A Report on “Last Mile” Technology and Its Current Status in 2019

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Executive summary

Introduction

This research was based on internet search engine queries, in person interviews, and scholarly research. The field of bike share and “last mile” mobility devices have only recently been made available to the public and in turn, the data related to each is so new and fast changing that research studies and data analysis have not yet been completed. The following research is intended to bring the most current data available along with personal/professional experience and opinion from my work through bike and pedestrian advocacy, course work projects during my graduate studies at the University of Wisconsin Milwaukee, and international experiences I have sought throughout my travels in the Netherlands, and China.

Background research

With the growing list of last mile transportation options, technologically driven mobility platforms across the world are the most fascinating topic I’ve followed through my career while learning about transportation in an urban setting. Many of the hands-on projects I’ve been involved with have incorporated these new and exciting options in one way or another. As a millenial who has grown up in the developing information age, I feel I have a unique perspective on the rise, decline, balance, and rebalancing story of this industry so far. The future of transportation options are changing the built urban environment, improving the quality of life for the average citizen, and renaming the key-holders to transportation providing entities.

The following report will encompass every aspect of the last mile industry I have encountered through my bike and pedestrian advocacy, international travels, and my graduate studies. This includes docked and dockless bikeshare programs, E-scooters, E-assist bikes, E-bikes, and special mobility devices. I will briefly outline the advantages and disadvantages of last mile technology, public safety concerns, vandalism, and international experiences as they relate to bike share models. I also outline current trends, and make recommendations / conclusions about planning for cities.

Introduction

The term “last mile” transportation refers to the final distance someone would have to travel from a bus stop, light rail, or train station to arrive at their destination, which is presumably about one mile and most often their home. “Last mile” devices are small efficient personal (usually single person) devices such as bikes, scooters, an other special devices. These devices can be powered by physical activity or electric motor (battery). The following section describes the different forms these devices can take on (platforms) along with a few notes for each.

Docked bike share

Docked bikeshare systems use a specialized electronically automated bike rack network known as a “dock” or “kiosk” in an area to check-out and check-in specially designed bikes within the network. These systems typically have two main types of users; casual users who use the kiosks automated screen to check out bikes with a credit card, and member users who typically have a physical pass or code designed to quickly and easily access the bikes in the docks.

Advantages of this system include predictability of available bikes and the locations they can be checked in and out from, worry free maintenance, and generally low fees for users. Some disadvantages are the limitations of kiosk location in proximity to a users final destination and the density required for kiosk locations to be economical. Typically you would find the majority of kiosks in the most densely populated downtown areas of cities as opposed to rural neighborhoods.

Dockless bike share

Dockless bikeshare systems differ from docked systems by one key factor in that they are not tied to a network of docking stations for users to check the bikes in or out. Dockless systems rely heavily on the use of smartphones and proprietary apps that allow users to locate, check-out, check-in the bikes, and make payments. This allows much more flexibility at the end of a users trip as they can park the bike much closer to their destination instead of having to find the specific location of a docked station to end their trip.

A disadvantage to this system is that the availability of the bikes are not always as predictable. Multiple trips on the bike may be interrupted because when a bike is checked back into the system it becomes immediately available to other users. Some systems have piloted the idea of "reserving" a bike but currently most systems do not support this option.

Another disadvantage of the dockless model stems from nature of how the bikes are secured. The majority of dockless bike share systems use a shackle that extends through the rear tire's rim between the spokes inhibiting the rotation of the wheel. This leaves the bike vulnerable to a wider variety of vandalism including minor instances of tipping over to more major offenses like being deposited in water features like lakes rivers and fountains.

E-scooters

An E-scooter is a small electric motor powered two wheeled mobility device with a low deck to stand on with handle bars for steering capabilities. They represent the most minimally basic platform for local transportation sporting an 15 mph top speed and an average trip distance of 1.6 miles[1].

E-scooter roots stem from the razor scooter popularized by Wim Ouboter for a short time in 2000 as his solution to “microdistances”. Wim Ouboter coined the term “microdistances” as a journey that was too short for a car, but too long on foot.[2] When expanding their product range in 2001, Micro Mobility Systems included an e-power scooter which is the earliest mass produced e-scooter available on the market. Todays E-scooters available in cities across the world are something of a big-brother to this earlier design with larger components such as bigger rubber wheels, and a larger battery and drive motor.

E-assist bikes

E-assist bikes are bicycles that specifically do not have a throttle. The “assisting” drive motor on this type of battery powered bike engages when force is applied to the petals and requires less exertion from the rider to gain momentum. The drive motor is disengaged when the user stops petaling. This type of bike is optimal for increasing the distance the average user can travel as well as mitigating the stresses of uneven terrain and still retaining the health benefits of being active.

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[1] https://qz.com/1325064/scooters-might-actually-have-good-unit-economics/

[2] http://www.ifpm.unisg.ch/org/ifpm/web.nsf/SysWebRessources/Realizing+the+Scooter+Dream/$FILE/Micro-Last2-e.pdf

With increased speeds this platform increases the risk of injury from crashes with terrain and/or vehicles. Given the small profile of cyclists, it will be much more challenging for drivers operating vehicles to identify and accommodate for this form of transportation. Currently this platform is NOT considered a motorized vehicle and is permitted on Wisconsin highways in the same way a mechanically driven bicycle would be.

E-bikes

E-bikes are two-wheeled battery powered vehicles that typically are operated by a throttle which can be engaged even when the user is not petaling. This platform is much like a small gas powered scooter. Currently this platform is considered a motorized vehicle and is not permitted to operate on Wisconsin highways without proper registration, which sets it apart from E-assist bikes. These platforms increase the distance a person can and is willing to travel, and in some cases allows the use of the bike for functional trips allowing the user to carry heavier loads such as groceries.

"According to figures from Dutch industry organizations RAI Association and BOVAG more than 1 million bicycles were sold in 2018"[3] This points to the growing popularity of E-bikes primarily from private owner/users. As with E-assist bikes, increased speeds also increases the risk and severity of injuries from crashes with terrain and/or vehicles. This increase in popularity should also be taken into consideration by traffic engineers and planners when considering future infrastructure projects.

[3] https://www.bicycling.com/skills-tips/a20044021/13-things-about-e-bikes/

Special mobility devices

It is important to include special mobility devices. This category of devices would include side by side bikes, three wheeled bikes, three and four-wheeled mobility scooters (widely used by elderly population), and recumbent bikes. These special mobility devices are typically used by persons who would otherwise have difficulty using any of the above mentioned platforms due to a physical handicap, special needs, or other factors making difficult or impossible to pilot the other platforms.

It is also important to note that when public funds are used to subsidize bike share systems, these bikes may be a requirement to meet specific ADA accessibility regulations. While this is still new territory calculating the quantity and quality of accessible devices, cities like Portland, OR and Detroit, MI are piloting adaptive bike rental programs to address these issues.[4]

Advantages of last mile mobility technology

Environmental impact

According to the Environmental Protection Agency, “The average passenger vehicle emits about 404 grams of CO2 per mile.” A 2014 study found that in Minneapolis/ St. Paul, approx. 90,000 km (56,000 mi) of vehicle miles were replaced by bikeshare trips.[5] Assuming the average gasoline vehicle has a fuel economy of 22.0 miles per gallon and travels around 11,500 miles per year producing 4.6 metric tons of CO2 per year, bike share trips prevented 22.4 metric tons of CO2 from entering the atmosphere in Minneapolis/ St. Paul alone.

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[4] http://betterbikeshare.org/2017/05/10/two-cities-explore-adaptive-bike-rentals-people-disabilities/

[5] http://mobility-workspace.eu/wp-content/uploads/Bike-shares-impact-on-car-use-3.pdf

Physical health

It is no surprise that physical exercise and general health are directly related. Researchers found that the increase in physical activity both decreased heart disease in men and reduced depression in women.[6] It was also found that the rate of injury was lower than for cycling in general due to reduced speeds, built in lights, better maintenance, and designated bike paths. Overall, it was said that the benefits of using a bike share program outweighed any risks especially for users between 45 to 59.

Some of the benefits of bikeshare can be directly quantified due to the data collected from each trip. Austin, Texas bikeshare B-cycle shows cumulative totals of system data including the total number of calories burned (67,100,038 currently). I learned that this is part of the overhead software data analysis tools provided by B-cycle while working with Milwaukee's Bublr Bikes (using Treks B-cycle platform and kiosks).

Disadvantages of Last Mile Mobility Technology

Declining Mass Transit Trips

While most of the data and research around the last mile technology promotes the advantages associated with increasing transportation options, it is important to point out some of the negative effects. The first I encountered was the effect on public transportation ridership. Increasing transportation options means the inevitable decrease in people riding the bus and other mass transportation options. For every 1,000 Citi Bike docks added along Brooklyn and Manhattan bus routes, bus trips dropped by 2.42%. This could be seen as a negative when trying to quantify funding for bus routes based on ridership.

Fast Paced Market Changes

It is also important to note that with the advent of transit disruptive technologies and the rate at which new technologies are being introduced to the market, it is hard to reliably tell which factors are affecting specific means of transportation. For example, it is only recently ride hailing apps such as Uber and Lyft have become a popular transportation option upsetting the taxi industry as well as bus ridership. Shortly after the ride hailing debut many bikeshare systems were introduced followed by E-scooters flooding transportation markets. There is a grace period which needs to be given for users to learn about the system and for the data to normalize and become available to be analysed. In my experience, the industry is changing so fast that it makes data analysis difficult or impossible to produce reliable results.

(personal note)
During my time interning with Bublr bikes I worked on a data analysis project. During this time period an E-scooter company (Bird) illegally deployed their product within Milwaukee city limits for one month before removing them after a cease and desist order from the City.[7] Bublr also

[6] http://www.montrealgazette.com/health/bike+sharing+health+benefits+study+finds/9572544/story.html
[7] https://www.smartcitiesdive.com/news/bird-scooters-milwaukee-wi-city-attorney-adam-stevens/526821/

increased the one-time walk-up rental fee at the same time the E-scooters were deployed. I was able to show a noticeable statistical difference comparing both annual pass ridership (which did not change) and walk-up users (which showed a decline in new ridership) over the course of three years of data. Challenges I encountered included the addition of stations in the network, adverse weather conditions such as excessive heat and rain, seasonal factors, events large enough to affect trip data, and multiple simultaneous variables such as E-scooter deployment and changes to the pricing structure. I was able to show a statistical change in ridership for that month for walk-up trips taken (decline) but was not able to reliably tell which variable directly caused the change or to what magnitude each variable contributed to the change. The data just had too many things changing too fast to reliably draw a useful conclusion. This is also the case on the Macro scale when multiple forms of transportation options are researched concerning the last mile data analysis.

Public safety

E-scooters are the least stable platform of mobility devices in my experience. While using this device, I felt that at any moment the E-scooter could become unstable and result in a severe injury. According to the Washington Post users have experienced a number of new injuries resulting in emergency room visits due to recent E-scooters becoming available in the city. “Cases of broken noses, wrists and shoulders, along with facial lacerations and fractures have been reported since last summer.”[8] This poses a serious safety concern for both citizen users and pedestrians who could get hit if a rider loses control.

Due to the youth of the mobility device systems being deployed in cities across the United States, many times the infrastructure is not prepared for the new traffic generated by the use of these devices. An example stems from the question, “Where exactly should and E-scooter be ridden within city limits?” Currently, there is no legal place to ride the scooters in Wisconsin and the question of safety is the main topic of discussion. Poor street conditions in colder climates due to snow removal and other challenges pose an extreme risk to riding on streets and bike lanes. Patrons exiting local businesses on foot and pedestrians are also at risk for being hit by users of these devices. During the month that Bird deployed their E-scooters multiple people were hit including one incident that “added fuel” to banning the devices.[9]

Vandalism

Destructive crime is definitely a challenge and disadvantage, and can range from simply tipping a device over, throwing bikes into lakes and rivers, or even cutting tires and brake cables. Generally the rate of vandalism depends on the design of the system, and the local municipality’s crime rates that exist before the mobility devices are deployed. While vandalism can never be completely avoided, some models are more vandal-proof while others are more

[8] https://www.washingtonpost.com/transportation/2019/03/15/cdc-is-studying-e-scooter-injuries/?utm_term=.583325b493e4

[9] https://www.wisn.com/article/alderman-pregnant-woman-hit-by-bird-scooter-adds-fuel-to-proposed-ban/22382642

vulnerable. In Baltimore where crime rates are rising, flaws in the bikeshare locking mechanism have forced local officials to take their program offline temporarily while upgrades are made.[10]

Docked bikeshares don't have to be concerned with their product being moved because of the secure nature of docked devices. This avoids models being outright stolen, moved outside the service area, or being deposited in local water features such as lakes and rivers. My experience working with Bublr Bikes in Milwaukee Wisconsin has shown that the majority of vandalism they experienced was in the form of graffiti or "tagging" bikes in their fleet by one individual. Their fleet has also experienced a mass tire slashing event targeting multiple stations in their downtown area costing the organization a substantial amount of funds and man hours to repair many of their fleet to working order.

Dockless bikeshare, E-scooters, E-assist bikes and E-bikes are all more vulnerable to theft and random vandalism. This is best shown by various social media accounts as public destruction of specific vendors platforms such as bird-graveyard popularizing the misuse and vandalism of freestanding devices.[11] Other cities have reported bike sharing companies have lost up to half of their fleet due to vandalism and flaws in the way the bikes are secured.[12]



International Success/Failure

There is a lot to be learned about last mile mobility by looking across the international stage's best successes and failures. In China, the dockless bike share market exploded into multiple competing bike share interests fighting for market dominance with several consequences. My personal experience traveling in China showed that the systems were widely used and accepted in every major city I visited and were ever present in every corner of my travels. The bikes themselves did take up space on public sidewalks but were well organized within city boundaries. There was also evidence that some of the bikes were not accepted in certain areas

[10] https://www.washingtonpost.com/local/trafficandcommuting/baltimore-bike-share-system-falls-victim-to-crime/2017/09/17/4d46a446-9972-11e7-87fc-c3f7ee4035c9_story.html?noredirect=on&utm_term=.efe5fe0defc8

[11] https://www.vice.com/en_us/article/vbj7xb/theres-an-entire-instagram-account-devoted-to-destroying-rideshare-scooters

[12] https://www.washingtonpost.com/news/dr-gridlock/wp/2018/07/01/theft-and-destruction-of-dockless-bikes-a-growing-problem/?noredirect=on&utm_term=.43fab87a644b

as seen in the photo of dockless bikes stacked around a tree in a public park area and toward the outskirts of the city where there were a surplus of bikes and not enough room to store them. There are several articles showing very dramatic photos of impressive numbers of dockless bikes, but it is hard to tell if these photos are actual “bike graveyards” or just staging areas.[13]



The dockless bike share industry in China is reaching a current critical point with several companies unable to survive the competition and the race for market dominance.[14] It will be interesting to see how bikeshare in China will adapt in relation to pricing, availability, and regulation in the near future.

In the Netherlands, OVfiets[15] is a subscription based bike share system with a much different model designed for the daily commuter. This system leverages the countries robust train network allowing passengers to quickly and easily check bikes out for a small 24-hour fee as long as the user holds an annual pass. The bike can be kept for up to three days incurring the same low rental fee each 24-hour period before the fees increase. It is also designed to be self balancing because of an additional fee if you do not return the bike to the same station the bike was checked out from. While this system has many more rules governing the use of the program, it is just another model to consider how a bike share could work in the correct environment.

[13] https://www.theatlantic.com/photo/2018/08/china-abandoned-bike-share-graveyards/566576/
[14] https://www.ft.com/content/4e7da9b6-037c-11e9-99df-6183d3002ee1
[15] https://www.ns.nl/en/door-to-door/ov-fiets

Current Status

Organizations providing shared last mile solutions such as bikeshare operators are in a critical time in their development. The industry is just over five years old and some of the proverbial new paint is starting to wear off of both the hardware and the funding for many of these providers. For example, China is seeing many of their competing dockless bike share companies file for bankruptcy due to stiff competition and investment dollars drying up. In America, all Chinese based dockless bikeshare providers pulled out of the American market[16] and this is a trend followed closely by some American based companies such as Limebike.[17] Many providers are showing that, like many other public transportation options, the need to be subsidized to make ends meet or expand.[18] Many other existing bikeshare companies are being bought out by larger transportation service providers such as Uber and Lyft.[19][20]

As the playing field narrows and electric bikes and scooters start to populate urban areas, competition for users will pose even more challenges to both cities regulating their use and companies trying to stay competitive. As the market competition narrows, prices may increase to sustain changing business models balanced by current pricing in order to remain competitive. I believe many of the learn-as-you-go lessons will balance out management and pricing of the systems to drive efficiency, improve safety, and advance the functionality of each of the platforms as they evolve.

Recommendations/ Conclusion

It is obvious that every city is different and each solution should be specially catered to the area being planned for. Conditions like seasonal weather, elevation, topography, and infrastructure are some of the obvious variables to consider. Vehicle driver behaviour (safety), public perception, culture, and population density are all examples of less obvious factors that affect the success of transportation planning for last mile projects. Over the course of my career and my travels, I have learned that the environment determines which platform will be the most successful in any area. In China, a dockless bikeshare company called ofo deploys specific bikes designed for the most popular uses in specific areas.[21] For example, if the majority of users in a specific area are women, the company will deploy more step-through bikes with more comfortable seats for women. If an area features more hills, bikes with more gears might be deployed to help with climbing the hills. If students have bookbags, larger baskets will be used on bikes closer to college campuses. The platform should specifically match the area it is intended for.

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[16] https://www.washingtonpost.com/news/dr-gridlock/wp/2018/07/25/mobike-becomes-second-dockless-bike-operator-to-pull-out-of-d-c/?utm_term=.fb9eecc8118e

[17] https://fox11online.com/news/local/green-bay/green-bay-looking-for-new-bike-share-partner-after-limebike-ends-services

[18] https://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2016/03/24/despite-popularity-bike-share-programs-often-need-subsidies

[19] https://www.engadget.com/2018/04/09/uber-jump-acquisition/

[20] https://blog.lyft.com/posts/lyft-becomes-americas-largest-bikeshare-service

[21] Source: In person interview at ofo headquarters in Beijing, China.

Pilot programs are the best way to guage many of the less obvious factors associated with a shared mobility device's success. Setting initial limitations to fleet size, distribution, and rebalancing strategies can show challenges which are much easier to address on a small pilot scale than if a full deployment approach was taken initially. Pilot programs can also show how dense metro areas can adjust to additional space being used by shared mobility devices. In many cities clearly delineated spaces needed to be defined to prevent devices from blocking sidewalks and right of way areas. Pilot studies and limitations on initial deployments are the best way to assess challenges with deploying these technologies.

Equity concerning the distribution of last mile mobility projects is a huge challenge for cities. For example, density is needed to make a bikeshare system economically sustainable, but the areas that usually need more transportation solutions are typically disadvantaged residential low-density areas. Often planners try to solve transportation equity inequalities by deploying new technologies in areas that prove the need for transportation solutions. Without a base ridership or safe and reliable infrastructure to support these programs, they generally don't meet the goals intended by their efforts. This is due to hidden factors such as public safety perception, deficient infrastructure, or the local culture. Cities can get a head start if these hidden factors can be identified and addressed before initial plans are implemented.

Last mile mobility solutions should build on existing successes. For example, if a trail is widely used by the general public for recreational biking, that area would be the best place to deploy a pilot program to build on. In my experience, safe dedicated infrastructure is directly related to the success of last mile mobility solutions. When people feel safe, comfortable, and devices like bikes and scooters are available, data reflects that ridership goes up substantially. Expanding on existing success is the best tactic to promote a successful last mile program.

In conclusion, the last mile mobility device industry is pushing forward at a super fast pace compared to traditional mobility options. Data and research is difficult to find and learn-as-you-go strategies are often implemented. There is no magic bullet solution to designing last mile mobility technologies, and each city should have an individualized plan specific to their needs. Cities should look at underlying factors such as safe infrastructure and management regulations that help support the success of these technologies before they are deployed. Pilot programs should be used to identify and address hidden issues before large scale deployment of any new system within a city is undertaken. Equity and accessibility factors are some of the most challenging pieces of these technologies, but are also the most important, and should also be addressed as early as possible in the planning process. Existing successes should be identified and leveraged as a starting point to expand on and ensure a successful last mile program. Overall, the benefits of last mile mobility technologies outweigh the disadvantages but proper management through diligent planning and adequate regulations will minimize their impact on other modes of transportation and activities within a city.