BIKE SHARE SYSTEM REVIEW

This section provides an overview of modern bike share in the United States and summarizes the experience of other cities implementing bike share and recent trends in the industry to understand what is required to implement a successful bike share program and to understand the potential benefits and risks associated with implementing a program in Tucson.

What is Bike Share?

Bike share is a mobility option that allows users to access bicycles located at a network of self-service stations. It is typically made available through a subscription fee that usually ranges from a few dollars for one-day access to $80 to $100 for annual access.

Figure 1 – Divvy is the name of the bike share system in Chicago (Credit: People for Bikes).

Bike share has become an effective mode of transportation for short point-to-point trips allowing subscribers to make spontaneous or planned trips. Most U.S. bike share systems allow subscribers to take unlimited trips during their membership period. There are no additional charges provided that the bicycle is returned to a station within 30 to 60 minutes. Following this "free ride period", most operators charge incremental fees to encourage users to return the bicycle and make spaces available for other users to park their bicycles. Most trips in existing U.S. bike share systems are between 15 to 35 minutes duration and around one-to-three miles long.[1]

Bike share is different from bicycle rental in that it encourages short trips and high turnover by using a fee structure that charges higher rates the longer a bicycle is kept out. In this way, renting a bicycle is generally more cost effective for longer time periods.

[1] Bike Sharing in the United States: State of the Practice and Guide to Implementation. Federal Highway Administration. United States Department of Transportation. September 2012.

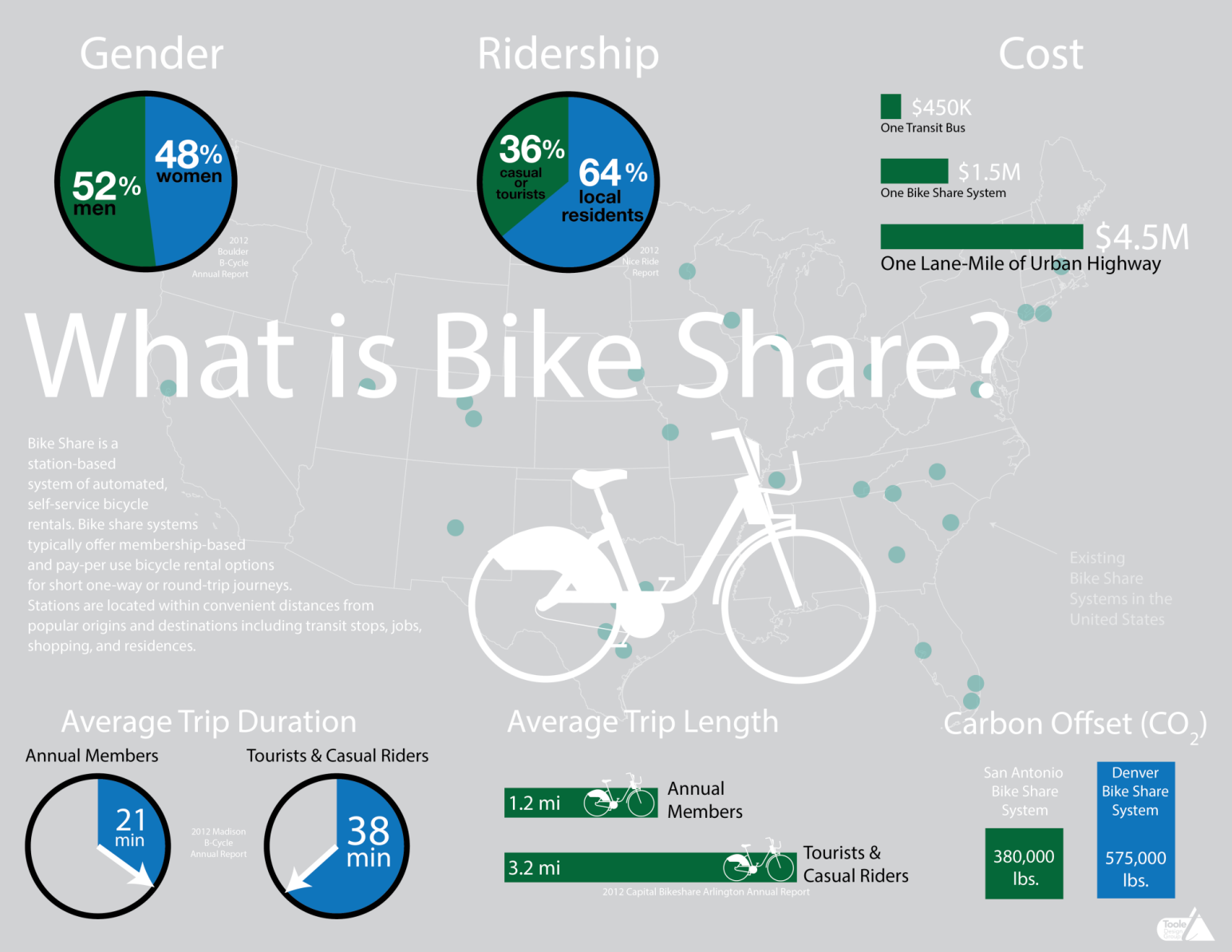


Figure 2 - What is Bike Share?

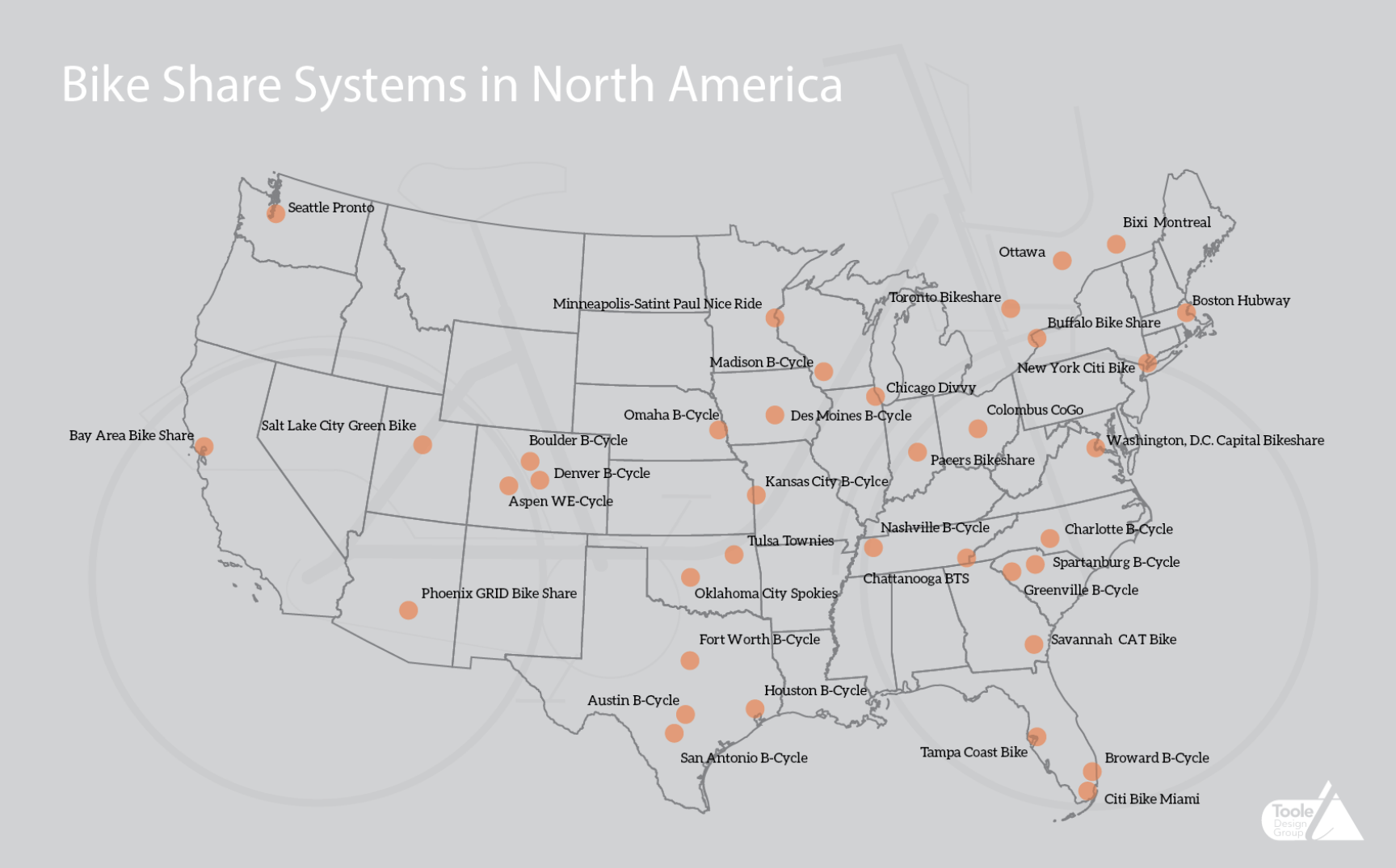


Figure 3 - Bike Share Systems in the United States

Elements of Bike Share

Most existing U.S. bike share programs are automated and do not require on-site staff. To provide easy access and increased accountability, systems utilize credit cards and radio frequency identification (RFID) technology in the stations and bicycles. The system is intended to be easy to use, from signing up for membership, to getting a bicycle, to feeling comfortable and safe when riding a bicycle.

There are two bike share technologies currently being utilized in the United States: station-based or "smart dock" systems and bicycle-based or "smart bike" systems. Both utilize RFID, credit card and GPS technologies. However they differ in where the technology is housed. Almost all current systems in the U.S. are smart dock systems; however, many cities are scheduled to launch smart bike systems within the next two years. Phoenix launched Grid Bike Share in November 2014 with a smart bike system.

In smart dock systems, users interact at a separate terminal or kiosk and the locking mechanism for the bicycle is located at the dock. With smart bike systems, all of the technology is housed on the bicycle itself including the lock.

While smart-bike technologies tend to be a lower capital cost per bike, they remain relatively untested in large city-wide applications and as such operating costs and other parameters are still largely unknown.

Peer Programs

There are over 40 operating bike share programs in the United States (Figure 5) and at least 15 more programs in various stages of planning. This section draws from experience around the country to provide a complete account of different technologies, business models, partner roles, operating costs, pricing structures, ridership and membership rates, success factors, and risks.

Detailed summaries are provided for five bike share programs operating in peer cities that were selected based on similarities in geographic and population size, transit infrastructure, presence of a college campus and other factors. These include:

- Phoenix: local example, private ownership model, smart-bike technology.
- Denver: comparable population size, non-profit ownership model, light rail integration.
- San Antonio: south-west city, agency-owned / non-profit operated model, regional pathway system.
- Minneapolis: multiple cities, major university campus, light rail integration, non-profit ownership model.
- Salt Lake City: south-west region, quasi-agency ownership model, very successful mid-sized city sponsorship and ridership model, light rail integration.

Detailed profiles are included in Appendix A for each of these cities and their key characteristics and performance metrics are summarized in **Table 1**.

Smart Dock System Elements

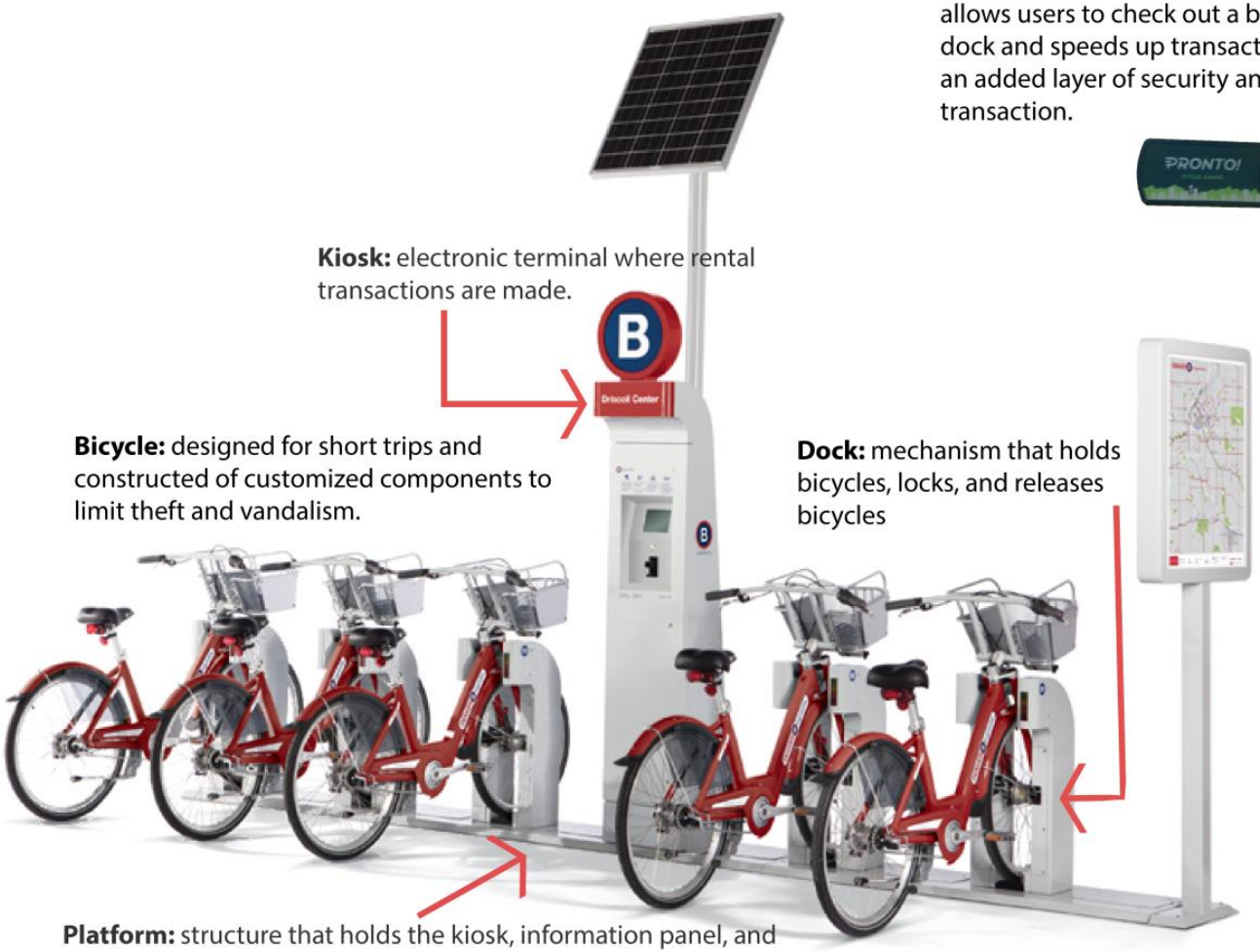
RFID Card/Fob: Radio Frequency Identification technology, usually in the form of a card or fob, allows users to check out a bicycle directly from the dock and speeds up transactions. This also provides an added layer of security and accountability to each transaction.

Kiosk: electronic terminal where rental transactions are made.

Bicycle: designed for short trips and constructed of customized components to limit theft and vandalism.

Dock: mechanism that holds bicycles, locks, and releases bicycles

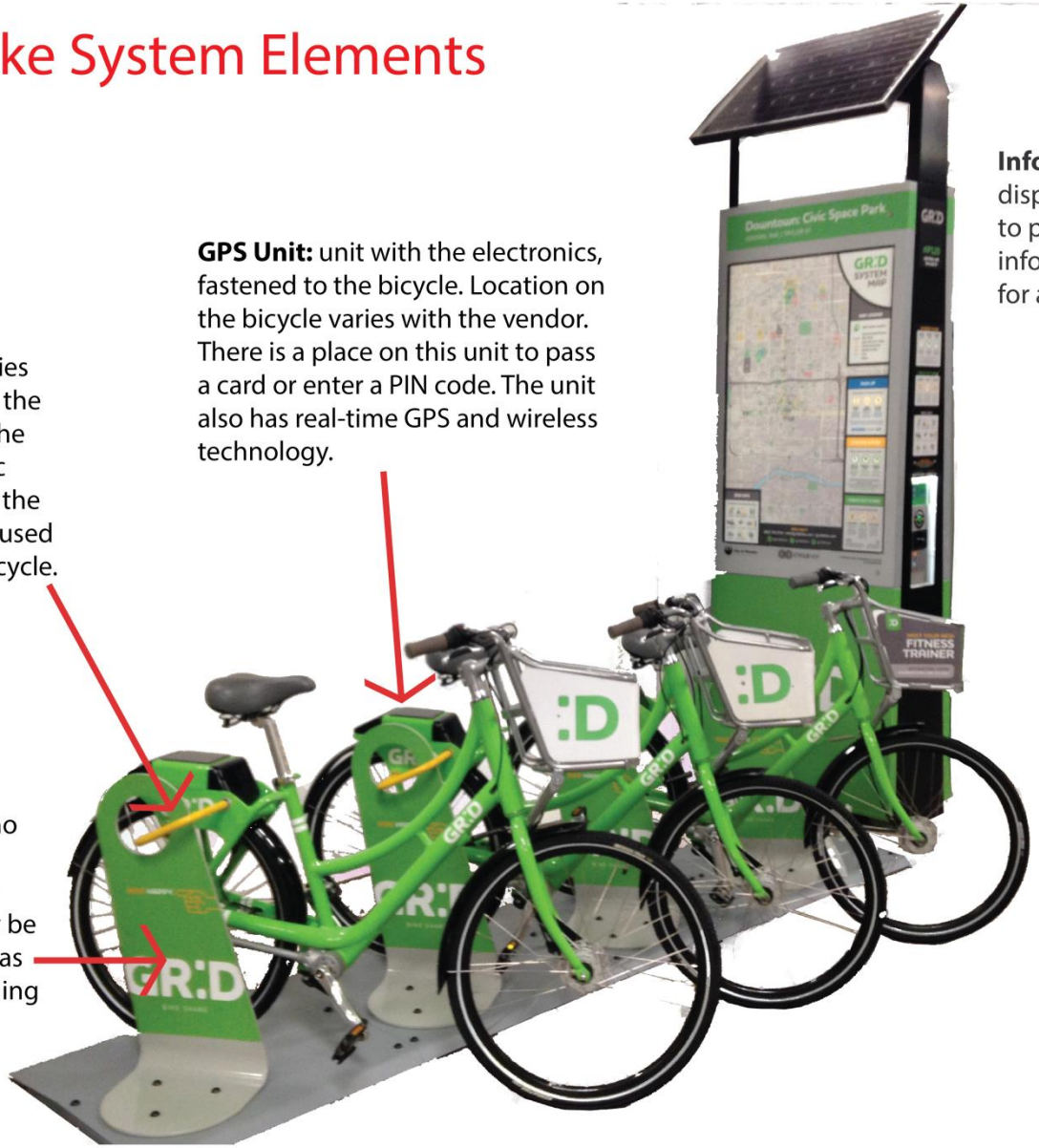
Informational Panel: a display that can be used to provide maps, information , and space for advertising.



Platform: structure that holds the kiosk, information panel, and docks. Most systems utilize wireless technology and solar power so that intrusion into the surface is not necessary. Most systems are modular, allowing various sizes and arrangements.

Figure 4 - Smart Dock System Elements

Smart Bike System Elements



Informational Panel: a display that can be used to provide maps, information , and space for advertising.

GPS Unit: unit with the electronics, fastened to the bicycle. Location on the bicycle varies with the vendor. There is a place on this unit to pass a card or enter a PIN code. The unit also has real-time GPS and wireless technology.

Lock: varies based on the vendor. The electronic aspect of the lock is housed on the bicycle.

Bicycle: specifically designed for short trips and constructed of customized components to limit their appeal to theft and vandalism

Dock: either be a "dumb dock" with no technology that accepts the locking mechanism, or may be any structure, such as a sign post, depending on the technology.

Figure 5 - Smart Bike System Elements

Table 1: Performance of Existing Programs in Comparable Cities.

	Phoenix, AZ	Denver, CO	San Antonio, TX	Minneapolis, MN	Salt Lake City, UT
System Name	Grid Bike Share	Denver B-cycle	San Antonio B-cycle	Nice Ride Minnesota	Green Bikes
Start Date	November 2014	April 2010	March 2011	June 2010	April 2013
Technology	Smart Bike	Smart Dock	Smart Dock	Smart Dock	Smart Dock
SYSTEM STATISTICS					
Number of Bikes	500	709	450	1,328	65
Number of Stations	50	82	53	146	11
Bikes per station	10.0	8.6	8.5	9.1	5.9
Service Area (sq. mi.)*	11.2	12.8	13.2	34	2
Station Density (stations per sq. mi.)**	4.5	6.4	4.0	4.3	5.5
MEMBERSHIP					
Cost of Annual Membership	$79	$80	$80	$65	$75
Cost of 24-Hour Membership	$5 / hour	$8	$10	$6	$5
Usage Fees	**Annual** members: 60 minutes free per day; $5 per additional hour; $25 daily maximum **Casual** members: pay as you go - $5 per hour **Other**: $2 "out of hub" parking fee	**All**: First 30 minutes free; $1 (31 -60 minutes); $4 (per additional 30 minutes)	**Annual** members: first 60 minutes free **Casual** users: first 30 minutes free **Usage fees**: Additional 30 minute increments: $2 **Daily maximum**: $35	**Annual** members: first 60 minutes free; $3 (60 – 90 minutes); $6 (additional half hours) **Casual** users: first 30 minutes free; $1.50 (30-60 minutes); $4.50 (60-90 minutes); $6 (additional half hours) **Daily maximum**: $65	**Annual** members: first 60 minutes free **Casual** users: first 30 minutes free **Usage fees**: Additional 60 minute increments: $3 **Daily maximum**: $72
Casual Members	n/a	51,153	26,031	54,451	9,689
Annual Members	n/a	4,023	1,824	3,500	308
RIDERSHIP					
Total Annual Trips	n/a	263,110	65,560	274,047	25,968
Annual Member Trips	n/a	63%	n/a	62%	n/a
Annual Casual Trips	n/a	37%	n/a	38%	n/a
Trips per Bike per Day	n/a	1.02	0.4	0.8	1.6
FINANCIAL					
Capital Funding	Private sources	DNC Legacy Fund, federal and state grants	Federal and state grants	Federal, state, county, and city grants; title sponsorship; contributions	Title sponsorship

	Phoenix, AZ	Denver, CO	San Antonio, TX	Minneapolis, MN	Salt Lake City, UT
Operating Funding	System revenues, sponsorship, and private sources	System revenues, sponsorship, and contributions	System revenues and sponsorship	System revenues, sponsorship, and contributions	System revenues and sponsorship
Operating Cost per Dock per Month	n/a	$114.13	$70.86	$30.77	$238.54
Farebox Recovery	n/a	64%	48%	62%	32%
BUSINESS MODEL					
Equipment Owner	Privately Owned	Non-Profit Owned	Agency Owned	Non-Profit Owned	Non-Profit Owned
Business Model	Privately Managed	Non-Profit Managed	Non-Profit Managed	Non-Profit Managed	Non-Profit Managed
Impetus Driven By	Mayor's Office and City staff	DNC Organizing Committee and Mayor's Office	City staff	Mayor's Office	City and Chamber of Commerce
City Role	Selected vendor / operator; planning assistance	Represented on Board; staff support	Office of Sustainability oversees the operating contract and seeks capital funding	Mayor serves as a Board member; funding partner	Founding partner; Mayor serves as a Board member, funding partner
Role of Others	Entirely privately owned and operated system	Variety of public / private Board members representing different sectors and skill sets	Non-profit Board consists of mainly private sector, but has a variety of skill sets.	Variety of public / private Board members representing different sectors and skill sets	System operated by Downtown Alliance; Other Board members include Chamber of Commerce, Tour of Utah, Visit Salt Lake, transit agency, and others

* Service area refers to the area of the city in which bike share stations are located.
** Number of stations per square mile within the service area.

Description

Denver B-Cycle is owned and operated by Denver Bike Sharing, a 501(c)(3) non-profit organization. It was implemented in 2010 with 50 stations and 500 bicycles and has expanded to a system of 82 stations and 709 bikes as of the end of 2013.

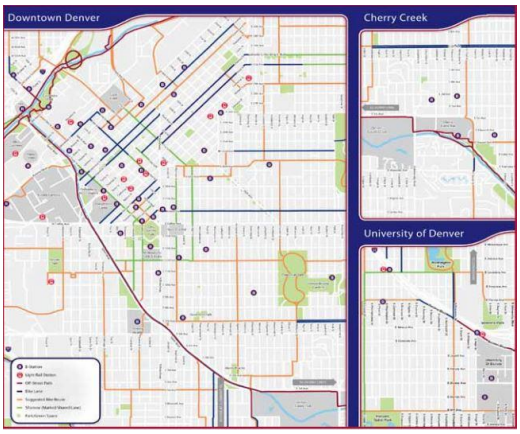
denver.bcycle.com

System Characteristics

Equipment:	B-Cycle
Equipment Type:	Solar/modular
Equipment Ownership:	Non-profit owned
Operator:	Denver Bike Sharing
Operations:	Year-round (365 days)

System Size[1]

Bikes:	709
Stations:	82
Docks[2]:	1,260
Days in Operation (2013):	365
Service Area:	12.8 sq. mi.
Station Density:	6.4 stations / sq. mi.

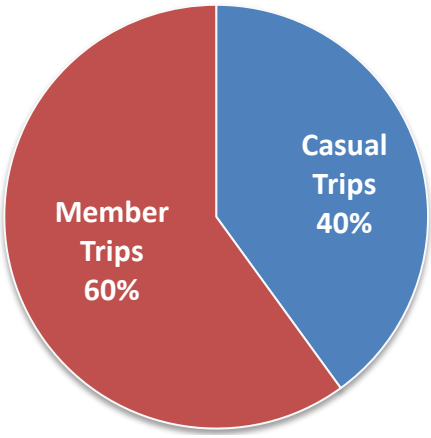


Demographics

City Population[3]:	649,495 (2013)
Metro Area Population[4]:	2,897,298 (2014)
Estimated Annual Tourists[5]:	13,600,000 (2012)
City Population Density[3]:	7,000 people / sq. mi.

Membership and Ridership (2013)[1]

Casual Subscriptions:	51,153
Annual Members:	4,023
Casual Subscriber Rides:	97,213
Annual Member Rides:	165,897
Total Rides:	263,110
Rides per annual membership:	41.2
Rides per casual subscription:	1.9
Population per bike:	916
Annual members per bike per 100,000 pop.:	0.87
Casual subscriptions per station:	624
Tourists per casual subscription:	233



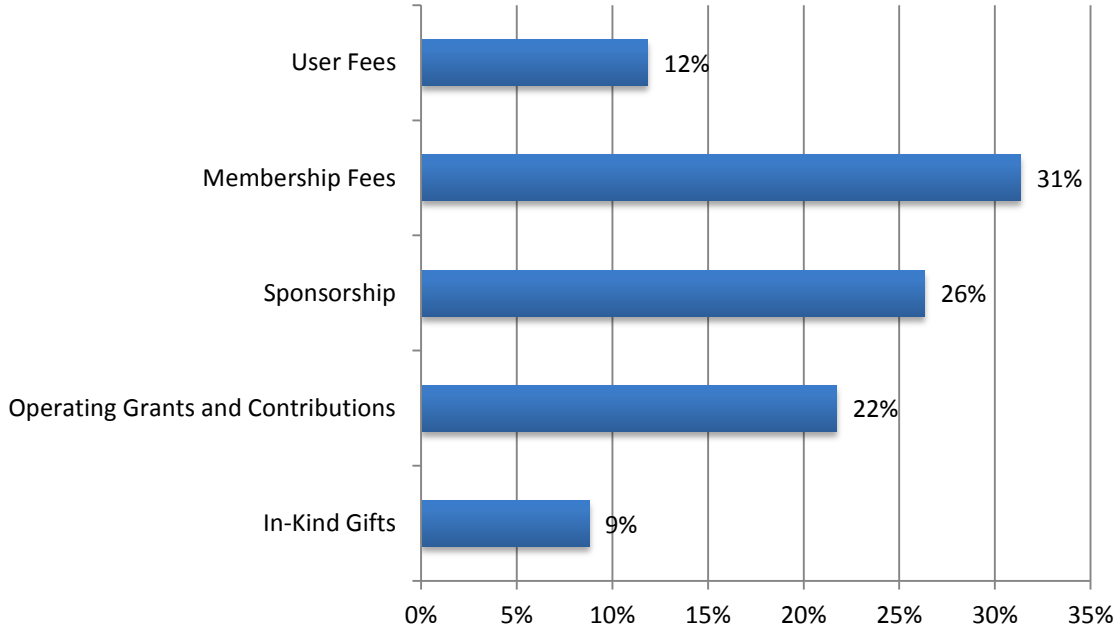
Total: **1.02** rides per bike per day

Business Model

The system was born out of a pilot program of 1,000 bicycles provided for the 2008 Democratic National Convention (DNC). The host committee chose bike share as one of the legacy programs to award $1 million from the DNC surplus. Community leaders and the City formed the Denver Bikesharing non-profit to own and manage the system. Operating revenues are generated from fundraising, sponsorship, membership and usage fees.

Membership Fees[6]		**Usage Fees**
Annual:	$80	First 30 minutes free
Monthly:	$30	Additional 30 minute increments:
Weekly:	$20	+ $1 (31 – 60 mins)
24 Hours:	$8	+ $4 (per additional 30 mins)

Breakdown of Operations Revenue



Operating Costs

Operating expense per bike per year:	$1,897.63
Operating expense per dock per month:	$114.13
Operating expense per ride:	$5.11
Fare box recovery[7]:	64%

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[1] Denver Bike Sharing Annual Report, 2013.

[2] Bike Share Map - Oliver O'Brien. http://bikes.oobrien.com/denver/November 2014

[3] United States Census Bureau. http://quickfacts.census.gov/qfd/states/08/0820000.html. 2014.

[4] http://www.metrodenver.org/do-business/demographics/population/ October 2014

[5] Visit Denver, http://www.denver.org/about-visit-denver/

[6] Denver B-Cycle Website, Rates. https://denver.bcycle.com/pricing.aspx. 2014

[7] Fare box recovery is the percent operating costs recovered from annual memberships, casual subscriptions, and usage fees.

Description

San Antonio B-Cycle launched in March 2011 as a 14 station/140 bike system in the downtown core. The system has since expanded several times to now be 53 stations and 450 bikes, increasing the density of stations downtown and extending the system north to Brackenridge Park and south along the San Antonio Mission Trail. The City of San Antonio owns the equipment and the system is managed and operated by San Antonio Bike Share, a specially formed non-profit organization.

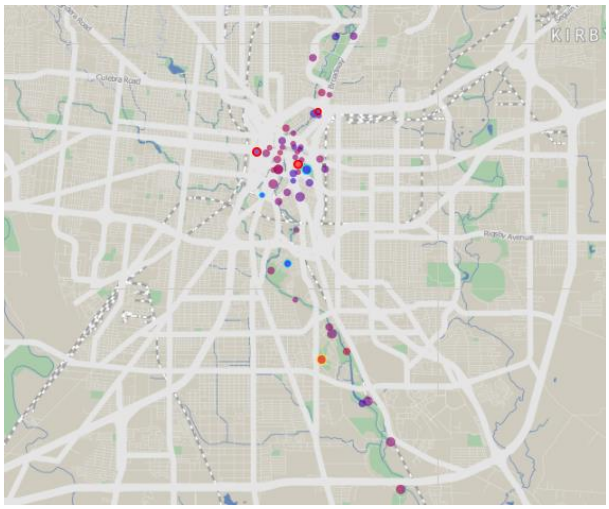
www.sanantonio.bcycle.com

System Characteristics

Equipment:	B-Cycle
Equipment Type:	Solar/Wired modular
Equipment Ownership:	City of San Antonio
Operator:	San Antonio Bike Share
Operations:	Year-round (365 days)

System Size[1]

Bikes:	450
Stations:	53
Docks[2]:	824
Days in Operation:	365
Service Area[3]:	13.2 sq. mi
Station Density:	4.0 stations per sq. mi

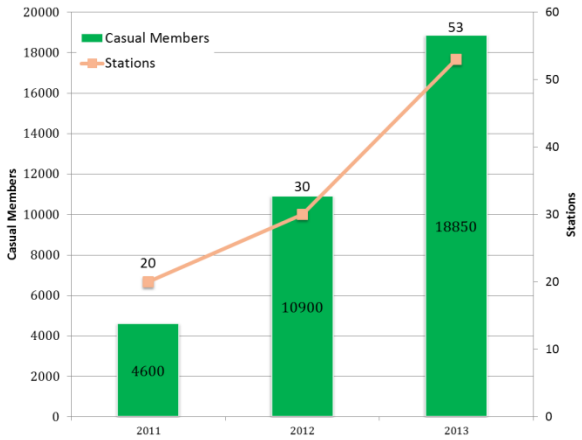


Demographics

City Population:[4]	1,382,951 (2012)
Estimated Annual Tourists[5]:	30,000,000
City Population Density:	2,880 people / sq. mi

Membership and Ridership[6]

Casual Subscriptions:	26,031
Annual Members:	1,824
Casual Subscriber Rides:	-
Annual Member Rides:	-
Total Rides:	65,560
Population per bike:	3,073
Annual members per bike per 100,000 pop.:	0.29
Casual subscriptions per station:	491
Tourists per casual subscription:	1,152



Total 0.40 rides per bike per day

Capital Funding Sources

Current System *(450 Bikes, 53 Stations)*

$841,579	American Recovery & Reinvestment Act (ARRA)
$403,522	Department of Energy
$42,645	Communities Putting Prevention to Work
$619,774	U.S. Department of Transportation Sarbanes Grant
$1,050,000	ARRA Energy Efficiency and Conservation Block Grant
$1,000,000	TxDOT

Business Model

The City of San Antonio initially issued a Request for Proposals for the system to be privately owned and operated but because of the type of funding secured for capital revised the business model so that the system's assets are owned by the City (the funds being administered by the Office of Sustainability) and the program is operated by a specially-formed non-profit.

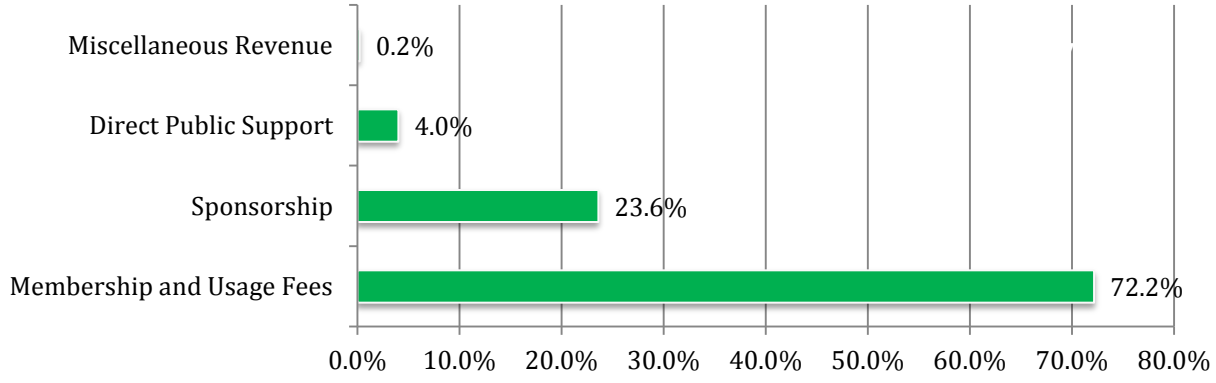
Membership Fees

Annual:	$80
7 days:	$24
24 hours:	$10

Usage Fees

Annual: First 60 minutes: no usage fee
Casual: First 30 minutes: no usage fee
Additional 30 minute increments:
$2 (each additional half hour)(max $35/day)

Breakdown of Operations Revenue[7]



Operating Costs

Operating expense per bike per year:	$1,933
Operating expense per dock per month:	$70.86
Operating expense per ride:	$6.91
Fare box recovery:	48%

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[1] As of April 2014
[2] Bike Share Map – Oliver O'Brien. http://bikes.oobrien.com/global.php
[3] Calculated as a best fit polygon with a ¼ mile buffer around existing stations
[4] 2012 US Census Estimates. State & County QuickFacts.
[5] www.visitsanantonio.com/nttw accessed on April 28, 2014.
[6] San Antonio Bike Share Annual Report, July 2012 – June 2013. At that time, the fleet consisted of 42 stations and 354 bikes.
[7] San Antonio Bike Share Annual Report, July 2012 – June 2013.

Description

Minneapolis Nice Ride launched in June 2010 in the City of Minneapolis and was expanded into Saint Paul the following year. To date, there have been no reported thefts and two crashes.

www.niceridemn.org

System Characteristics

Equipment:	PBSC Urban Solutions (Bixi)
Equipment Type:	Solar/modular
Equipment Ownership:	Non-profit owned
Operator:	Nice Ride MN
Operations:	Seasonally April through October

System Size

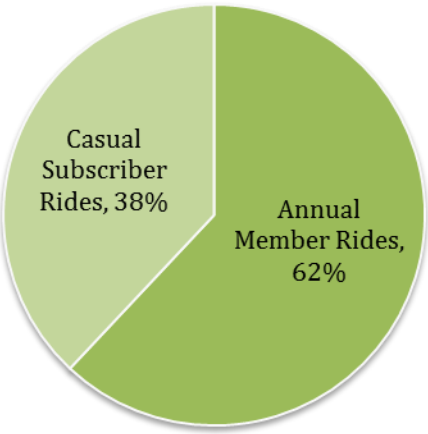
Bikes (Reported[1] | Active)	1,328 | N/A
Stations:	146
Docks[2]:	2,656
Service Area[3]:	34 sq. mi
Station Density:	4.3 stations/sq. mi

Demographics

System Population[4]:	683,650 (2012)
Metro Area Population[5]:	3,459,146 (2013)
Estimated Annual Tourists[6]:	17,900,000
System Population Density[7]:	6,559 people / sq. mi.

Membership and Ridership (2012) [1]

Casual Subscriptions:	54,541
Annual Members:	3,500
Casual Subscriber Rides:	103,850
Annual Member Rides:	170,197
Total Rides:	274,047



Rides per annual membership:	48.6
Rides per casual subscription:	1.9
Population per bike:	515
Annual members per bike per 100,000 pop.:	0.37
Casual subscriptions per station:	373
Tourists per casual subscription:	329

0.8 rides per bike per day

Funding Sources[1]

Expansion Funds *(through 2013)*

Public Funding	$5,063,000
Presenting Sponsorship	$2,675,000
Total Capital	$7,738,000

Business Model

The Nice Ride non-profit was established to own and manage the system with revenues generated from fundraising, sponsorship, membership, and usage fees. The system received considerable support from the City and in particular the Mayor's Office during the establishment of the system.

Membership Fees

Annual:	$65
Annual Student:	$55
30 Day	$15
24 Hours:	$6

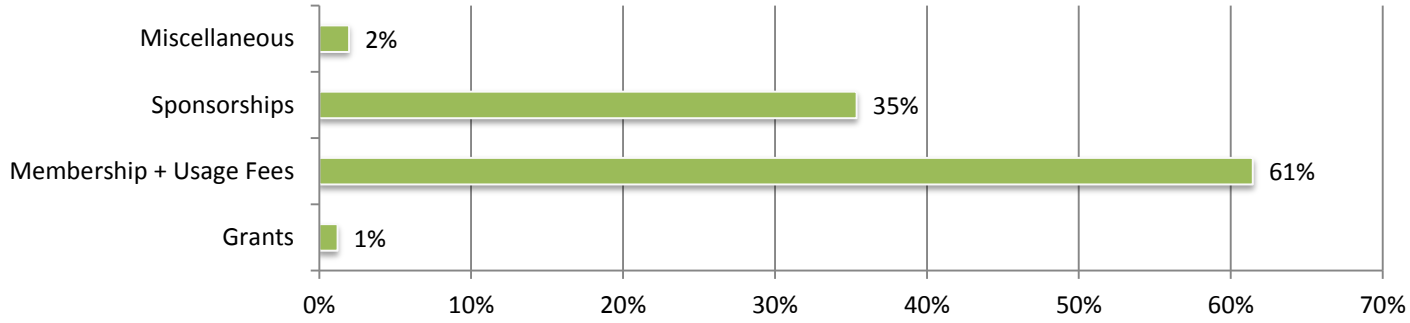
Usage Fees

Annual members: first 60 minutes free; $3 (60 – 90 minutes); $6 (per additional 30 minutes)

Casual members: first 30 minutes free; $1.50 (30 – 60 minutes); $4.50 (60 - 90 minutes); $6 (per additional 30 minutes)

Daily maximum: $65 per day

Breakdown of Operations Revenue (2012)[1]



Operating Costs[1]

Operating expense per dock per month:	$30.77
Operating expense per ride:	$3.58
Fare box recovery[8]:	62%

Equity Strategy

Target sponsored 600 free memberships for low-income residents. In addition, Nice Ride hired a staff person to sell discounted $20 memberships. The outreach resulted in a few partnerships and events but almost no subscriptions.[9]

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[1] Nice Ride Annual Report 2012, 2013 Mid-Season Update. Per dock per month cost calculated over 12 months, although system is not operational November through April.
[2] Bike Share Map – Oliver O'Brien. http://bikes.oobrien.com/global.php. 2012.
[3] Service area is calculated as the area encompassing every station plus a ¼ mile buffer around each station.
[4] The System population is calculated as the sum of the populations in Minneapolis and St. Paul. Population sources: United States Census Bureau. 2012. January 2014.
[5] US Census. http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk. 2014.
[6] Meet Minneapolis, http://www.minneapolis.org/sites/default/files/u7/pdfs/MediaKit_Meet.pdf
[7] The average system population density calculated as the average of the population densities in Minneapolis and St. Paul. Population and land area taken from US Census Quick Facts. January, 2014.
[8] Fare box recovery is the percent operating costs recovered from annual memberships, casual subscriptions, and usage fees.
[9] Bringing Bike Share to a Low-Income Community: Lessons Learned Through Community Engagement, Minneapolis, Minnesota, 2011, http://www.cdc.gov/pcd/issues/2013/12_0274.htm.

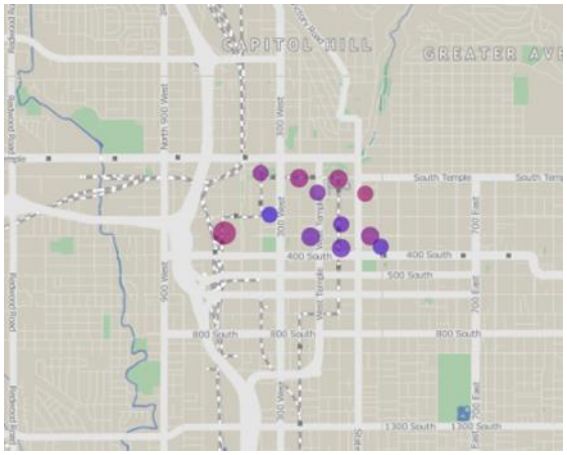
Description

GREENbike in Salt Lake City is a relatively new bike share system that opened in April 2013. It is primarily located downtown with 65 bikes at 11 stations. The operating model is unique in that GREENbike, SLC Bike Share is a 501(c)3 non-profit organization that is a public / private partnership between Salt Lake City, the Salt Lake Chamber of Commerce and the Salt Lake City Downtown Alliance. The system is operated by the Downtown Alliance. Local public funding and significant sponsorship was used to launch and operate the system.

www.greenbikeslc.org

System Characteristics

Equipment:	B-Cycle
Equipment Type:	Solar/modular
Equipment Ownership:	Non-profit
Operator:	Downtown Alliance
Operations:	24 hours, 7 days / week Closed for winter



System Size[1]

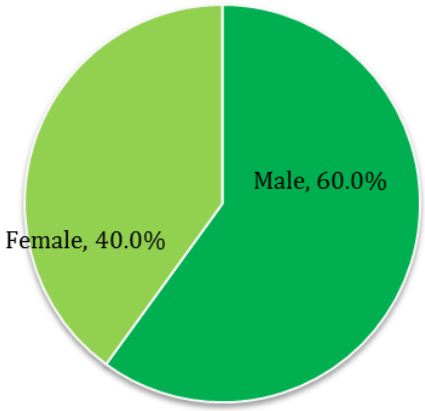
Bikes:	65
Stations:	11
Docks:	165
Days in Operation (2013):	251
Service Area (Mi^2):	2
Station Density (Stations/Mi^2)	5.5

Demographics[2]

City Population:	189,000 (2012)
Metro Area Population (approx.):	1,100,000 (2012)
Estimated Annual Tourists:	N/A
Average System Population Density:	1,678 people / sq. mi.

Membership and Ridership (2013)[3]

Casual Subscriptions:	9,689
Annual Members:	308
Casual Subscriber Rides:	-
Annual Member Rides:	-
Total Rides:	25,968
Population per bike:	2,910
Annual members per bike per 100,000 pop.:	2.5
Casual subscriptions per station:	880
Tourists per casual subscription:	-



Total 1.6 rides per bike per day

Funding Sources[3]

Initial System (65 Bikes, 11 Stations)

Capital

Title sponsors – Select Health

Operations

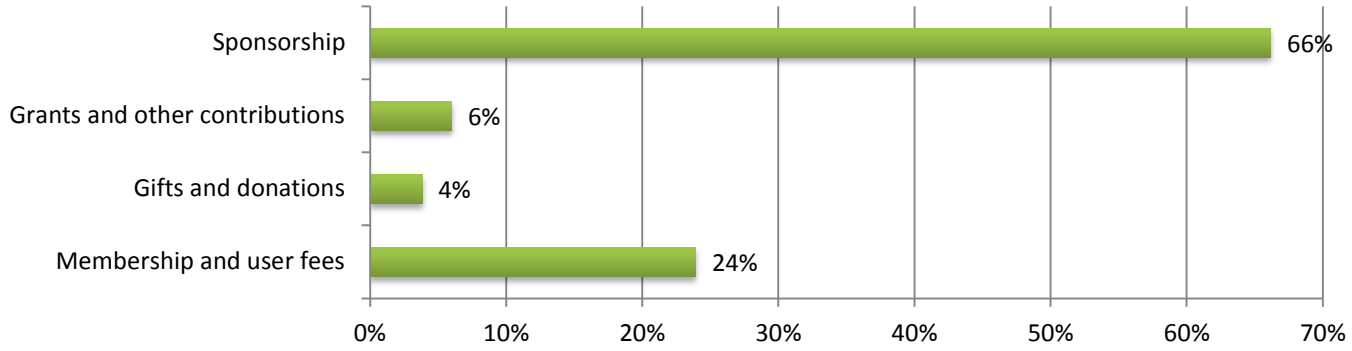
Basket sponsor – Rio Tinto
Nine station sponsors - various
Membership card and helmet sponsors

Business Model

The impetus for a bike share system was driven from the Mayor's Office. However, the City did not have the funds to launch the system and so asked the Downtown Alliance if they would take on responsibility for developing a business model and seeking funds for the system. The Downtown Alliance secured a title sponsor and other sponsors sufficient to launch and maintain operations for an 11 station system in 2013.

Membership Fees[4]		**Usage Fees[4]**
Annual:	$75	Annual members: first 60 minutes free
Annual Discounted:	$56	Casual members: first 30 minutes free
4-Day Pass:	$15	Usage fees:
24 Hour Pass:	$5	$3 (additional hours); (max $72/day)

Breakdown of Operations Revenue[1]



Operating Costs[1]

Operating expense per bike:	$4,844
Operating expense per dock per month:	$238.54
Operating expense per ride:	$12.13
Fare box recovery:	32%

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[1] Information provided by GREENbikes on October 15, 2014.

[2] United States Census Bureau (2012). July 2014.

[3] Information provided by GREENbikes on October 15, 2014 and http://utahpolicy.com/index.php/features/featured-articles/2344-live-work-play-bike. Accessed July 2014.

[4] Rates taken from GREENbikes website: https://www.greenbikeslc.org/pricing.aspx Accessed on November 24, 2014.

Pricing structures are similar in most peer city systems offering annual membership for between $65 - $80 and 24-hour passes for $5 to $10. Many of these systems offer annual members a 60-minute free ride period and casual users a 30 minute free rider period. Phoenix, along with a number of systems in planning, will use a different fee structure to try and increase system revenues from annual members who currently make the majority of trips in the system but pay the least. Grid Bike Share will offer annual membership that allows members 60 minutes of free time per day (rather than per ride). Casual memberships will be replaced with a $5 per hour pay-as-you-go rental option.

Although the peer city systems vary in size (from 11 to 146 stations), all of these systems provide stations at densities between 4.0 to 6.5 stations per square mile. Peer cities have observed differing levels of success in terms of membership and ridership but in all systems, these statistics have increased each year, e.g., Minneapolis has seen a 40% increase in total trips since its first full year of operation in 2011 and Denver B-cycle has experienced a nearly 30% increase in the same time period. Ridership rates varied between 0.4 to 1.6 trips per bike per day. It is uncertain all of the factors that influence ridership rates, but in the case of the peer cities the lowest density systems also experienced the lowest ridership.

The case studies show that there is no single "right" way to form, implement, or operate a bike share system in a medium sized community. In all cases, cities have built on the momentum created by those championing the idea. In some instances this is a community group (such as in Boulder and Aspen[2]), a business improvement association (such as in Salt Lake City), or through the local transit agency (in the case of Fort Worth). However, most systems receive their impetus from city government, and, in particular, programs have tended to be most successful (especially in obtaining capital and sponsorship dollars) when there has been early and visible mayoral support for the program.

There is also no one "right" business model. The advantages and disadvantages of different business models will be discussed in detail as part of a future section of this report. Although the case study cities show that a popular model for mid-sized communities is to include a non-profit (given their ability to receive funding from a variety of sources, generally community-minded mission, and ability to reduce operating costs through in-kind services), there are several new models being considered in other cities, e.g., the privately owned and operated business model in Phoenix (it will be the first mid-sized city to operate under this model – which was previously found only in large tourist markets such as New York City and Miami Beach) and a city-operated system in Boise, ID (which will be the first time an agency has taken on operations).

Capital and operating costs generally come from a variety of sources, with the most prevalent capital sources being use of federal or state grants with a local match. Operating revenues generally come from a combination of system revenues (membership and usage fees) and sponsorship / advertising. In mid-sized communities, system revenues generally cover only a portion of the operating cost (ranging from 32% in Salt Lake City to 64% in Denver). In mid-sized communities there is some potential to attract a

[2] The WE-Cycle system in Aspen, Colorado was also established through the grass-roots efforts of local champions of the concept.

system-wide sponsor as well as numerous smaller sponsors. This can take significant time and effort to identify, commit, and retain sufficient sponsorship to make the system financially sustainable.

Phoenix launched a smart-bike system in November 2014. The early impetus for bike share came from Mayor Stanton, who saw the creation of a bike share system as an early initiative of his downtown sustainability platform. The City of Phoenix had applied for capital funding through CMAQ in a joint application with the City of Tempe. However, the Mayor's interest in launching bike share sooner than the federal funding would allow, led Phoenix to issue a Request for Proposal with no public funds seeking a company to purchase, implement, operate, and maintain a bike share system in the City of Phoenix, with possible future expansion to the Cities of Tempe and Mesa. The RFP received two respondents and the City selected CycleHop to own and operate the system using smart-bike technology provided by Social Bicycles.

The Cities of Mesa and Tempe are not part of the initial system launch, but could join through an add-on clause in the contract that would allow any community in Arizona, including Tucson, to add onto the contract without having to go through separate procurement.

The Phoenix system, named Grid Bike Share, will be a privately owned and operated system that is funded by system revenues, sponsorship, and advertising. The system was scheduled to be the first large scale deployment of smart bikes and was initially scheduled to launch in December 2013 however was delayed several times because of equipment development and supply issues. Grid Bike Share launched on November 25, 2014.

Potential Benefits and Risks

From the experience of other U.S. bike share programs, this section summarizes some of the potential benefits and risks associated with a bike share program in Tucson and focuses on the areas of mobility and transportation, economic and financial performance, health, environment, and safety.

It is important that both the potential benefits and the potential risks be considered so that an informed decision can be made on the feasibility of bike share in Tucson.

Mobility and Transportation

Mobility and Transportation Benefits

Bike share trips tend to be short – between one to two miles in length and about 20 minutes in duration. As a result, they provide an option for trips too far to walk but inconvenient or too short to wait for transit.

Many bike share users combine their membership with transit, car share, walking, and other transportation options to reduce their dependency on automobile travel. In some places, this has resulted in a fundamental shift in trip-making and household vehicle ownership. In addition, cities have found that bike share contributes positively to people's perception and enjoyment of the city.

One of the biggest opportunities in Tucson is the chance to use bike share to augment the city's recent investment in Streetcar. Bike share offers a first and last mile transportation option that could extend the reach of existing fixed route services, simplify connections between routes, and relieve over-capacity transit services delaying the need for costly increases in bus service frequency or additional fleet capacity.

The connection to transit is highlighted in other communities. For example, the most popular stations in each of the five communities in which Bay Area bike share operates are at the Caltrain Stations. In Washington D.C. over half (54%) of respondents to Capital Bikeshare's member survey stated that at least one of their bike share trips in the previous month had started or ended at a Metrorail station[3]. A study by the University of Maryland[4] found that 6 of the 7 busiest stations in the Capital Bikeshare system were located at Metrorail Stations and that bike share ridership is associated with higher transit ridership. Seventy-eight percent of Boulder B-cycle annual members also have a transit pass and 34-percent use the system to connect to transit[5].

Recognizing that transit agencies are important partners in bike share programs, the Federal Transit Administration (FTA) has funded several different systems including in Boston and Chattanooga. To be eligible for FTA funding stations must be within a 3 mile radius of transit and funds can be used towards

[3] LDA Consulting (2013). *2013 Capital Bikeshare Member Survey Report.* Accessed online at http://capitalbikeshare.com/assets/pdf/CABI-2013SurveyReport.pdf on December 13, 2013.

[4] *Bicycle Sharing and Transit: Does Capital Bikesahre affect Metrorail Ridership in Washington, D.C.?* Ma, Ting et. Al. Accessed online at: http://smartgrowth.umd.edu/assets/bikeshare_transit_for_parisws_v1.pdf on November 20, 2014

[5] Boulder B-cycle *2013 Annual Report.* Accessed online at: https://boulder.bcycle.com/LinkClick.aspx?fileticket=AyhiVuJAAfI%3D&tabid=1104 on November 24, 2014.

bike share docks, equipment and other capital costs (the cost of the bikes and operating costs are not eligible)[6].

Bike share has also been effectively used to quickly and affordably introduce new riders to bicycling. It reduces many of the common barriers to entry for new bicyclists such as new riders do not need to own a bicycle to ride, they do not have the concern of storing or maintaining a bicycle, nor do they have the concern that the bike will be stolen when it is parked. A survey of Hubway members in Boston found that 12% bicycled less than once per year prior to joining Hubway and a further 16% bicycled less than once per month prior to joining[7].

Tucson is already recognized as a gold-level bicycling friendly city by the League of American Bicyclists[8]. The addition of more bicyclists could provide the impetus for further investment in bicycling facilities and make a push towards platinum BFC status. **Figure 6** shows an example of how the City of Boston increased its on-street bikeways in conjunction with the implementation and launch of bike share.

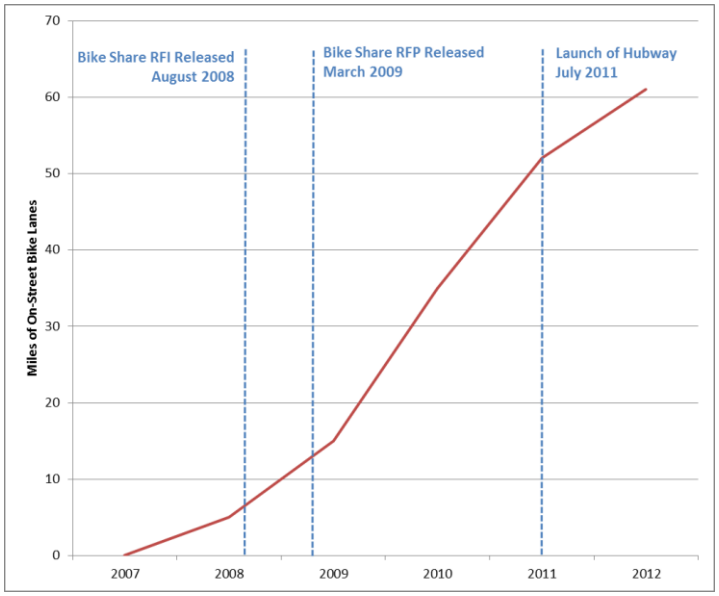

Figure 6: Increase in On-Street Bikeways in Boston with the Launch of Bike Share.

Mobility and Transportation Risks

Although 20-40% of bike share trips replace single occupancy vehicle trips,[9,10] the remainder of trips are entirely new trips, augment public transit trips, or may actually replace public transit or walking trips. A full, holistic analysis of the impact of bike share on public transit and active transportation has not been undertaken. However, some bike share trips may detract from other public transit or active transportation trips.

Economic and Financial Performance

Economic and Financial Benefits

There are a number of economic benefits that bike share offers at a community, business, and individual level.

[6] Federal Transit Administration's *Frequently Asked Questions and Answers Concerning Bike Sharing Relative to the United States Department of Transportation.* Accessed online at http://www.fta.dot.gov/documents/Informal_Q_and_As_Final_6-14-12.pdf on December 26, 2013.
[7] Presentation titled The Hubway Influence on New Riders given by Nicole Freedman, 2013. Accessed online at: http://baystateroads.eot.state.ma.us/movingtogether/docs/Freedman-Moving%20Together%202013.ppt.pdf.
[8] http://bikeleague.org/community
[9] National League of Cities (2011) Integrating Bike Share Programs into a Sustainable Transportation System.
[10] Nice Ride Minnesota (October 2011) Presentation about Nice Ride Minnesota.

At a community level, bike share is recognized as a means for attracting or retaining residents, students, and workforce talent. Many communities use it as a tool in their (re)vitalization and redevelopment efforts and to promote their image as a forward thinking, bicycle friendly community. Bike share embraces new technology, social media, and is part of the new sharing economy, which are attractive characteristics to younger demographics and professionals.

Bike share also serves visitors and is a unique way for tourists to see a city, helping attract their spending power. The amount of national and international press coverage generated by a bike share system would serve to emphasize the city to visitors, businesses, and employers. For example, the launch of Charlotte B-cycle in North Carolina received exposure in 18 newspapers including the New York Times[11].

There have been several studies into whether businesses located near bike share stations have seen an economic benefit. A recent study of annual members of the Nice Ride system in Minneapolis / St. Paul found that annual members made a number of commercial trips that they would otherwise not have made because of bike share. Based on the average amount that respondents' spent for these trip types, the researchers calculated that Nice Ride annual members created an additional $150,000 in economic activity at local businesses over the course of one bike share season[12].

A study of five Capital Bikeshare stations in 2013 also suggests a positive economic impact on surrounding commercial areas[13]. A majority of riders travelling to these stations spent money within a four block area and planned to return to the neighborhood on a regular basis. Further, approximately 20-percent of riders to these stations would not have made the trip if not for bike share, suggesting that bike share generated new spending trips to these commercial areas. A survey of businesses around these stations showed that 70-percent believe that Capital Bikeshare has had a positive impact on their neighborhood and approximately 60-percent would like to see more stations.

For employers and local businesses, bike share may be an addition to a company's health and wellness program or become part of their travel demand management program. Many bike share programs offer corporate membership packages with memberships sold at a discounted rate.[14]

Most bike share systems rely on sponsorship to generate operating revenues. This may be an opportunity for local businesses to get exposure in a particular market or location.

A bike share system creates a small number of local jobs operating and maintaining the system.

For individuals, the economic benefits come in the form of reduced household expenditure on transportation and health care, which combined make up over 22% of annual average household expenditure in the United States[15]. Compared to the cost of operating an automobile, bike share

[11] From the Sponsor's Perspective (2013). Accessed online at www.bikeshare.com on December 12, 2013.
[12] Schoner, J.E., Harrison, A. and Wang, X. (2012). Sharing to Grow: Economic Activity Associated with Nice Ride Bike Share Stations. Humphrey School of Public Affairs, University of Minnesota.
[13] *Economic Impact & Opperational Efficiency for Bikeshare Systems. Anderson, Ryan et al,. Accessed online at: http://ralphbu.files.wordpress.com/2014/01/virginia-tech-capital-bikeshare-studio-report-2013-final.pdf on ovember 19, 2014.*
[14] Hubway Corporate / University Accounts, accessed online at http://www.thehubway.com/corporate on December 27, 2013.
[15] U.S. Department of Labor, Bureau of Labor Statistics, Consumer Expenditure Survey, 2010.

membership is relatively inexpensive with most programs costing between $50 and $100 per year. In comparison, the median cost of annual car ownership is approximately $9,100[16]. Annual members of Capital Bikeshare in Washington D.C. saved an average of $800 per year on personal transportation costs[17].

Economic Risks

Most bike share systems are not economically self-sustaining, i.e. operating costs are greater than system revenues. Therefore, the organization responsible (public agency, non-profit, or private company) must ensure that the requisite funding is available to support capital purchases, expansion, and ongoing operations. If membership and ridership are not significant, then the cost of operations needs to be recouped through other funding sources.

Based on stakeholder conversations, there are likely only few potential large sponsors for a bike share system in Tucson. It is likely that the system owner will need to employ a multi-pronged strategy towards sponsorship, which includes title and/or presenting sponsorship as well as station, bike and other types of smaller sponsorships.

Although there are several examples in North America where the initial business model was not initially successful (e.g., Montreal, Ottawa, Toronto, New York), all systems to date have identified a new business and/or ownership model. Should such an occurrence happen, or if a system doesn't garner high ridership or membership, it can reflect negatively on a city's image.

There has been a fear in many communities that bike share will threaten local bike rental businesses. Some actions have been taken to reduce this risk including developing a price structure to deter long term rental of the bike share bikes and identifying bike rental and retail locations on the station maps. The impact is expected to be limited as the bike rental shops in Tucson rent out high-end road bicycles.

Health

Health Benefits

The health benefits of bicycling are well known in helping to address preventable diseases such as obesity, heart disease, and diabetes[18,19]. As such, bike share can have a positive impact on both physical and mental health.

Nearly a quarter of the adult population in Pima County is obese[20] and bike share is a means for people to incorporate active transportation into their daily lives and lower medical and health care costs.

[16] For comparison, the median annual cost of car ownership is approximately $9,100 based on information from www.consumerreports.org accessed on December 12, 2013.

[17] 2013 Capital Bike Share Annual Member Report. Page vii. accessed online at http://www.capitalbikeshare.com/assets on November 18, 2014.

[18] British Medical Association (1992). Cycling Towards Health and Safety. Oxford University Press.

[19] Lindström, J. et al. The Finnish Diabetes Prevention Study: Lifestyle intervention and 3-year results on diet and physical activity. Diabetes Care, December 2002, vol. 26 no. 12 3230-3236. Accessed online at http://care.diabetesjournals.org/content/26/12/3230.full on December 13, 2013.

Additionally, businesses in the health care industry may be interested in sponsoring part of a bike share system as part of a public health and prevention strategy.

A study of the Bicing bike share system in Barcelona, Spain published in the British Medical Journal in 2011 compared the benefits of increased physical activity to the additional risks introduced from increased inhalation of air pollutants and increased exposure to traffic crashes. The study found that over 10 deaths were avoided each year due to increased physical activity, offsetting any smaller increases in expected deaths from air pollutant inhalation and traffic crash exposure[21].

The health benefits of bike share are recognized by the health care industry. The federal government, through the Center for Disease Control (CDC), has funded several different systems including in Boston and Nashville. The private sector is also represented with many bike share systems in the United States supported by health care providers such as Blue Cross Blue Shield (Nice Ride Minnesota) and Kaiser Permanente (Denver B-cycle) through partnerships and sponsorships[11].

Health Risks

Safety is a large concern for bike share users; however, thus far the safety record for bike share systems has been impressive. This risk is described more in the Safety Risks section below.

Environmental

Environmental Benefits

Bike share can reduce greenhouse gas emissions by replacing trips taken previously by automobile. These impacts can be multiplied when bike share is used in combination with transit and other modes to reduce dependence on automobile use and change travel patterns.

In communities where bike share is a transportation option, surveys have shown that approximately 20 – 40 percent of annual member bike share trips replace what would have been an automobile trip[9,10]. A survey of Capital Bikeshare members in Washington D.C. in 2011 showed that bike share trips had replaced approximately 4.4 million vehicle miles[17], representing a 4% decrease in the city's annual driving mileage[22].

For individuals, most bike share systems offer member logins where people can track the amount of greenhouse gas emissions avoided through their bike share trips. Employers can also use these statistics to help track the organization's greenhouse gas emission reductions and foster competition among employees to see who can ride the most or the farthest.

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[20] Pima County Health Department (2014). State of the County's Health. Accessed online at http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Health/Health%20Data,%20Statistics%20and%20Reports/State%20of%20the%20County%2001-29-2014%20[Compatibility%20Mode].pdfl on October 13, 2014.

[21] Rojas-Rueda, D. et. al. (2011). The Health Risks and Benefits of Cycling in Urban Environments Compared with Car Use: Health Impact Assessment Study. British Medical Journal 2011; 343:d4521. Accessed online at: http://www.bmj.com/content/343/bmj.d4521 on January 2, 2014. Statistics reported are based on the sensitivity analysis that assumes 10% of Bicing trips replace car trips.

[22] Federal Highway Administration, Highway Statistics 2011: Urbanized Areas – 2010 Miles and Daily Vehicle – Miles Traveled. Accessed online at http://www.fhwa.dot.gov/policyinformation/statistics/2011/hm71.cfm on December 27, 2013.

Environmental Risks

A major part of bike share operations is rebalancing the system – that is, moving bikes around from full stations to empty stations to ensure the availability of bicycles and empty docking points. Typically, this operation is undertaken by vans. Because of the relatively high cost and low availability of non-GHG options, there are few operations that utilize electric or other environmentally friendly vehicles. There have been no studies on the emissions of such vehicles, or other aspects of operations, on the overall environmental impact of a bike share system. However, this negative impact should be noted.

An important issue raised by local stakeholders was the impact of extreme heat both on ridership and on the comfort and performance of the equipment[23]. Other cities have observed dips in ridership on hotter days. In terms of equipment protection, none of the bike share equipment vendors in the United States currently offer covered stations. However, a Japanese company has constructed a solar charging station for a fleet of electric bikes that it makes available for community use[24] and there are American companies that manufacture solar-powered, covered stations for electric car and electric bicycle recharging (see **Figure 7**)[25]. Covering bike share stations would add significant cost and make station placements more permanent. These impacts will need to be considered in planning the system. Please note that no such systems have been implemented to date in the US.

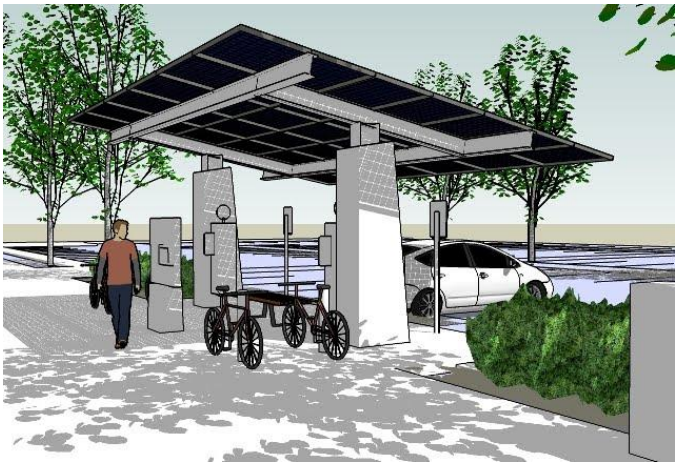

Figure 7: Illustration of a Solar eBike Charging Station in Portland, Oregon.

Safety

Safety Benefits

Safety has been a concern to all cities that have implemented bike share. However, although still relatively new, bike share has an extremely impressive safety record. To date, no system in the United States has recorded a fatality and the rates of injury crashes are typically lower than

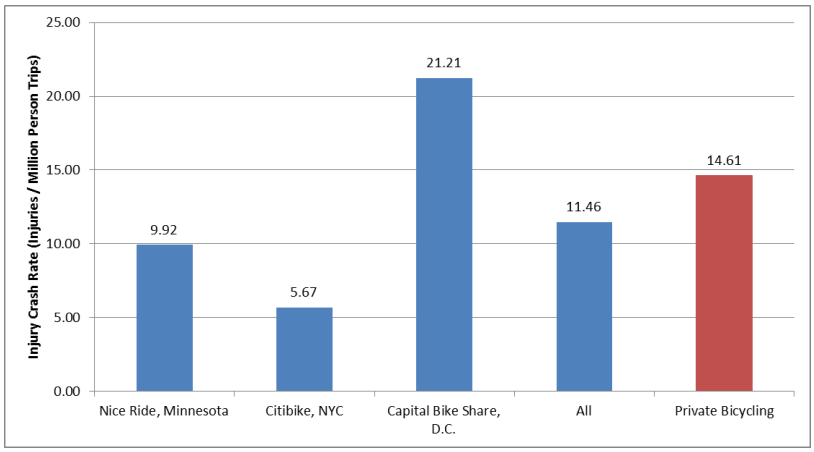

Figure 8: Comparison of Injury Rates for Bike Share and Private Bicycling.[26]

[23] City staff identified several issues with solar powered ticket vending machines at Streetcar stations malfunctioning due to the heat of the sun melting certain components.
[24] http://inhabitat.com/sanyo-installs-solar-parking-lots-in-japan-for-electric-hybrid-bicycles/ Accessed on November 24, 2014
[25] http://breakfastonbikes.blogspot.com/2010/07/omsi-first-out-with-sanyo-solar-ebike.html Accessed on November 24, 2014

private bicycling, as shown on **Figure 8**[26].

Introducing more riders to a community has a "safety in numbers" effect. Millions of bike share trips were taken in almost 30 U.S. cities in 2013 significantly increasing the number of bicycling trips in these cities. For example, in New York, there were an additional 40,000 bike trips per day due to Citi Bike and bike share trips made up approximately 29% of the 113,000 daily bicycle trips made within the bike share service area.

Along with the high visibility of stations, the high volume of riders results in greater awareness of bicyclists by drivers. In fact, the "safety in numbers effect" is well established. A study published in Injury Prevention in 2003 showed that the "likelihood of a person walking or bicycling being struck by a motorist varies inversely with the amount of walking and bicycling"[27].

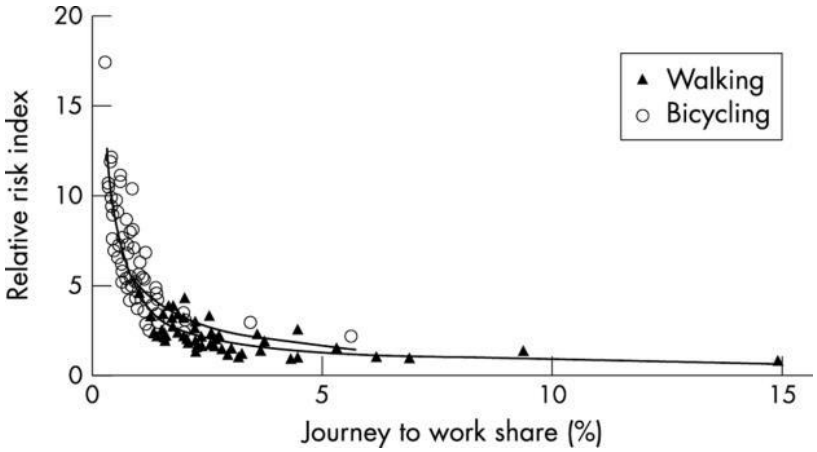

Figure 9: Walking and Bicycling Injury Rate (Relative Risk) in 68 California Cities in 2000. [24]

Exposure of riders to road rules and safety hints through safety messaging at bike share stations and websites.

Bike share provides a unique opportunity to communicate with riders about road rules and regulations and safety hints through safety messaging at bike share stations, on the program website, through social media, and on the bicycle itself. Messaging may include:

- Don't ride on sidewalks.
- Ride with the flow of traffic.
- Watch out for car doors.
- Encouragement of helmets and communication about where to purchase a helmet.
- Watch out for right-turning vehicles.

The strong safety record of bike share is also impacted by the introduction of bikes with many built in safety features. The features of the bicycle are shown on **Figure 10** and include:

- Built-in front and back lights, brakes, and reflectors.
- An upright position for the rider.

[26] Only Capital Bikeshare has a higher injury crash rate than private bicycling. It is uncertain why the injury crash rate is higher in Capital Bikeshare than in other systems and higher than the private bicycling rate.

[27] Jacobsen, P.L. (2003). *Safety in Numbers: More Walkers and Bicyclists, Safer Walking and Bicycling*. Injury Prevention 2003;9:205-209. Note that the injury rate (referred to as the "relative risk index") reduces exponentially with the number of bicyclists using the road system (in this case using journey to work mode share as a proxy for the overall amount of bicycling).

- A heavy bike (typically 40-45 lbs) with wide handlebars where riders generally keep slow speeds and do not weave in traffic.

In addition, the operator undertakes regular maintenance of the bike fleet to ensure safety.

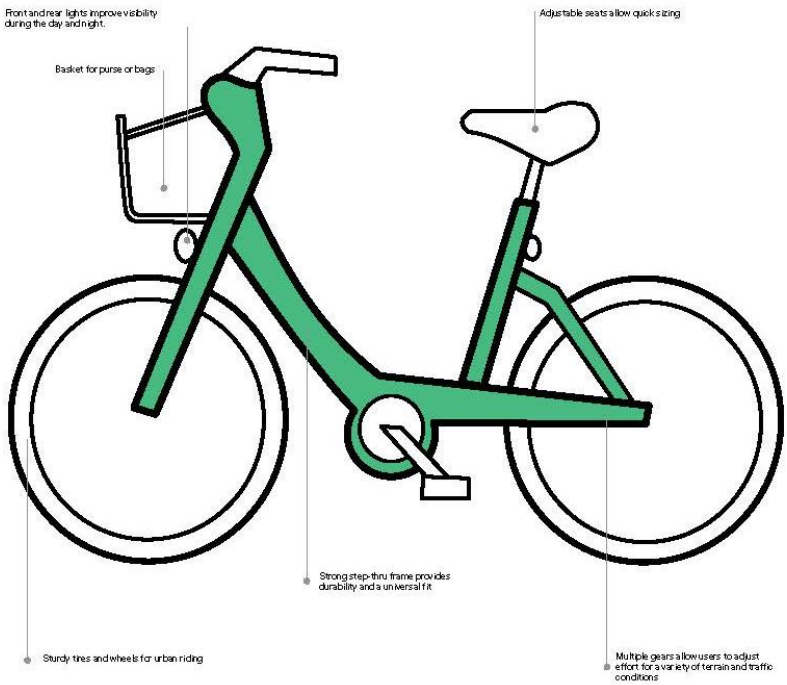

Figure 10: Safety Features of the Bike Share Bicycle. [28]

Safety Risks

Many communities have had strong concerns about safety prior to implementation, including:

- Lack of bicycle infrastructure for safe cycling (see the Mobility and Transportation section).
- Introducing inexperienced riders to the streets.
- Low helmet usage rate among bike share users (a study of bike share trips in Boston and Washington D.C. showed that less than 20% of bike share riders wore a helmet[29]).
- Pedestrian concerns of riders breaking rules such as riding on the sidewalk or against traffic (particularly for the elderly pedestrian population).

Although the safety risks are real and should be mitigated, none of these considerations have proven to be a significant deterrent for any existing systems. This is evidenced by the strong safety record of bike share in almost all communities that it has been introduced.

[28] Atlanta Bicycle Coalition (2013). Atlanta – Decatur Bike Share Feasibility Study. Accessed online at: http://issuu.com/atlantabike/docs/atl-dec_bikeshare_book_lowres# on January 2, 2014.

[29] Fischer, C.M. et al. (2012). Prevalence of Bicycle Helmet Use by Users of Public Bikeshare Programs. Published in the Annals of Emergency Medicine, Vol. 60, Issue 2, pp. 228-231.

One of the major concerns in Tucson is the interaction of bike share bicycles with the Streetcar tracks. In general, cities with streetcar or light rail tracks often see an increase in bicycle crashes related to bicycle tires getting caught in the streetcar tracks.

The Living Streets Alliance conducted an 18-month study of bicycle crashes resulting from the interaction with Streetcar tracks. Crashes were reported online using a self-reporting tool established for the study. A total of 86 crashes were reported between August 2012 and April 2014[30]. The majority of crashes were reported as no injury or only minor injuries (including minor cuts, scrapes, or bruises), however 30-percent of crashes were reported as major cuts, broken bones, or a visit to the hospital. The major reported crash causes included:

- Approximately 43-percent were attributed to the bicyclist simply crossing at a bad angle or otherwise getting their tire stuck in the tracks.
- Approximately 40-percent were attributed to the bicyclist having to take some evasive action to avoid vehicles, obstacles or other incidents occurring in the bike lane.
- Approximately 14-percent were attributed to the physical environment, i.e., the bicyclist having to maneuver around some sort of roadway design feature.
- Approximately 3-percent were attributed to the tracks being wet or obscured following rain.

Although crashes were reported along the entire Streetcar route, there were clusters of crashes at the Main Gate area, thought to be the result of double-parked cars, taxis, loading, and large numbers of pedestrians requiring bicyclists to swerve into the streetcar tracks. Other large clusters were reported at the 4th Avenue intersections with Toole Avenue and University Avenue.

Nevertheless, a survey of six cities that have both streetcar or light rail and an operating bike share system including Charlotte, Denver, Kansas City, Minneapolis, San Francisco, and Seattle reported only one streetcar-related bicycle crash where a rider fell on the Muni tracks in San Francisco. Some of the reasons for the better safety record of bike share bicycles around streetcar tracks are the wider tires of the bicycles (that do not fit all the way into the track) and the generally more cautious behavior of bike share riders.

Summary of Benefits and Risks

Bike share provides a multitude of mobility, transportation, community-building, economic, health, environmental, and safety benefits. However, there are also risks associated with launching a bike share program.

Some of the major benefits that bike share could bring to Tucson include:

- Providing an additional transportation option that by itself or combined with other options presents an opportunity to reduce dependence on automobile transportation.

[30] http://www.livingstreetsalliance.org/our-work/projects/streetcar-crash-data/. This may not include all bicycle crashes resulting from interaction with the streetcar tracks as some bicyclists may not have known about the self-reporting tool. Note that there were no reports of crashes involving the bicyclist being struck by other vehicles, streetcars, or pedestrians.

- Expanding and enhancing existing transit service by providing a new first- and last-mile option, in particular, to augment the City's recent investment in Streetcar.
- Introducing new riders to the benefits of bicycling by reducing some of the common barriers to entry.
- Providing an impetus for further investment in bicycling facilities.
- Building on the City's reputation as a forward-thinking, bicycle-friendly community, and using bike share to promote the city to potential employers, residents, and visitors.
- Providing an economic benefit to local businesses.
- Reducing household transportation expenditures.
- Improving physical and mental health and reducing health care costs.
- Reducing greenhouse gas emissions.
- Providing safely designed and well maintained bicycles in order improve comfort through the safety in numbers effect.
- Introducing new opportunities to promote safety messaging to all road users.

The major risks include:

- The possibility that some bike share trips may detract from other public transit or active transportation trips.
- The need to ensure that sufficient funding is available to support capital, expansion, and ongoing operations. Most bike share systems are not economically self-sustaining from membership and usage fees alone.
- Concerns that bike share may threaten the local bike rental and retail markets.
- Ensuring that rebalancing efforts do not offset the greenhouse gas emission benefits of the system.
- Introducing new riders onto some streets that do not have significant bicycle infrastructure.
- Exposing a larger number of riders to the possible risks associated with interacting with the Streetcar tracks. However, other cities with bike share and streetcar or light rail have reported very few crashes as a result of the tracks.
- The timeliness of obtaining political support, fundraising, and implementing a bike share program and the public image risk of implementation delays.
- The changing landscape of the industry means there are very few vendors with a strong track record on the market.