Bikeshare Paradigms, User Perceptions, and the Urban Experience:

A Comparative Analysis of Mobike Shanghai & Citi Bike NYC

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Abstract

Bicycle sharing schemes have gone global and the number of shared bicycles in use has ostensibly more than doubled over the past two years. Two general paradigms of bikeshare are currently competing for resources as well as hearts and minds of potential customers. Dockless bikeshare (best represented by Mobike Shanghai) and docked bikeshare (best represented by Citi Bike New York) are opposites in many regards, but their goals tend to dovetail. This study addresses the similarities and differences of these bikeshare paradigms, investigating their impacts on users' experiences of their respective urban milieus and the antecedents and correlates of user perceptions, based on survey questionnaires deployed in Shanghai and New York. This study finds that dockless bikeshare shows advantages over docked bikeshare, manifested in a greater diversity of ridership among participants, more substantive perceived effects on users' relationships with their urban environment, and an overarching importance of convenience to user perceptions. The projected expansion of bikeshare, especially dockless bikeshare underscored the timeliness of this study. By offering future directions for researchers and policymakers, this study will thus aid interested parties in decision-making process with regard to bikeshare support and implementation.

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Introduction

Bicycle sharing schemes have gone global and the number of shared bicycles in use has ostensibly more than doubled over the past two years. Two general paradigms of bikeshare are currently competing for urban resources as well as the hearts and minds of potential customers. The goals of dockless bikeshare (best represented by Mobike Shanghai) and docked bikeshare (best represented by Citi Bike New York) tend to dovetail, both aiming to influence local culture toward greener and more sustainable ways of transportation and living. However, the user experience with dockless and docked bikeshare can be divergent.

Popularity and prevalence of bike-sharing vary from place to place. In China today, dockless bike-sharing companies have been likened to the Uber of bikes (Huang, & Horwitz, 2017). They have fundamentally altered how cities move as well as how people interact and connect. The unprecedented scale of urbanization in China has facilitated considerably more rapid implementation of urban experiments like dockless bike-sharing (Seto, 2013). Moreover, the lax regulatory apparatus in urban China has enabled cutthroat competition in these spaces—official industry standards and regulations were not codified until July of 2017 (Xinhua, 2017). Elsewhere, bike-sharing has been less noteworthy. In New York City, for instance, bike-sharing has been an expensive proposition largely hindered by financing and regulation.[2]

As more global cities move forward in an effort to transform local culture and promote bike-sharing, it is imperative to learn from users' experiences and perceptions of Shanghai and New York's bike-sharing. Getting more people on bikes and out of cars can ease congestion and

[2] CitiBike bikes cost in excess of $6000 per bike (Shapiro, 2017), representing a significant hurdle for an efficacious largescale roll-out thereof which can both meet New York's demands and find reason to exist outside of either highly gentrified or, at least, highly capitalized areas. Moreover, New York has been quick to consider and pass new regulations to ensure that negative effects are not felt, yet this invariably retards progress.

invigorate areas that might have previously been otherwise inaccessible, and thus is a noble endeavor in terms of environmental stewardship, community building, public health, and even modern urban development.. A comparative analysis of development of bikesharing in Chinese urban agglomerations and New York City can will shed light on the divergent consequences of two models of bikesharing.

This study addresses the similarities and differences of these bikeshare paradigms, investigating the antecedents and correlates of user perceptions as well as their impacts on users' experiences of their respective urban milieus. The purpose of this research is therefore two-fold: first, to establish an understanding of Citi Bike and dockless bike-sharing in China (specifically, Shanghai), and, second, to help inform interested parties with regard to making effective decisions in the bike-sharing apocalypse which may very well descend upon New York City in the near future. Citi Bike recently celebrated 50 million trips since its 2013 launch on 10,000 bikes, yet, as of August, there were already 1.5 million shared bikes in Shanghai alone (Manskar, 2017; Horwitz, 2017). There is a place for bike-sharing in this world, especially insofar as it can bring positive benefits to cities. Still, negative outcomes, such as sidewalk congestion and potential environmental burden, must be closely investigated, monitored and mitigated. In terms of this study, New York City represents the forerunner that adopted early but never quite got it right, while Shanghai should be regarded as the risk-embracing source of what-not-to-dos and this-works-toos. The key expectation is that the profligacies with bike-sharing of Shanghai and a multitude of other Chinese cities may be understood as a public policy initiative investigation on steroids.

As such, this study looks at Citi Bike in New York and Mobike (as an embodiment of Chinese bike-sharing—including competitors like Ofo and others—in general) in Shanghai for lessons regarding the contemporary bike-sharing phenomenon. The two research questions considered by the study are:

(1) In what ways are New York City's Citi Bike bike-sharing program and China's dockless bike-sharing boom (embodied by the move-fast-and-break-things ethos of Mobike and Ofo) similar and different?

(2) How do their similarities and differences impact users' experience and user perception?

These questions are valuable to planners first and foremost because of their timeliness. As Post Editorial Board (2017) predicts, bike-sharing is generating tremendous momentum around the world and cities like New York City must prepare. Bike-sharing can serve the public (through health and convenience), the earth, and even the city quite well. Nonetheless, significant challenges must be considered. While bike-sharing, in its modern incarnation, first developed in the mid-1990s, it already reached critical mass by 2015 and, since then, it has been pushing forward with such pace that urban planners can fail to keep up (Goodyear, 2017). As per the regularly updated Bike Sharing Map (2017), there have been at least 2118 implementations of bike-sharing thus far, and nearly 2000 of them are still operational in some capacity.

Additionally, these questions are important to look into because bike-sharing can shape cities in subtle or even conspicuous ways by influencing public behaviors and perceptions, forcing planners to watch and react as changes cascade out of their control. A greater proportion of urban traffic is by bike, thus necessitating more bike paths; property near such paths has started to increase in value; parts of cities have become more accessible (S. N., 2013). Furthermore, the egalitarian nature of bike-sharing represents a tide that can lift all boats. In Chinese cities, young professionals and old construction workers alike make great use of

Mobike's services. The move-fast-and-break-things nature of Uber around the globe has strained regulators and city planners to the brink, but it has also changed cities. But cities are uniquely positioned to ensure greater oversight of the next wave of the sharing economy, bike-sharing. Whether public, like Citi Bike, or private, like Mobike,[3] bike-sharing programs in cities utilize public resources and can therefore be held accountable by effective city planning and public policy. Lessons ascertained from Mobike's breakneck pace of implementation and development in Shanghai should prove invaluable to American as well as foreign city planners in the immediate future.

This research is both significant and timely. The large cities of the world are at a crossroads today, facing decisions on whether bike-sharing will figure prominently in their futures or whether traditional models of transportation will continue to take precedence. Chinese bike-sharing corporations have extended the grasp of their competition outside of the Chinese borders, waging their war in Singapore, Malaysia, the United Kingdom, and even the United States among other places. As New York goes, so may many other of the world's great cities. The timeliness of this study is underscored by the manner in which bikeshare, and especially dockless bikeshare, continues to metastasize. This study may thus aid interested parties in the decision-making process with regard to bikeshare support and implementation. Study methodology hinges upon the use of a survey questionnaire, deployed in Shanghai and New York, focusing on user perceptions and experience.

Findings from this study point to a general discrepancy between user engagement and experience with differing bikeshare paradigms. These findings emerge from an analysis of three hypotheses: (1) Dockless bike-sharing in Shanghai, China, caters to a significantly more diverse

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[3] Insofar as sidewalk space, for instance, is considered a public resource, even private firms that don't rely on urban capital make significant use of public space. A common concern with bikeshare in China, for instance, is that firms like Mobike take advantage of these public resources (i.e. the so-called commons).

population than Citi Bike New York does, (2) Dockless bike-sharing entails broader effects on the city than the docked bikeshare paradigm does, and (3) Convenience is the most important factor for riders. Implications from this study and potential considerations for future research are commented on to ensure that these findings are not only taken into consideration, but also effectively contextualized. A greater diversity of ridership among dockless bikeshare participants, more substantive perceived effects of bikeshare on users' relationships with their urban environment, and an overarching importance of convenience to user perceptions point to specific areas of focus that city planners could address in future bikeshare deployments, whether docked or dockless.

Left: Citibike NY Image 1 Right: Mobike in Shanghai

Background

In order to understand the bikeshare phenomenon in New York City, Shanghai, and elsewhere today, it is useful to consider the background—not just historically and in these cities specifically, but also with regard to the popular media's conception more broadly. Lessons from a decades-long history of bike-sharing are unsurprisingly easy to connect to the modern-day lessons from the contemporary bike-sharing boom, while the bike-sharing experience in Shanghai and New York alike has already been investigated carefully. Research and reportage is responsible for significant insights. Altogether, a background on bike-sharing yields a multitude of meaningful points to consider: the degree of regulation appears closely connected to the popular adoption of the service, urban planning is of tremendous importance (not just for adoption, but also for outcomes such as those associated with health benefits), and technology absolutely is capable, in this case, of making life better, easier, and altogether more efficient.

History

Although bike-sharing has only reached critical mass in recent years and continues to develop internationally at a scale and scope that is unprecedented, it has over 50 years of history. DeMaio (2009) breaks this history of bike-sharing into three distinct generations: a rudimentary first generation with normal bikes provided for public use with no oversight or restrictions; a second generation using stations but still ensuring anonymity; and a third generation in which technological improvement enabled greater oversight and accountability. The first generation, starting in 1965, involved Amsterdam's *Witte Fietsen* (White Bikes) program—painted bikes which could be ridden to any location by any member of the public and then, theoretically, left available for the next user. This initial program was the vision of anarchists and radicals as per Andersen (2016). As though predicting China's problems with Mobike et al.'s dockless shared bikes in recent times, many of the bikes were "thrown into the canals or appropriated for private use" (DeMaio, 2009, p. 42).[4] Ultimately, the *Witte Fietsen* program was dubbed a "massive failure" (Goodyear, 2017).

The second generation of bike-sharing programs was developed in Denmark in the early 1990s and then involved a large-scale implementation in Copenhagen in 1995, but these new bikes (which utilized stations, or docks, throughout the city) were also a failure because of poor user accountability (DeMaio, 2009). Reliance upon a system of anonymity and good will, it seemed, had the unpleasant side effect of facilitating bad behavior. Bikes were broken and stolen in large numbers.

The following year, in 1996, England's Portsmouth University debuted the third generation biking system, a shared bicycle program with activation through individual user card swiping (Goodyear, 2017). This finally enabled bike-sharing programs to track who was renting the bikes and, thus, who was stealing or misusing them. Third-generation bike-sharing systems utilize more advanced technology including mobile phones, magnetic stripe cards, and smartcards to facilitate the reservation, location, and access to shared bikes (Shaheen & Guzman, 2011). By 2009, DeMaio (2009) notes that roughly 120 third generation bike share programs were in existence. Many of these were, like Portsmouth University's, small-scale and focused on a specific area or campus (whether that of a school or a corporate enclave). Some theorists have

[4] In fact, an October 2016 incident in Shanghai during which an individual threw Mobikes into the Huangpu River garnered significant public attention, drawing a sharp focus on the suddenly-all-too-identifiable deleterious environmental and especially social effects of China's bike-sharing boom (Dixon, 2016). Because of a lack of accountability ostensibly attributable to poor city planning and a low degree of municipal involvement in bike-sharing regulation, commentators were quick to point the finger at the specter of bike-sharing.

identified fourth-generation bike-sharing programs as a new phenomenon, citing greater integration with other public transportation modes (e.g. through the implementation of a single shared transit card to allow access to multiple local public transit options) and more seamless integration of developing technologies (e.g. solar power, GPS functionality) is characteristics thereof (Shaheen & Guzman, 2011). Nonetheless, a delineation between third- and fourth-generation bike-sharing systems remains opaque and largely unnecessary for theoretical or practical inquiry.

Since 2009, the number of third-generation bike-sharing programs in existence has ballooned. By the end of 2016, official estimates suggest that roughly two million "public use bicycles in automated and/or information technology-controlled systems" were operational in "approximately 1,175 cities, municipalities or district jurisdictions in 63 countries" (Britton, 2017). Although the global bike-sharing landscape is shifting even more rapidly in recent times, current estimates hold that there are over 2,000 programs operational or under construction in nearly as many cities (Bike Sharing Map, 2017). The total number of shared bikes on the roads globally has, spurred on by the Chinese boom and in line with the worldwide metastasizing of behemoths Ofo and Mobike, eclipsed that 2016 estimate of two million bikes. In fact, while official figures are not publicly available, Mobike and Ofo each purportedly have between seven and ten million bikes on the road in China alone, while the distant third-place competitor for the Chinese market, Bluegogo, claims roughly 700,000 bikes on Chinese roads (Economist, 2017). In the span of roughly one full calendar year, the number of shared bicycles on the road globally had increased tenfold or even more.

New York

New York's Citi Bike program was not initiated until 2013. Prior to that, other American cities including Washington D.C., Minneapolis, and Denver had already introduced bike-sharing programs (Goodyear, 2017). New York City first publicized an interest in bringing shared biking to the city in 2011, and the two years prior to Citi Bike's release were a time in which an "unprecedented public input process" occurred, leading to the 2012 unveiling of the first bike-sharing system solely funded through corporate sponsorships (Citi Bike, 2017; Goodyear; 2017).[5] Sponsors included Citibank and Mastercard, with a commitment from Goldman Sachs coming years later. The initial Citi Bike release consisted of 6,000 docked bicycles that could be ridden from one dock to any other in the city. Today, Citi Bike has over 100,000 annual members, hundreds of stations, and 10,000 bikes (Citi Bike, 2017). According to a report by Kaufman et al. (2015), the first two years of Citi Bike implementation were a success based on intelligent planning (nearly three-quarters of stations are located within five-minutes from subway stations), proximity to major transit stations (Grand Central Terminal and Penn Station are key locations), and timeliness (dovetailing with the sharing-economy boom and existing in post-recession NYC).

Citi Bike has generated positive as well as negative press from popular media sources, and if any true consensus merits support, it is likely that Citi Bike has thrust New York City into the new millennium of sustainable, highly livable cities, inspiring many debates on just what such a city should look like. Some concerns regarding Citi Bike have even been raised on health issues, with Plitt (2017) arguing that Citi Bike handlebars are among the city's most germ-

[5] Notably, many cities have publicly-funded bikeshare programs (e.g. San Francisco, Boston, Chicago) as bikeshare is conceived of as a public good. As with any public funding matter, the issue can turn political: Mayor Bloomberg 'sold' the public on bikeshare in NYC by repeatedly stipulating that no public subsidy would be granted (see Coscarelli, 2014).

infested surfaces. Furthermore, health related benefits of Citi Bike were the source of debate following the June 2017 death of a Citi Bike cyclist who was struck by a charter bus (Haag and Alani, 2017). Even though New York City has often been lauded for its implementation of bicycle lanes, the accident brought safety concerns associated with bike-sharing programs into critical focus. One major point of contention for the development of Citi Bike has been the location of its bicycle docks (i.e. its accessibility in presence in specific neighborhoods, for certain communities, and for certain types of residents): affluent locales were the first to see Citi Bike's implementation, whereas expansion into low-income neighborhoods relatively delayed (Fitzsimmons, 2016). Insofar as one of the major promises of shared bicycling is accessibility and egalitarianism in transportation, Citi Bike was certainly falling short of the mark. The conversation surrounding Citi Bike's expansion has been a source of ire for many, in fact. Docks for the bikes have created problems in areas where public space and sidewalk availability is already at a minimum (Rizzi, 2018). It is no surprise, then, that even Citi Bike has entertained the idea of implementing dockless shared bicycles as a way to underwrite future penetration throughout the five boroughs (Furfaro, 2017). As Citi Bike becomes increasingly ubiquitous throughout the city (expanding across the five boroughs) and New York becomes more amenable to cycling culture, it stands to reason that the future of personal and public transportation in the city will err toward the pedal-powered (Hu, 2017b).

The conversation surrounding Citi Bike's influence on New York City's culture, present and future, has inevitably turned toward a discussion of expanding the city's bike-sharing culture as well as options. Because of the slow growth of Citi Bike (as well as its reluctance with regard to entering low-income markets), the local Department of Transportation and various other city planning boards have suggested that the future of New York's bike-sharing might not be solely the province of Citi Bike (Harp, 2017). Dockless bike-sharing, whether by Citi Bike or other companies such as Mobike or the stateside upstart Spin, may be the way of the future, but New York has thus far stymied its implementation. Spin, for example, was served with a cease-and-desist letter prior to roll out (Hu, 2017a). Dockless bikes have been an area of serious concern for urban governments and local municipalities: they desire an ability to “rebalance the dockless bikes in accordance with community need” as well as “jurisdiction over bike maintenance, safety standards, [and even] data-sharing” (Anzilotti, 2018). Chaos in many cities that have allowed dockless bike-sharing to flourish has underwritten concerns that such programs will more than likely fail in most cities as well as concerns that they will take advantage of urban resources rather than contribute to them (Lindeman, 2018; Schmitt, 2018). One statistic which proponents of such theories turn to is usage numbers: firms like Mobike have not been forthcoming with such figures, but while Citi Bike boasts over 5 rides per bike per day, figures from Ofo and Spin in Seattle point to fewer than half as many daily rides per bike (Schmitt, 2018). In short, Citi Bike, despite notable concerns, has been a positive, commendable bike-sharing effort, but the success thereof has not impelled public policy experts to support further experimentation with the bike-sharing format.

Citi Bike is the largest bike-sharing program currently existing in the United States, and the program continues to grow. In 2016, users took 25% more trips than in the prior year (NACTO, 2016). Bikes can be found in Manhattan, Brooklyn, Queens, and Jersey City, and 50 million trips have already been undertaken (Citi Bike, 2017). The system continues to expand, with prospective stations expected in Astoria and Long Island City (Bultman, 2017). Though they typically stand out as an excellent option, a recent interactive map indicates that, in some places and during certain timeframes, they tend to lose out to taxicabs when it comes to timing

(Schneider, 2017). While Citi Bike remains the only player in New York City's bike-sharing universe, recent reports indicate that the Department of Transportation is preparing a request for dockless bike-sharing firms to propose entry into the market (Walker, 2017). As such, the city is currently approaching what may be an inflection point for bikeshare: a greater push is being made to democratize bikeshare (e.g. spread it throughout the five boroughs) with or without Citi Bike.

Shanghai[6]

Shanghai, on the other hand, as a city teeming with pedestrians, electric scooters, cars, and taxi cabs, suffers from rather centralized and time-dependent congestion, and it is difficult to imagine a taxi getting somewhere faster than a bike within the city's central area. China has had a long love relationship with bikes, but the rise of Mobike et al. has been something else entirely—a shared-bike system in which riders typically make a deposit (around 300 yuan, or $45) and then pay either per month or per ride (rarely in excess of 1 yuan, or about $0.15). This low cost has become a major selling point of China's bicycle-sharing boom, as it underwrites the dramatic increase in usage of shared bicycles for short trips. Consider, for instance, how the city of Shanghai has a starting cab fare of roughly 14 yuan (roughly $2.10), nearly one dollar more expensive than the cost of a shared bicycle journey that lasts for 30 minutes or less. These bikes are dockless, meaning that users may ride them from anywhere to anywhere. They operate by way of QR code, allowing anybody with a smartphone to download an app, scan, and ride. There are already over 16 million such shared bikes in China, far more than anywhere else in the world (Hernandez, 2017). Estimates point at some 1.7 million of these bicycles being in Shanghai alone

[6] Note that other Chinese cities have similar programs. Mobike, Ofo, and their competitors have a strong presence throughout urban China.

as of September of 2017, and reports suggest that the aggregate annual capacity for bicycle production by Mobike and Ofo is roughly 30 million (Jiang, 2018; Yang, 2017). Flooding the global bicycle-sharing market in order to push out competitors is something that Ofo and Mobike have demonstrated a noteworthy ability to undertake.

Bicycling has long been important for China. It is important to note, though, that the share of bicycling as a travel mode has declined steadily since the 1990's in most major Chinese cities. From the time when Mao came to power up until roughly 1980, the Chinese populace dreamed of owning san zhuan yi xiang ("three rounds and a sound"), including a watch, a bicycle, a sewing machine, and a radio (Wetherhold, 2012). More recently, Chinese state media has dubbed dockless bike-sharing as one of China's four great modern inventions (Xinhua, 2017). Today, China is the world-leader in bike-sharing programs, as it once again becomes the "Kingdom of Bicycles" following a tremendously fast-paced boom in the latter half of 2016 (Poon, 2017; Yang & Liu, 2017). While Ofo and Mobike started in 2015, bike-sharing was first introduced in China during 2013 in Hangzhou with a docked bikeshare system (Mead, 2017). Today's key firms developed throughout China at an unimaginable rate, dumping bikes in urban centers by tens of thousands. These firms have been propelled by a glut of private finance (especially from parent companies Tencent and Alibaba) as well as a dearth of stunting urban oversight and regulation. Other bike-sharing firms like Xiaoming and the now-defunct Bluegogo sprouted up to compete, but the Mobike-Ofo rivalry remains the defining one in Chinese cities today. In fact, other bike-share services have largely been relegated to the provision of niche services such as electric bikes or flashy gold bikes.

Of course, bike-sharing is not solely a win-win proposition for cities. It has led to a significant number of negative effects in Shanghai and elsewhere in China, causing sidewalk congestion, bad public behavior, and the development of graveyards of damaged bikes being neglected rather than fixed, for instance (That's Shanghai, 2017). Image 1 depicts this disparity, showing the relative orderliness of docked bikeshare above (Citi Bike, New York) compared to the propensity for trouble with dockless bikeshare below (Shanghai Mobike). These are disruptive technologies and public as well as private interests have urged policy makers to react, just as New York City has moved in to do and as Paris has recently done (Clerq, 2017). In Shanghai, even, regulators have attempted to address the problems associated with bike-sharing with a renewed fervor in recent months. A broad regulatory framework has been enacted, limiting the number of new bikes that can be put on the roads, enforcing parking codes more aggressively (such as through the implementation of geofencing technologies), forcing shared bicycles in poor condition to be removed from circulation, and overseeing the relocation of bicycles during peak usage hours (Jiang, 2018).

Around the world, other cities have followed Shanghai's example and taken lessons from its regulatory shortcomings. Seattle, for instance, has promoted bike-sharing as a way to enact a more sustainable future for the city, but it has been careful to implement strict regulations: a cap on the number of shared bicycles a single operator may oversee has been implemented, limiting the best-performing and most regulatory compliant operators to a maximum of 2,000 bikes (Jiang, 2018). Ultimately, the proliferation of bike-sharing systems has been a cause of significant concern among policymakers around the world. The implementation of such systems has, in many cases (the Shanghai one chief among them), left much to be desired.

Literature Review

The following section provides a broad overview of the scholarly, grey literature, and, briefly, popular literature related to the topic of bikeshare. Opportunities, shortcomings, future areas of interest, and realized benefits of bikeshare are hence considered. Additionally, the literature relating to Shanghai Mobike and New York Citi Bike are also reviewed.

Bike-sharing has come to embody the promise of a smarter, more connected and sustainable city. According to DeMaio (2009), bike-sharing's key impacts to the urban milieu include the creation of a larger cycling population, a decrease in greenhouse gas emissions, increased usage of public transportation modes, and public health benefits (p. 43). In a review of the scholarly literature on the impacts and directions of bike-sharing schemes, Fishman et al. (2013) tracks the major themes which arise from the bike-sharing literature: users value convenience and costliness, are more likely to own a personal bicycle than nonmembers, are less likely to wear helmets than other cyclists, and most frequently substitute other sustainable transportation options for shared biking. Moreover, Ricci (2015) finds that congestion, pollution, and carbon emissions remain unaffected by bike-sharing implementations. Although such findings seem rather problematic in terms of the positive future of shared biking schemes around the world, it is worth noting that the body of literature has yet to catch up to the ubiquitous nature of modern bike-sharing firms like Mobike. Whereas bike-sharing was previously more of a novelty, it is now a fact of life for many residents in Chinese cities. In fact, this is also the case elsewhere throughout the world, as major cities like Paris and even Seattle have undertaken bike-sharing initiatives as a key feature of local sustainable development policy. It is for this reason that Midgley (2011) and others continue to highlight bike-sharing as the future of "sustainable mobility."

Popular literature has been quick to identify myriad benefits of bicycle-sharing systems, readily extolling the virtues thereof for decades already. (Notably, many of these benefits have been difficult to quantify or have, at least, required significant qualification insofar as they are contingent upon all manner of other considerations: *Are bike-sharing users riding when they would otherwise be in an automobile? What is the environmental impact of more bicycle production as opposed to, for instance, the implementation of some other form of public transit? Where does one draw the line between convenience and oversaturation? Does the area have the infrastructure to support more cyclists, or might they negatively contribute to congestion?*) Key benefits included a reduction of greenhouse gas emissions insofar as bicycle trips might be used instead of automobile trips as well as an overarching change to behavioral trends (often referred to by reporters as *going green*) (Shaheen & Guzman, 2011). Moreover, shared-bicycle systems have been responsible for noteworthy innovations and have also been sites of early adoption for such green technologies (Yang, 2017). Solar panels, smart lock technologies, internet connectivity for the internet of things, and other technologies such as pedal-powered air pollution scrubbers have all been promising technological outgrowths of the bike-sharing boom. Bicycle-sharing has also increased convenience and accessibility for urban residents, perhaps even opening up new areas of the city to greater commercial activity. Reduced congestion, transport flexibility, reduced fuel consumption, financial savings for individuals, and the social benefits connected with sharing have all been cited as attractive benefits of bike-sharing as well (Nikitas, 2016). Moreover, health benefits such as to cardiovascular health have commonly been regarded as reason enough to champion bike-sharing, but some sources indicate that cities with insufficient bicycling infrastructure have seen an uptick in cyclist injuries and deaths, thus counteracting any purported health benefits (Laursen, 2014). Still, it remains the case that bike-sharing programs have a very real promise for cities worldwide—socially, economically, and in terms of personal health alike.

One major theme in the bike-sharing literature is the theme of bike-sharing's impact on personal health and wellbeing. Bicycling represents a form of "active transportation," and while the benefits of active transportation (i.e. walking or cycling) are different for age, gender, ethnicity, and geographic location (e.g. due to pollution), they are nonetheless quite meaningful when compared to the health outcomes of non-active transportation (Mueller et al., 2015). Evaluating the implementation of a shared-biking system in Ireland, Murphy and Usher (2015) finds that 68% of users[7] did not cycle for their trips, many of which were between work and home, prior to shared bicycle availability. This indicates that health benefits accruing as a result of the extra exercise gained from bicycling were likely being substituted for automobile trips. Moreover, Shaheen et al. (2012) finds that 72% of bicycle share system users across four North American studies report spending considerably more time cycling. Not only does bicycle sharing give residents a new transportation option, but it also has the added benefit of changing local culture and facilitating the development of positive, more healthful personal habits. Notably, some studies have indicated that these health benefits are more readily identifiable among men than women as well as among older individuals, but they are primarily related to the fact that most people who utilize bicycle sharing would have been using some different form of public transportation (Woodcock et al., 2014). The health benefits of bicycle sharing are largely contingent upon the substitution of automobile use for bicycling, and studies have shown that there is almost universally a significant amount of such substitution (Fishman et al., 2014;

[7] The total population of which was only 22% female.

Grabow et al., 2012). In the case that users see bicycle sharing as a substitute for walking short distances, though, it is important to recognize that it can become an impediment to rather than cause of better health outcomes. Users who bike the last kilometer home when they might have previously done so on foot are actually harming rather than aiding their health.

As such, some risks to personal health stemming from bike share uptake have been documented: users in cities with poor air quality are exposed to more air pollution than they would be while slightly more cycling deaths occur in cities that have implemented bike-sharing (Rojas-Rueda et al., 2011). The air pollution concerns, notably, may be mitigated by the fact that cycling results in an aggregate decrease to automobile-related air pollution emissions, and thus a greater uptake of bicycle sharing can contribute to a greener city with better air quality that is, in turn, safer for residents to cycle in (Grabow et al., 2012). An increase in cycling deaths is likely attributable to the fact that bicycle sharing programs do not include shared helmets and often fail to promote helmet use. In fact, research has found that users of shared bicycles are significantly less likely to wear a helmet while riding than their peers who own bicycles are (Kraemer et al., 2012). Furthermore, the cycling deaths might also be a matter of different demographics patronizing bikeshare than would normally ride bicycles: bikeshare users are more likely to be younger as well as female than their bike-owning peers (Buck et al., 2013). Concerned citizens and research groups alike have brought the safety issues associated with more cycling in cities to the attention of policymakers, and thus greater bicycle sharing adoption is likely correlated with a more deliberate focus on improving bicycle safety. Policymakers are paying attention, as they recognize that infrastructure is particularly influential not just for bicycle safety but also for the promotion of cycling more broadly (Pucher et al., 2010; Garrard et al., 2008; Liu et al., 2012; Reynolds et al., 2009; Teschke et al., 2012). If bicycle sharing is increasing the frequency of bicycle related fatalities or injuries, then this increase is likely more closely connected to municipal policies and developments—as such, it is something that could, under effective stewardship, improve markedly over time. As to whether this increase in injuries or fatalities has happened, the verdict is ultimately still unknown: Graves et al. (2014) reports a 28% decrease in cyclist injuries following the implementation of bicycle sharing systems in five cities, while Murphy and Usher (2015) finds that 93% of users report greater awareness of cyclists on the road when they are in their cars. That is, individuals who participate in bike-sharing may develop new behaviors and a greater consciousness even when they are not cycling. Overall, the benefits of bicycle sharing to personal health are largely considered to outweigh the impact of these negative factors (Mueller et al., 2015; Rojas-Rueda et al., 2011).

Research has frequently addressed the major question of bicycle sharing being used as a substitute for automobile usage. Insofar as this substitution is among the most important factors in determining overall outcomes from the adoption of bicycle sharing, this question is at the heart of the matter. According to Shaheen and Martin (2014), roughly 40% of bike-sharing users in four different North American cities reported a reduction in time spent in the automobile, with 36% of Montreal users, 25% of those in Toronto, 52% in Minneapolis, and 41% in Washington, D.C. claiming that bicycle sharing improved their ratio of active to sedentary transportation. Moreover, Hamilton and Wichman (2015) finds that neighborhood bikeshare docks coincide with a relatively minimal (2-3%) decrease in local traffic congestion. More recently, Hamilton and Wichman (2018) estimates a 4% decrease in traffic congestion in neighborhoods with bikeshare implementation. Still, there is not a research consensus on the role of bicycle sharing in reducing automobile usage. Research from cities as far afield as Barcelona, Lyon, Paris, and Montreal has found a reduction of automobile trips between 2 and 10%, but most users of bicycle sharing are actually substituting it for public transportation rather than their personal automobile usage (Buis, 2008; Curran; 2008; Bachand-Marleau, 2010; Midgley, 2011). In a broad synthesis of the literature of bicycle sharing, Fishman et al. (2013) finds that most users who join bicycle sharing systems are substituting from other sustainable modes of transportation or even from walking, thus indicating that cities should temper their expectations for the benefits associated with bicycle sharing implementation. The environmental, social, and personal health footprint users are developing by switching to shared bicycles has, therefore, often been overexaggerated. Notably, this is closely connected to various city-specific characteristics. Some cities undoubtedly have higher switching costs for riders, while others (especially those with fledgling public transportation systems) may actually have much lower switching costs and thus experience higher adoption rates from users who might otherwise commute in single occupancy automobiles.

Importantly, even if users are not overwhelmingly improving their transportation footprint by switching to such systems, bicycle sharing has come emerged as one piece of a green city's public transportation puzzle. Smart bicycle sharing is considered a key part of urban mobility in sustainable cities (Midgley, 2009; O'Brien et al., 2014; Jappinen et al., 2013; Pucher & Buehler, 2009). Simply having the option available can buttress broader public transportation availability and accessibility, making public transportation a more desirable option for many who might otherwise eschew it. First, it can facilitate connections with other public transportation options, such as through the decision to place docks (in the case of systems following the Citi Bike model) or large geofenced parking enclosures for bicycles (in the still-improving Mobike model) near public transportation hubs such as subway stations. Light rail, subway, train, and bus routes all benefit from such linkages (Barber et al., 2018; Yi et al., 2018; Welch et al. 2018).

Disparities even in this benefit are notable, though, as Ji et al. (2017) finds that female bikeshare users (who are already less likely to use bikeshare) exhibit considerably less benefit in terms of bike-to-rail connections, while the same finding holds to older users as well. The option to take shared bicycles may also relieve pressure on other public transportation options, such as overcrowded bus routes or metro lines with many stops in high-density areas. According to Shaheen and Martin (2014), people who use bicycle sharing frequently use it to connect (especially in terms of the last mile) with a bus or train that they might have otherwise regarded as out of reach. One crucial result of this, in addition to the benefit of stimulating public transportation usage, is that it can improve overall travel times to get from one area to another in or around the city (Jappinen et al., 2013). In Ireland, Murphy and Usher (2015) found that 56% of bicycle sharing users combined cycling with train usage and 35% of users combined it with bus routes. Unsurprisingly, usage of shared bicycle systems is highest at and around public transportation hubs (Goodman & Cheshire, 2014). Furthermore, while bikeshare stimulates those connections to the broader public transportation network in suburban areas with lower population density, bicycle sharing also alleviates pressure on high-traffic overcrowded urban public transportation routes (Shaheen & Martin, 2014). Ultimately, the availability and accessibility of bicycle sharing as a transportation option for urban and suburban residents has a non-negligible impact on behavior, and part of this impact is stimulating greater usage of a city's public transportation system at large (Shaheen et al., 2011; Kaltenbrunner et al., 2010). As such, cities that oversee effective implementation of bicycle sharing systems can generate positive benefits in other areas of interest.

Insofar as bicycle-sharing has become an integral part of the urban public transportation puzzle, it has also served as somewhat of a window into urban inequality. In some cases, it has been reported to have an exacerbating (or negligible, at least) effect, whereas other cases have been quite positive. On one hand, proponents champion bicycle-sharing systems as a way to facilitate greater access to the city at an attractive price for citizens from a wide array of backgrounds and socioeconomic statuses, but, on the other hand, the reality has not always matched up with this idealism (as is the case with other hypothesized benefits as well). Ursaki and Aultman-Hall (2016) argues that the equity of bikeshare access in the United States, at least, continues to leave much to be desired—even though docks are typically spread out over the most densely populated areas of cities, this inadvertently has the effect of "limiting access to bikeshare for traditionally disadvantaged groups" (p. 13). A recent trend in the research has been to investigate equitable access for people of color (especially those residing in low-income areas), and the general finding has been that these people remain underserved (Howland et al., 2018; Dill et al., 2018; Barajas, 2018). Bikeshare users, in North America and Europe at least, are typically white, male, well-educated, upper class, and young (Wang & Lindsey, 2018). There is no easy solution for this in the case of docked bicycles. Expansion is a costly proposition and efforts that do not pay off over time will invariably necessitate local government subsidization in one way or another. Goodman and Cheshire (2014) confirms the difficulty of ensuring more equitable access, finding that efforts to do so in London were unimpressive at best. With regard to this problem, the distinction between divergent possibilities associated with docked and dockless bikeshare programs is only magnified: dockless bikeshare can be more convenient for a wider array of users, but that does not necessarily mean that it solves the problem of simple economics (Mateo-Babiano et al., 2017). Economic benefits that accrue to the city as well as to the individual, though, may sufficiently subsidize such outcomes.

Bicycle sharing has also long been hypothesized as an economic boon and also as a means to cheaply and effectively enhance mobility in urban areas. The rapid growth of bicycle sharing in developing countries like India and China, for instance, has granted underserved populations more access to the city and more of an ability to get around for opportunities (e.g. employment-related ones) that were previously perceived as out-of-reach to them (Pucher et al., 2007). To be sure, context is quite important—developed and developing countries may expect different outcomes from bikeshare. This, along with other benefits of bicycle-sharing, can precipitate a variety of economic benefits at the individual, household, city, and even more macro levels. According to Buehler and Hamre (2014), 70% of businesses in cities with bike-sharing programs report economic enrichment directly connected to the improved accessibility owing to cycling improving local mobility. Researchers quantified a $1.20 per user per week increase in spending at businesses near bicycle-sharing stations, and 20% of businesses as well as 23% of users reported visible impacts on spending patterns (Buehler & Hamre, 2014).

A reduction in neighborhood congestion, as reported by Hamilton and Wichman (2015), is also a process which undoubtedly leads to economic benefits for an area. Less congestion entails more mobility as well as more parking options—both of which contribute positively toward the consumers' decision to patronize an area or local business. Similarly, as the popular maxim *time is money* specifies, a reduction of overall travel time (something which, as per Buehler and Hamre, 2014, was reported by 73% of bikeshare users) can translate directly to economic benefit. Individuals who spend less time commuting to work, for instance, and more time in the office almost invariably exhibit productivity gains as well as less absenteeism (Van Ommeren & Puigarnau, 2011; Lyons & Chatterjee, 2008; Redmond & Mokhtarian, 2001). In terms of a citywide economic impact, bicycle-sharing systems have also been posited as beneficial for the tourism outlook and economy of an area. Estimates by the European Cycling Federation, for instance, point to visiting cyclists spending between 3 and 4 times more per day than visitors who only patronize automobile transportation—those who cycle are less likely to carry a full day's worth of supplies with them, and they also burn more calories, thus developing more hunger (Timothy & Boyd, 2014, p. 157). Wang et al. (2018) uses data from Citi Bike to analyze the impact of bikeshare variables on neighborhood level attractions such as those associated with tourism—when coupled with built environment characteristics, bikeshare capacity and accessibility can have an advantageous effect. Whereas researchers have observed and quantified these benefits in European cities with integrated bicycle-sharing and tourism plans, the efficacy of bike sharing as a tool for tourism development is less concrete without such integration and partnership (Timothy & Boyd, 2014). On a much more direct user-oriented level, the economic benefits are even more readily apparent: the nominal cost associated with renting a shared bicycle (as low as $0.15 in the case of Mobike) is considerably lower than costs associated with any other form of transportation, public or personal. Suffice it to say that, at least with regard to its impact on the commute and on behavior of riders, bike-sharing can have a positive economic impact.

Recently, bike-sharing has become a Big Data opportunity that scholars, city-planning professionals, and technophiles alike are rushing to solve. Some research has investigated the optimization of station location (Garcia-Palomares et al., 2012; Raviv et al., 2013), other studies have used user data to investigate activity patterns (Vogel et al., 2011), and others still have sought to solve the problem of inventory management and bike allocations (Raviv & Kolka, 2013; Schuijbroek et al., 2013; Chemla et al., 2013). For Townsend (2013), this big data problem is fundamentally one of "the quest for a new utopia." The main idea is that smarter bike-sharing can be a very useful tool for smarter cities, thereby ensuring public health benefits, environmental benefits, and a more sustainable future. Even at Citi Bike, specifically, research has been carried out on the optimal allocation, positioning, and rebalancing of shared bicycles: according to O'Mahony & Shmoys (2015), overnight rebalancing could be more effectively undertaken[8] simply by deploying more trucks. While this does not represent a novel solution, it is a mark of the progress being made in the relationship between Big Data and shared bicycle services optimization. Big Data has also been used to create a visualization of Citi Bike ridership that can help with real-time problem solving as well as anticipating issues before they arise (Oliveira et al., 2016). Crucially, many of these studies focus on docked bikeshare systems—for instance, the rebalancing problem (as investigated by Chemla et al., 2013, and others) takes on a particularly different character when no dock is required. There is more of an invisible hand, so to speak, at work, shaping the market based on precisely what the market needs or requires at a specific time and in a specific geographic location.

Citi Bike & Mobike

Data from the Citi Bike and Mobike programs have been made available to different degrees. Whereas Citi Bike, as a company directly answerable to New York City's Department of Transportation, is particularly transparent with regard to its collection of data, Mobike is a private firm and has been less forthcoming. Nonetheless, some literature has been made available which provides an interesting source of comparison between the two different programs. According to Mobike Global (2017), the collection of Big Data from the GPS-facilitated bike-sharing program has enabled a few interesting conclusions to come to light: 70% of users are

[8] In fact, Citi Bike was already at work on this problem as of 2015 and has since deployed trucks overnight to aid in the overnight rebalancing problem.

between the ages of 20 and 50, while those in their thirties and younger primarily cycle to workplaces and school; older users frequently use bicycles for dining out and shopping; 90% and 51% of trips in Shanghai start near a bus station and subway station respectively; and males take more trips than females. Mobike Global (2017) further finds that cycling has increased in urban China by over 100%, car trips have been more than halved, illegal rickshaw usage has decreased, pollution (the day-to-day variation thereof) does not impact ridership, and data science applications have pushed cities to become smarter. Different areas of the city are seeing different patterns of use at different times, 540,000 tons of CO2 emissions have been offset, and 460 million liters of gas have been saved (Mobike Global, 2017). Kaufman et al. (2015), on the other hand, focuses on where trips typically originate and end-up for Citi Bike users. Notably, the docked requirement for these bikes means that users have fewer options and their relationship with the bikes (and, thus, with the city) is more circumscribed. Findings were that males accounted for 78% of riders and a majority of trips originated from transportation hubs such as Grand Central Terminal and Penn Station. Additionally, Schneider (2017) finds that Citi Bike users are less active during inclement weather, the company found greater success over time at allocating bikes effectively, and trips follow distinct patterns throughout the day. Other third-party studies researchers have undertaken studies of Citi Bike over time, as well. Basch et al. (2014) addresses one of the major safety concerns associated with bicycle-sharing programs, finding that "over 4 of 5 Citi Bike users do not wear a helmet and, further, helmet non-use rates are consistent across Citi Bike locations, time of day, and day of week" (p. 507). As a follow-up, Basch et al. (2015) argued that Citi Bike education initiatives to promote helmet use have been overwhelmingly ineffective. Not all of the research on Citi Bike has taken such a negative tone, though. In an overarching study of user experiences and habits, Gordon-Koven and Levenson

(2014) concludes that "New Yorkers will benefit from improved mobility and additional transportation options" as a result of Citi Bike expanding throughout the five boroughs (p. 4). Analyzing the role of Citi Bike stations in connecting people with other transport options, the report finds that certain "activity hubs", such as docks near Pennsylvania Station and Grand Central Station had already at that early date become integral parts of the New York City public transportation milieu. Still the question of who will benefit and how they will benefit remains an open one. In addition to concerns about equitable access to Citi Bike, reports have raised concerns regarding Citi Bike's stark gender disparity in ridership (Kaufman, 2014). Fishman (2016) links this gender disparity to a country's overall bicycling culture: strong cycling countries exhibit high levels of female participation in bikeshare programs whereas weak cycling countries have male-dominated bikeshare implementations. Many questions are still available to answer, and many problems are still open to solve.

Summary

Ultimately, a literature review on the contemporary state of bicycle-sharing around the world yields many insights, but what it especially underscores is the notion that the benefits and efficaciousness of bicycle-sharing is highly context-dependent and particularly variable from one location to another. Without cycling-related infrastructure (or at least a plan for the development thereof), without an integrated public transit system and promotion plan, and without additional incentives to substitute away from automobile usage, the social, economic, and personal health benefits associated with bike-sharing implementation may be almost utterly counteracted. Similarly, unless a city expresses its commitment to green and sustainable urban development in other ways, it may only become a less hospitable place for bicycle sharing activities. The attitudes and behaviors of bicycle sharing users are fundamentally important means to inform the decisions of policymakers and local planners, but, as the literature review indicates, such things can only go so far without a concerted and well-integrated effort. Of course, the tools to guide this effort are rapidly becoming more available than ever, as the optimization of all manner of bicycle-sharing problems has become a task that Big Data analysis has begun to tackle with aplomb. Citi Bike and Mobike stand at opposite ends of the bicycle-sharing spectrum, yet the outcomes which they report are not altogether so opposite. In New York and Shanghai alike, the experiences with shared bicycle programs reported by the broader body of literature have not yet been fully realized (or, at least, fully accounted for), but they are undoubtedly playing out on a day-to-day basis.

Methodology

The methodology of this study includes an overview of the hypotheses, a discussion of the two locations of interest (representative of their respective bikeshare paradigm), as well as explanations of site selection, sampling method, questionnaire design, and the analytical framework.

Hypotheses

Two central hypotheses and one secondary hypothesis emerged through a consideration of patterns in the bikeshare literature as well as potential topics of focus which have not been sufficiently investigated thus far therein. These hypotheses anchored the study.

The two central hypotheses are:

(1) Dockless bike-sharing in Shanghai, China, caters to a significantly more diverse population than Citi Bike New York does, and

(2) Dockless bike-sharing has broader effects on the city than the docked bikeshare model does.[9]

(3) Convenience is the most important factor for riders.

These hypotheses account for one relatively basic question and one question with a more substantial number of antecedents (and, hence, necessitating more complexity in both survey design and analysis). The rationale behind the first hypothesis stems from the notion that bikeshare unhindered by the high costs associated with a docked model can be more readily deployed in areas of the city where commercial as well as residential activity are more diverse.

[9] 'dockless' and 'Shanghai' are interchangeable, while 'docked' and 'New York' are similarly interchangeable.

Furthermore, I expect fewer constraints and impediments to access would facilitate diversity. The rationale behind the second hypothesis also relates to lower barriers to access (in terms of price as well as availability), as well as the basic idea that being able to park a bike anywhere enables (or even promotes) certain opportunities such as visiting friends, seeing an interesting store and electing to look inside on a whim, turning down intriguing side streets with that same possibility in mind, and, of course, riding to areas that bikeshare might otherwise underserve.

Moreover, riders who see bikeshare as convenient will more readily patronize it—they may regard it as an obvious addition to their public transit routine or a clear option in any other circumstance. Convenience undoubtedly promotes usage. Whether considering mobile phone applications, public transit options, or various other services, it stands to reason that convenience invariably factors into the decision-making process. In this case, the contention is that it will be the most dominant correlate of bikeshare usage.

New York City: Citi Bike

In stark contrast to Shanghai, New York City has overseen the implementation and expansion of Citi Bike (as well as other potential bikeshare operators) with strong regulatory guidance. Local policymakers have sought to head off any potentially detrimental effects of bicycle-sharing-run-rampant by taking an active role in development and regulation. Citi Bike has become synonymous with successful American bikeshare operations, and it also exists as a case study in effective bikeshare management and expansion. That is not to say that there are no problems—as the literature review indicates, extant problems have been identified and, in many cases, addressed to some extent—but, rather, that positive outcomes from Citi Bike appear to have been well-managed while negative ones have seemingly been mitigated. Ultimately, I selected Citi Bike because it is the dominant bikeshare platform in New York City and also because of the publicity it has garnered, the openness of data, and the rapidly developing body of academic research on it. I selected New York City as a city of interest first and foremost because of the location of Columbia University within the city, and, also, because New York's status as a world-leading urban locale. Cities big and small in the United States and elsewhere look to the example of New York City for city planning guidance, public policy recommendations, and advice on progressive urban development (in addition to research on the shortcomings thereof). If other cities and governments look to New York as a model, then they undoubtedly see the city's experience with Citi Bike as instrumental in guiding their own bikeshare journey. As a docked bikeshare operator in a world-leading city with a robust regulatory framework supervising sharing economy developments, Citi Bike stands out as an ideal program for investigation and analysis.

Shanghai: Mobike

Shanghai has become a veritable laboratory for bikeshare experiments with millions of shared bicycles and a (previously expanding but now contracting) number of shared bicycle operators. The two dominant operators are Mobike and Ofo, but Mobike was selected for this study as a representative embodiment of Chinese bike-sharing more broadly. In terms of bicycle, ridership, and strategic characteristics, Mobike and Ofo are not highly differentiated. Each company has sought expansion overseas, and each company, heavily reliant on venture capital funding as they have been, has struggled to achieve a self-sustaining profitability. Because of a variety of issues related to the public perceptions of these firms and, especially, the availability of English-language research and news commentary on Mobike (compared to a dearth of the same on Ofo), though, Mobike was selected. Furthermore, I selected Shanghai as a city of interest precisely because of the proliferation of bicycle sharing therein. Whereas Beijing has had a similar experience, Shanghai's relative distance from Chinese government regulations has enabled bikeshare ventures therein to compete nearly unimpeded. Beijing also is less appealing as a city of interest for bikeshare analysis since Beijing's urban structure (especially with regard to its reliance on ring roads) makes bicycling over longer distances a less appealing proposition. In short, I identified Shanghai as the more appealing dockless bikeshare city for analysis and identified Mobike as the more appealing dockless bikeshare operator for analysis.

Site Selection & Sampling Strategy

In consideration of the overarching research goals, the study implemented a questionnaire survey in order to gather qualitative and quantitative data from users of Mobike and Citi Bike bicycle-sharing programs. The task of site selection and sampling focused on (1) selecting bicycle-sharing locations, (2) designing the survey questionnaire instrument, (3) sampling strategy, and also (4) analysis of data accrued from sampling. Moving ahead, I elaborate on these four aspects of site sampling strategy:

Having already identified Citi Bike NYC and Mobike Shanghai as the bikeshare program of interest for this analytical study, the next task at hand was to select sites for distribution of the survey instrument.[10] Shanghai and New York are, suffice it to say, very different in terms of all manner of characteristics, thus complicating any attempt to select sites based on some representative adherence to a singular narrative surrounding either or both cities. For ease of survey dispersal as well as diversity of respondents, sites were therefore limited to high-traffic

[10] See Appendix A for the survey instrument and sub-section Questionnaire Survey for an explanation thereof.

areas frequently regarded as transit hubs. Rather than residential areas with socioeconomic uniformity, sites selected were commercial centers with a high degree of connectivity to urban and even suburban transportation options. The rationale behind this site selection was to ensure that I could distribute sufficient questionnaires in a short timeframe to populations that varied in terms of age, gender, socioeconomic characteristics, and fundamental relationship to their urban environment.

I selected two sites for survey gathering in Shanghai and two additional sites were selected in New York City. Data from Gordon-Koven and Levenson (2014) along with more recent analysis from Kaufman and O'Connell (2017) informed site selection for Citi Bike analysis: Pershing Square North was in 2014 and 2017 alike the number one station for trip starts and trip ends, while Columbus Circle (Broadway & W 58th St) has remained one of the most popular stations for trip inception connecting uptown and downtown as well. These stations are popular sites of Citi Bike usage throughout the day, as their locations are not residential or commercial, but are also transit hubs with sites of interest to tourists in relative proximity. Columbus Circle and Pershing Square North were thus identified as optimal locations for questionnaire survey dispersal. In Shanghai, I selected the northeastern corner of People's Square (where Xizang Middle Road and Nanjing Road Pedestrian Street meet) as the first location of interest owing to its high foot- and bicycle-traffic, attractiveness as a tourism hotspot, and status as a major transit hub. Next, the southeastern corner of Grand Gateway 66 Mall was selected (at the intersection of Huashan Road South and Hongqiao Road). In addition to being located within walking distance of a popular metro station, I recognized this location as a high-traffic commercial locale and also as a key waypoint for dispersal throughout Shanghai's Former French Concession (an area regarded as especially conducive to bicycle riding as a result of a low traffic burden outside of rush hour times and other factors). These sites in Shanghai and New York serve many residents and visitors at all hours of the day and night.

I undertook sampling on two separate occasions at each of these sites. Twenty surveys were sought at each location for each visit. The sampling methodology was thus on-site convenience sampling. I planned an initial for a weekday morning during peak transit rush hours (7:30-10:00 AM) and a follow-up visit at each site for weekday evening off-peak hour (7:30-10:00 PM). In Shanghai, this was undertaken on Wednesday, December 30, 2017 for People's Square and Tuesday, December 26, 2017 for the Grand Gateway 66 Mall location. In New York, survey questionnaire distribution took place on Tuesday, January 16, 2018 at Columbus Circle and Thursday, January 25, 2018 at Pershing Square North. At each site and at each time, respondents completed twenty surveys which I then gathered, thus totaling 40 surveys per site, or 160 total questionnaire surveys for the study. The major focus of sampling was therefore to attain this large selection of surveys, and I selected respondents randomly to help achieve as representative a sample as popular of the local user population. Notably, the dockless nature of Shanghai's bikeshare ventures means that Mobike, Ofo, and other bikeshare bicycles are generally found in close proximity to one another, but I targeted respondents based on their patronization of Mobike alone. As such, only riders parking their Mobikes or scanning a Mobike to rent it were propositioned for administration of the survey questionnaire. Then I administered the survey in person, enabling respondents to select their answers and complete the survey roughly within a two-to-five-minute period. This choice to offer a short, primarily multiple-choice survey ensured that response rate would remain high as respondents would be less likely to identify the survey as an impediment to their ability to get to where they were going on time.

Survey[11]

I designed a questionnaire survey to collect data on Mobike Shanghai and Citi Bike NYC users. I constructed the brief, primarily multiple-choice survey to evaluate how users perceive the bike-sharing operations in their cities, how they make use of them, what potential benefits might accrue, what sorts of changes might be beneficial, and how the docked/dockless paradigm impacts their own user experience. Questions were written to include the term “bikeshare” rather than ‘Mobike’ or ‘Citi Bike’, thus ensuring that the questions could remain almost entirely uniform across the surveys deployed in New York City and Shanghai.

Survey questions were split into thematic sections. First, I considered demographics: Gender and Age alone factored into the demographic analysis, as I regarded data on socioeconomics as well as race/ethnicity as potentially confounding given the multicultural nature of this study. China has considerably lower income per capita than the United States, and it also has a very high degree of wealth inequality. Moreover, official statistics provided by China are not always accurate, while rising incomes in recent years (and thus since figures have been released) further complicate the matter. Even if the study were to arbitrarily split respondents into their respective low-, medium-, and high-income cohorts, analysis might not prove particularly fruitful. Ethnicity could be even more confounding or, at least, fruitless, as China is considerably homogenous with regard to racial and ethnic diversity. Targeting non-Chinese could be confounding as it would introduce the opinions and concerns of international users, and as such the decision to focus on Chinese users in China was made.

The next grouping of questions detailed ridership and usage statistics, asking about bikeshare membership, frequency of usage, and experience with convenience of finding a shared

[11] See Appendix.

bicycle. Notably, membership options are quite different for Mobike and Citi Bike, but I grouped potential responses together so as to simply provide a single uniform question that I could more readily apply for analysis. Whereas riders can use Citi Bike with an annual membership, a three-day pass, or a single day pass, Mobike allows users to pay-per-ride, pay a monthly fee, or pay for three months, six months, or even a full year at once. Because of this, I developed an additional metric for ease of analysis: membership could be either 'Long' (Monthly, 3- or 6-month pass, or annual pass) or 'Short' (pay-as-you-go, 1-, or 3-day pass). I grouped weekly ridership frequency as 1-6 to denote 'less than once daily', 7-14 to denote 'once or twice per day' (regarded as a representation as either commuting to work or conducting commercial activity through shared bicycle usage), and 15 or greater as a stand-in for 'high frequency' usage.

A third grouping of questions focused on the user experience with the bikeshare program in the urban environment. Questions investigated user perceptions of the strength of the bikeshare program, user suggestions for safety improvements, and the role of bikeshare in shaping the user's experience with their city. Finally, one last question investigated the user perception of the docked/dockless shared bicycle paradigm in their respective location. I asked users if a shift (partial or complete) to the opposite paradigm might positively implement their usage of the bikeshare program. I developed this tenth and final question to help culminate a quick and convenient overview of their experience and perceptions.

Analytical Framework

Analysis of the data accrued from survey distribution utilized basic statistical techniques to identify differences between responses in Shanghai and New York City. I gathered the 160 total surveys into Microsoft Excel where basic analysis was conducted on single questions and on relationships between certain responses. In addition to Microsoft Excel, I used Stata and Data Pine to aid in analysis, insights, and the creation of figures. Although general analysis was primarily limited to statistics pertaining to the specific hypotheses addressed by the study, interesting implications and relationships in the data that emerged were also analyzed and commented on. Surveys were essentially self-administered, and although I did not chart the response rate, it was similarly high in both cities, enabling the twenty surveys per location per timeframe to be gathered expediently in most cases. Although I chose two locations for each city in order to ensure that I could gather a broader and more representative sample, no distinctions were made between locations in analysis as the focus was, instead, solely on comparing the Shanghai and New York City bikeshare experience. For similar reasons, a distinction in analysis between night and day findings was not pursued.

Findings

I used Microsoft Excel, Stata and Data Pine to analyze the data and excluded time and specific location or survey administration from data analysis. This analysis was conducted in the same groups which demarcated the survey questionnaire (demographics, ridership and usage, user experience and urban life, bikeshare paradigm), with more in-depth analysis considered in places where connections were deemed either relevant to one of the hypotheses or especially noteworthy. Data analysis with little relevance to the hypotheses was thus generally excluded (e.g. gendered distinctions relating to specific questions or groupings thereof). Most sections of data analysis include a discussion of the population in aggregate as well as a discussion of docked/dockless distinctions.

Demographics

The first two questions on the survey questionnaire deal with respondent demographics—specifically, gender and age. Out of the total respondent population of 160, 102 (63.75%) were male and the remaining 58 (36.25%) were female. This disparity among the total population was largely a reflection of the stark gendered disparity among New York City respondents, where, out of the total 80, 57 (71.25%) were male and the remaining 23 (28.75%) identified themselves as female. In Shanghai, the gender disparity was not as evident among bikeshare users: among the 80 total respondents, 45 (56.25%) were males and the remaining 35 (43.75%) were females. These findings were further corroborated by researchers' observations during sampling. Although sample populations in neither city represented a balanced bikeshare usage between males and females, Shanghai more closely approximated such a balance and, when broken down into the two separate locations, People's Square and Grand Gateway 66 sampling both included merely 2-3 males over what would have been an even gendered split.

Similar to the question of gender, age disparities were also evident in the data. Bikeshare usage skewed rather young on the aggregate, but few users were from the youngest end of the spectrum: 20 (12.5%) of respondents identified themselves as under the age of 19, 63 (39.375%) were aged 19 to 25, 56 (35%) were aged between 26 and 40, and the remaining 21 (13.125%) respondents were over the age of 40. Among the 80 New York City respondents, 6 (7.5%) were under the age of 19, 35 (43.75%) were between the ages of 19 and 25, 33 (41.25%) were aged between 26 and 40, and the remaining 6 (7.5%) respondents were over the age of 40. The age breakdown in Shanghai, on the other hand, included more participants at the high and low ends of the spectrum: 14 (17.5%) respondents were under the age of 19, 28 (35%) were aged 19 to 25, 23 (28.75%) were aged 26 to 40, and the remaining 15 (18.75%) respondents were over the age of 40.

I also investigated a relationship between age and gender in the data set. Among the 20 respondents aged under 19 years old, 16 (80%) were male and 4 (20%) were female. As such, young women were noticeably less active bikeshare participants than women of other ages. Participants between the ages of 19 and 25 were 63.5% male (40) and 36.5% female (23). Between the ages of 26 and 40, this ratio was 57.14% male (32) and 42.86% female (24). Among respondents aged over 40 years old, two-thirds (14) were male and one-third identified as female (7). These differences between the gendered distribution of age groups among bikeshare participants was also evident in the differences between Shanghai and New York City respondents. In New York City, respondents under the age of 19 were 83.33% male, while respondents in the same age group were 78.57% male in Shanghai. Between the ages of 19 and

25, 80% of respondents in New York City were male while only 42.86% of Shanghai respondents were male. Among 26 to 40-year-old respondents, 57.58% of New York City bikeshare riders were male and 56.52% of Shanghai bikeshare riders were male. Finally, respondents over the age of 40 were 83.33% male in New York City and only 60% male in Shanghai.

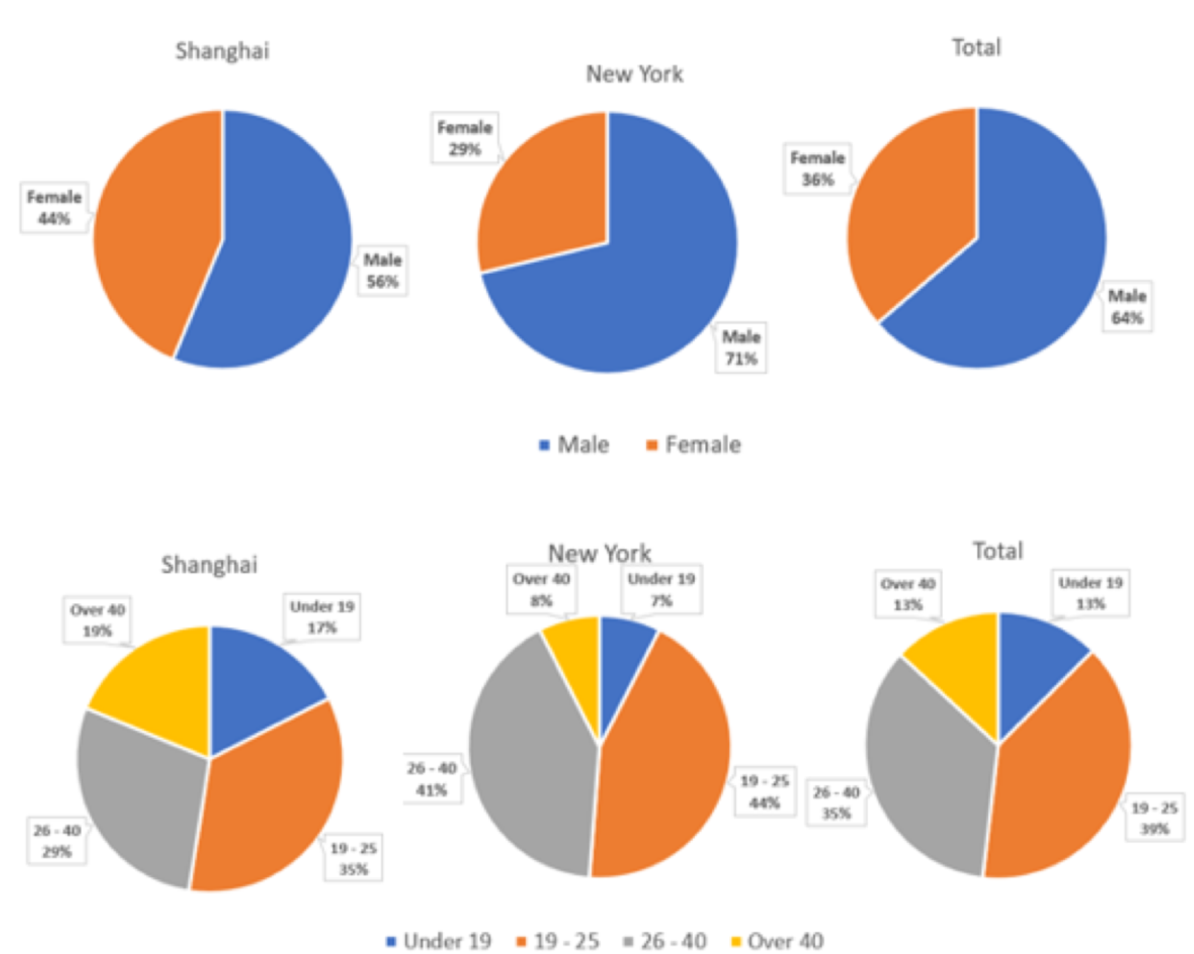

Chart 1: Demographics

Ridership & Usage

Drawing comparisons between Citi Bike and Mobike in terms of ridership and usage statistics may be a complex endeavor because of various differences between cities and programs, but some basic insights are nonetheless available. This is especially apparent in terms of membership status, since Mobike and Citi Bike have different options for membership: whereas Citi Bike requires riders to have 1-day, 3-day, or annual passes, Mobike allows riders to pay-as-they-go, pay monthly, pay 3month prices. In Shanghai, 23 (28.75%) respondents answered 'pay-as-you-go', 45 (56.25%) were monthly subscribers, 12 (15%) had 3month pass. Fifty-eight (72.5%) of the 80 surveyed Citi Bike riders were annual pass holders while the remaining 22 (27.5%) were 1- or 3-day pass holders. Thus, among the total population of respondents 115 (71.875%) had long-term membership while 45 (23 from Shanghai and 22 from New York) opted for the short-term membership option.

Frequency of bikeshare usage also exhibited some differentiation between Shanghai and New York City users. Among the total population of respondents, 45 (28.125%) used their respective bikeshare program 1-6 times per week, 75 (46.875%) used it 7-14 times per week, and 40 (25%) used it at least 14 times per week. In New York City, though, the ratio of high- to low-frequency users was dramatically different. Low-frequency users accounted for 36.25% (29) of bikeshare users, medium-frequency users for 52.5% (42) of them, and high-frequency users for only 11.25% (9) of them. In Shanghai, on the other hand, these numbers were 20% (16) low-frequency, 41.25% (33) medium-frequency, and 38.75% (31) high-frequency.

Furthermore, differences in time to find a shared bicycle are starkly evident between the two cities. The most common time-to-find for the aggregate population was two to five minutes with 84 (52.5%) respondents selecting that response followed by 40 (25%) responses of six to ten minutes, 23 (14.38%) respondents citing a one-minute average time, and, finally, 13 (8.13%) respondents noting that it takes, on average, over ten minutes for them to find a shared bicycle. In Shanghai, 54 respondents (67.5%) cite two to five minutes to find a bicycle, while 13

(16.25%) cite one minute, 10 (12.5%) cite six to ten minutes, and only 3 (3.75%) cite more than ten minutes as their average time to find a shared bicycle. In New York City, time to find a shared bicycle is considerably more akin to a bell curve for users: 30 respondents each noted two to five and six to ten minutes to find a bicycle, representing a full 75% (37.5% per response) of the sample population, while 10 respondents each noted one and more than ten minutes as their time to find a bicycle. In Shanghai, average time to find a bicycle was thus reported as significantly lower than in the New York City response cohort.

A connection between reported average time to locate a shared bicycle and stated frequency of use emerges as an intriguing insight from ridership and usage data. As CHART 2 indicates, the time to find a bicycle is noticeably correlated with ridership frequency over the total population of users. This is evinced by the percentage of users from different time-to-find cohorts in each frequency of usage response category. Among the cohort of bikeshare users from whom weekly frequency of usage is within the range of 1 to 6 rides, only 4.44% cite finding a bicycle within an average time

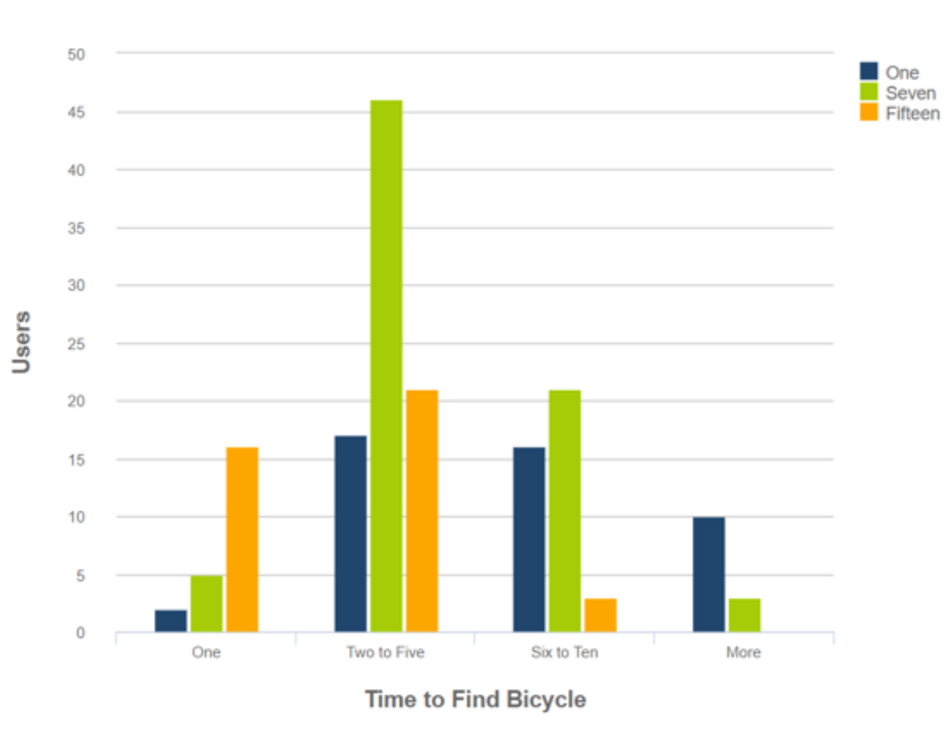

Chart 2: Time to Find (Minutes, Average) & Frequency of Use (Weekly Trips)

of one minute, yet 37.78% cite their time to find at between two and five minutes, 35.56% cite six to ten minutes as their time-to-find, and 22.22% report taking more than ten minutes on average to locate a bicycle. In comparison, riders who ride 15 or more times per week cite finding a bicycle within one or two to five minutes most frequently (40% and 52.5%, respectively), while on 7.5% of them cite a time-to-find of six to ten minutes. Among riders of the highest frequency, none reported taking more than ten minutes to find a bicycle on average. Users who did report taking more than 10 minutes on average typically—that is, 77% of them—rode with low frequency. In New York City, this disparity is especially pronounced. Among all Shanghai users, 6.25% of low-frequency and 6.06% of medium-frequency riders cite one minute to find a shared bicycle as their average time-to-find, yet 32.26% of high-frequency riders reported that especially low time-to-find. In New York, though, the difference is even more evident users: 3.45% of low-frequency and 7.14% of medium-frequency riders cite one minute to find a shared bicycle as their average time-to-find, meanwhile a full 66.66% (two-thirds) of high-frequency riders reported the lowest time-to-find.

User Experience & Urban Life

Overall, bikeshare users appear to have a strong distribution of opinions with regard to the key strength of bikeshare in their urban experience. A survey question querying which strength (convenience, environment, health, cost) users felt to be the dominant one of their city's respective bikeshare program returned mixed results. Among the entire population, 32.5% (52) of respondents favored convenience, 17.5% (28) favored the environment, 20.63% (33) favored health, and 29.38% (47) favored cost as the key benefit of bikeshare. In Shanghai, these figures were skewed away from health and dramatically in favor of cost, with 48.75% (39) of respondents selecting cost, 31.25% (25) selecting convenience, 13.75% (11) selecting the environment, and only 6.25% (5) referencing health as the dominant benefit associated with bikeshare. In contrast to these responses, survey participants in New York saw health and convenience as the key strengths of Citi Bike: 35% (28) selected health, 33.75% (27) selected convenience, 21.25% (17) selected the environment, and only 10% (8) of respondents selected price. The user experience of bikeshare in the urban milieu, the data seemingly suggests, is different in Shanghai and New York City.

User perception of potential safety improvements for bikeshare operators is similarly different across the two cities, but the divergence in this case is not quite as pronounced. The aggregate respondent sample saw better traffic control (e.g. stricter traffic codes and more robust enforcement thereof) as the most crucial means of securing better safety outcomes in bikeshare. 52.5% of respondents, totaling 84 people, selected that as their response. Meanwhile, 5.63% thought more cyclists on the road would be the most beneficial factor for safety improvement, 16.25% cited the promotion of helmet wearing, 18.13% believed more and better bike lanes would be the best option, and 7.5% of respondents felt that slower speed limits would have the most impact on bikeshare safety outcomes. Shanghai respondents were less interested with the numbers of cyclists on the road (3.75%) than their New York City counterparts (7.5%) and dramatically less interested in campaigning in favor of helmet wearing (5%) than respondents in New York (27.5%) were. Shanghai respondents were primarily concerned with traffic control (66.25%), but also exhibited a minor interest in bicycle lanes (15%) and speed control (10%). In New York City, speed was less of an issue (5%), while respondents regarded bicycle lanes (21.25%) and traffic control (38.75) as far more noteworthy means of securing better outcomes in bikeshare safety.

I considered four domains of interest regarding the urban experience: Friends (the act of seeing them), Going Out (e.g. social gatherings, restaurants, bars), Shopping, and Exercise. The survey questionnaire asked respondents to report whether their bikeshare experience had increased (plus), decreased (less), or had no impact on the amount of time they spent with the aforementioned domains. As Table 1 shows, very few Citi Bike or Mobike users reported reductions in any of the four domains which they saw as attributable to bikeshare usage.

		Going Out	Seeing Friends	Shopping	Exercise
Shanghai	Less	1.25%	3.75%	5%	10%
	No	37.50%	30%	63.75%	25%
	Plus	61.25%	66.25%	31.25%	65%

Table 1: Reported Bikeshare Impact on Domains of Urban Experience

		Going Out	Seeing Friends	Shopping	Exercise
NYC	Less	7.50%	11.25%	5%	5%
	No	65%	57.50%	48.75%	18.75%
	Plus	27.50%	31.25%	46.25%	76.25%

In Shanghai, these numbers are especially noteworthy for 'Going Out' and 'Seeing Friends', where respondents saw bikeshare as overwhelmingly positively impactful. Interestingly, Citi Bike users were quicker to cite bikeshare as a positive influence in terms of exercise (especially) as well as shopping than users in the Mobike Shanghai cohort. Overall, respondents in Shanghai and NYC were not markedly differentiated with regard to the perception that bikeshare might decrease their time with some urban experience metric, but respondents in the former cohort more commonly saw bikeshare as positively impactful while those in the latter cohort exhibited a greater tendency to perceive it as having no real impact. In Shanghai, dockless bikeshare was more closely connected with Going Out and Seeing Friends, but Citi Bike in New York had a closer connection with shopping and exercise.

Moreover, the overall impact of bikeshare usage on factors associated with the urban experience (seeing friends, shopping, going out, exercise), as reported, was positive. While ‘no impact’ holds sway as a dominant or, at least, significant response in many cases, the aggregate impact of bikeshare on these factors across the whole population should be noted. Out of the whole population of respondents, only 5% (8) provided answers indicating that bikeshare did not positively influence a single factor in a positive fashion. (Interestingly, 6 of these 8 were Citi Bike users.) Thus, 95% of respondents reported that at least one factor was positively improved through their experience with bikeshare. In stark contrast to this finding in the data, 78% (125) of all respondents reported no negative impacts at all across the four domains, while only 2.5% (4, three of whom came from the New York City cohort) reported more than 1 negative impact on a domain of interest. Meanwhile, 67.5% (108) of respondents reported bikeshare positively influencing at least 2 of the domains, 35.625% (57) reported it impacting at least 3 of the domains positively, and the average number of domains positively impacted was just over 2. In Shanghai, there were 179 total positive responses for an average of 2.24 domains positively impacted per respondent. In New York, 144 total positive responses break down to 1.8 domains positively impacted per respondent on average. Factoring in ‘Less’ and ‘No change’ responses as ‘-1’ and ‘0’ respectively, an aggregate score for Shanghai respondents was 163 (2.0375 average) and an aggregate score for New York was 121 (1.5125 average). On the aggregate and across each individual population, the role of bikeshare in positively impacting domains associated with the urban experience was found to be markedly positive.

The role of Citi Bike and Mobike in influencing the users’ urban experience in terms of opening up their respective city to them was not as universally positive as I expected. While only 12 respondents (7.5%) claimed that bikeshare had resulted in them seeing less of the city, 70 claimed that bikeshare had resulted in no change (43.75%) while a similar number, 78 (48.75%), claimed that bikeshare had influenced them to see more of the city than they had before. In New York, nearly two-thirds of respondents (50, or 62.5%) felt that bikeshare had not impacted their experience with the city, nearly one-third (25, or 31.25%) cited a positive influence, and 5 respondents felt bikeshare to cause them to see less of the city. In Shanghai, roughly two-thirds (53, or 66.25%) of respondents claimed that bikeshare had opened up the city to them, one-quarter (20) believed that nothing had changed in that respect, and 8.75% (7) believed that bikeshare was a negative influence on the amount of the city that they interacted with. Although one might expect the free-wheeling nature of bicycle riding to almost invariably open up the city to users, this was apparently not necessarily the case in New York and not even universally so in Shanghai, either.

In addition to the distinction between Shanghai and New York City, I evaluated bikeshare user responses with regard to urban experience in connection with other important distinctions. The aggregate score across the four domains of urban experience in consideration (seeing friends, shopping, going out, exercise) did not display a robust, clear connection to any specific variable of interest, although the users' perception of the key strength of bikeshare appeared to be somewhat correlated. The fact that measuring urban experience in this fashion positions it as an all-encompassing factor likely with an intricate and broad set of correlates and drivers helps to explain the lack of a clear, driving factor. Across the entire population, though, the perception of strength did seem to make a difference with regard to this aggregate of urban experience: users who selected price had an aggregate urban experience score of 2.1, while those who selected health, convenience, and the environment, respectively, responded with aggregate urban experience scores of 1.9, 1.6, and 1.4. Thus, who reported price as the dominant strength of bikeshare reported the highest aggregate positive change to their urban experience while those who saw the environment as fundamentally key reported the lowest aggregate positive change. It is important to note, here, that this finding is perhaps more consistent with the earlier finding that Shanghai bikeshare users were more likely to cite price while New York bikeshare users were more likely to cite the environment—thus, the average aggregate urban experiences change by strength is more than likely a reflection of city-level trends. Extending this analysis, it is useful to consider the more direct question related to whether users saw more or less of the city (or noticed no change in that regard). Recoding the variable as 1 (plus), 0 (no), and -1 (less), some trends emerge. Most notably, urban experience questions regarding Friends and Shopping were distinctly correlated with this response. Users who reported seeing their friends more because of the role of bikeshare in their lives exhibited an average response of .5, while those who cited no change had an average response of .34 and those who saw their friends less had an average of .17. For shopping, figures followed the same trend with respective figures of .48 (more), .38 (no change), and .13 (less). Here, it is clear that bikeshare that brings friends together and/or stimulates commercial activity is bikeshare that users perceive as opening up the city to them.

Docked & Dockless Consideration

The survey questionnaire's final query asked residents of Shanghai if employing a docked bikeshare model would influence them to increase bikeshare usage and residents of New York if employing a dockless bikeshare model would influence them to increase bikeshare usage. To facilitate analysis, I arrange answers (from Strongly Disagree to Strongly Agree) from 1 to 5. First, the Citi Bike cohort exhibited an inconclusive trend toward uncertainty: the dominant responses: 10% selected 'Strongly Disagree (1),' 15% 'Disagree (2),' 27.5% each 'Unsure (3)' and ‘Agree (4),’ and the remaining 20% of New York respondents strongly agreed (5) that they would increase usage under a dockless model. For Shanghai residents, the dominant response was relatively certainty that a docked bikeshare model would not reasonably impact their usage: 26.25% of users strongly disagreed, 42.5% disagreed, 21.25% were uncertain, and the remaining 10% (7.5% agree, 2.5% strongly agree) felt docked bikeshare to be a potential boon for their bikeshare experience. Therefore, the average response for Shanghai residents was 2.1875, far on the disagree side of uncertainty, while the average response for New York was 3.35, only slightly on the agree side of uncertainty.

The correlation between bikeshare paradigm and user beliefs regarding the potential personal impact of an alternative paradigm is strongly influenced by time-to-find. This is most noticeable among users who report a time-to-find of six to ten or more than ten minutes: the only

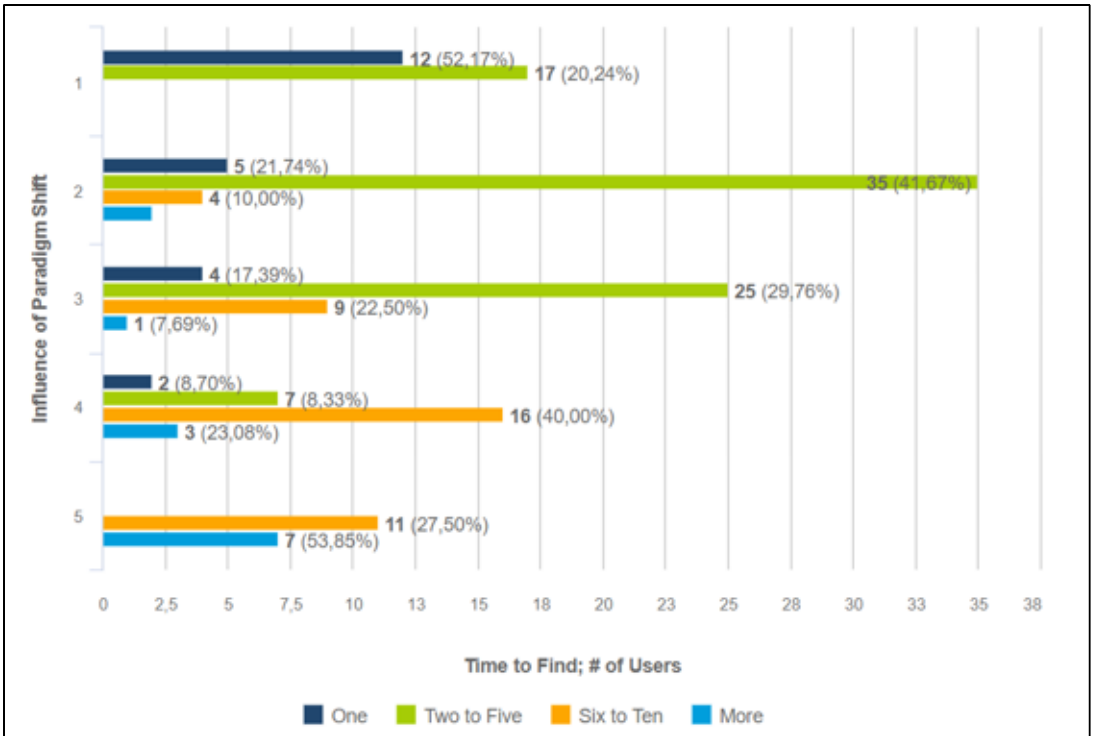

Chart 3: Time to Find & Interest in Paradigm Shift

users who select these two answers for time-to-find Strongly Agree that a switched bikeshare paradigm would influence them to increase bikeshare usage. At the other end of the spectrum—bikeshare users who Strongly Disagree that instituting the opposite bikeshare paradigm would increase their usage profile—the only time-to-find responses that are represented are one and two to five minutes. Users who have no interest in a different bikeshare paradigm than the one that they are already familiar with are universally well-served by the location of shared bicycles, while those who strongly agree that they would benefit are universally less well-served. Furthermore, the responses more broadly exhibit a clear pattern: lower time-to-find respondents are less likely to agree with the proposition, while higher time-to-find introduces, first, more uncertainty (as is the case among two to five minute-to-find respondents who overwhelmingly selected Disagree and Unsure), and then more agreement.

User propensity to accept a paradigm shift also bore a clear connection to user perception of the key strength associated with bikeshare as they experienced it. Although Chart 4 initially appears to obfuscate any clear pattern (a point which can

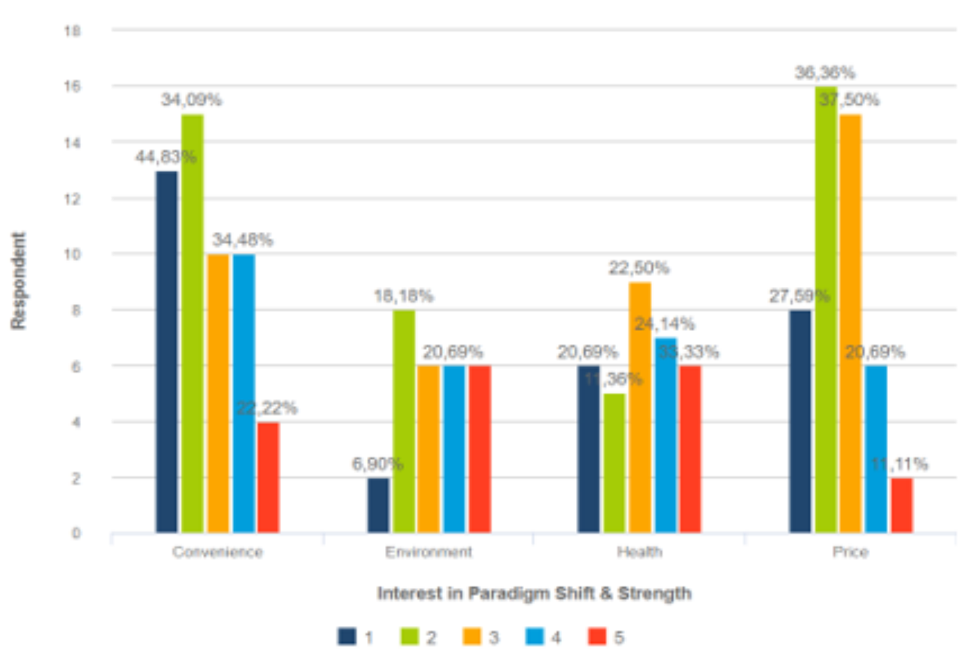

Chart 4: Bikeshare Strength & Interest in Paradigm Shift

be attributed to the overwhelming proclivity of users to view either price or convenience as the definitive strength of bikeshare), an analysis of percentage of users based on perception of key bikeshare benefit and decomposed by willingness to support a paradigm shift is quite useful for showing which perceptions were most directly connected with sentiments regarding a paradigm shift. Crucially, nearly 45% of all users who reported strongly disagreeing with a potential paradigm shift cited convenience as the key benefit of bikeshare. In comparison, only 28% of users who strongly disagreed referenced price. Moreover, the percentage of users selecting disagree was relatively even between convenience and price respondents and there was significantly more uncertainty among price respondents, indicating that both factors detract from a potential willingness to participate in a new bikeshare paradigm, but convenience generates more vociferous attitude toward this pronouncement and, importantly, inspires fewer reservations.

Discussion

The fundamental basis for this analysis is the differentiation between Shanghai and New York City bikeshare user experience. As such, an overview of basic findings in the data, as related to differences in the Shanghai and New York City populations—that is, as related to dockless and docked bikeshare populations, respectively. Shanghai respondents had a broader, spread out distribution in terms of age, and more of them were over the age of 40 than as reported by their New York counterparts. Similarly, the distribution of users by gender was broader in Shanghai whereas docked bikeshare users were predominantly male. Although it is undoubtedly tied to pricing policy, more New York riders had annual passes, whereas Shanghai users were primarily on a pay-as-you-go or monthly membership model. Frequency of usage was more varied in Shanghai, with significant numbers of both very high usage and infrequent usage, while New York users primarily reported middling usage (e.g. usage that might more reasonably represent commuter status). Overall, time-to-find trended lower in Shanghai, while users there more likely than their New York counterparts to see the primary strength of bikeshare as a toss-up between price and convenience (docked bikeshare users still felt bikeshare to be convenient, but also frequently saw health as the primary benefit). Ideas regarding safety improvements varied, but users generally agreed that traffic control improvements would make the biggest difference. Questions dealing with the influence of bikeshare usage on the urban experience were predominantly answered more positively in Shanghai, where users reported greater social as well as commercial impacts and more readily claimed to see more of the city because of bikeshare. Finally, Shanghai bikeshare users were more ambivalent about switching to a docked bikeshare model, whereas New York City bikeshare users exhibited a greater interest in the introduction of a possible paradigm shift. Ultimately, these general areas of analysis not only help to paint a clear picture of the differences between bikeshare user experiences in Shanghai and New York City; they also underwrite and facilitate more significant evaluation of the hypotheses of this study.

Hypothesis 1: Diversity

The first hypothesis of this study focuses on the diversity of populations that utilize bikeshare, stipulating that "Dockless bike-sharing in Shanghai, China caters to a significantly more diverse population than Citi Bike." Despite diversity's strong connotation with race and ethnicity, this study excised that particular factor in favor of a more general discussion of diversity which considers age and gender for reasons elaborated on in the Methodology. As stated, this hypothesis is largely confined to the Demographics subsection of the survey questionnaire. A cursory look at the data signposts the truth of this hypothesis, yet a discussion of these findings in light of connections to the literature review as well as possible implications is still merited.

The gendered distribution of riders in this study points to an extant gender gap in bikeshare usage. More importantly, though, it points to a serious difference in the size of this gender gap between Shanghai and New York. Among the total population, 64% of riders were male; in Shanghai, 56% of riders were male; in New York, a full 71% of respondents were male. This survey of Citi Bike ridership finding below 30% of users to be female puts New York City on par with Dublin's bikeshare program in this regard: as analyzed in Murphy and Usher (2015), only 22% of riders there were female. Furthermore, these findings confirm Kaufman's (2014) findings that Citi Bike is a male-dominated bikeshare program and Wang and Lindsey's (2018) remark that bikeshare has largely been the province of men. In fact, these findings are in line with a wide body of bikeshare and bicycling literature which holds that bikeshare and, more broadly, cycling, are male-dominated affairs owing to a multitude of reasons (Abasahl et al., 2018), necessitating campaigns for female uptake (Riggs et al. 2016). This has even been found to be the case in China, where Ji et al. (2017) indicates a more sizeable gender gap than the one realized herein for Shanghai. Additionally, the results of this study appear to confirm Mobike Global's findings (2017) that males take more trips than females (although, a lack of specific numbers in this case suggests only the existence of a gender gap but fails to comment on the size of this disparity). Ultimately, results in this study relating to users' gender generally confirm prior findings from the extant body of literature, showing that the first hypothesis is worthwhile.

Results relating to users' age, too, both confirm prior findings from the (admittedly smaller) extant body of literature and support the diversity hypothesis. In Shanghai, the age breakdown is indicative of higher participation in bikeshare at the high and low ends of the age spectrum, whereas the New York City respondents were considerably more agglomerated in the 19-25 and 26-40 age groups. Chart 1 above provides visual evidence of this phenomenon, but, in terms of percentages, it is also quite clear: 17% of Shanghai respondents were under 19 compared to only 7% in New York, while the respective percentages for the Over 40 age grouping were found to be 19% and 8%. In some way or another, Shanghai's bikeshare program was more appealing and accessible to older as well as younger populations. These results further provide evidence in support of Mobike Global's (2017) noncommittal report that 70% of users fell within the 20-50 age range but does not align directly with Ji et al.'s (2017) finding that more Chinese bikeshare users were quite young. Furthermore, an analysis of the gendered distribution of age groups in this survey hews rather closely, at least in the case of Citi Bike, to the findings of Wang and Lindsey (2018), noting that most bikeshare users are young males. Users under the age of 19 were primarily male in both cities, but a clear distinction emerged in the 19-25 age group, where Citi Bike respondents were 80% male and Mobike respondents were predominantly (57%) female. This distinction, along with the age differences in general overview, is sufficient proof of a more diverse ridership at Shanghai Mobike than at Citi Bike in New York.

This study ultimately finds ample support for the hypothesis that Mobike has a more diverse ridership than Citi Bike, and this finding is an interesting one with far-reaching implications for future bikeshare endeavors. First, though, it is necessary to qualify the finding: dockless and docked bikeshare are far from the only key difference between Shanghai and New York City, and, as such, it stands to reason that other antecedents undoubtedly play a role in diversity. Fishman (2016) offers the best explanation of differences between locations where bikeshare thrives with diverse ridership and implementations where it is more male- and youth-dominated: strong cycling countries and cultures promote greater diversity which is especially visible among the number of women who take up bikeshare programs, while weak cycling countries and cultures more readily display significant disparities in gender as well as age. In spite of its status as a popular hobby in the United States, cycling is simply not a common choice for travel in the automobile-dominated suburban and urban landscapes that are especially common there. China retains a strong cycling culture as has historically been the case, where success was once connoted by “three-rounds and a sound,” of which the bicycle was one round (Wetherhold, 2012). By this explanation, it is entirely unsurprising that Mobike might garner a more diverse ridership than Citi Bike, but other statistics from this study (especially those relating to frequency of bikeshare usage and accessibility of bicycles) point to dockless bikeshare’s influence on ridership and, likely in turn, on diversity.

The major implication of these findings relates to health: As the relationship between cycling, health, and well-being has been well-established in the literature, uptake by a more diverse population and, ostensibly, a larger one, can readily translate to more positive health outcomes for more people. Mueller et al. (2015) explains that the benefits that bicycle riding confers on users vary markedly between different demographic delineations. Older individuals who might be more at risk of heart disease, for instance, may seriously benefit from substituting car ridership for bikeshare usage or simply by patronizing bikeshare as a hobby. The role of bikeshare in promoting health for a more diverse segment of the population is also admirable, as Buck et al. (2013) comments that bikeshare users tend to be more diverse than bicycle-owning cyclists. Other implications include working toward solving the inequitable nature of bikeshare as reported primarily in the literature focusing on European and North American bikeshare programs, bringing more diverse subsets of the population into contact with one another, and generating more economic benefits for the urban areas promoting more diverse bikeshare ridership potentially by way of a dockless bikeshare program.

Hypothesis 2: Effects

The second hypothesis of this study focuses on the perceived effects of bikeshare on users' relationships with their urban environment. Specifically, the notion that users might engage with the city differently or see more of it overall was investigated through the hypothesis that "Dockless bike-sharing entails broader effects on the city than the docked bikeshare paradigm does." As was the case with the first hypothesis, Hypothesis 2 emerges as immediately credible through even a cursory glance at this study's findings. Nonetheless, a discussion of these findings in light of connections to the literature review as well as possible implications are still merited.

Although the role of bikeshare in influencing user experience with the city is not a popular theme of the extant bikeshare literature, findings from this study are generally supportive of connected findings. Notably, this is becoming more of an area of focus as the body of research on bikeshare expands, but this is primarily in relation to big data rather than perceptions of user experience. User perceptions of bikeshare and the connection between that and the urban experience has been overlooked thus far, but some commentary has been relevant regardless. After all, the promise of bikeshare has been the promise of a smarter, more connected and more sustainable city (Midgley, 2009; O'Brien et al., 2014; Jappinen et al., 2013; Pucher & Buehler, 2009). Sustainable mobility (Midgley, 2011) remains a watchword today for bikeshare, but mobility hasn't necessarily been taken to mean unimpeded or uninhibited in that context. Results from this study, though, indicate that users do value these things, and users do believe bikeshare to positively impact their urban experience. This is perhaps most evident in an overview of the different domains of bikeshare experience as perceived by bikeshare users (friends, going out, exercise, shopping). In Shanghai, the overall perception was of more positive impacts being realized, while Citi Bike users exhibited a greater tendency to perceive no significant impact. While Mobike ridership was positively connected with perceptions of Going Out and Friends, Citi Bike usage was positively connected with perceptions of Exercise and Shopping. What this entails, altogether, is that bikeshare users are realizing greater flexibility (Nikitas, 2016) in their urban experience. This is the case in Shanghai (in accordance with Mobike Global, 2017) as well as in New York (in accordance with Gordon-Koven & Levenson, 2014).

What is especially noteworthy about these findings is the fact that users perceived bikeshare usage to have nearly universally positive impacts regardless of bikeshare paradigm. The degree to which users recognized these positive impacts, though, pointed to more benefits in the urban experience accruing through dockless bikeshare programs. Considered in the aggregate, the four domains of interest showcase the overall perception of improved urban experience—95% of respondents reported at least one positive factor, and Shanghai users reported an average of 2.24 positively impactful domains while New York users reported an average of 1.8 positively impactful domains. Taking negative experiences into account, Mobike users reported an average impact of 2.04 while Citi Bike users reported an average impact of 1.51. Both of these increases are meaningful, but Shanghai users perceive 25% more positive impact on urban experience than New York users do. Users' beliefs about whether bikeshare opened up their respective city to them evinces an even more dramatic distinction: two-thirds of Citi Bike users reported no impact, while, in Shanghai, two-thirds of users claimed to recognize a positive change in the amount of the city that they were becoming acquainted with as a result of their utilizing bikeshare. Indeed, these cities are, to a small extent or to a larger one, more open to bikeshare users than they were before, dovetailing with earlier findings (S.N. 2013; Mobike Global, 2017; Gordon-Koven & Levenson, 2014).

Support for this hypothesis is not as robust as support for the diversity hypothesis, but it is nonetheless acceptable. With some qualifications and with some areas of greater or less divergence, dockless bikeshare in Shanghai imbues users with a greater perception that their urban experience has been positively changed by way of bikeshare. This has some particularly interesting implications that deserve recognition. Primarily, the importance of this is economic in nature, as greater bikeshare utilization that has more impact on the bikeshare implementing city can readily be translated into dollars-and-cents benefits. Hamilton and Wichman (2015), for example, finds that bikeshare can reduce congestion, resulting in a more open and accessible city—in turn, this can benefit local neighborhood attractions (Wang et al., 2018) and ensure economic enrichment for businesses in cities with improved accessibility owing to bikeshare (Buehler & Hamre, 2014). Findings relating to accessibility from this study make this an especially noteworthy result. Furthermore, a reduction in overall travel time (as quantified in Buehler & Hamre, 2014) facilitates more availability to partake in other activities. Bikeshare might provide users with more exercise, yet it may also free up that extra 45 minutes before work that they need to stop in at the gym or go for a run; it might introduce them to new areas of the city with new commercial possibilities, but it may just as easily help them to find enough time to visit the mall (or visit friends, for that matter) when they otherwise might not have. The fact that this experience is generally contingent upon accessibility and is overall more pronouncedly positive in Shanghai indicates that dockless bikeshare may amplify these effects, facilitating greater positive citywide impacts.

Hypothesis 3: Convenience

The third hypothesis focuses on the idea that convenience is the most important factor for bikeshare users. This idea essentially holds that dockless bikeshare, by virtue of being the more convenient paradigm among the two, is unsurprisingly the more popular option (in terms of perception, frequency of usage, and other variables of interest) among riders. A cursory analysis finds fledgling support for this hypothesis, but a narrower focus finds that it, too, should be upheld. This has clear implications regarding future bikeshare implementations and expansions, and it is based on interesting results which, together, posit dockless bikeshare as the more convenient and therefore more desirable option for users.

Although convenience is a broad term, it has clear connotations when used in relation to public transportation: convenient bikeshare should save users time, not exact any onerous restrictions or requirements on them, and help them to easily get to their destination. Bicycle sharing schemes have taken note of this, and research holds that they do save users time (Jappinen et al., 2013; Murphy & Usher, 2015) and they help users get to where they are going through robust connectivity with transit hubs (Barber et al., 2018; Goodman & Cheshire, 2014). Moreover, users value convenience (Fishman et al., 2013), and one way that this is unfortunately exhibited is in their tendency to eschew helmet wear (Basch et al., 2015). These findings are broadly confirmed by the results of this study: convenience is the top response as the key benefit of bikeshare among the total population, though considerably more Shanghai residents answered Price and more New York users answered Health than Convenience. Furthermore, only 16.25% of the total population thought helmet promotion might have the largest positive impact on safety. Other respondents may have felt that bringing a helmet is simply an inconvenience, though this is purely speculation.

The strongest evidence for the overwhelming importance of convenience in bikeshare ridership comes from connections associated with accessibility (i.e. time-to-find). First and foremost, findings indicated a strong correlation between low time-to-find and referencing convenience as the dominant benefit. Users for whom bicycles were more available almost invariably saw convenience as a greater benefit than other possible ones. Next, low time-to-find was strongly correlated with a higher frequency of ridership (see Chart 2). Accessibility, convenience, and ridership are all closely intertwined. Convenience also had a very noticeable impact on a user's willingness to support a bikeshare paradigm shift: those with a high time-to-find among Citi Bike users were the most agreeable toward the potential introduction of dockless bikeshare, while this was also true, albeit to a lesser extent, of their Mobike high time-to-find counterparts who were more likely to be agreeable to the introduction of a docked bikeshare program. Finally, as Chart 4 shows, users citing convenience as the primary benefit of bikeshare were less amenable to a paradigm shift than any other users were. In this study, convenience certainly did stand out as important factor. Future bikeshare implementations and expansions should take these results into consideration: convenience is important not just for new user uptake, but also for sustained usage with significant frequency as well as sustained support of the bikeshare model at hand. More competition in the future will entail users switching over to whichever model provides them with the greatest convenience.

Conclusion

A variety of limitations hamper the ability to effectively apply these results to broader contexts and other related bikeshare questions. First of all, while docked and dockless represent two fundamental paradigms in the bikeshare problem, city-specific contextual information plays an overwhelmingly important role in the realization of the outcomes therewith. This matter has been already addressed with respect to the diversity hypothesis and the effect hypothesis. Some limitations also developed as a result of this study's methodology, such as how transit hubs played an important role in sampling in Shanghai as well as in New York City. Notably, though, Mobike bikes are available throughout Shanghai—there are agglomerations of bikes at and around transit hubs, but bikes can be found almost anywhere. Sampling at transit hubs alone may have ensured greater similarities between New York and Shanghai methodology, but it may have also introduced some degree of bias in favor of individuals who solely use bikeshare to go to and from the metro. These users would be less likely than their more freewheeling peers to see the impact of bikeshare on shopping or even exercise (as it would represent a negative health outcome rather than a positive one). Shanghai and New York are two distinct cities with distinct populations, and they both experience and internalize change at a rapid clip, thereby limiting the applications of these findings. Most importantly, though, the potentially confounding role of all manner of cultural and city-specific factor limited the broad survey questionnaire.

Future studies intending to increase the understanding of user perceptions of the dockless and docked bike-share paradigms in relation to urban experience could extend these findings in a multitude of directions. First, future studies should consider the correlation between convenience, health, ridership, and other variables in more quantifiable terms. This study sought general comparisons, but I did not design it to comment on specific quantifiable results of that nature. A study, for example, detailing the relationship between accessibility, ridership, and health outcomes across the two bikeshare paradigms could be quite fruitful and intriguing. Furthermore, future studies should seek to disentangle culture-specific factors from these results, thereby generating a more robust and valid understanding of underlying factors and correlations. Another potential direction for future studies could be to investigate actual effects (e.g. through the use of big data) and their relationship with these perceived impacts. User perception, after all, does not directly equate to effects realized within the urban environment at large. Finally, future research comparing dockless and docked bikeshare paradigms should consider the role of public policy in relation to urban outcomes such as pollution or the monopolizing of sidewalk space by bicycles.

Ultimately, all three hypotheses of interest in this study were upheld: there is a greater diversity of ridership among dockless bikeshare participants, more substantive perceived effects of bikeshare on users' relationships with their urban environment, and an overarching importance of convenience to user perceptions. With each passing month, the role of bikeshare continues to increase in global metropolises. Furthermore, its role is changing—evolving, subsuming more and newer antecedents and producing more and greater effects. Citi Bike New York and Mobike Shanghai represent two fundamentally opposed paradigms of bikeshare ridership, yet they have goals (and impacts) that frequently dovetail. In many cases, perceptions of the positive effects of these bikeshare schemes are almost universally upheld, yet dockless bikeshare remains positioned as a more user-friendly, convenient (for the user) option correlated with increased diversity of ridership and broader effects on the urban experience.

Policymakers must take these findings into consideration when considering future bikeshare schemes. Comprehensive bike-sharing systems of the future must consider sustainable business models and prioritize supportive infrastructure and safety concerns (Shaheen & Guzman, 2011). Users may favor the options characteristically associated with dockless bikeshare, but more docks spread out over more locations could mimic this convenience and accessibility if properly considered in an expanded Citi Bike scheme. Planners need not eschew extant regulations in favor of allowing dockless bikeshare to run wild in order to realize the benefits thereof. Similarly, planners, in New York City and elsewhere, might use these findings to consider a dockless bikeshare solution that implements geofencing and upholds contemporary regulations while assuaging concerns therewith. The future of bikeshare appears undecided, but one thing is certain: the users will buy-in, and cities will never be the same again.

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Appendix: Survey

COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK — COLUMBIA GSAPP

Thank you for your participation. I am a master student in Columbia University. I'm doing a study about Citi Bike

Q1. Gender: What is your gender? __________

Q2. Age: What is your age?

- ☐ Under 19 years old ☐ 19-25 years old ☐ 26-40 years old
- ☐ Above 40 years old

Q3. How has bikeshare influenced your relationship with the city?

- ☐ Yes,I see less of it
- ☐ Yes, I see more of it
- ☐ No Change

Q4.which Citi Bike membership you have?

- ☐ Annual
- ☐ Monthly
- ☐ 3 or 6 month pass
- ☐ 3 or 6 day pass
- ☐ Pay as you go

Q5. What are you using Citi Bike for?

- ☐ Going out [Decrease / No Change / Increase]
- ☐ Seeing Friends [Decrease / No Change / Increase]
- ☐ Shopping [Decrease / No Change / Increase]
- ☐ Exercise [Decrease / No Change / Increase]

Q6. What is the Strength of Citi Bike? (Choose as many as apply)

- ☐ Cheap ☐ Convenience
- ☐ Environmental Friendly ☐ Other

Q7. How long do you walk to find Citi Bike?

- ☐ Within 1 Mins ☐ 2-5 Mins ☐ 6-10Mins ☐ Over 10Mins

Q8.Which of the following is most important to make your Citi Bike ride safer? (Choose as many as apply)

- ☐ Improving Road Conditions ☐ Helmet Promotion
- ☐ More Bike Lanes ☐ Better Traffic Control
- ☐ More cyclists Biking on Road
- ☐ Lower the speed of Cars

Q9: Frequency

	1-6	7-14	15+	Never	Other
Average number of Using Citi Bike per Week					

Q10. If Citi Bike release dockless bikes that mean you can leave your bike in any location, would you more intend to ride more? Did you agree or disagree to this decision?(1 is strongly disagree and 5 is strongly agree)

- ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Other Comments:

COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK　COLUMBIA GSAPP

感谢您参与这次调查，我是一名哥伦比亚大学城市规划的一名研究生，我的调查课题是共享单车：

Q1. 您的性别是？___________

Q2. 您的年龄是？

- ☐ 19岁以下　☐ 19-25岁　☐ 26-40岁
- ☐ 40岁以上

Q3. 请问您是摩拜单车或者OFO的会员么？

- ☐ 是，我办理了包月　☐ 是，我办理了季卡
- ☐ 不是，单次消费

Q4. 共享单车对您出行造成多大影响？

- ☐ 外出　【增加 / 不变 / 减少】
- ☐ 朋友　【增加 / 不变 / 减少】
- ☐ 购物　【增加 / 不变 / 减少】
- ☐ 健身　【增加 / 不变 / 减少】

Q5. 共享单车是否影响了你与城市的关系？

- ☐ 影响很少
- ☐ 影响很大
- ☐ 没影响

Q6. 您认为共享单车的优点？(可以多选)

- ☐ 价格便宜　☐ 节能环保
- ☐ 方便，随用随放　☐ 其他

Q7. 一般您找到一辆共享单车的时间是多久？

- ☐ 少于 1 分钟　☐ 2-5 分钟　☐ 6-10 分钟　☐ 10分钟以上

Q8.您认为共享单车的缺点？(可以多选)

- ☐ 配戴头盔
- ☐ 有太多车停放在路边不用，浪费资源
- ☐ 设置更多自行车道
- ☐ 更好的交通管控
- ☐ 降低车速

Q9: 您使用共享单车的频率

	1-6	7-14	15+	从不	
摩拜单车					
OFO 小黄车					

Q10. 如果摩拜单车有特定区域停车位，您对此的看法？（1分是特别不满意，5分是特别满意）

☐ 1　☐ 2　☐ 3　☐ 4　☐ 5

其他评论添加：