02-bikesharing_and_bikemi

October 27, 2021

1 Sharing Services: History and Challenges

1.1 A Brief History of Bike Sharing Services

The concept behind bike sharing systems (BSS) has been around since at least the 1960 (DeMaio, 2009). Perhaps unsurprisingly, the first BSS operator was Dutch: it was called Witte Fietsen, or White Bikes, and was deployed in Amsterdam, 1965. The bikes for the sharing service were painted in white, in order to distinguish them from private bicycles, and were made freely available with no locks. Even less surprisingly, "the total absence of security mechanisms led to theft and vandalism, and a rapid demise of Witte Fietsen", as pointed out by Fishman (Fishman, 2015).

Since this failed attempt, researchers have identified three further generations of bike sharing systems (Parkes et al., 2013), along the lines of their technological improvements. Being one of a kind, Witte Fietsen was basically the only representative of the first generations of bike sharing systems. According to DeMaio, the so-called second generation of bike sharing system was launched in the 1990s, in Denmark (1991 and 1993) and subsequently in the Netherlands (1995). These systems were designed with better insurances against frequent usage, as well as vandalism: "The Copenhagen bikes were specially designed for intense utilitarian use with solid rubber tires and wheels with advertising plates, and could be picked up and returned at specific locations throughout the central city with a coin deposit" (DeMaio, 2009). These incentives were not enough, as the time was not yet prime for better customer identification technologies as well as tracking systems.

New features such as "electronically-locking racks or bike locks, telecommunication systems, smartcards, mobile phone access, and on-board computers" became the norm since 1996, following the example of services such as Bikeabout, developed by Portsmouth University in the United Kingdom (DeMaio, 2009). With Bikeabout, students could use a magnetic stripe card to rent a bike. Since then, a couple of third-generation bike sharing services launched every year across Europe, such as in France (Rennes, 1998) and Germany (Munich, 2000). These services managed to deter theft with "dedicated docking stations (in which bicycles are picked up and returned), as well as automated credit card payment and other technologies to allow the tracking of the bicycles" (Fishman, 2015). The peak of the third generation was reached around the second half of the 2000s, when Velo'v and its 1500-bike fleet were launched in Lyon in 2005, followed by the 7000 bikes deployed by Velib in 2007 in Paris.

Since then, bike-sharing spread to the rest of the world, and around the first half of the 2010s China established itself as a leader. In 2014, the global bike-sharing fleet was estimated at almost one million bicycles, three fourths of which where in China (Fishman, 2015); the country also had more than double the number of bike-sharing systems (237) compared to Italy (114) and Spain (113), while there were only 54 in the USA (Fishman, 2015). China is now the leader in sharing services, followed by Europe - which today still maintains its lead over the US, where "the adoption process

it at an earlier stage and is gaining momentum" (Parkes et al., 2013).

This ongoing surge in popularity is once again due to technological breakthroughs: the fourth generation of bike sharing services exploits the Global Positioning System (GPS) and smartphones to deploy fleets of dock-less (or flee-floating) bikes and e-bikes. China could establish itself as leader also thanks to the rise of mobile technology and apps like WeChat, which was launched in 2011 and quickly became the most used platform in the country: "By the end of 2015, WeChat had 762 million monthly active users worldwide, and roughly 91% of them were from China; moreover, around 639 million users accessed WeChat on a smartphone" CHEN 2017. WeChat is ubiquitous in China and living without it nigh impossible ("In Cina vivere senza WeChat è complicato," 2018), as the platform supports cash transfers and is used for shopping, tipping and paying services.

These new technologies drastically lowered the entrance barriers and the otherwise high upfront investments to set up a bike sharing network. One of the most popular BSS, ofo, was born in 2014 thanks to a collective of students at China's Peking University, who realised they could use the GPS on user's phone to track the bikes. They chose the name "ofo" because word itself resembled a biker and brought together some 2000 bikes to use on-campus (Schmidt, 2018). The service was so popular that they quickly made it into a company.

According to Samantha Herr, executive director of the North American Bikeshare Association in Portland, Maine, "large-scale venture capital and cheaper equipment are the game changers that propelled the explosive growth of dockless companies like Mobike and ofo". Dockless bikes are of "lower quality than their docked counterparts" and do not require expensive technologies to interface with a docking station: "That makes them cheaper to mass produce and drop off in new markets" (Schmidt, 2018). It is not by chance that most free-float BSS are completely private, while docked systems almost always feature a partnership between the private sector and local administrations.

Today, according to the estimates on the website Bike Sharing World Map, there appear to be almost 1900 bike sharing services in the world, with almost 1000 that have closed down and 300 to be opened. According to an interview to Russell Meddin, the website founder, in 2018 there were 16 to 18 million free-float bikes, plus 3,7 million docked bikes.

1.2 The Challenges of Sharing Services and the Sharing Economy

Sharing services are not without flaws. For example, Ma and their coauthors warn against some of the worse consequences of the sharing economy as a whole: "exploitative capitalism", labour precarity, widening income gaps and "platform capitalism" (Ma et al., 2018). The researchers make a dramatic claim: "Left unaddressed, these trade-offs risk becoming crippling contradictions to the potential of the sharing economy in promoting urban transformations to sustainability" (Ma et al., 2018). This situation represents a great challenge for public administrations, as the pace of innovation is always much faster than policy-making, and regulating the more controversial aspects of a rapidly growing and popular platform is easier said than done.

Lawmaking takes years: as an example, the two "champions" of the sharing economy, Uber and AirBnB, were valued almost 70 and 30 billion dollars in 2017 (Stone, 2017), despite the press already outlining some of the most controversial aspects of their business models. Uber could never really get past the scandals (Goggin & Taylor, 2019), especially those concerning the sexist culture of the company (Jackson, 2021), and this played a role in the weak IPO performance of the startup in 2019 ("Nel primo giorno di quotazione in borsa, le azioni di Uber hanno perso il 7,6 per cento," 2019).

In the meantime, other competitors were facing accusations about the legal status of their "riders", and so did many other companies in the so-called gig economy, like Deliveroo (the renowned food delivery service). In countries such as Italy, this eventually led to the companies being ordered to recognise the employee status of the workers on the platform, further questioning not only the profitability but also the ethical basis of their business model (Secondo la procura di Milano, Uber Eats, Glovo, Deliveroo e Just Eat devono regolarizzare 60mila rider con contratti di collaborazione, 2021). Legal actions in Italy resulted in the company being placed under external management (Uber Italia è accusata di sfruttamento dei rider ed è stata commissariata, 2020), while in some US States, Uber and its primary competitor, Lyft, are now bound to observe a minimum wage (Seattle ha imposto una paga minima per gli autisti di Uber e Lyft, 2020).

However, these results only came several years later, and the same happened to AirBnB: despite a unexpectedly successful IPO ("La quotazione in borsa di Airbnb è stata un successo," 2020) in the midst of the pandemic ("La crisi della sharing economy," 2020), the company now also has to face tighter regulations that undermine their business model ("Airbnb Urges Housing Reform in Berlin after Court Overturns Permit Rejection," 2017) ("La nuova sentenza europea sugli affitti brevi," 2020) ("Le città europee contro gli affitti brevi," 2021).

To a lesser extent, this is a concern for bike-sharing services as well - in particular for dockless bike sharing systems, which have undergone an unforeseeable growth in the past five years. As Ma and their coauthors synthesise, the unregulated and unexpected growth of Mobike in Shangai results in hitting "a threshold of oversupply, under-distribution and user misbehaviour problems, which endanger[ed] the environmental and social sustainability of innovative urban mobility schemes" (Ma et al., 2018). They proceed to state that "[T]he social, political and infrastructural institutions in cities have not developed adequate capacities and norms to respond, absorb and adapt to changes brought by under-regulated commercial and technological forces embodied in the modern sharing economy" (Ma et al., 2018).

The growth of Mobike was so fast that it also "exacerbated problems of user misbehaviour such as theft, vandalism and illegal parking, undermining the sharing values and public space resources that FFBSs require to operate efficiently" (Ma et al., 2018). Besides, this triggered venture capital funds (VC), which flocked to bike-sharing startups, leading to more than 1,7 million new bikes flooding the streets of Shanghai: "The oversupply of shared bikes created a serious strain on public resources. Massive numbers of bikes were dumped in public spaces, exacerbating existing crowding and stress on the city's roads and parking spaces" (Ma et al., 2018). The collaboration between private enterprises and public officers began to deteriorate: bikes were ordered to be removed, while new BSS startups "dropped their bikes without any notice in advance" - a strategy that was also used in other parts of the world. The authors claim that this "unintended tragedy of the commons" was due to "under-regulated FFBSs", which had to put their private interests (profitability) first if they wanted to survive the competition (Ma et al., 2018).

1.3 The Elephant on the Sidewalk: Electric Scooters

Nowadays, bike sharing systems contend roads (and sometimes even sidewalks) with new competitors: electric scooters, or moped, which have become surprisingly popular across the globe in recent years, displaying a stronger growth trend and adoption compared to BSS. The literature on the history of e-scooters services is still quite young, but authors generally trace the beginning of electric scooter systems (ESS) to 2017, specifically to the US (Yang et al., 2021). Scooters arrived in Europe, specifically in Brussels, during the summer of 2018 (Moreau et al., 2020).

E-scooters have since developed quite rapidly, even faster than dockless bike sharing services (Yang et al., 2021), and today it is estimated that they make up almost two thirds of the shared micromobility trips in the US, while almost one in four citizens in Paris tried one in 2019 (Yang et al., 2021). However, moped did not come without hassles. For one, "rented and privately-owned e-scooters suddenly became a conspicuous, controversial and disruptive presence in urban public space" (Tuncer et al., 2020). Besides, their road status is not quite clear, and legal frameworks are still not ready to adapt to include e-scooters, which "upset the normal order of traffic and public space" (Tuncer et al., 2020). While they are used at least as widely as bikes (if not more), they do not seem to belong to roads more than skateboards, not to mention sidewalks.

Their advantages are clear: being electric, they can travel longer distances with lesser effort. Besides, scooters are handier and more portable than bikes. There are some disadvantages, too: scooters are electric and thus require charging, which introduces another step in the reallocation procedure. Overall, this entails greater costs for the service providers: while manufacturing costs might be assumed to be equivalent, recharging the batteries and moving them to and from the charging station surely translates into higher operational costs (Zhu et al., 2020). Furthermore, some authors in the literature also find that scooters have a shorter life span and thus "at present, the use of e-scooters shows a higher impact than the transportation modes they replace" (Moreau et al., 2020). This calculation does not include "end-of-life treatment", which could positively affect their "GWP" or "Global Warming Potential" (Moreau et al., 2020). The authors suggest a list of measures that could reduce their impact, which include increased cooperation with the public sector: "new electric charging stations that are installed in the city could also include charging devices for e-scooters"; however, the supplier should also provide incentives, for example "a financial incentive for the users to drop the e-scooter off at charging areas and plug them in" (Moreau et al., 2020).

However, the literature is still too young to coherently assess the impact of e-scooters and their relationship with existing sharing service and public transport network. For example, it would be deemed reasonable that e-scooters might provide a good alternative to private transportation, yet "several studies suggest that they are frequently used instead of walking" (Tuncer et al., 2020), as it was found by (Laa & Leth, 2020), (Mitra & Hess, 2021), (Nikiforiadis et al., 2021) and (Sanders et al., 2020). Some authors specifically found that "People travelling with bicycle or motorcycle were not attracted by e-scooters novelty" (Nikiforiadis et al., 2021) or that are more likely to be employed for recreational purposes, "potentially filling a niche" (Sanders et al., 2020). One interesting trend that e-scooters display is that, after trying the service, some users do buy a scooter of their own (Tuncer et al., 2020), and e-scooters owners are more likely to use them as a replacement for their private cars (Moreau et al., 2020).

In other words, borrowing from economic jargon, it is still not clear why and when e-scooters are to be considered substitutes or complements of traditional modes of transport, and the same goes for bike sharing. On the one hand, it seems clear that e-scooters (and bikes) do not consistently replace private vehicles and cars in particular. By the way, this reinforces the idea that in order to transition towards a greener economy, promoting sharing services must go hand in hand with investments in public transportation networks, as well as improving existing biking infrastructure (Laa & Leth, 2020).

For one, it might be expected that adoption of e-scooters translates into a decline in bike rentals. These are the findings of Yang and their coauthors (Yang et al., 2021), who estimated that in Chicago weekly usage of bike sharing in e-scooter sharing operation area declined by slightly more than 10 percent. Specifically, the usage of bike-sharing service subscribers was down by 4 percent,

while the drop across non-subscribers was as big as 34 percent (Yang et al., 2021). Indeed, this might reveal that subscribers choose bikes for endogenously different reasons - i.e., they might deem them better suited for commuting. After all, "bike sharing use during non-peak hours decreased but was not affected during peak hours" (Yang et al., 2021). The drop was more marked with short trips, for which bike usage was down by almost 11 percent - twice as much as the decline in medium-duration trips (5,5) but almost half as much as in short trips (20,5). In general, it seems that docked bikes are preferred for commuting (Reck & Axhausen, 2021) (Reck et al., 2021).

1.4 Sharing Services in Milan: BikeMi and its Competitors

BikeMi was introduced in December 2008 in a partnership between the City of Milan and Clear Channel Italia, a subsidiary of a global media and advertising group. In 2015, pedal assisted bicycles were introduced. Now the service counts 325 stations with 5430 bikes: 4280 are "classic", 1000 are e-bikes and 150 are "pedal-assisted" (i.e., electric) with a child seat (Who We Are - BikeMi, n.d.). Including private enterprises (fully free-float), there are a total of 15400 bikes up for sharing, of which 3500 are electric. Private companies were progressively introduced in 2017, after public procurement and a testing phase (Bike Sharing - Comune Di Milano, 2021).

Mobike was the first, in July 2017, deploying 4000 bikes across Milan and Florence (P.Sol, 2017). ofo joined around the same time and economic Newspaper *il Sole 24 ORE* reported that, by November 2017, MoBike had deployed 8000 bikes in Milan and 7000 more in the rest of Italy, while ofo had 4000 bikes (Magnani, 2017). This resulted in BikeMi losing some 5 percent of their subscribers. ClearChannel, the service provider, disclosed that in 2009 they had some 10700 subscribers, which became around six times as much by 2017. At the time, BikeMi was reported to have 4650 bikes, of which 1000 were electric (Magnani, 2017). Surprisingly, BikeMi was reporting a profit: 200 thousand euros. Operating costs amounted to 6 million euros, two of which were covered by subscriptions and the remainder by advertisement revenue (Magnani, 2017).

The article was also reporting rumours about a fusion between the two private operators, which were undergoing extensive losses and could not be seen reaching the profitability goals they set themselves for the following years. In 2018, ofo was already said to be close to failure, while Mobike was allegedly looking to sell their operations in Europe (Salvioli, 2018). Indeed, ofo failed in 2020, while the Italian Idri Bk (manager of Mobike fleets) bought the European branch of Mobike on November 2019. From the operation, the new sharing service Movi (now RideMovi) was born, after ofo had already withdrawn from the Italian and European market (Soldavini, 2019). Now in Milan there are three bike sharing services: BikeMi is the only docked one, with rentals services open from 7 a.m. to 1 a.m. and from 7 a.m. to 2 a.m. during summer, plus 24 hours on Fridays and Saturdays. The other two services, RideMovi and Lime, are free-floating and operating 24 hours a day (Bike Sharing - Comune Di Milano, 2021).

Electric-scooter sharing services arrived in Milan only on February 2020 (Monopattini in Sharing - Comune Di Milano, 2021), right before the first wave of the COVID-19 pandemic and following a one-year long public procurement. Each provider was allowed a fleet of 750 e-moped, for a total of 2250 vehicles and three providers. To face the mobility challenges of the pandemic, the cap was increased to 6000 and the number of providers was doubled.

1.5 Competitors and Data in Our Analysis

The history of BikeMi's competitors has several implications for our analysis. While we will be discussing the data and the choices for our project in the next chapter, it is worth anticipating some

points. For one, we can already rule out electric scooters and their effects, as they only appeared in 2020 - a year for which we would have BikeMi data. However, given the pandemic break out, we chose not to forecast rentals in that period of time.

The situation becomes more complicated when it comes to the other dockless bike-sharing services. For one, we could not obtain data from any of the other providers, which either failed or sold all their activities to other private enterprises. Not having data about dockless services forces us to change our data strategy, but the literature comes to help. As we have outlined above, several authors found that docked bike-sharing systems are mostly used for commuting and are less sensitive to the introduction of free-floating BSS. Since ClearChannel only registered a 5 percent decrease in subscriptions since the FFBSS introduction, we feel reassured when accepting that we will only be able to model FFBSS effects with a dummy variable. After all, in just a few months private operators introduced at least as many bikes as BikeMi had: 4000 for ofo and 4000 for Mobike, which became twice as many in less than six months after the launch of the service. Given these numbers, a decline of only 5 percent does not seem worrisome.

If we buy the "docked bikes services are less sensitive to dockless ones" assumption, i.e. that docked bikes are preferred for commuting, it can be enough to forecast the number of bikes during peak hours. In the next chapter, we will see that peak commuting hours perfectly overlap with peak BikeMi usage. Finally, there is a considerable data gap from July 2018 to the end of that year, which forced us to analyse data from 2015 to that date only. All in all, the instability and novelty of free-floating bike sharing services has likely dampened their usage growth. For all the reasons outlined so far, we concluded that the lack of ways to account for ofo and Mobike data would not hinder our forecasts significantly. Besides, adopting the policymaker perspective, it would be quite difficult to have your competitor's data available.

1.6 BikeMi: a Review of the Literature

Saibene and Manzi (Saibene & Manzi, 2015) analyse survey data to evaluate the level of satisfaction for "all the actors involved": service management, city council and users. The area taken into consideration was inside the "Bastioni", i.e. inside of the historic hispanic walls. This area coincides with the so-called "Area C", where cars have restricted access since 2012 (and paid access since 2008 with the so-called "Ecopass"). Sorrentino, Manzi and Virili (Sorrentino et al., 2019) also investigate the "organisational identity" of Clear Channel Italia, the service provider, focusing on the normative and utilitarian dimensions that characterise a public service. In particular, they observe how the "publicness" and "privateness" of BikeMi interact and how public accountability and social impact interact with Clear Channel's profitability goals.

Toro and his coauthors (Toro et al., 2020) perform a similar analysis with data from June 2015 to December 2018 - the same period we analyse. They find that the service is "extensively used for commuting to work-related activities" and that "only strong meteorological conditions can impact the use of the service" (Toro et al., 2020). Indeed, it seems reasonable to assume that commuters are more inelastic to moderately adverse weather, as light rain or cold. The authors also implement a clustering algorithm to analyse bike-sharing services patterns, a widespread step in the literature - especially for forecasting about dockless services. The goal of this strategy is to "identify temporal-spatial patterns for specific users' typologies" (Toro et al., 2020). They dispose of 13,789,569 records for 3650 traditional bikes and 1150 electric bikes (150 with a child seat). The service operates from 7 a.m. to midnight.

The authors remove all records before the service working hours, as they might inadvertently

capture “extraordinary schedules” or maintenance. They do the same for trips whose duration was shorter than a minute and “records whose arrival or departure did not match with the existing stations” (Toro et al., 2020). They identify two types of users, occasional and regular, according to the 75th percentile threshold, i.e. 36 trips, with findings consistent with the literature. Regular users use the service more during weekdays with two different peaks along the day, and occasional users during holidays and weekends, with larger activities at lunchtime and evening hours (Toro et al., 2020).

Through spatial analysis, the researchers confirm that traffic flows from the periphery to the city centre in the mornings and back in the evenings, with greater use in the proximity of train stations. These patterns are also captured by cluster analysis. Looking at the weather, the usage starts to decline “dramatically” only around the 20mm threshold. Also Croci and Rossi (Croci & Rossi, 2014) find that their results are robust to “confounding factors such as weather conditions”. Their research establishes that “the presence of metro and train stations, universities, museums, cinema and restricted traffic areas in correspondence of bike sharing stations significantly increase use. On the other hand the presence of tram and bus stops and theatres does not and has an opposite influence” (Croci & Rossi, 2014). Lastly, Cappozzo and their coauthors work on scrapped BikeMi data to classify stations to determine “the future *full*, *empty* or *not problematic*” state of each station (Cappozzo et al., n.d.).