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Dockless: The Future of Bike Shares

After seventy years of American transportation planners focusing almost exclusively on accommodating cars in our cities, the past two decades have seen a remarkable surge in "old-fashioned" modes, such as streetcars and bicycles, as tools to create new transportation solutions. In the decade since the GPS and booking technology that makes modern bike shares both feasible and profitable became available, a vast assortment of private companies and private-public partnerships have brought bike share programs to cities big and small around the world. At the moment, a large majority of bike shares in the United States operate with a station-based system- but that is changing.

The station-based type of bike share can be found in US cities from New York to Pasadena. They are often meticulously mapped out, with considerations for public transit and public space usage built into their metrics for success. With the newer dockless bike shares, however, there is less need for such planning to make a profit and so it seems there are fewer incentives for a considerate approach to integrating the bikes into the transportation system as a whole. Like automated vehicles, dockless bike shares could be (and in a few cases, are) the cause of serious disruptions to city transportation and development plans. It is therefore essential that planners and policy makers across the country have a solid understanding of the risks and benefits of dockless bike sharing systems so they may better incorporate this new generation of bike sharing into their communities.
"Dockless bike share adds even more convenience for users who no longer need to worry about empty bike share stations at the front end of the trip or full stations upon arrival. However, this convenience for users can be a problem for both system operators (who must rebalance bikes to meet demand) and cities (who must manage a clutter of bicycles on sidewalks already under pressure from competing uses)." – Alta Planninng+Design[1]

China: Titan of Dockless Bike Shares

It is important to note that, while that the technology required to create a modern bike share platform is new, the ability to do so without relying on a docking system is only a few years old. While dockless bike shares (DBS) use the same "smart" technology that is closely associated with Silicon Valley, China has been the most aggressive leader in bringing this new form of bike sharing to the streets of its cities. There are probably countless reasons for this, but the need to reduce local pollution and traffic congestion are almost certainly present in the mind of Chinese policy makers. Many of these leaders are also old enough to remember the 1980s, when 63% of all journeys in China were made by bike (by 2014, that number was 17.8%),[2] so there may be less cultural resistance to commuting by bike than in the United States. Ofo, China's first major DBS company, was founded in 2014 and in just four years the company has expanded across 21 countries and operates a fleet of 10 million bicycles, most of which are in China. The enthusiasm for a new solution to

these pressing problems and a high level of competition among bike share startups in China initially outpaced regulation. As a result, local governments have stepped in to clean up after the ensuing masses of DBS bicycles clogging up sidewalks, plazas, and roads in cities such as Shanghai and Beijing. Photos of DBS bicycle "graveyards", featuring mountains of brand-new and brightly colored bikes, have been making rounds on Twitter for a few years now. "This is not a field of tulips," reads the caption of one photo published in *The Atlantic*,[3] "but a drone's-eye-view of tens of thousands of unused share bikes lined up in a field near Shanghai." In 2017, one Shanghai district claimed to have confiscated 5,000 DBS bikes, many of which were "illegally parked" by their users. Another image of a sports field in the Anhui province shows an unorganized heap of bicycles whose bright colors are obscured by shrubbery as nature begins to swallow them whole. The government confiscations have caused serious problems to companies operating in an already saturated market, forcing some major companies to "consult" with the government in order to reclaim their bikes.[4] In November 2017 BlueGoGo, the third largest bike share company in China, declared bankruptcy after little more than a year in operation, leaving tens of thousands of bikes on the streets to be vandalized, confiscated, or simply left in place. Before joining at least three other bike share companies in filing for bankruptcy in 2017,[5] BlueGoGo was planning a launch in Seattle. The starkness of the photos coming from China should send a chill down the spine of every planner and bicycle advocate in America who is watching the spread of bike shares in the US with cautious optimism.

It is the phenomenon in China that has prompted some of the earliest research on DBS systems. As a result of their newness both Google Scholar and JSTOR feature a limited number of articles focusing on BDS systems (only 82 on Google Scholar since 2017, compared to 16,000 on bike shares in general), but eight of the top ten "most relevant" results on Google Scholar were either written by authors based primarily in China or about DBSs in a Chinese city.

The Chinese city that has drawn the most attention appears to be Shanghai. As of this writing, the city is home to at least half a dozen different dockless bike share operations. In June 2017 the total number of DBS bikes in the city was around 280,000, but has been estimated that that number has exploded to 1.5 million bicycles today.[6] That is 6,250 bicycles for every 100,000 people. For comparison, NYC's CitiBike bike share, which is the largest system in the US by station count, provides 146 bikes for every 100,000 New Yorkers. Another difference between DBSs in Shanghai (and in the rest of China) is that they are dirt cheap- about 7 cents USD for a 30-minute ride compared to CitiBike's $3 USD for the same time. Possibly as a result of the affordability of the bicycles, a 2016 study[7] found that 90% of *station-based* bike share users in Shanghai rode such a bike more than twice a day. However, it seems that success of DBSs in China is largely built upon abundance, not cost. A 2017 report published by writer/researcher/China Channel co-founder Matthew Brennan suggests that the biggest frustration with DBSs is "when I want to get a bike (and) there are none close by" (55.2% of respondents), while only 14.5% mentioned a dissatisfaction with the pricing/billing method. Therefore the company "who can put the most bikes out into circulation the fastest will likely win the war," according to Brennan, who added, "Traditional methods of user acquisition e.g

online promotion, discount coupons, billboards, are all secondary to the most important factor which is having the bike there in front of you available for use."[8] The earlier study also suggests, "the users' attitude to the paid use is not totally based on the users' demands and experiences and hence doesn't influence the ride frequency of the users." A third study on DBSs in Shanghai used two questionnaires to determine, compared to transit and walking, DBS users saw reduced travel times and increased reliability. This study concluded that "solving problems of unsafe cycling environment and bike unavailability will remarkably increase usage of such bikes."[9] In fact, the challenge of effective "rebalancing"- which ensures the visibility and availability of DBS bikes shares to as many users as possible at all times- appears to be a common theme in studies written about cases in China. Four authors out of Tsinghua University in Beijing proposed[10] a "deep reinforcement learning" algorithm to incentivize users to rebalance the DBS system themselves. The author's Hierarchical Reinforcement Pricing system (which sounds awfully similar to the reward system in Portland's Biketown bike share) is proclaimed as having outperformed "state-of-the-art methods in both service level and bike distribution." The suggested reason for these authors' attempt to solve this problem can be found in their abstract, in which they describe bike sharing as the "environment-friendly way for traveling."

Researchers in China are starting to catch up to the DBS boom now that companies such as Mobike and Ofo are sharing their user data. At the same time the Chinese government has begun to regulate the market. The national government's Ministry of Transportation issued the first formal regulation of dockless bike-sharing in August, 2017, followed by at least 30 cities passing their own regulations. Shanghai issued its first regulation in October. [11]

DBSs Gets a Toehold in the United States:

As DBS companies have oversaturated the market in China, the heavy-hitters are starting to test the waters in new markets, including the United States. By the end of 2017, a report from the National Association of City Transportation Officials (NACTO) counted "five major dockless bike share companies reported operating in approximately 25 cities and suburbs,"[12] including two of China's biggest DBS companies, Ofo and MoBike. Ofo has started programs in Washington DC, San Diego, Chicago, Seattle, and Camden, NJ.

Seattle was a notable pick for Ofo's first experiment in the US. Kicking off their program in August 2017, Ofo arrived only months after the collapse of Pronto Cycle Share, Seattle's publicly owned station-based bike share that began in 2014. While some have commented on the negative impact a mandatory helmet law had on Pronto's ridership,[13] I have argued (in a paper for a previous PSU course) that Pronto's failure was largely due to political infighting that led to a poor layout of the stations, causing rebalancing issues. If Ofo and competitors like California-based Limebike succeed (and it appears they are) where Pronto failed, it might suggest that getting rid of docks offsets the limits of not having any public funding or a partnership with the city's Department of Transportation.

Camden is an equally interesting pick, as it "is now the lowest-income city (median income $27,000) in the US to have a bike share system."[14] During its

currently ongoing 7-month pilot program, which is supported by a local grant, Ofo will be offering rides on their bright-yellow bikes at the rate of $1 per hour, or one-sixth of the price of a Citibike ride in New York City. A low-cost ride on a bike that will go wherever the users take them is especially significant, as station-based bike shares in the US have regularly been accused of under-serving low-income and minority populations- even as they take in public money. One striking example of this can be found in Washington DC where despite the population being around 50% black, only 4% of the memberships in the publicly-funded program were held by African-Americans in 2016.[15] If Ofo and its private American competitors can make a profit providing low-income areas with dockless systems, there would be profound ramifications throughout public-private bike share systems, many of which are still looking to prove themselves to a skeptical public. Some have already speculated that the presence of DBSs has diversified Washington DC's riding population over the past year.[16] "They were willing to invest in places that other people were not," Charles Brown, a senior researcher at the New Jersey Bicycle & Pedestrian Resource Center Charles Brown, told StreetBlog USA. "And I think that in itself is noble," Brown added.

However, just because US cities like Camden and Seattle are looking for a little disruption in order to get in on the hottest fad in urban transportation planning, it doesn't mean that they are unaware of the pictures coming out of Shanghai. In the same document that brought Ofo to their city, the Camden City Council passed a resolution that makes Ofo "responsible for ensuring bicycles do not obstruct fire hydrants, bus stop operations, traffic, crosswalks, and other public spaces."[17] The resolution also noted that the council is expecting Ofo to provide its residents with access to "safe, affordable, innovative and environmentally friendly transportation options."[18] Meanwhile, Seattle has also produced a set of bike share regulations that are aimed specifically at DBSs. Like Shanghai, Seattle has set a cap to the number of bicycles a private company can introduce to its streets. In Seattle's case it is a phased process in which providers can only introduce 500 bikes in the first month. Seattle has also stipulated where DBS bikes are allowed to be parked (the "landscape/furniture zone of the sidewalk"), what safety fixtures (rear reflectors and headlights) as well as maintenance fixtures (a mechanism that allows users to notify the company of any damage) are required on every bike, and the items needed to apply for a SDOT permit (including a "plan for providing an equitable bicycle share service"). Significantly, one of the first safety requirements is about electric bicycles, which "shall have fully operable pedals, an electric motor of less than 750 watts, and a top motor-powered speed of less than 20 miles per hour when operated by a rider weighing 170 pounds."[19]

Despite this cautious enthusiasm, DBSs have not exploded in popularity in the US at the same rate as they did in China. In October, DBSs companies in Washington DC logged a total of 56,477 trips, compared to 338,152 for Capital Bikeshare according to DDOT (see citation #14). The 2017 NACTO report paints a grimmer picture for DBS operators: while 35 million bike share trips were taken in 2017, up 25% from the year before, only 1.4 million (4%) were made on dockless bikes. This is despite the fact that DBS companies introduced about 44,000 bikes in 2017, or 44% of the total number of bike share bikes in the country. When excluding

the four largest station-based systems in the country, the numbers don't look much better for DBSs: 58% of the national bike fleet, 16% of the total number of trips. Measuring rides per bike per day (r/b/d), the report found that station-based systems in the US averaged 1.7 r/b/d, significantly higher than the DBS average of 0.3 r/b/d. As NACTO is relying on self-reported data for many of the DBS programs, the organization admits that there is some uncertainty about the data, but notes "the large influx of dockless bike share bikes across the US has not yet translated into substantial mobility gains." The report also comments on the number of DBS companies that have merged with other companies, ceased operations, or filed for bankruptcy in the past year, including BlueGoGo. "The extreme degree of venture capital funding, coupled with generally low ridership, brings questions as to the overall sustainability and volatility of the dock less bike share market," concludes NACTO's report.

Research Gap in the United States:

At the moment, there appears to be a significant research gap regarding dockless bike shares in the United States. This is understandable, as the presence of DBSs in the US is younger than the current presidential administration, but it is also troubling. DBSs have the potential to massively disrupt the attempts of cities across the US to seamlessly meld bike shares into their existing transit and street systems. At the same time, DBSs might open up the bike share market to include communities that are under-served by existing station-based bike shares. However, the research on American DBSs that does exist suggests that the future of this debate will not be defined by the benefits and risks of either system as they exist today, but also by their ability to incorporate new technology.

"Why would anyone walk?" asks the abstract of an article tellingly titled *The Pace of Change: Why do Walking and Biking Still Matter in an Autonomous Future?* [20] While the short paper concludes that walking and biking *do* still matter, and the last 60 years of planning around the automobile tell us why, it also notes that one of the potential risks of a boom in autonomous vehicles is that "attention to AV vehicles places priority on road space for cars," forcing DBS bikes to overwhelm sidewalks. Other researchers are already coming up with ways to place DBSs within a broader rideshare-transit-pedestrian system. In a study in New York City, a group of researchers tested a multimodal carpool system that has much in common with Uber's ExpressPool service. The researchers found "initial evidence that multimodal connections between ride-hailing and dockless bikesharing are feasible, reduces passenger trip times, and decreases road congestion."[21]

These two articles are just scratching the surface at what needs to be understood before incorporating bikes into an AV future, and the DBS market is not waiting around for the academics to figure out this pressing issue. Instead, it is going full-steam towards introducing electric bikes, which are faster, heavier, and therefore more difficult to stop when going full speed- three factors that come with serious safety concerns. Now that Uber has purchased electric bike sharing service Jump Bikes, it is likely that public bike share operators will have to introduce their own e-bikes to keep competitive or ask city governments to introduce new regulations. Going without regulations on DBS companies at all has proved too risky

in the US. Dallas, which has zero regulations on DBSs, will see its city council vote on whether to create a permitting system and an office of city employees dedicated to monitoring DBSs on June 27th. This vote comes after the city "quickly had more than 20,000 bikes that were not being used very often," according to Jump Bikes CEO Ryan Rzepecki,[22] cluttering the streets à la Shanghai. A permitting system might be a start, but if e-bikes continue to grow in popularity cities will have to think of a whole new way of organizing its bike lanes to accommodate them. This will require more than basic regulations (as in Seattle) on where DBS bikes should be parked, but there appears to be no guiding research available on this subject.

Conclusion: A "Bike" New World

While writing this paper I quickly realized that there is much, much more to say about dockless bike shares than has been adequately researched. Part of this is certainly a result of the newness of DBSs, but I feel I need to underscore that the constant revolutionizing of bike share and transportation technology over the last five years is playing an equal role. So much change is happening in the bike share markets, on streets where they have been introduced, and even in the bikes themselves that it feels almost impossible to surmise what will happen in the next five months, let alone five years. But I do feel that the contents of this white paper can be useful in understanding the current narrative of dockless bike shares, which is defined by environmental concerns, equity considerations, and profit margins.

Here is what I will be keeping an eye on in order to guess the future of DBSs: e-bikes, e-scooters (which I didn't even have time to mention!), autonomous vehicles, multi-modal rideshare ventures (like Uber), and finally DBS regulations in US cities. Any one of these factors could potentially turn the fate of this radically new bike share technology.

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[1] Alta Planninng+Design: https://altaplanning.com/dockless-bike-share/
[2] Time Magazine: http://time.com/5218323/china-bicycles-sharing-economy/
[3] The Atlantic: https://www.theatlantic.com/photo/2018/03/bike-share-oversupply-in-china-huge-piles-of-abandoned-and-broken-bicycles/556268/
[4] CNN Travel: https://www.cnn.com/travel/article/china-shanghai-bikes/index.html
[5] The Guardian: https://www.theguardian.com/world/2017/nov/17/anger-as-chinese-bike-sharing-firm-shuts-up-office-with-riders-deposits
[6] The Guardian: https://www.theguardian.com/uk-news/2017/nov/25/chinas-bike-share-graveyard-a-monument-to-industrys-arrogance
[7] Tang, Yang et al, *Research on Users' Frequency of Ride in Shanghai Minhang Bike-sharing System*: https://ac.els-cdn.com/S235214651730683X/1-s2.0-S235214651730683X-main.pdf?_tid=95553f2a-027f-448a-a04c-0d13f25aecb9&acdnat=1528439567_6108edaa1d8f2e524758faf16f3e6e03
[8] China Channel: https://chinachannel.co/china-bike-sharing-report-march-2017/
[9] Zhou, Shiyi et al, *Effects of Dockless Bike on Modal Shift in Metro Commuting: A Pilot Study in Shanghai*: https://trid.trb.org/view/1496506

[10] Pan, Ling et al, *Rebalancing Dockless Bike Sharing Systems*: https://arxiv.org/pdf/1802.04592.pdf
[11] World Resources Institute: http://www.wri.org/blog/2018/01/chinese-cities-aim-rein-bike-sharing-boom
[12] NACTO: https://nacto.org/bike-share-statistics-2017/
[13] The Guardian: https://www.theguardian.com/cities/2017/apr/18/seattle-mandatory-helmet-law-kill-bike-share-scheme
[14] StreetsBlog USA: https://usa.streetsblog.org/2018/05/10/dockless-companies-delivering-bike-share-to-underserved-areas/
[15] CityLab: https://www.citylab.com/equity/2017/07/what-keeps-bike-share-white/533412/
[16] CityLab: https://www.citylab.com/transportation/2018/01/can-dockless-bikeshare-pump-up-cyclings-diversity/549629/
[17] The Inquirer: http://www.philly.com/philly/news/new_jersey/is-camden-ready-for-bike-sharing-residents-will-find-out-this-may-20180411.html (the photos from Shanghai are mentioned by the author of this article).
[18] Courier Post: https://www.courierpostonline.com/story/news/local/south-jersey/2018/04/09/camden-ofo-bike-share/499875002/
[19] Seattle.gov: https://www.seattle.gov/Documents/Departments/SDOT/BikeProgram/BicycleSharePermitRequirements.pdf
[20] Nisenson, Lisa et al. *The Pace of Change: Why do Walking and Biking Still Matter in an Autonomous Future?*: https://search.proquest.com/openview/546cae492ffaa5d187e384d6059f73a0/1?pq-origsite=gscholar&cbl=42116
[21] Luo, Qi et al. *Multimodal Connections between Dockless Bikesharing and Ride Hailing: An Empirical Study in New York City: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3062381*
[22] Reuters: https://www.reuters.com/article/us-usa-bikesharing/bike-sharing-companies-face-an-uphill-ride-in-u-s-idUSKCN1GS0YX