿Por qué usaría el sistema?
  - Bueno para el medioambiente
  - Muy eficiente y conveniente
  - Reducir el tráfico en la ciudad
  - Divertido
  - No usaría el sistema

## Appendix D (Bike Shop Interview)

		Monster Bikes	Cikla
Q1	<i>We noticed from some data collection that people are worried about dangerous neighborhoods. Why would people believe they are unsafe? Traffic, crime, etc. Can you indicate some possible neighborhoods?</i>	Traffic. There are not sufficient bike lanes in the city	Crime. People try to rob nice bikes
Q2	<i>How would you navigate on a bike in El Centro?</i>	All of el Centro is dangerous	It is very difficult to navigate El Centro
Q3	<i>Do you have any ideas on how you would get into el Centro from the North and South directions?</i>	Take Avenida Espana to Huayna Capac, other routes are up to the user because they are all difficult to ride on	Go down and around to Benigno Malo. That is the best way to get up to El Centro
Q4	<i>Why did you choose these routes? Please explain.</i>	-	-
Q5	<i>In your opinion what are the biggest issues that prevent bicycling in Cuenca?</i>	Lack of bike lanes, Traffic, and crime	Lack of bike lanes. With no bike lanes, there are no bikers. if there are no bikers, the culture doesn't change
Q6	<i>What are some things that would promote more biking in Cuenca?</i>	A panic button at the bike share stations and bike lanes	More bike lanes, and more cyclists
Q7	<i>How can biking be promoted in El Centro?</i>	It is very difficult to change anything in El Centro	-

**Appendix D cont.**

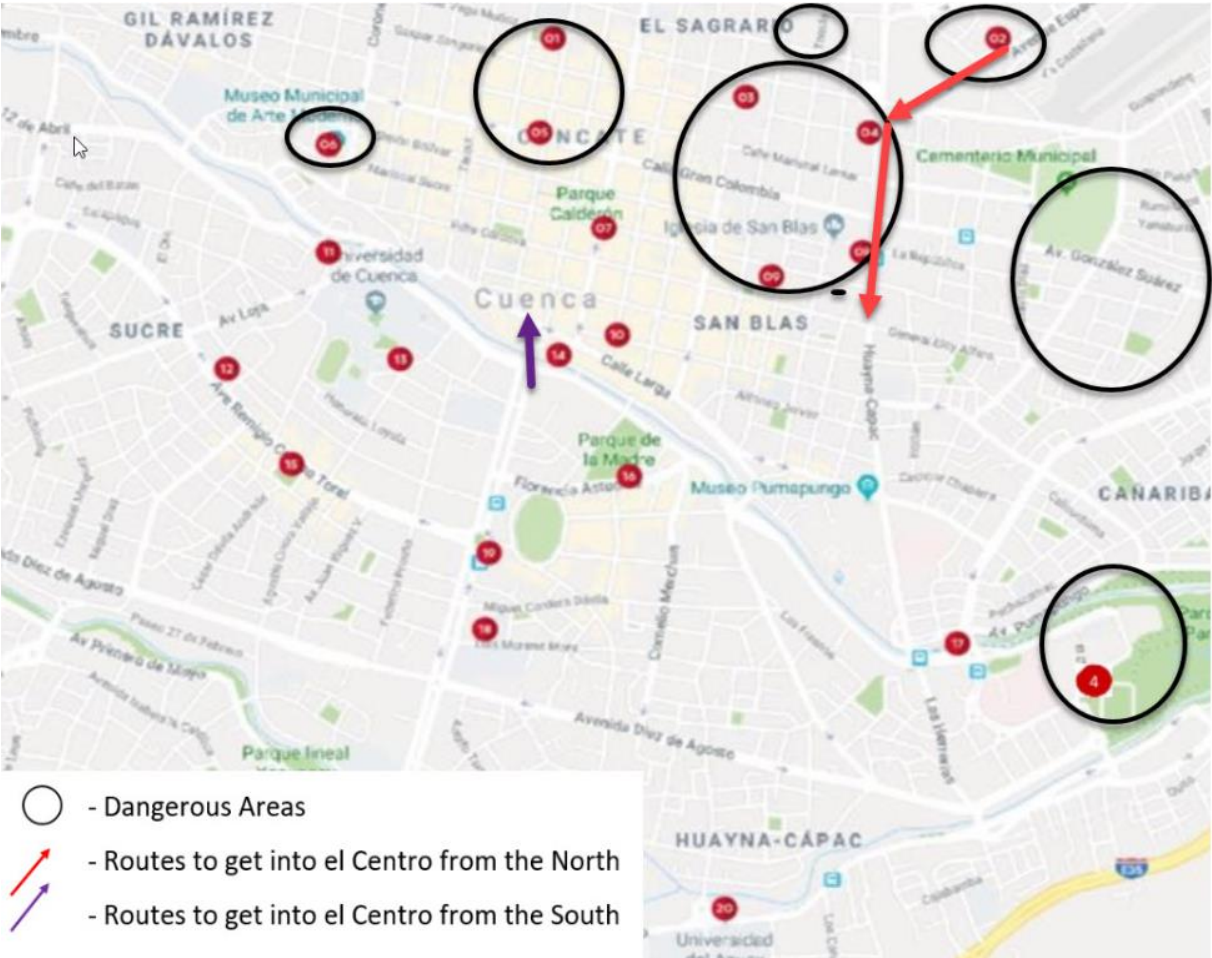
		Podium Bike	Cube
Q1	<i>We noticed from some data collection that people are worried about dangerous neighborhoods. Why would people believe they are unsafe? Traffic, crime, etc. Can you indicate some possible neighborhoods?</i>	Traffic. On a normal day there is too much traffic	Depends on the location. Some places are dangerous for crime. And some roads have too much traffic
Q2	<i>How would you navigate on a bike in El Centro?</i>	Too much traffic	It is very complicated. There are not a lot of roads with space for a bike
Q3	<i>Do you have any ideas on how you would get into el Centro from the North and South directions?</i>	Benigno Malo at the end of Av Solano	Take Avenida Espana to Huayna Capac
Q4	<i>Why did you choose these routes? Please explain.</i>	-	-
Q5	<i>In your opinion what are the biggest issues that prevent bicycling in Cuenca?</i>	Cars. They don't respect cyclists	Drivers. They do not respect cyclists
Q6	<i>What are some things that would promote more biking in Cuenca?</i>	It is a cultural problem. Culture would need to change	The culture is very complicated.
Q7	<i>How can biking be promoted in El Centro?</i>	-	-

**Appendix D cont.**

		Base Extreme	La Bici Tienda
Q1	<i>We noticed from some data collection that people are worried about dangerous neighborhoods. Why would people believe they are unsafe? Traffic, crime, etc. Can you indicate some possible neighborhoods?</i>	Traffic and crime. People try to steal high end bikes	Traffic
Q2	<i>How would you navigate on a bike in El Centro?</i>	There is too much traffic. Also lots of buses and tranvia	Don't ride in el centro
Q3	<i>Do you have any ideas on how you would get into el Centro from the North and South directions?</i>	Take Avenida Espana to Huayna Capac	-
Q4	<i>Why did you choose these routes? Please explain.</i>	-	-
Q5	<i>In your opinion what are the biggest issues that prevent bicycling in Cuenca?</i>	Drivers. They do not respect cyclists. Also, there is too much traffic	Traffic
Q6	<i>What are some things that would promote more biking in Cuenca?</i>	The culture is hard to change	-
Q7	<i>How can biking be promoted in El Centro?</i>	-	-

Appendix E

High Crime areas and Recommended Directions to Travel into el Centro



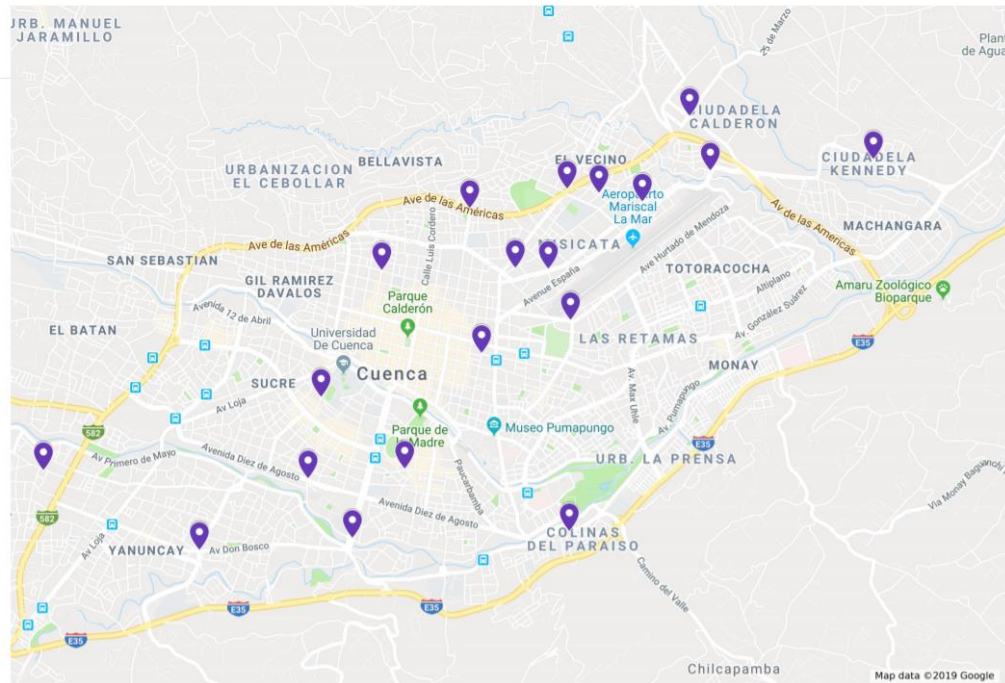
## Appendix F

### Accident-Related Data

#### Bici Pública

Accidentes de Ciclismo

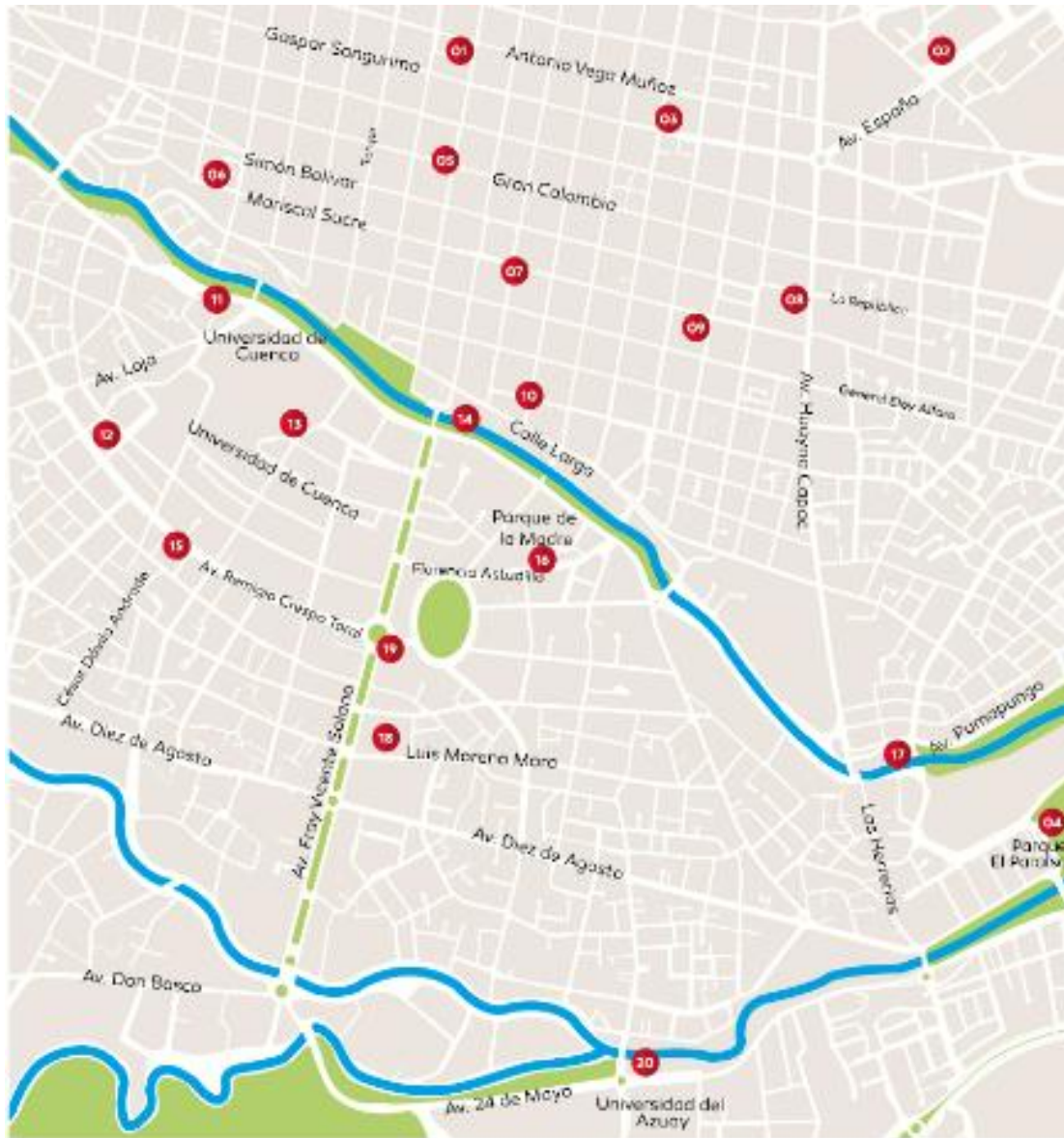
All items





## Appendix G

### Station Map



#### Estaciones Bici Pública Cuenca

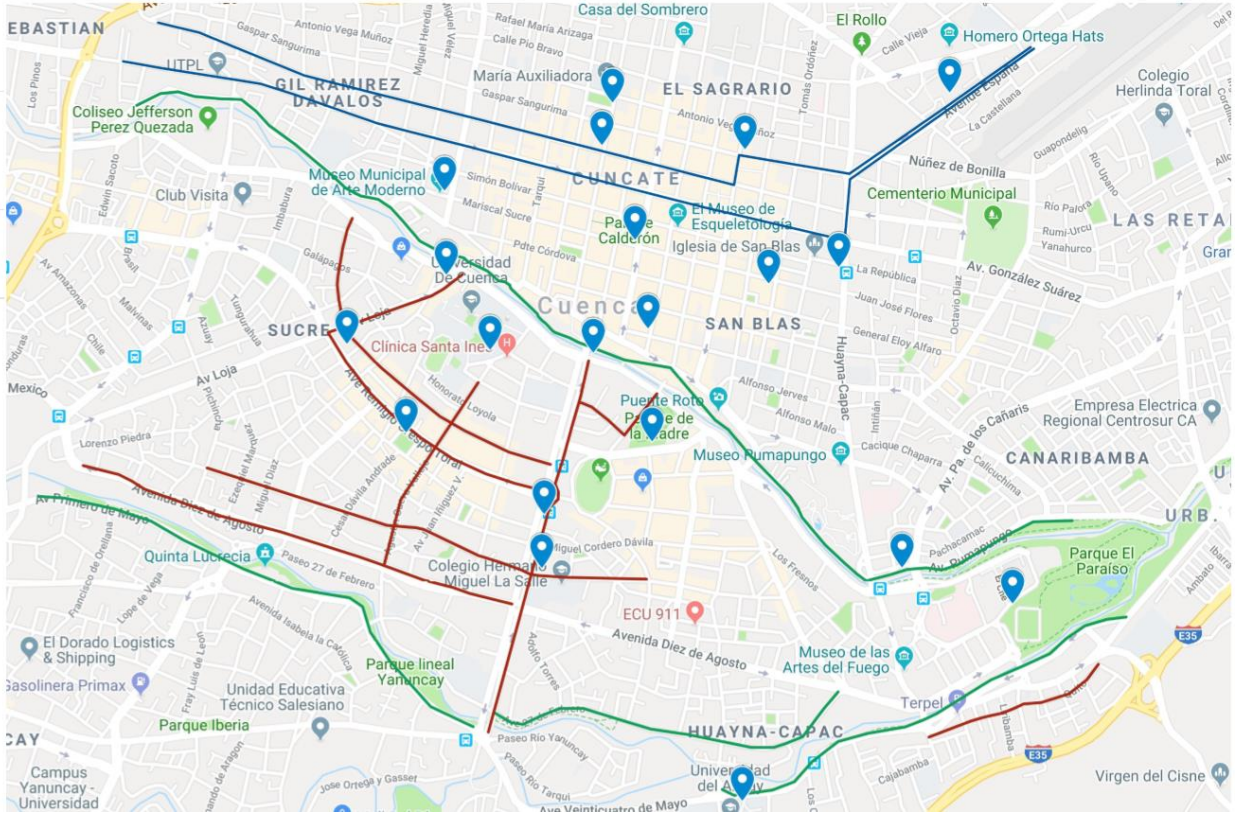
01	ESTACIÓN 01 BPC PLAZOLETA MARÍA AUXILIADORA	02	ESTACIÓN 02 BPC TERMINAL TERRESTRE DE CUENCA	03	ESTACIÓN 03 BPC PLAZA CIVICA - MERCADO 9 DE OCTUBRE	04	ESTACIÓN 04 BPC PARKING DEL PALACIO - PARKING EL PARAISO Y AV 10 DE AGOSTO
05	ESTACIÓN 05 BPC PLAZOLETA DE SAN SEBASTIÁN	06	ESTACIÓN 06 BPC PLAZOLETA DE SAN TO DOMINGO	07	ESTACIÓN 07 BPC PARKING CALDERÓN	08	ESTACIÓN 08 BPC PORTA, ARTESANAL - EDUCER
09	ESTACIÓN 09 BPC PLAZOLETA VÍCTOR J. CURSTA	10	ESTACIÓN 10 BPC PLAZOLETA LA MERCED	11	ESTACIÓN 11 BPC UNIVERSIDAD DE CUENCA PLAZOLETA EL NÚMERO	12	ESTACIÓN 12 BPC REMIGIO CRESPO
13	ESTACIÓN 13 BPC AGUSTÍN CUEVA - FACULTAD DE ARQUITECTURA J. DE CUENCA	14	ESTACIÓN 14 BPC 12 DE ABRIL - JUNTO AL PUENTE DEL CENTENARIO	15	ESTACIÓN 15 BPC FESTA DE BICICROSS LA CONCORDIA	16	ESTACIÓN 16 BPC PARKING DE LA MADRE
17	ESTACIÓN 17 BPC MUSEO PUMAPUNGO	18	ESTACIÓN 18 BPC COLEGIO HERMANO MIGUEL DE	19	ESTACIÓN 19 BPC AV. SOLANO - ESTADIO	20	ESTACIÓN 20 BPC UNIVERSIDAD DEL AZUL

## Appendix H

Map of Bike Lanes/Recreational Paths/Train Route

# Bici Pública

- Estaciones
  - Estaciones
- Ciclovías/Caminos
  - Ciclovías
  - Camino recreativo
- Tranvía
  - Tranvía



## Appendix I

### Station Numbers and Locations

Station #'s and Locations					
1	Plazoleta Maria Auxiliadora	8	Portal Artesanal - EDEC EP	15	Pista de Bicicross La Concordia
2	Terminal Terrestre de Cuenca	9	Plazoleta Victor J. Cuesta	16	Parque de La Madre
3	Plaza Civica - Mercado 9 de Octubre	10	Plazoleta La Merced	17	Museo Pumapongo
4	Parque El Parasio y Av. 10 de Agosto	11	Universidad de Cuenca Plazoleta El Farol	18	Colegio Hermano Miguel La Calle
5	Plazoleta de San Sebastian	12	Remigio Crespo	19	Av. Solano – Estadio
6	Plazoleta de Santo Domingo	13	Agustin Cueva - Facultad de Arquitectura U de. Cuenca	20	Universidad del Azuay
7	Parque Calderon	14	12 de Abril		

## Appendix J

### Bike Share User Costs

Trips and Memberships	Costs	Trip Extension & Fines	Required Payment
Sign-up fee	\$3.00	Extra 30mn or less	\$0.50
Cost per trip	\$0.25	Extra hour	\$2.00
Cost per day*	\$10.00	Failure to check the bike out for an extra hour	\$20.00 fine
Cost per 3 months*	\$15.00	Failure to return bike within 24 hours	\$250.00 fine
Cost per year*	\$30.00		

Table 1. Bike Share Costs

\*The single trip, 3 month, and yearly memberships only allow 30 minute trips. Trips exceeding 30 minutes require fees. The day membership allows unlimited trips and trip times with no extra fees.

## Appendix K

### Road Qualities

- One way roads with lanes for Buses only.
- Ex. Antonio Vega Munoz



- One way roads with two car lanes



- One way roads with one car lane



- One way roads with parking.
- Ex. Simon Bolivar



**Appendix K cont.**

- Two way roads with no parking
- Ex. Simon Bolivar before Padre Aguirre



- Roads with a Tranvia
- Ex. Gran Colombia y Calle Maris



## Appendix L

### Map of Bus Routes in Cuenca



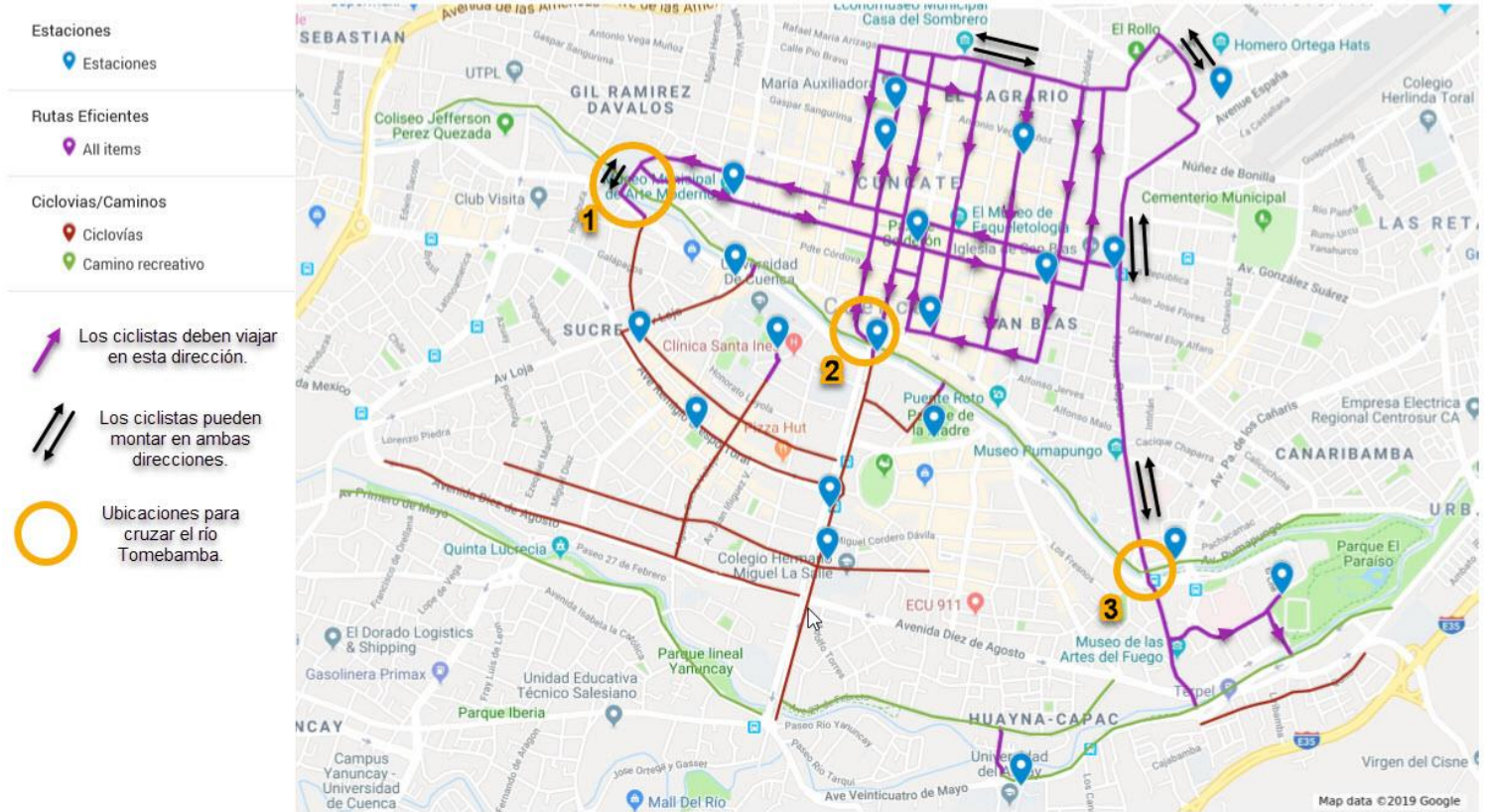
Bus Routes

[Digital image]. (n.d.). Retrieved from <http://www.alternatur-cuenca.com/bus-map.html>  
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

# Appendix M

## Transportation Map

### Bici Pública



Final Transportation Map



Appendix M cont.

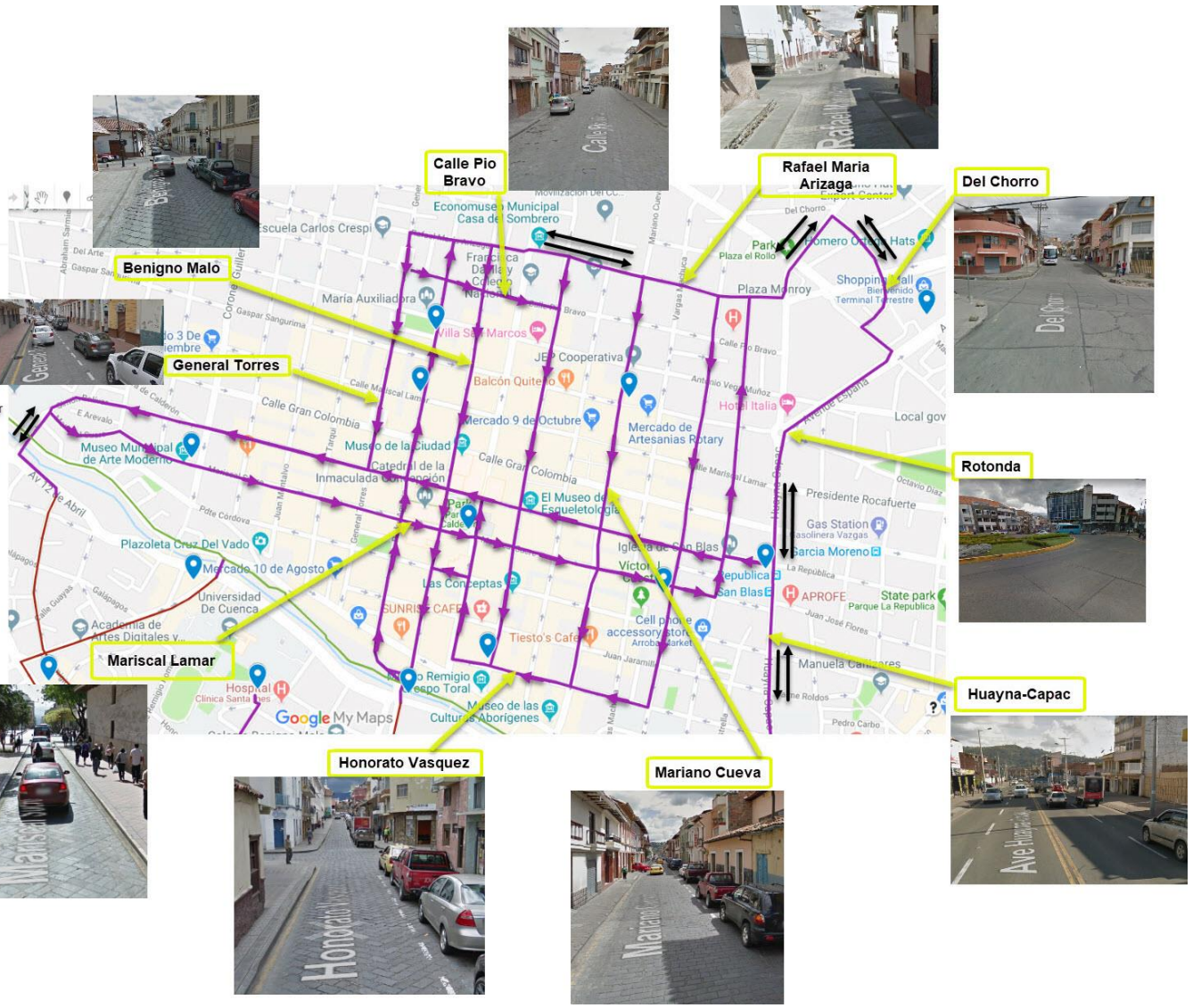
Transportation Map (el Centro)

Bici Pública

- Estaciones
  - Estaciones
- Rutas Eficientes
  - All items
- Ciclovías/Caminos
  - Ciclovías
  - Camino recreativo

Los ciclistas deben viajar en esta dirección.

Los ciclistas pueden montar en ambas direcciones.

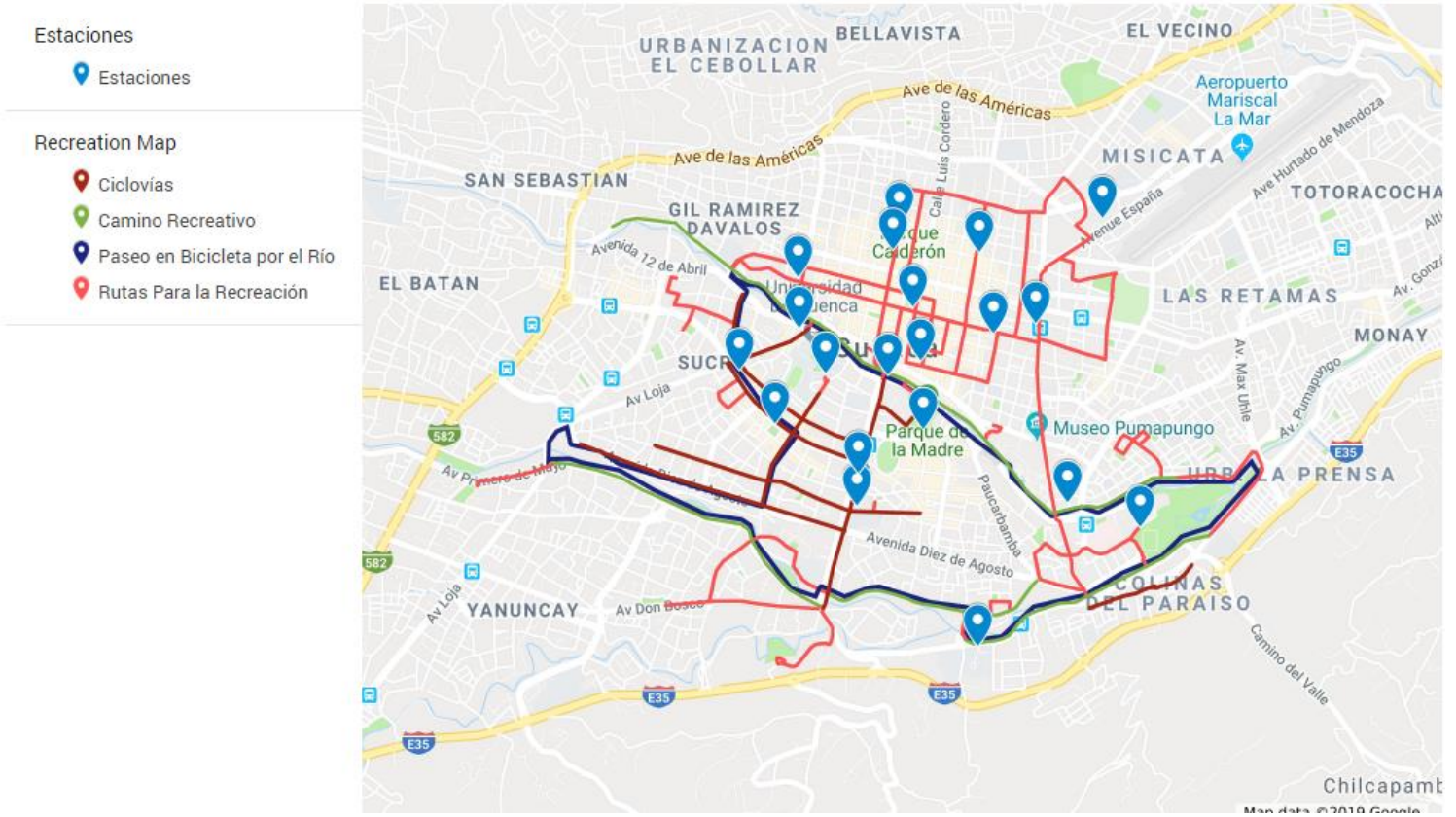


Final Transportation Map (El Centro)

# Appendix N

## Recreation Map

### Bici Pública



Recreation Map

Appendix N cont.

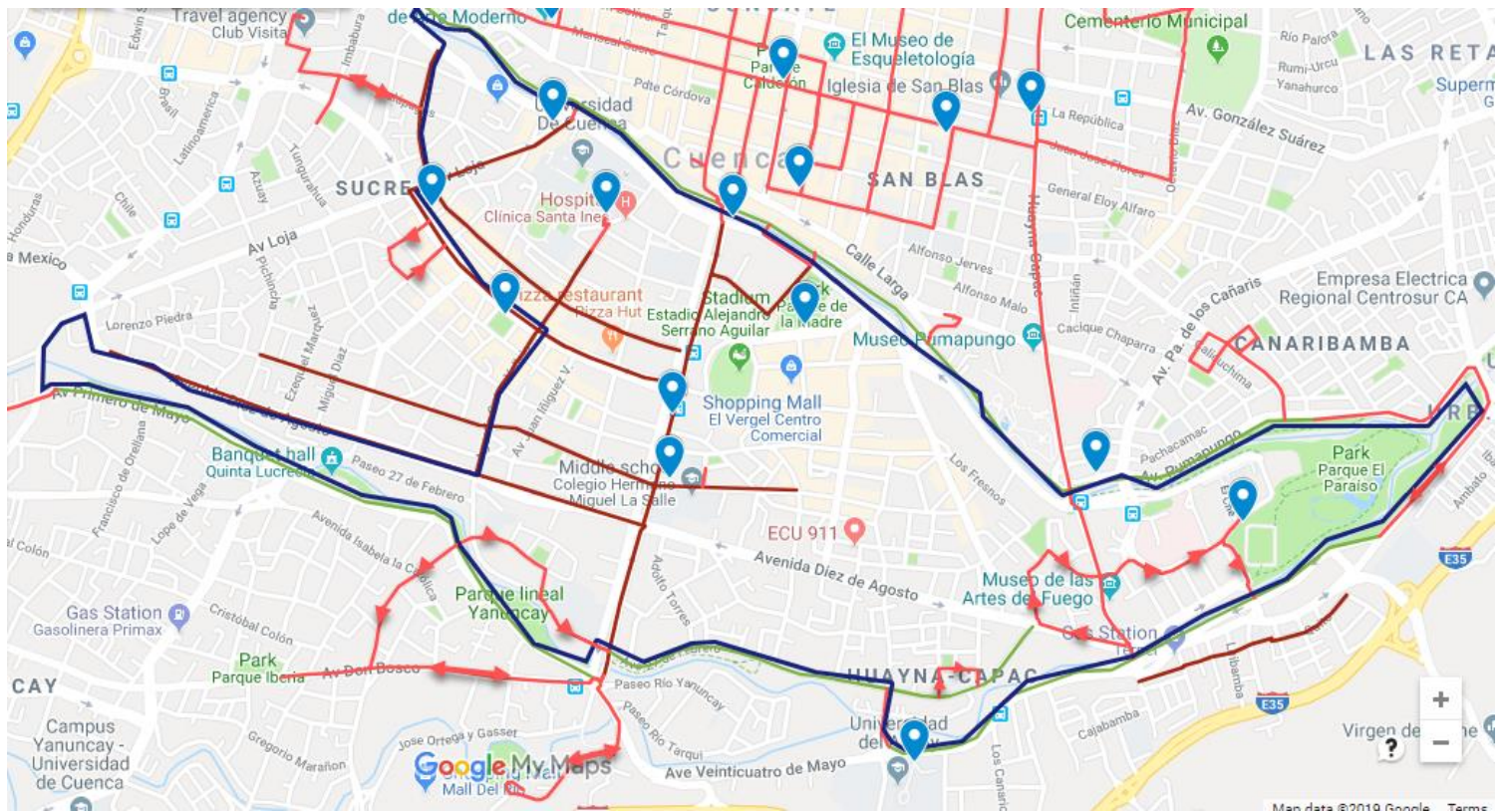
Recreation Map (el Centro)



Recreation Map of El Centro

## Appendix N cont.

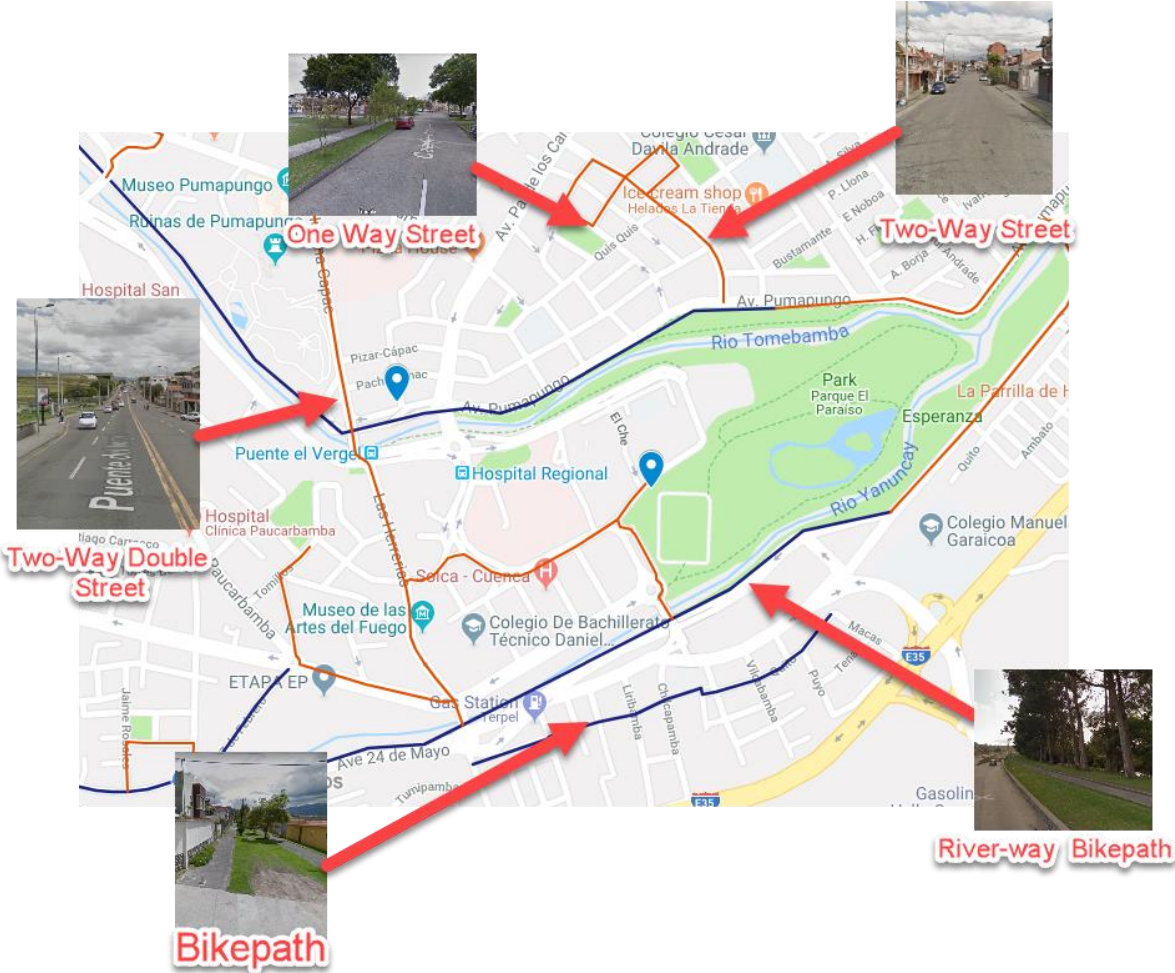
### Recreation Map (River Loop)



Recreation Map of “South of El Rio Tomebamba”

Appendix N cont.

Recreation Map (Types of Roads)



Type of Roads in Recreation Map

# Appendix O

## Self-Guided Tour



**2** Parada 2  
Estacione su bicicleta en la estación 14

**Actividades:**  
 • Ir al Museo de la Ciudad  
 • Disfruta el Parque Calderon

**3** Parada 3  
Estacione su bicicleta en la estación 10

**Actividades:**  
 • Ir al Museo de Remigio Crespo Toral y el Museo de las Culturas Aborígenes



**4** Parada 4

Estacione su bicicleta en la estación 17

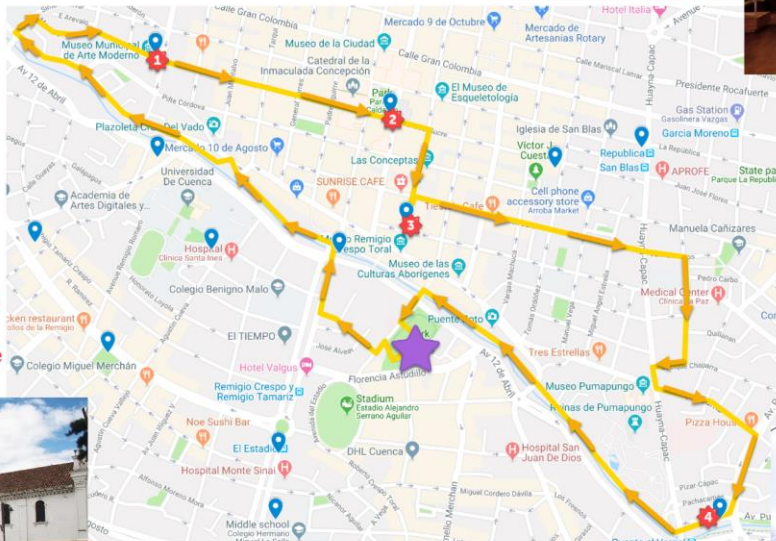
**Actividades:**  
 • Camina hasta el Museo Pumapungo y mira las ruinas.  
 • Mira las Ruinas de Pumapungo

**1** Parada 1

Estacione su bicicleta en la estación 6

**Actividades:**

• Mira el arte en el Museo Municipal de Arte Moderno  
 • Caminar al Parque San Sebastian



★ Empezar / terminar



## Self-Guided Tour

## Appendix P

### Locations of Popular Attractions in Cuenca

#### North of Rio Tomebamba

##### Parks

Attraction	Road
Parque San Sebastian	Mariscal Sucre
Plaza de San Francisco	Padre Aguirre
Parque Calderon	Mariscal Sucre
Parque Maria Auxiliadora	Padre Aguirre
Parque Plaza el Rollo	Barrial Blanco
Cementerio Municipal	El Sagrario
Parque La Republica	Octavio Diaz
Parque Prensa	El Observador
Parque PÚBLICO CIUDADELA ALVAREZ	Cacique Chaparra

##### Museums

Attraction	Road
Museo Pumapungo	Huayna Capac
Museo de la Ciudad	Benigno Malo
Museo Municipal de Arte Moderno	Mariscal Sucre
El Museo de Esqueletologia	Presidente Borrero
Museo de las Madres Conceptas	Hermano Miguel
Museo Manuel Agustin Landivar	Bajadas de los Molinos y Calle Larga
Museo de Historia de la Medicina	Av 12 de Abril

## Appendix P cont.

### Churches

Attraction	Road
Santo Domingo	Padre Aguirre
Catedral de la Inmaculada Concepcion	Mariscal Sucre
Iglesia de San Alfonso	Simon Bolivar
Santuario Mariano del Carmen de la Asunción	Padre Aguirre
Iglesia del Carmen de la Asunción	Padre Aguirre

### Other tourist sites

Attraction	Road
Plaza el Otorongo	Recreational Path on Rio Tomebamba
Casa de las Palomas	Benigno Malo



## Appendix P cont.

### South of Rio Tomebamba

#### Parks

Attraction	Road
Parque Fogata	Valle de Gonzaga
Parque La Paz	Imbabura
Parque San Marcos	Jose Burbano
Parque Bicicross	Ave Remigio Crespo Toral
Parque La Plateria	Alfonso Moreno Mora
Parque Yanuncay	Río Yanuncay Camino Recreativo
Parque Madre	Federico Malo
Parque El Paraíso	Rio Tomebamba Camino Recreativo
Parque Sagitario	Alberto Palacios
Parque Tarqui	Camino Viejo a Turi
Parque Iberia	Av Don Bosco
Parque el Recreo	Aspar de Villaroel
Parque Urano	Called Miguel Delgado
Parque La Compañía	Miguel de Santiago
Parque Las Candelas Park	J. Fajardo

#### Museums

Attraction	Road
Museo de Metals	Av Solano

#### Churches

Attraction	Road
Iglesia de Jesucristo de los Santos de los Últimos Días	Av Solano
Parroquia Nuestra Señora del Carmen "Virgen de Bronce"	Avenida Diez de Agosto
Iglesia Luterana Paz de Dios	Av Veintisiete de Febrero