

## **Micro-Mobility Storage in San Diego**

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## Socio-Economic Impact Research

Before creating solutions to the challenge presented, the effects of micro-mobility on individuals, businesses, communities, and the environment are crucial to measure. This first step ensures micro-mobility benefits society instead of hurting it.

### *Effect on the Individual*

With a growing presence of shared micro-mobility around the world, there is a shift in individuals' transportation behaviors. The Internal Transport Forum observed a 15% substitution rate of cars to a type of micro-mobility in the United States. This study highlights a transition to micro-mobility in the United States and the need to accommodate this transition. However, there is a concern that this new increased usage of micro-mobility will replace the usage of other forms of public transportation, economically hurting the industry and the workers. Contradictorily, a study done by Nils Fearnley on the effect of the new shared micro-mobility in urban communities, found that these shared modes of micro-mobility are mostly used in multi modes of transport during a trip, where the average trip length is around 11-12 minutes. (Fearnley) Fearnley shows that the increased usage of micro-mobility promotes the usage of other forms of transportation by acting as a middleman between other forms of mobility.

These changes in transportation behaviors can lead to individual benefits for micro-mobility users. A shared bike and e-bike company, Donkey Republic, ran a study in

Copenhagen to measure the societal benefit of using their product or other forms of micro-mobility compared to larger transportation options, such as cars, buses, and rail. Donkey Republic found that using a bike leads to a health benefit of 131 EUR-cents per marginal passenger-km, 88 EUR-cents per marginal

Table 1. Cost savings and GHG impacts across different transport modes in Copenhagen

	EUR-cents per marginal passenger-km in urban areas		CO <sub>2</sub> emissions per passenger kilometre (pkm)	Modal shift
	Congestion cost	Health benefit	GHG (LCA)	Share of trips replaced by Donkey bikeshare
Donkey	0	131	17	-
eDonkey	0	88	45	-
Car (ICE)	35	-12.2	162	6%
eCar	35	-126	124	1%
Bus (ICE)	6	-2	92	30%
Rail	0	-1	66	20%
e-Scooter (shared, 2nd gen)	0	-140	107	5%
Bike	0	131	16	14%
eBike	0	88	34	
Walk	0	151	0	24%

Source: Donkey Republic and Dresden University (2021).

passenger-km for e-bikes, and -140 EUR-cents per marginal passenger-km for shared e-scooters. Compared to a health benefit of -12.2 EUR-cents per marginal passenger-km for cars and -2 EUR-cents per marginal passenger-km for buses, the usage of bikes and e-bikes exponentially benefits the user's health. (International Transport Forum 2021) On the other hand, the usage of shared e-scooters hurts a person's health more than cars and buses, which could be explained by the main tendency to use shared e-scooters to replace walking and cycling. (Sanders et al., 2020) Beyond the health benefit, The Micromobility Coalition reported that "the widespread availability of micromobility services, particularly for first- /last-mile connections, would increase access to 35% more jobs for Seattle city residents while shortening commute time and reducing reliance on cars." (International Transport Forum 2021) The report indicates the accessibility benefits of micro-mobility in creating easier access to a larger job market for individuals. This main usage of micro-mobility acting as the middleman between another form of transportation and destination can be explained by micro-mobility mainly replacing walking in order to reduce the commute time. This reduction in commute time allows unemployed individuals to consider jobs that are farther away.

Although there are few studies and data on the comparison of injury/hospitalization rate of micro-mobility versus other forms of transportation, studies have shown a high fatality rate for micro-mobility users in crashes. The International Transport Forum (ITF) in 2020 found that around 80% of fatalities in crashes of individuals on a standing e-scooter or pedal cycle were caused by a motor vehicle. (International Transport Forum 2021) Especially in urban cities, micro-mobility users are at a higher risk of crashes with motor vehicles due to the high congestion of cars in those areas. However, the increasing usage of micro-mobility all across the United States, implementation of safer infrastructure for micro-mobility users (i.e. SANDAG Regional Plan), and safer guidelines for micro-mobility usage can lower this car congestion and lead to safer trips for those users by lowering the likelihood of crashes with motor vehicles.

### *Effect on Businesses*

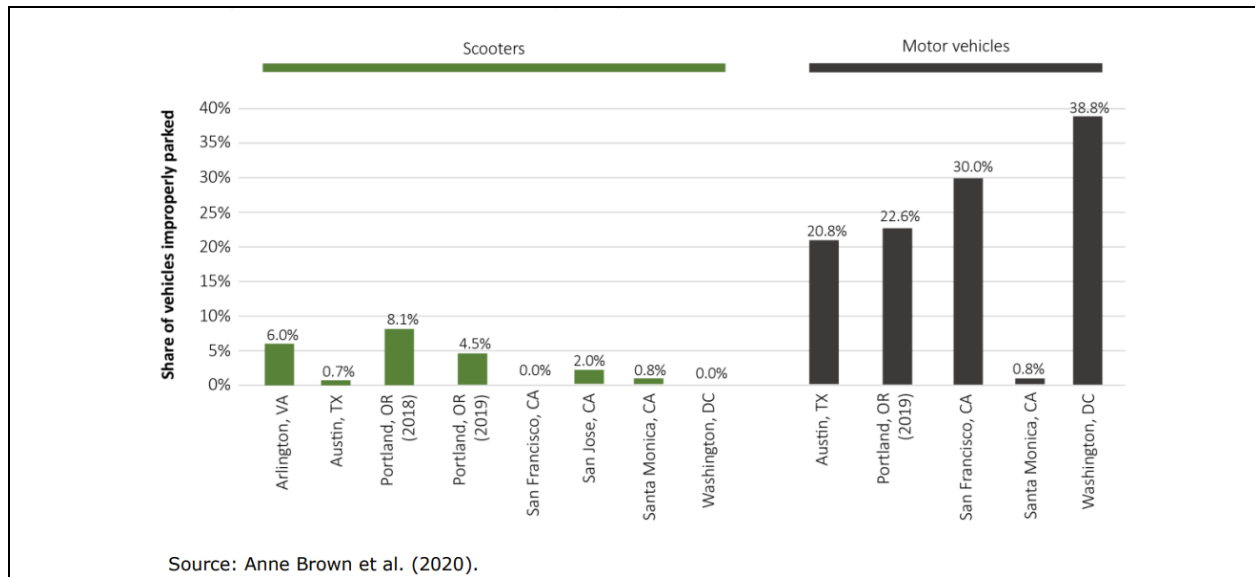
Local businesses can also be affected by this transition to micro-mobility in the United States. Multiple studies done in a few US states and foreign cities have all seen similar results in the effect of micro-mobility usage on businesses. They all concluded that customers who came by bike tended to buy smaller purchases, but visited the stores more frequently. (Hillcrest Business Association) One study done by PeopleforBikes and The Alliance for Biking and

Walking found that on average, customers that come by bike spend \$75.66 per month, while customers that come by car spend \$61.03 per month. This is because customers that come by bike visit the stores 57.8% more than customers who come by car. (PeopleforBikes et al.) A reason for this relationship between spending behavior and transportation usage may be due to the speed of each type of transportation and reason for traveling. Due to the much higher speeds of cars, it is more difficult for car users to easily see storefronts when driving by. In addition, individuals most likely use cars in order to get to one destination. On the other hand, the slower speed of bikes and other forms of micro-mobility allows customers to not only be physically closer to storefronts but easily see products and stores when traveling. Bike users also may be more likely than car users to be traveling by bike for leisure purposes. From the available studies, we conclude that micro-mobility usage by customers can increase customer expenditures and store visibility for storefronts, however, more data and studies need to be done.

#### *Effect on the Community*

One of the main concerns of the growing shared micro-mobility industry is the clutter on sidewalks and streets. Most of the shared micro-mobility is dockless, meaning they can be parked anywhere, causing many to be distressed about accessibility for physically disabled or hindered individuals. Many governors in the United States implemented policies and rules for shared micro-mobility companies in order to reduce the clutter of dockless shared mobility. In San Diego, there were fears of the county becoming infested with e-scooters and e-bikes, so many local San Diego governments passed strict regulations for the companies or banned them.

However, recent research partly contradicts this main concern. A 2020 study on the observed scooter and car parking behaviors in a selected few United States cities found a much lower percentage of inappropriately parked scooters compared to cars. (Anne Brown et al., 2020)



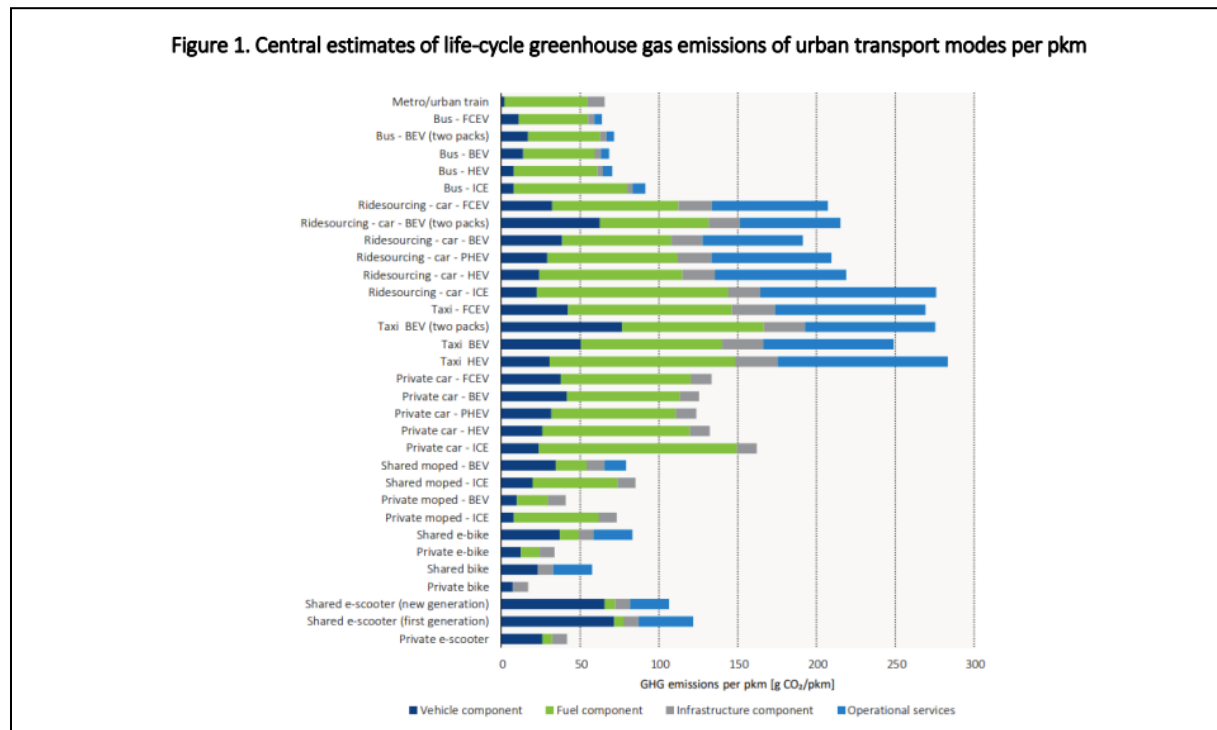
Along with the study, governments are working with shared micro-mobility companies to continue to alter the regulations and policies in order to address the concern, while providing easy access to the shared mobility devices.

### *Effect on the Environment*

Most would reasonably hypothesize that the usage of micro-mobility would benefit the environment, however, due to the rise of the e-scooters, this was not necessarily true. The first generations of the shared electric micro-mobility did not differ much from the environmental costs of cars due to the constant operational needs and short lifecycle. (International Transport Forum 2021) These electric micro-mobility devices consistently needed a worker to drive out to a specific device and fix it, or be replaced by a new unit. The greenhouse gas emissions (GHG) from the repair trips and resource depletion to replace a unit, lead to this low difference in environmental benefit.

However, the new generations of shared electric micro-mobility have expanded in lifespan (at most 60 months) and need fewer repairs, causing a lowering of GHG emissions for the shared micro-mobility. ITF in 2020 analyzed the environmental impact of various modes of transportation (see chart below). The analysis suggested that “the lifecycle GHG emissions from an e-scooter, calculated on a per pkm basis, may be around 37% lower than those of conventional private cars and those of shared bikes 60% lower.” (ITF, 2020a) The report also highlighted that the usage of privately-owned bikes and e-bikes has the lowest environmental

impact or lifespan GHG emissions than any other mode of transportation. (ITF, 2020a) With



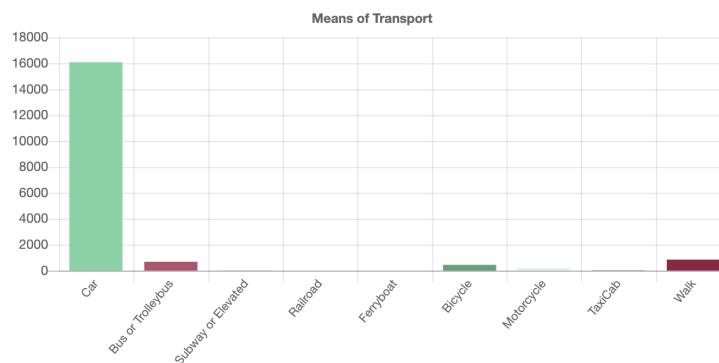
the transition to micro-mobility and the comparatively lower GHG emissions, micro-mobility can lower the motor vehicle congestion on roads, further reducing GHG emissions by motor vehicles. Lower congestion can lead to reductions in GHG emissions because motor vehicles are not wasting fuel waiting in traffic. In addition, the reduced motor vehicle usage can also decrease the communities' demand for more road space, allowing cities to implement more micro-mobility infrastructure, such as separated bike lanes.

## Corridor Choice

Based on quantitative and qualitative research, Hillcrest has a myriad of characteristics that fits to implementing compact micro-mobility storage. Starting with quantitative research, 94.48% white collar creates the community of Hillcrest. They are people that may need micro-mobility either for daily commute to work or commute to place for leisure time. Since the area is relatively small, people can travel by bike to move from place to place practically. With the average household income \$78,720,



It means that most of the people can afford bikes in this area. Although 90% of the population chose to use cars to transport, the percentage of people using cars is decreasing year to year with 1.2%. Meaning that, people try to choose other types of transportation, and it



provides opportunities for more potential micro-mobility users.

On the other hand, there are qualitative statistics that stand out to make Hillcrest a highly possible corridor. It contains separate bike lanes that will provide micro-mobility users safety. It is an essential factor since from our survey people are mainly concerned with the problem of safety. Explaining more detail along the intersection of Fourth Avenue and University Avenue, it



also contains a separated bikeway, and most importantly with shopping areas and small stores that will attract people's attention and be willing to stay. At the end of Fourth Avenue, there is more residential housing meaning that the distance is not far for local residents. Along fifth avenue, it contains a separate bike way and intersects with University Ave's already established bike lane, contains more shopping stores, and has a shopping mall northward of University Avenue. Both these streets inside Hillcrest provide potential opportunities for people using micro-mobility to have leisure time in these areas. With qualitative and quantitative research, we conclude that Hillcrest will be a suitable corridor to implement our designs.

## Micro-Mobility Storage Designs

### *Alpen Bike Storage Capsule*



Description: A compact bike storage capsule made by Alpen Inc. This capsule can hold bikes with a max seat height of 46 in. (close to 4 ft) and a max bike length of 75 in. (slightly longer than 6ft). The bike is secured with a simple lock and key mechanism. The back has an opening for a plug allowing electric bikes to be charged within the capsule.

#### Cost Breakdown:

3 Capsules.....	\$1,529x3=\$4587
Installation (drilling+shipping).....	>\$1,000
Maintenance (1 year of painting, labor, and gas).....	\$3,600
Estimated Total	<b>\$9,200</b>

#### Strengths of this design

The strengths of the Alpen bike storage capsule are manifold beyond its above-average bike protection in comparison to other storage options like bike racks. First, it is compact, so multiple capsules can be fit into a small space—say, a bike corridor island in Hillcrest. Second, it comes outfitted with spots to hold all the accessories that a biker may carry with them instead of storing only the bike: these include space for a pump, helmet, cleaning materials, etc. The multipurpose holders can also be used to store other small items for temporary safekeeping (of course, keeping them on your person may be better). Third, the capsule is quite weatherproof for its price and functionality: it is waterproof and made of non-reactive polyethylene. Fourth, although it is compact, Alpen states that this capsule can fit most bikes, including “mountain bikes with wide handlebars” which negates the concern associated with the size of the capsule.

#### Weaknesses of this design

The greatest weakness of this type of storage is its cost-to-efficiency ratio. Although the capsule justifies its market price through the aforementioned benefits, it can only hold one bike

at a time. Since cost and value for money are the most important factors in deciding whether or not to use a particular storage method, this may not be the best design for large-scale storage because a u-shaped bike rack may provide more value for the money spent.

#### Potential Opportunities

These capsules provide an opportunity to beautify the community through murals. Professionals can be hired to create art on the capsules and make them minor attractions on the road on top of being highly protective bike storages. Furthermore, some of the costs of the capsule can be offset by charging a small fee on its use. To increase efficiency, a parking model can be used wherein bikers pay based on how much time they leave the bikes in the storage. To make things easier, the payment method can be linked to widely used apps like Pronto so that new customers don't need to download anything new or use a difficult method to pay the fee.

#### Potential Threats

If murals can be painted on these capsules, so can graffiti. Graffiti needs to be regularly painted over, which makes SANDAG incur additional costs. Furthermore, there doesn't seem to be a solution to prevent theft of the capsule although Alpen says it "attaches securely to ground surface to prevent theft of the entire unit" ("ALPEN Classic Bike Capsule"). If this is solved, this will significantly reduce installation costs because all that will be needed to install the capsule is for it to be carried to the specified location and placed there. If Alpen can be believed, then there will also be no disturbance to the community when it is being installed.

### *Bike Box Mini-Tower*

Description: “Semi-automated parking solution with a low energy impact. Each level parks 14



bikes to a total of 28 bikes. The tower is rotated by manually turning a large wheel next to the lift to select your box. Parking on the first floor is done by lowering the electronic lift, where the bike is then parked on a docking station on which you can secure it with a chain-lock. When the lift arrives at the first floor, a gentle push will take the bike into the box and the parking is done. This solution is designed to minimize the impact of energy consumption...the roof can be outfitted with solar panels [or a] rainwater catcher” (“Mini.Tower”).

#### Cost Breakdown (base layer only with 14 bike capacity):

Materials.....	\$23,305
Installation.....	>\$5,000
Maintenance (1 year of painting, labor, gas, electricity).....	>\$24,000
Estimated Total (before transportation)	>> <b>\$52,305</b>

**(Cost will be at least 2 times the current cost if a layer is added)**

#### Strengths of this design

This design is very space efficient. According to the designer, “by implementing the patented design of the box, where the bike is parked backwards and [with a] turned front wheel, we can minimize the use of space to only 0.5m<sup>2</sup> per bike on a total 14m<sup>2</sup> surface” (“mini.tower”). The design can improve the community as well if outfitted with a vertical garden (as seen below) which can reduce CO<sub>2</sub> levels in the city and beautify the neighborhood.

#### Weaknesses of this design

The greatest weakness of this design is its massive cost. Solely the materials cost multiple times the estimated cost of shipping, installing, and maintaining the Alpen capsules for an entire year. However, the cost estimates come from the designer himself, who hails from Europe.

Therefore, SANDAG is highly likely to be able to acquire cheaper materials from the US and ship it to San Diego at much lower cost than shipping from Europe. Furthermore, if solar panels are outfitted to the roof of the structure, the structure may be able to function without needing electricity from outside sources, which significantly broadens the location potential of the design and reduces costs. As a result of its space efficiency, the structure may not be able to handle beefier bikes with wider handlebars or larger bodies. Lastly, the installation of this structure will temporarily present heavy disturbance.

#### Potential Opportunities

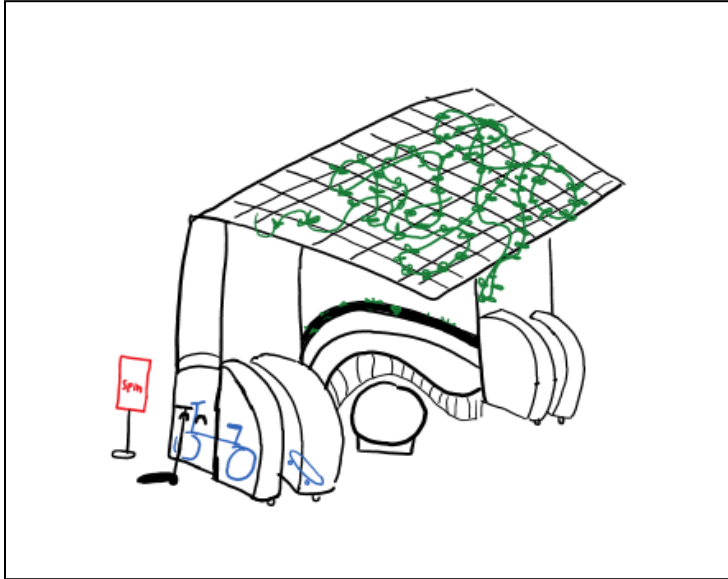
These can be used to significantly improve the ambience of the neighborhood as seen in the image. Furthermore, as SANDAG gains more funding, a second layer can be added with much lower installation costs to double the capacity of the storage structure. As mentioned before, the environmental effects of the vertical garden addition present a fantastic opportunity to improve the community.

#### Potential Threats

The greatest threats to this design are vandalism and accidents. If someone decides to vandalize this structure (which seems very unlikely), reinstallation costs are very high. Accidents present an obvious threat; however, these are also very unlikely because these will most probably be situated in the pedestrian right-of-way rather than on or near the streets themselves.

### *Covered Bench Design*

**Description:** A curved bench with a backrest that extends horizontally to be a planter behind the seating area (the thick black portion with hints of green). There is a table at the center and an



awning providing the bench shade. The awning has a checkered-style overhang so that vines can be intertwined and provide shade. There are four storage capsules partly built within the awning structure that allows community members to place any type of storage in and secure it with a lock. For shared micro-mobility devices, companies can place stations for their products around the bench. The Covered Bench would be

located within Village Hillcrest on 5th Avenue.

#### Cost Breakdown:

Structure.....	\$26,300
Curved Bench with planter.....	\$3,000
Awning w/ incorporated storage.....	\$22,200
Wood.....	\$15,000
Storage .....	\$7,2000
Cement Table .....	\$1,100
Installation .....	\$5,000
Maintenance (1 year) .....	\$24,000
Estimated Total	<b>\$55,300</b>

#### Strengths of the Covered Bench

Implementation of the design in the designated space can:

- Promote usage of micro-mobility

- With many of the community members fearful of theft of their micro-mobility, the bench can provide a secure storage option for people to feel safe using their micro-mobility devices.
- Create a place for the community
  - The bench acts as a placemaking destination for the community to use and gather around. Consequently, its placemaking can promote the businesses within Village Hillcrest and surrounding areas.
- Increase customer visits to local businesses
  - With data showing that customers that come by bike visit stores more often than car users, the bench's placemaking and promotion of micro-mobility usage can indirectly lead to higher rates of customer trips to the stores with Village Hillcrest or surrounding it.
- Lower costs for SANDAG
  - With Village Hillcrest being on private property, the product would only need approval from the property owners to be installed, which saves time and money for SANDAG to implement the design.

#### Weakness of the Covered Bench

The main issues with the covered bench design come from the cost of the design and implementation of it. Despite the cost of the design being fairly rough, it still comes at a large expense with the building of the structure and yearly maintenance of it. The production of the product will be costly due to the customization of the bench. In addition, the maintenance of the bench will most likely be large due to typical wear and tear, service for individuals who are unable to access the storage, and possible graffiti or larger damages. The implementation of the product into Village Hillcrest is also a problem because there is no prior approval of the design by the property owners to install the design. There is a further need to contact and process the design through the company or owners. Without prior approval, the product is at risk of not being approved to be installed.

#### Potential Opportunities

The Covered Bench Design takes advantage of the growing micro-mobility companies and markets by providing the necessary infrastructure for micro-mobility users. With the 15% substitution rate, there is a growing market for both shared and privately-owned micro-mobility

storage. Economically, the bench, as previously mentioned, can indirectly increase trips by micro-mobility users to surrounding businesses and potentially bring profit to SANDAG and Village Hillcrest if a storage price is incorporated. A fee for the promotion of a shared mobility company on the structure can also bring economic benefits.

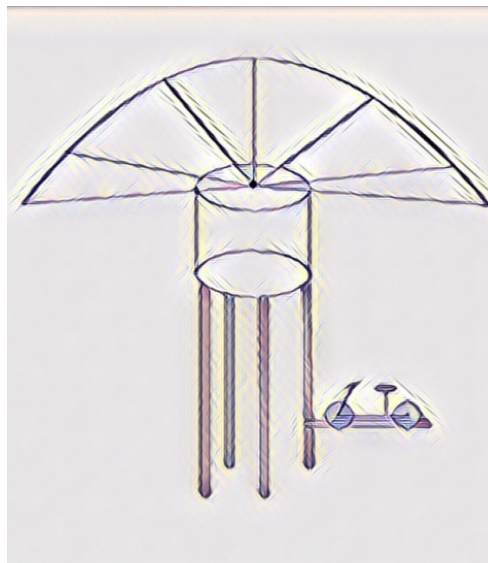
#### Potential External Threats

The Covered Bench Design does face some challenges if it were implemented. The possible threat of graffiti or damage by individuals can exponentially increase the cost of the product and lower its attractiveness to community members' usage. Additionally, the possibility of bad press can decrease the responsiveness to the bench and its usage, while reducing the trust and likability of SANDAG and/or Village Hillcrest. Lastly, if a storage price were implemented, it can consequently reduce the usage of micro-mobility in the area.



### *Umbrella Design*

**Description:** An umbrella shape with four metal rods supporting the whole structure. The top



umbrella provides some shades as well as protection to the bikes by blocking sunlight and potential rain. For its specific use as a storage, the four extended metal pieces each are attached to the metal rods, using the pulley mechanism. When putting the bike on the storage, pull the extended metal pieces out horizontally, then put bikes on it, and then lock the bike and lift it up to the top using the pulley. For shared micro-mobility, it will be located along Fifth Avenue, and it can also potentially be located in the Hillcrest village. For the dimension of this design, it will have 0.8 diameter with 3.5m height.

#### Cost Breakdown:

Structure.....	\$3,500
Lock on the extended metal(4).....	\$ 700
Metal Pieces(4 steel rod, 4 extend pieces).....	\$ 1500
Umbrella top .....	\$ 300
Pulley mechanism .....	\$1000
Installation .....	\$1,000
Maintenance (1 year) .....	\$12,000
 Estimated Total	 <b>\$16,500</b>

#### Strength of the Umbrella Design:

- It will benefit the public for transportation use.
- Promote SANDAG values for micro-mobility and public transportation construction.
- This Umbrella design is a relatively cheaper design compared to other design with electronics and use of electricity,

- Environmentalists and the micro-mobility community will support the projects because it helps to promote an environmentally friendly way of commuting.

#### Weakness of the Umbrella Design:

- There is a possibility of not having too much revenue, because SANDAG does not charge for using public storage
- Potentially doesn't promote use of micro-mobility because non-micro-mobility users don't pay attention to using micro-mobility storage.

#### Potential Threats of the Umbrella Design:

- During the short-term, it is possible to have few people using them because it is an innovative design.
- It can be massive paperwork for implementing a new storage that is along the street, tourists and residents may complain about the micro-mobility for any reason because they have complained before.

#### Potential Opportunities of the Umbrella Design:

- With the increasing needs of micro-mobility, the value of the umbrella design will eventually increase because of its frequent usage.
- It is a new market for many potential customers. If the storage works well in the Hillcrest area, other companies may try to use the same type of storage in other places where the demographics are similar to Hillcrest.

**Conclusion**

The four designs detailed above all present great opportunities to go beyond bike racks and bike corrals towards more secure and multifunctional storage. All 4 designs can greatly improve the ambience of the neighborhood, with the larger designs serving as minor attractions while the smaller ones serve as colorful additions to the community. Furthermore, they are very likely to reduce bike theft and promote investment into additional bike infrastructure in nearby districts. With theft being a major concern of potential micro-mobility users, each design is a great opportunity to increase micro-mobility usage and broaden the micro-mobility market by dramatically increasing security of micro-mobility in comparison to more common methods of storage. Finally, this is a chance to reduce the environmental impact of San Diego by indirectly removing cars from the streets, so we hope that one or more of these designs pique SANDAG's curiosity and are implemented.

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