Sustaining dockless bike-sharing based on business principles

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ABSTRACT

SUSTAINING DOCKLESS BIKE-SHARING BASED ON BUSINESS PRINCIPLES

by
Neil Horowitz

Currently in urban areas, the value of money and fuel is increasing because of urban traffic congestion. As an environmentally sustainable and short-distance travel mode, dockless bike-sharing not only assists in resolving the issue of urban traffic congestion, but additionally assists in minimizing pollution, satisfying the demand of the last mile problem, and improving societal health. Despite the positives that this new transportation mode provides, currently there are few effective measures in place to make the development of dockless bike-sharing providers more sustainable.

This study endeavors in establishing a foundation for resolving this problem through developing business models of dockless bike-sharing based on business theory and principles, and utilizing the largest dockless bike-sharing company in China as of November 2018 named Mobike as an example within these business models. The long-term sustainability issues of dockless bike-sharing are identified through various methods including an operational analysis of one of Mobike's largest divisions located in Beijing, China, and potential solutions to those issues as well as policy implications are presented based on the research and analysis conducted.

SUSTAINING DOCKLESS BIKE-SHARING BASED ON BUSINESS PRINCIPLES

by
Neil Horowitz

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SUSTAINING DOCKLESS BIKE-SHARING BASED ON BUSINESS PRINCIPLES

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CHAPTER 1

INTRODUCTION

At the present time in urban areas, the value of money and fuel is increasing because of urban traffic congestion. In order to effectively reduce traffic congestion and develop a sustainable transportation system, bike-sharing has been a choice for decades. However, recently a new form of bike-sharing has gained popularity. In early 2016 this new form of bike-sharing called dockless bike-sharing appeared in China **[1]**. Although bike-sharing is not uncommon in other parts of the world, the Chinese version gives a completely new meaning to the concept of bike-sharing. Because of Global Positioning System enabled applications and the mobile internet, users are now able to pick up a dockless bicycle anywhere in a city and leave it in any legal parking spot at the end of their trip. The concept is quite popular among students and young professionals from all over the country because dockless bike-sharing is convenient and economical. A typical 30-minute ride costs around 1 Yuan which exchanges for around 15 Cents depending upon currency fluctuations. In order to understand dockless bike-sharing it is first important to understand bike-sharing all together.

Bike-sharing has been defined as "an innovative transportation program, ideal for short distance point-to-point trips providing users the ability to pick up a bicycle at any self-serve bike station and return it to any other bike station located within the system's service area" **[2]**. Bike-sharing functions as an important transportation mode in connecting some of the gaps that exist in modern transportation networks **[3]**. Some of the other benefits of bike-sharing include reduced traffic congestion during the peak hour, increased mobility, lower transportation costs, health benefits, and greater environmental sustainability. Bike-sharing first began in the Netherlands in 1965 and it grew slowly for decades **[4]**. Although multiple authorities in transportation have acknowledged that dockless bike-sharing, in addition to other forms of bicycling are a legitimate solution to resolving the issues of urban traffic congestion pollution, and public health issues, the cost of offering bike-share services to the public has previously limited the viability of this form of transportation. Prior to the introduction of dockless bike-sharing technology into the industry, governments had reportedly needed millions of dollars in order to start bike-share programs. This included the acquisition of docking stations which are expensive to build, costing between ¥3,469.00-10,407.00 a bicycle, aside from being an added inconvenience for users **[5] [6] [7] [8]**. Since the mid- ‘2000s dockless bike-sharing has been rapidly growing all over the world because of the development of information technology. In recent years, with the popularity of the sharing economy, a growing number of investors have provided capital funding to this field; further accelerating its growth.

1.1 Problem Statement

With the fast growth of bike-sharing around the world, as well as the substantial benefits provided by the dockless form of bike-sharing, it is essential that this new mode of transportation be properly implemented, managed, and promoted. However, at this time, there are still no effective measures in place to make the development of dockless bike-sharing providers more sustainable **[9]**. Considering that dockless bike-sharing is a very new transportation mode, there has been very little research performed on it: yet much of what has been published focuses on the problems with dockless bike-sharing related to its sustainability in the long-term.

1.2 Methodology

This study has endeavored in resolving this problem beginning with reviewing sharing economy, traditional bike-sharing, and dockless bike-sharing literatures. Business models for dockless bike-share were then developed based on business theory and principles. A Chinese dockless bike-sharing firm named Mobike was then chosen for further research and an operational and microeconomic analysis. The reason for choosing this firm was because it is one of the largest dockless bike sharing companies in the world **[10]**. Both Mobike and a competitor named Ofo currently account for 95% of the dockless bike-share market **[11]**. In consideration of the bike-sharing industry as a whole, at the start of 2018 Mobike had around 33% market share **[11] [12]**. The element of size made Mobike one of the best representations of the actualities of dockless bike-sharing companies available. Considering the firms significant size there was also more information available on it in comparison to other firms in the industry; which enabled a better analysis **[10]**.

In order to develop an accurate depiction of Mobike's transportation operations and cost and revenue structure, data and information was gathered from various reliable sources such as scientific research reports, government publications, major media publications, and from Mobike's Beijing division through a current employee. Although the ability to examine operational data specifically from the Beijing division occurred by chance, out of the other 175 Mobike operating divisions, Beijing is an ideal city to examine considering that Beijing along with Shanghai, Guangzhou and Shenzhen account for 35% of all dockless bicycles deployed in China as of 2018 **[11] [13]**. In regards to both dockless and non-dockless bike-sharing, Mobike accounted for at least 22% of the bike-sharing market in Beijing as of May 2017 **[1] [14]**. The operational data from Mobike's Beijing division was cleaned and then analyzed in order to gain as many insights as possible into the day-to-day operations of Mobike in Beijing City. Some data utilized in the analysis was directly available, and other pieces of data had to be extrapolated, calculated, and inferred from other information found on the company. Mobike's total dockless bicycle fleet supply, as well as Mobike's dockless bicycle fleet supply in Beijing was then aligned with current available industry demand. A business model was then developed with consideration of all of these resources. Various hypothetical microeconomic scenarios were then tested within these models in order to gain a better understanding of Mobike's profitability potential. The long-term sustainability issues of dockless bike-sharing were then identified, and potential solutions to those issues as well as policy implications were formulated based on the research and analysis conducted.

1.3 Further Research

In order to improve the current findings of this research, both experimental and applied research will need to be conducted into dockless bicycle supply and demand control mechanisms. First in evaluation of innovative redistribution techniques, and second in regards to aligning dockless bicycle fleet supply with available industry demand. This order is necessary because enhanced redistribution techniques will reduce the number of dockless bicycles needed in dockless bike-share providers' fleet supplies. Additionally, further experimental and applied research will need to be conducted in regards to identifying both an optimal and sustainable profit model. Ineffective solutions will need to be identified, and potentially effective solutions will need to be tested in practical environments. All of the previously mentioned gaps in the current research available will need to be researched in order to assist in further resolving the problem statement.

CHAPTER 2

LITERATURE REVIEW

Considering that dockless bike-sharing is a relatively new transportation mode, very few publications exist on the topic. However, the few publications which do exist identify the same or similar issues effecting this new form of transportation. A study titled "Critical Factors to Achieve Dockless Bike-Sharing Sustainability in China: A Stakeholder-Oriented Network Perspective" produced by Tongji University in Shanghai, China as well as Jiangxi University in Nanchang, China identified stakeholder-associated factors and corresponding interrelations through literature analysis and interviews, and the social network analysis (SNA) method which was employed to recognize those critical factors and the associated links. The identified critical factors were then further abridged into six main challenges for dockless bike-share providers. Half of the six main challenges identified in the study are both directly and indirectly related to aligning dockless bike-share supply with users' demand. The first challenge was stated to be quantity control: including the factors and links contained in this challenge mainly referring to a series of problems caused by an oversupply of bike sharing. However, contrarily, the study also mentioned that if too few bike-sharing services are available, that could also lead to a reduction in traffic accessibility; highlighting the importance of a balance between supply and demand. The researchers further stated the second main challenge to be that waste recycling difficulties due to the oversupply of dockless bicycles had led to public spaces being occupied. The third main and quantity control related challenge was stated by the researchers to be exploration of a new profit model; and moreover, a sustainable one. It was stated that the exploration of this new profit model will determine the future of dockless bike-share providers **[15]**.

A second study performed by researchers from both Southeast University in Nanjing, China and the University of Leeds in Leeds, United Kingdom analyzed the travel characteristics of dockless bike-share, chose respondent attributes and attitudes as influential variables, and applied a binary logit model to explore the influencing factors of dockless bike-share use. This publication titled "Free-Floating Bike Sharing in Jiangsu: Users' Behaviors and Influencing Factors" identified multiple major obstacles to the development of dockless bike-share, including irrational distribution of dockless bike-share schemes and a lack of regulations as well as complete policy. The study did acknowledge that more advanced models had been used in the transport domain such as multinomial and ordered logit models, as well as structural equation modeling: however, it was also stated that those models were not suitable to analyze the empirical data collected in the research. Since the questionnaire did not include questions about users' general satisfaction with, attitudes, or experiences, whether the respondent had used dockless bike-share or not was utilized as the dependent variable. This was also identified as a limitation in regards to the questionnaire design. External factors such as the traffic environment and weather changes which also may affect dockless bike-share use were also not incorporated in the study. However, the findings that dockless bicycles of operators including Velib System and JCDecaux are utilized 4 times a day are aligned with reports from those operators **[16]**. The problems with dockless bike-sharing are additionally confirmed by other publications such as "Understanding the Usage of Dockless Bike-Sharing in

Singapore" which investigates the impact of dockless bicycle fleet size on the usage of that fleet.

The question of whether the marginal utility of dockless bicycle usage decreases when fleet size increases was answered by regressing two different models. The first model utilized dockless bicycle fleet size as an explanatory variable and the second model utilized the square root of the explanatory variable. In addition to fleet size, in this analysis, external factors such as the built environment and weather conditions were taken into consideration utilizing a spatial autoregressive model. Although the results did identify a positive correlation between dockless bicycle fleet size and bicycle usage, it was further noted that as fleet size increases, each new dockless bicycle induces fewer new trips; eventually resulting in a profit loss. In the publication, it was additionally stated that it was believed that the main interests in rapid fleet expansion of dockless bike-share providers was most likely to "squeeze competitors out of the market, rather than promote further usage". It was further stated that such growth is not sustainable since public space and resources are limited. The overall utilization levels per dockless bicycle where also identified to be low, along with decreasing marginal benefits. In regards to further research, the publication identified answering the question of "Whether, or what industry regulation is necessary?", as well as a discussion on appropriate regulation guidelines for dockless bike-sharing riders and operators as a topic for further research **[17]**.

In regards to assessment of an optimal profit model, another study investigated the revenue variations that occur, and optimal pricing for dockless bike-share operators that choose to enact a monthly subscription strategy. Various different types of dockless bike-share users were identified, and platform requirements were depicted in order to identify the platform revenue. Although no other publications exploring monthly pricing strategies have been identified, and the publication is most likely the first to examine this strategy for dockless bike-share providers, it was acknowledged that the strategy had not been tested in a practical environment. Two possible, however untested outcomes were recognized. The first was that the strategy might convert low-value users who do not use dockless bike-sharing on a regular basis, into those who are regular users, and those who are high-value users who intended to purchase a bicycle into permanent dockless bicycle renters. The other, and possible negative impact was recognized to be that the introduction of a monthly pricing strategy might introduce a monthly price which produces lower revenue than previous rental generated revenue **[18]**. Multiple studies focusing on the redistribution aspect of aligning dockless bike-share supply and user demand were located. One such study titled "A Relocation Strategy for Munich's Bike Sharing System: Combining an operator-based and a user-based Scheme", identified the two different types of redistribution strategies, as well as the advantages and disadvantages of both of them, and ideal fleet imbalances in order to apply them.

The first is called a user-based strategy which has the advantages of low cost since no redistribution staff is required considering that users redistribute the dockless bicycles in exchange for a reward. This strategy also incorporates no extra relocation trips. The disadvantages of this type of relocation strategy are that it is not efficient in regards to timing, and that it depends on the willingness of users to cooperate; which is difficult to predict. The second type of redistribution strategy is an operator-based strategy where fleet relocation is efficient since operators are accountable, and a combinatorial maintenance period in-between dockless bicycle relocation is possible. In addition to the advantages of this strategy, the disadvantages include that redistribution staff must be reimbursed, and that it is not environmentally sustainable in consideration of the need for redistribution vehicle support which allows for the transportation of up to 40 dockless bicycles in one vehicle. The first redistribution strategy can be applied if fleet imbalances are less than 15%, and the second can be applied if fleet imbalances are higher than 15%, or in combination with a user-based redistribution strategy. The studies research was based on the global positioning system data of the dockless bike-share operator named Call-a-Bike in Munich, Germany: and it identified the mobility patterns of users in order establish a demand model to optimize the distribution of dockless bicycles within the operating area. External and other factors were considered such as weather conditions, holidays and weekends. The analysis established that on an average Monday morning, 25% of Call-a-Bike's dockless bicycle fleet was located in low demand areas due to the previous weekend when usage patterns differed from weekdays. In assuming redistribution tours with one vehicle and one employee each, the labor costs were found to be four working hours, and a perfect fleet distribution was established after a time period of two hours **[19]**.

In another study about dockless bike-share redistribution, researchers from the University of South Florida proposed a method for extracting operational management insights from historical trip data of shared mobility systems in a United States Department of Transportation grant funded study titled, "Analysis of Free-floating Bike Sharing and Insights on System Operations or Analyzing Mobility Patterns and Imbalance of Free Floating Bike Sharing Systems". Independent variables were taken into consideration and methods were applied to remove any unnecessary interactions. An additional method to decompose continuous variables into binary variables was proposed in order to improve the base model mentioned in the studies literature review. Dockless fleet imbalance times were identified including 6:00 AM-7:00 AM, 9:00 AM-10:00 AM, and 3:00 PM-4:00 PM on Monday through Thursday, as well as 7:00 AM-8:00 AM, 1:00 PM-2:00 PM, and 4:00 PM-5:00 PM on Friday. The insights from this research allowed the researchers to identify 1:00 AM-6:00 AM, excluding Tuesdays in September when the time range increases to 1:00 AM-8:00 AM, as the optimal time for static rebalancing or on-site maintenance. The ideal months and seasons for static rebalancing were identified as April and Fall, and the ideal months and periods for dynamic rebalancing were identified as May, June, July, September, and holidays. Ideal times for dynamic rebalancing including for both operator- and user-based redistribution strategies were identified as 10:00 AM-12:00 PM, and 1:00 PM-3:00 PM on Monday through Thursday, as well as 9:00 AM-1:00 PM and 2:00 PM-4:00 PM on Friday [**20**]. An additional publication conducted by researchers at Tsinghua University and the Chinese University of Hong Kong worked further on resolving the problem of an imbalance between dockless bike-share supply and user demand: and in the research paper it was stated that, "bike-sharing imbalance can cause severe problems not only to users and service providers, but also to cities. Therefore, it is crucial for bike sharing providers to rebalance bikes efficiently, so as to serve users well and to avoid congesting city sidewalks and causing a bike mess".

The publication, which is titled, "Rebalancing Dockless Bike Sharing Systems" focused on resolving the problem of aligning current dockless bicycle fleet supply with real-time user demand through a novel deep reinforcement learning framework for incentivizing users to assist in redistributing the dockless bike-sharing system, by adaptively adjusting the allocated prices to users **[21]**. Each of the previously summarized publications encompass the majority of research available to the public on the topics of dockless bike-share industry supply and user demand alignment, redistribution, and identification of an optimal profit model. Each of these studies has therefore been considered in regards to the problem statement.

CHAPTER 3

DOCKLESS BIKE-SHARE TECHNOLOGY

The foundation of dockless bike-sharing is the smart-lock. The smart lock combines the internet of things, global positioning systems, and 3G telecommunication modules so that users can locate nearby dockless bicycles at any time through using the dockless bike-share company's mobile application. Dockless bicycle users can use the mobile application directly, or use a third-party application indirectly. What makes dockless bike-sharing distinctive from traditional bike-sharing is that the user is not required to return the bicycle to the original dock and may park the bicycle in any legal parking space. The smart-phone application can additionally assist the user in locating a public bicycle dock. The owning enterprise is able to visualize where the entire fleet of dockless bicycles is in real-time through a global positioning system application. Moreover, the application will collect the data and information on the trajectories of the user's trip, providing travel information for transportation agencies.

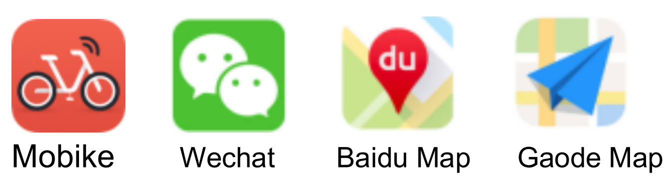

Figure 3.1 Depiction of Mobike user Applications.

Source: Institution for Transportation and Development Policy (2018)

3.1 How Dockless Bike-Sharing Works

With various enterprises the user may locate a dockless bicycle with a mobile application; unlock the dockless bicycle smart-lock with a quick response code, also called a machine-readable code, which is used for storing information on the company's mobile application; and manually re-lock the dockless bicycle once the trip is complete. When a user is finished with a trip and the dockless bicycle is parked and locked in any legal parking area, the rental fee will be processed through the mobile application.

Locate Scan and Ride Lock and End

Figure 3.2 How Dockless Bike-Sharing Works.

Source: Mobike Company Website (2018)

3.2 Dockless Bike-Sharing Providers

Dockless bike-sharing business models have evolved with the advent of mobile technology-based systems. In the bike-share market, dockless bike-sharing companies are privately owned and operated. This means that the owner or private investors provide all of the funding for the operations and equipment. By September of 2018 there were fifty bike-sharing companies operating a combined fleet of twenty-three million bike-sharing bicycles in China **[11]**. In the largest four cities which include Beijing, Shanghai, Guangzhou, and Shenzhen, there where around five million bike-sharing bicycles **[1] [24] [25] [26]**. The largest four cities, as well as the other cities in China in which these companies operate in, and the number of dockless bicycles in those cities can be seen in the image below.

Figure 3.3 The number of dockless bicycles in major cities in China.

Source: Institution for Transportation and Development Policy (2018)

By February 9th of 2018, the previously mentioned fifty bike-sharing companies in China had increased to 77, and then declined to 57 because of many companies being unable to control high operational and maintenance as well as theft and vandalism costs, and lack of funding **[11]**. Major dockless bike-share companies that are still operational have high levels of funding. This is depicted in the figure below which compares the funding of three currently operating companies, including that of Mobike's, to that of a competitor named Bluegogo which declared bankruptcy in November 2017 **[1]**.

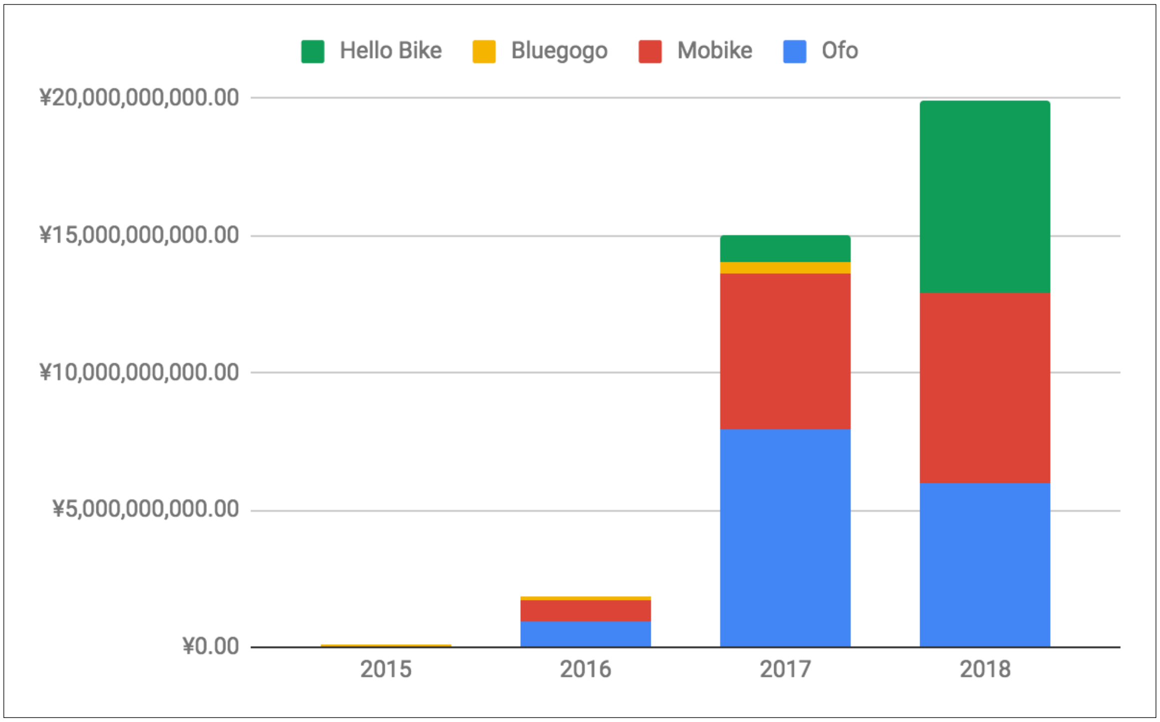

Figure 3.4 Total funding by year for bluegogo and the three largest dockless bike-sharing Companies in China (Including Mobike's estimated funding for 2018).

Sources: Crunchbase (2018), *Maulani*, Anisa *(2018, 01, 26), South China Morning Post (2018, 07, 26)*

3.3 Funding and Investment in Mobike

From October 30th 2015 to December 19th 2017, Mobike had ten funding rounds amounting to a total of at least ¥6,507,844,000.00. Most of Mobike's funding in earlier funding rounds including series A, B, and C was provided by venture capitalists and private equity firms. However, funding in later rounds such as series D and E, as well as private equity rounds has been largely provided by companies in interrelated industries who have established partnerships with Mobike and are positioned to benefit from investing in the company **[31]**. These include companies such as LINE Corporation which has partnered with Mobike to integrate the company's services as an exclusive bike-share function within the LINE Corporation mobile application: and Foxconn Technology Group which as of January 23rd 2017 had been reported to have partnered with Mobike in order to manufacture 5,600,000 of Mobike's Dockless Bicycles **[33] [34]**.

Table 3.1 Total Funding and Investment in Mobike Since December 19th 2017

Announcement Date	Transaction Name	Number of Investors	Lead Investors	Funding Raised
Oct 30th 2015	Series A	1	Joy Capital	¥20,814,000.00
Aug 19th 2016	Series B	4	Panda Capital, Joy Capital, Sinovation Ventures	¥69,380,000.00
Aug 2016	Series B+	2	Sinovation Ventures, Vertex Ventures	At least ¥69,380,000.00
Sept 30th 2016	Series C	9	Hillhouse Capital Group, Warburg Pincus	¥693,800,000.00
Oct 2016	Series C+	Unknown	Hillhouse Capital Group, Tencent Holdings, Panda Capital	Unknown
Jan 4th or April 1st 2017 (Date Unknown)	Series D	7	Tencent Holdings	¥1,491,670,000.00
Jan 23rd 2017	Funding Round	1	Foxconn Technology Group	Unknown
Feb 20th 2017	Private Equity Round	2	Temasek Holdings	Unknown
June 15th 2017	Series E	8	Tencent Holdings	¥4,162,800,000.00
December 19th 2017	Private Equity Round	1	Line Corporation	Unknown
Total	-	18 Individual Investors	-	At least ¥6,507,844,000.00

Sources: Mobike Company Website (2018), Dr. Nedopil, Christoph et al (2018, 08, 03) P. 1, Zhang, Yi (2018, 04,13) P. 7., Crunchbase (2018)

3.4 Unprofitable Operations

In December 2017, Mobike had around 13 million rides per day as can be seen in the image below.

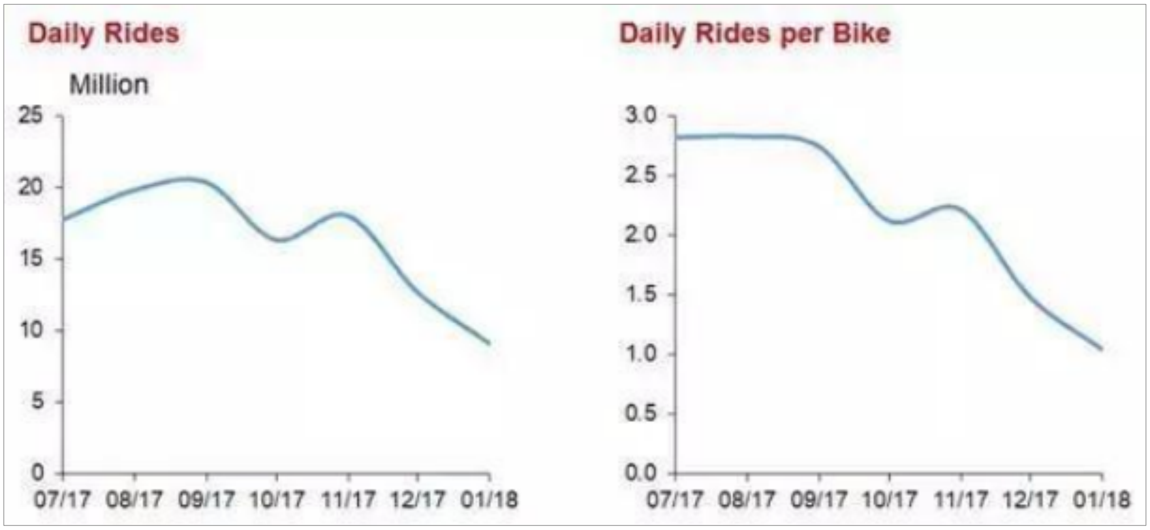

Figure 3.5 Mobike's daily rides and daily rides per bike for 07/17-01/18.

Source: Blue Whale TMT (2018, April, 02), Figure 3

So, one can perform the following basic equation to get the total number of rides in December:

$$\begin{aligned} &\textbf{13 Million Rides Per Day in December 2017} \\ &\times\ \textbf{31 Days in December 2017} \\ &= \textbf{403,000,000 Total Rides in December 2017} \end{aligned} \qquad \textbf{(3.1)}$$

You can then multiply the total rides in December 2017 times an average unit price of .81 Yuan per ride based on the bike type allocation of Mobike's Beijing fleet to arrive at Mobike's revenue for December 2017 **[14]**.

$$\begin{aligned} &\textbf{403,000,000 Total Rides in December 2017} \\ &\times\ \textbf{¥.81 Yuan Per Ride (Average)} \\ &= \textbf{¥326,430,000} \end{aligned} \qquad \textbf{(3.2)}$$

However, according to Mobike's profit/loss statement as can be seen below, in December 2017, the company's revenue was ¥110,000,000. That leaves ¥216,430,000 unaccounted for. The logical conclusion is that the ¥216,430,000 that cannot be accounted for is due to both monthly and yearly members. These members pay Mobike either ¥20 for unlimited monthly rides, or ¥240 for unlimited yearly rides **[23]**. These types of users result in a substantial loss for Mobike; as can be seen by the company's Net Profits at the bottom of the figure.

Table 3.2 Mobike's Profit/Loss Statement on December 2017 (In Yuan)

Mobike P/L (Dec 2017)	
RMB in Million	**201712**
Revenue	**110**
Cost of Sales	**-565**
Depreciation	-282
Operation	-283
Gross Profits	**-455**
SG&A	**-146**
Comp & Benefits	-60
Marketing Expense	-39
Advisory Expenses	-38
Other Expenses	-9
Impairment Loss	-80
EBIT	**-681**
Net Profits	**-681**

Source: Blue Whale TMT (2018, 04, 02), Figure 2

CHAPTER 4

BUSINESS MODELS OF DOCKLESS BIKE-SHARE OPERATIONS

With great technology and an urgent need to satisfy travel demand for first and last mile connections in urban areas, it is logical to expect that dockless bicycles are in high demand and dockless bike-share companies thrive as business entities. However, the quick rise and fall of bike-share companies in China and the difficulties they have encountered overseas during expansion implores the question –What happened **[36]**? What went wrong? Some of the answers are hidden in the business models and travel demand analysis as presented below:

4.1 Costs of Dockless Bike-Sharing

The costs of dockless bike-sharing can be divided into the two separate categories of capital expenses and operating expenses. Capital expenses can be defined as funds utilized by a company to obtain, upgrade, and maintain physical assets that will benefit that company in the future. Capital expenses in regards to dockless bike-sharing companies include the funds utilized to obtain, upgrade, and maintain business properties, dockless bicycle re-distribution vehicles, and dockless bicycles. The costs to obtain Mobike's properties and dockless bicycle re-distribution vehicles are not stated in the company's financial statements, and the information needed to estimate these costs is not accessible. With an average fleet size of around 7,649,401 dockless bicycles costing around ¥2,000 each, the initial purchase of Mobike's fleet costs around ¥15,298,802,000. However, initial investment costs have not been included in the business model of Mobike as this model is devised to assess whether Mobike can be profitable, and what is necessary for Mobike to be profitable after these initial investments are recompensed. Given the most recent available profit and loss statement from Mobike, upgrading and maintenance expenses are also unlisted, and are therefore presumed to be included in Mobike's operating expenses. In consideration of this upgrading and maintenance expenses have been set under this category, and costs have not been grouped under capital expenses. Operating expenses can be defined as the expenses required for the daily functioning of a company. The operating expenses of dockless bike-sharing companies can be further subdivided into both fixed, and variable costs.

4.1.1 Fixed Costs

Fixed costs in relation to dockless bike-sharing can be defined as business expenses that are not dependent on the quantity of dockless bicycle rides produced by the business. These include advisory, software development and platform maintenance, and marketing, and vandalism costs. Marketing expenses are defined as fixed rather than variable costs as the quantity of marketing costs is believed to be dependent on the effectiveness of both the opportunities chosen and the advertisements presented. Additionally, vandalism costs are believed to be fixed costs rather than variable costs as it is believed that the proportion of the population willing to commit crimes of vandalism is static at any given time and does not increase with opportunity for vandalism.

4.1.2 Variable Costs

Variable costs in relation to dockless bike-sharing can similarly be defined as business expenses that are dependent on the quantity of dockless bicycle rides produced by the business. These include the maintenance, depreciation, and redistribution costs of the dockless bicycles, compensation and benefits, office rent and supplies, and other expenses which include interest expense and losses from disposing of fixed assets. Compensation and benefits are believed to be variable costs considering that if more dockless bicycle rides are produced, then more dockless bicycles will be needed to fulfill those additional rides, and that would require more employees for both re-distribution and management of the operation. If more employees are needed to manage the operations then more offices space and supplies would be needed as well, which is why this cost is additionally categorized as a variable cost. Other expenses are also believed to be a variable cost given that if more dockless bicycles rides are produced and more dockless bicycles are purchased to fulfill those additional rides, then that would require higher insurance costs which are presumed to be included in this expense type, and more assets to eventually need to be disposed of. Considering the need to purchase dockless bicycles in order to support the business, dockless bike-share companies are characterized by an asset-heavy business model. In consideration of the fact that as more dockless bicycles are purchased, the cost of each purchase per dockless bicycle will decrease as can be seen in Figure 4.1 below, dockless bike-sharing has a significant economy of scale. Utilizing Mobike as an example, at the beginning of the company's research and development phase, the cost of purchasing a dockless bicycle was up to ¥6,000. However now during the operational and maintenance phases, the company’s cost of producing a dockless bicycle is only around ¥2,000 to ¥1,200 **[37][38]**.

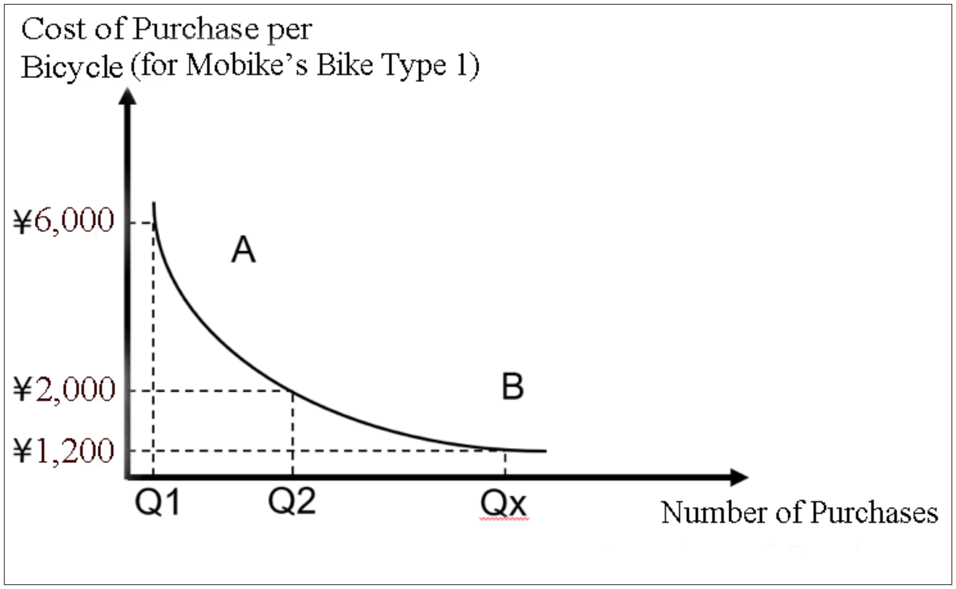

Figure 4.1 Mobike's decrease in average cost per bicycle from a significant increase in bicycles rides.

Source: Blue Whale TMT (2018, April, 02), figure 2, P. 6

4.2 Revenues of Dockless Bike-Sharing

The revenues of dockless bike-sharing can be divided into the two different categories of both operating and non-operating revenue. Additionally, under some business models, users are assigned ratings points, which can be deducted for inconsiderate behavior such as forgetting to lock a bike. Once a user's score drops below a certain level, they can be charged a higher price for trips. A user could theoretically get charged up to ¥100 for a 30-minute ride **[39] [40]**.

4.2.1 Operating Revenue

Operating revenue in relation to dockless bike-sharing can be defined as revenue generated directly from the main business of renting dockless bicycles. Regular trip usage fees and membership fees, as well as advertisement fees account for the operating income of dockless bike-sharing companies. Mobike's as well as other companies trip usage and subscription fees can be seen in Table 4.1 below. Mobike subscriptions which allow users unlimited rides on a monthly basis for ¥20, and on a yearly basis for ¥240 are categorized as operating revenues because they are associated with the core operations of these companies. Advertising fees are also classified as operating revenues considering that they can be either a direct result of a rental, or associated with the core operations of a dockless bike-share company. Almost every user-visible operation page in a dockless bike-share mobile application can be utilized for advertising. These operation pages include: open screens, pop-up windows, bluetooth unlock pages, digital password pages, scan code pages, timing pages, ride end pages, dockless bicycle icons and buttons, personal center and activity center icons, and activity center banners. In addition, advertisements can also be sent through the short-message-service push, also called a completed ride text message from the company. Major dockless bike-share companies such as Ofo have mobile application advertisements that are billed in accordance with both pay-per-click and cost-per-thousand advertising.

In pay-per-click advertising the customer is charged whenever a user clicks on that company's advertisement, and cost-per-thousand advertising charges the customer a specific fee for every 1,000 viewings of that advertisement. Advertisements on the dockless bicycle frame include rear wheel triangles, baskets, handlebar triangles, seat covers and axles **[51]**. As of November 25th 2017, Mobike did not have advertisements on any of the physical frames of the company's dockless bicycles **[52]**. Each of these dockless bicycle frame advertisement types are depicted in figures 4.2 and 4.3 below.

Table 4.1 The Costs of Using Dockless Bike-Share Services in China for 11 Major Companies

	Subscription Cost		Trip Usage Fee	
Company	Monthly	Yearly	0-30 Minutes (Cost Doubles Every 30 Minutes)	Daily Maximum
Mobike	¥20.00	¥240.00	¥0.50 (Bike Type 2), ¥1.00 (Bike Type 1)	¥24.00 (Bike Type 2), ¥48.00 (Bike Type 1)
Ofo	¥20.00		¥0.50	¥24.00
Youon			¥1.00	¥48.00
Hello Bike	¥20.00	¥240.00	¥1.00	¥48.00
U-bicycle	¥10.00		¥1.00	¥48.00
Baicycle			¥1.00	¥48.00
Bluegogo			¥0.50	¥24.00
Xiaoming			¥1.00	¥48.00
Qibei Bike			¥0.50	¥24.00
Kuqi Bike			¥0.30	¥14.40
Zhixiang Bike			¥1.00	¥48.00

Sources: Mobike Company Website (2018), Ofo Company Website (2018), Youon Company Website (2018), Hello Bike Company Website (2018), U-bicycle Company Website (2018), Baicycle Company Website (2018), Bluegogo Company Website (2018), Xiaoming bikeshare - Guangzhou City (2018), Qibei Bike Company Website 2018, Kuqi Bike Company Website (2018), Zhixiang Bike Company Website (2018)

Figure 4.2 Dockless bicycle body advertisements including rear wheel triangles, baskets, handlebar triangles, and seat covers.

Source: Zhang, Dan (2018, May, 30)

Figure 4.3 Dockless bicycle axle advertisements.

Source: Zhang, Dan (2018, May, 30)

4.2.2 Non-Operating Revenue

Non-operating revenue in relation to dockless bike-sharing can similarly be defined as revenue not generated directly from the main business of renting dockless bicycles. Non-operating revenue for dockless bike-sharing companies consists of revenue from interest on user deposits. This is revenue generated through interest on long-term user deposits invested with banks **[53]**.

4.3 Profitability of Dockless Bike-Sharing Operations

The profitability of dockless bike-sharing companies can be considered to be linked to two separate yet interconnected and equally significant parts. The first which can be called the break-even point is realized when the average usage per dockless bicycle in a dockless bike-share company's fleet given a certain time period is considered, with all other factors effecting profitability remaining fixed. The second, called the break-even price is realized when adjustments are made to the costs as well as revenues of a dockless bike-share company, with average usage per dockless bicycle in a dockless bike-share company's fleet given any time period remaining fixed. The interrelation between these two profitability factors can be seen in the figure below. With regards to dockless bike-share costs and revenues, in addition to the previously mentioned subscription costs, two other variable costs and two sources of operating revenue can be identified to have a key impact on the profitability of a dockless bike-share company. The two other key variable costs effecting profitability include operation and maintenance costs, as well as depreciation costs. The operation and maintenance costs include the costs to purchase, redistribute, and maintain the dockless bicycles. The sources of operating revenue that can be recognized as having a key impact on profitability are both the usage fee, as well as the revenue from advertisements on the dockless bicycle frame.

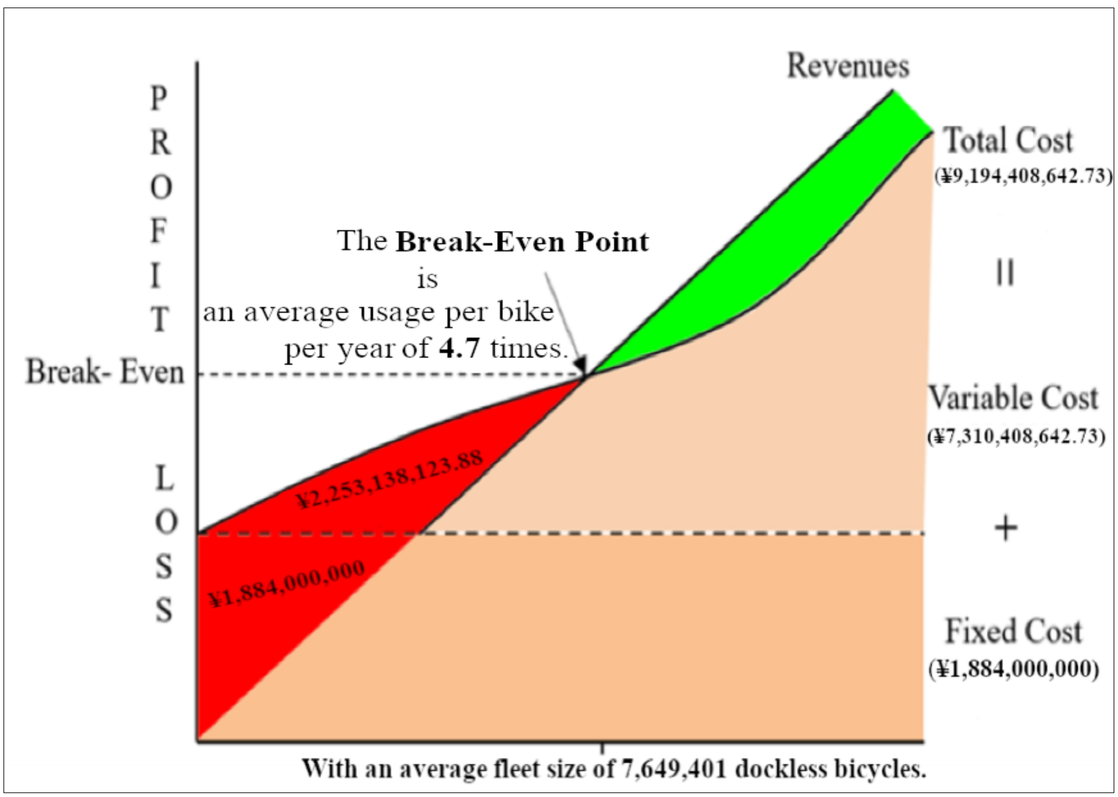

Figure 4.4 The costs, revenue, and break-even point of Mobike.

Sources: Blue Whale TMT (2018, April, 02), figure 2, P. 6, Mobike Unpublished Raw Data (2017, September, 26), Chen, Lin (2017)

Each of these can be isolated in order to better understand how they affect the profitability of a dockless bike-share company through the equation utilizing Mobike's figures below. When revenue from operations (RFO) is equal to the total cost (TC), the simple formula shown below can be derived:

$$
\begin{aligned}
&\textbf{RFO = TC when:}\\
&\mathbf{P\times N\times F\times T = TFC + TVC}\\
&\mathbf{P\times N\times F\times T = TFC + V\times N}\\
&\mathbf{BEP} = \frac{TFC+V\times N}{P\times N\times T\times F}
\end{aligned}
\qquad \textbf{(4.1)}
$$

Where:

RFO = Revenue from Operations

TC = Total Cost

P = Price per Use (¥)

N = The Number of Dockless Bicycles in the Fleet

F = Average Dockless Bicycle Usage

T = Effective Days (Business Days Estimated Using Historical Weather Forecasts)

TFC = Total Fixed Cost

TVC = Total Variable Cost

V = Variable Cost per Bike

BEP = Break Even Price

When the estimated figures of Mobike are entered into the formula, the following results are realized:

$$\textbf{BEP} = \frac{\text{¥}\mathbf{1{,}884{,}000{,}000} + (\text{¥}\mathbf{921.84} \times \mathbf{7{,}649{,}401})}{(\text{¥}\mathbf{.81} \times \mathbf{7{,}649{,}401} \times \mathbf{300} \times \mathbf{2.15})}$$

$$= \frac{\text{¥}\mathbf{8{,}935{,}552{,}902.54}}{\text{¥}\mathbf{3{,}996{,}429{,}552.4}}$$ **= A Break-Even Price of Around 2.2 Times the Current Average Price Per Rental = 2.2 × ¥.81 = ¥1.81**

In order to estimate whether or not increasing Mobike's usage fee would have a negative or positive effect on Users' Average Usage, a price elasticity model would need to be developed which the information necessary for is not currently accessible. However, the other key source of revenue which has an impact on a dockless bicycle company's profitability can be factored into the equation utilizing an estimate from Mobike's largest competitor Ofo which currently advertises on the company's dockless bicycle frames. Calculated at the lowest price of the body advertisement, plus the scheduling fee, one month's advertising fee is nearly 1/2 of the cost of a dockless bicycle; around ¥600-1,000 per body advertisement per dockless bicycle **[51]**. These advertisement types are forbidden in some cities; including Beijing. However, this element cannot be measured since the number of these cities is not known. When these estimated figures including a low estimate of one month's advertising fee of ¥600 per bicycle per month are applied to 5% of Mobike's current average fleet size, the following results are realized:

$$\textbf{BEP} = \frac{\text{¥}\mathbf{1{,}884{,}000{,}000} + (\text{¥}\mathbf{921.84} \times \mathbf{7{,}649{,}401})}{((\text{¥}\mathbf{600} \times (\mathbf{7{,}649{,}401} \times \mathbf{.05})) \times \mathbf{12}) + (\text{¥}\mathbf{.81} \times \mathbf{7{,}649{,}401} \times \mathbf{300} \times \mathbf{2.15})}$$

$$= \frac{¥8{,}935{,}552{,}902.54}{¥2{,}753{,}784{,}360 + ¥3{,}996{,}429{,}552.4}$$ **= A Break-Even Price of Around 1.32 Times**

the Current Average Price Per Rental = 1.32 × ¥.81 = ¥1.10

If Mobike was able to secure advertising spots on 5% of the company's dockless bicycle frames then the company's break-even price would be reduced by ¥.76. In addition to realigning Mobike's key sources of revenue, reducing the company's operation and maintenance as well as depreciation costs each by around a quarter, and entering the estimated figures into the equation produces the following results:

$$\textbf{BEP} = \frac{¥1{,}884{,}000{,}000 + (¥743.82 \times 7{,}649{,}401)}{(¥.81 \times 7{,}649{,}401 \times 300 \times 2.15)}$$

$$= \frac{¥1{,}884{,}000{,}000 + ¥5{,}689{,}777{,}451.8}{¥3{,}996{,}429{,}552.4}$$ **= A Break-Even Price of Around 1.9 Times the**

Current Average Price Per Rental = 1.9 × ¥.81 = ¥1.53

In order for Mobike to be able to realistically reduce these costs, the company would have to reduce its dockless bicycle fleet size. Depending on how many dockless bicycles Mobike's fleet size would be reduced by, this adjustment could have an effect on Users' Average Usage if users would have difficulty locating a dockless bicycle in a convenient amount of time.

CHAPTER 5

A CASE STUDY OF DOCKLESS BIKE-SHARE IN BEIJING

It is clear from the previous calculations that Mobike is currently not a profitable company. In consideration of this, one of the previously mentioned three methods for increasing profitability would need to be applied in order for Mobike to continue operating in the long-term. In order to realize whether or not Mobike's current operations are both efficient and effective, or if they could be a source of Mobike's lack of profitability, a case study of Mobike's operations in Beijing, one of the largest bike-sharing cities in China, can be conducted. It should be noted that Beijing is a unique city in regards to Mobike as Beijing is the birthplace of Ofo; Mobike's largest competitor. In regards to this fact, Ofo has experimented with its pricing and operation strategies extensively in Beijing: however, Mobike accounted for at least 22% of the bike-sharing market in Beijing as of May 2017 **[54] [1] [14]**. This case study also assists in gaining more insights into whether or not the option of reducing fleet size is feasible. In order to produce this case study data was retrieved directly from Mobike through a current employee. It should also be noted that this data is only for the time period of a week, which does limit its utility. However, this week is in the month of May which is both spring and a peak tourist season in Beijing; both factors which make this limitation less severe **[55] [56]**. The weather that took place during this week in Beijing is also considered good conditions for bicycling **[57] [58]**.

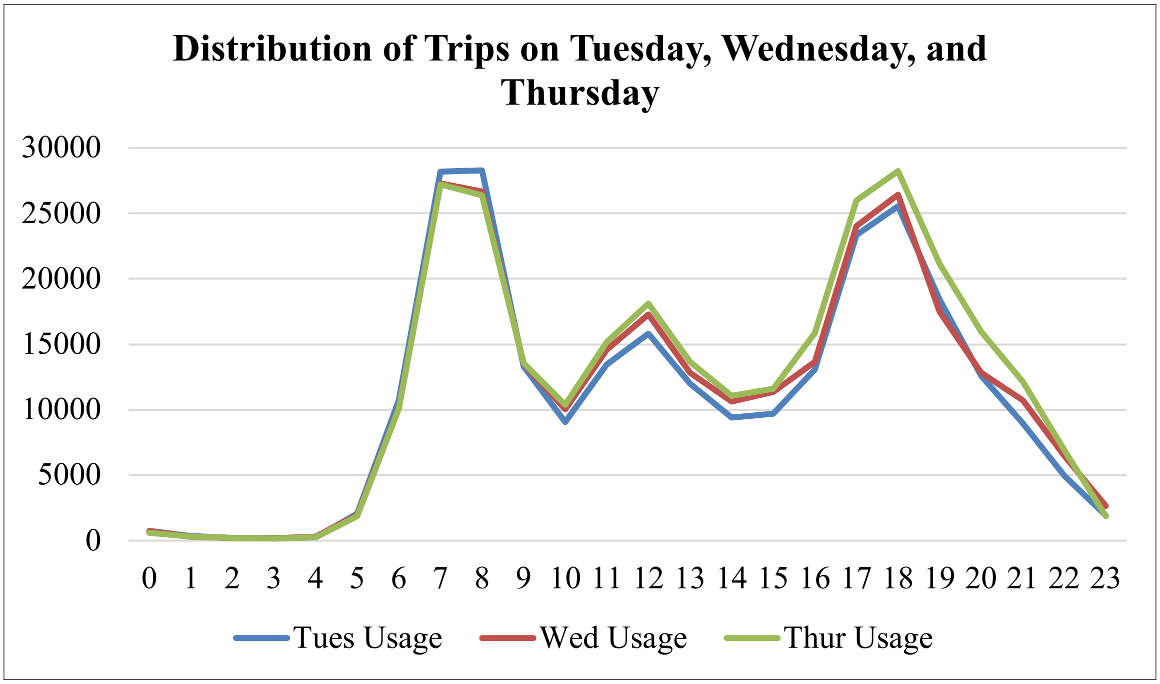

Figure 5.1 Distribution of trips on Tuesday, Wednesday, and Thursday.

Source: Mobike Unpublished Raw Data (2017, May, 10-16)

On three standard weekdays, 6 AM to 8 AM and 5 PM to 8 PM are the morning and evening peak periods. More than 50% of rentals occurred during these times. When the mid-size peak occurring between the hours of 11 AM to 1 PM is included, it is clear that the majority of Mobike's weekday users in Beijing are regular commuters and residents have adopted dockless bike-sharing as a regular transportation mode. In knowing this it would be essential for Mobike to be re-distributing the company's Beijing fleet around residential areas from the hours of 11 PM to 4 AM, at work related establishments from the hours of 9 AM to 11 AM, and at work related establishments and last-mile transit stations from the hours of 2 PM to 11 PM.

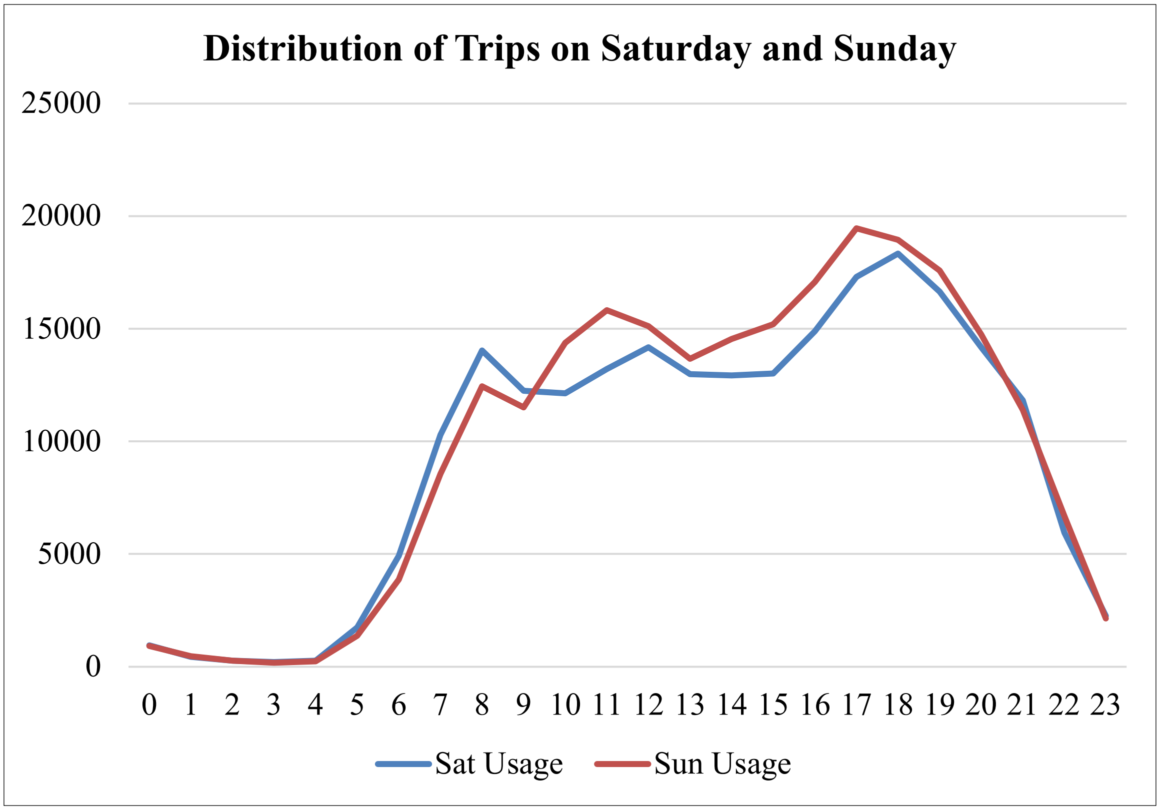

Figure 5.2 Distribution of trips on Saturday and Sunday.

Source: Mobike Unpublished Raw Data (2017, May, 10-16)

On the weekends, most users prefer to use Mobike's services in the evening peak period occurring between the hours of 5 PM to 8 PM. There is a sharp increase in the number of trips occurring during the morning hours of 5 AM to 8 AM. However, this increase in the number of trips is noticeably much more gradual than the morning increase in trips occurring on Tuesday, Wednesday, and Thursday. This is followed by a subtle increase in the number of trips occurring during the lunch hours of 10 AM to 1 PM, leading up to the evening peak period. The initial portion of the increase in trips occurring during the hours of 5 AM to 8 AM can most likely be attributed to users who wake up at early hours regardless of the day of the week, and the more gradual characteristic of this trip increase can most likely be attributed to users casually awaking without the responsibilities of the work-week. With this as well as the evening peak period considered, a depiction of leisure trips can be realized. In knowing this it would be essential for Mobike to be re-distributing the company's Beijing fleet to residential areas from the hours of 11 PM to 9 AM, and to leisure areas such as restaurants, museums, parks, and plazas afterwards. The figure on the following page depicts the distribution of trips from 12 AM on Friday to 12 AM on Monday. The trips on Monday and Friday can be seen to be aligned with those on Tuesday, Wednesday, and Thursday. It can also be realized that many more residents are using Mobike's services for commuting purposes rather than leisure, which further supports the idea that dockless bike-share is being utilized as a regular transportation mode in Beijing.

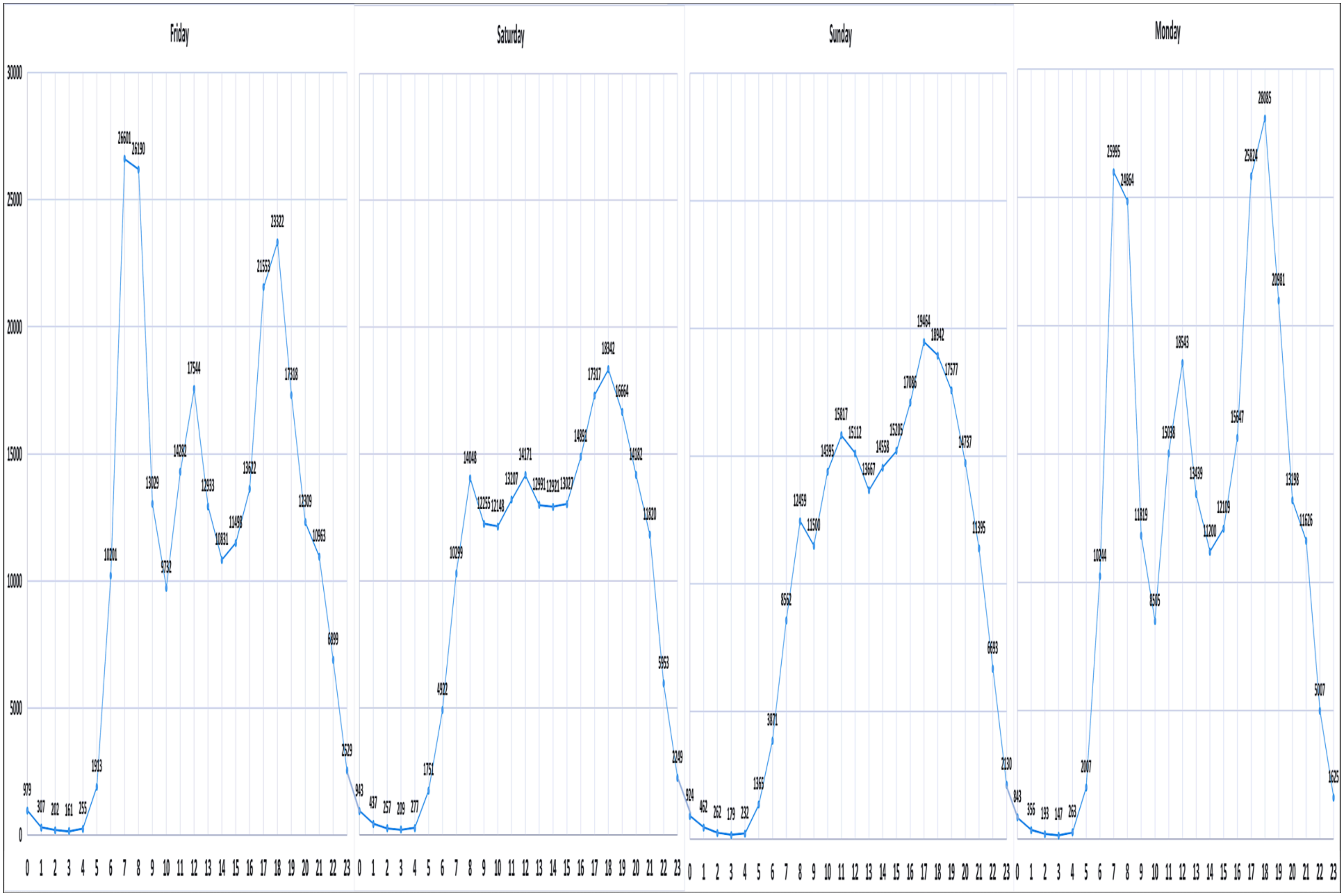

Figure 5.3 Distribution of trips from Friday 12 AM-Monday 12 AM.

Source: Mobike Unpublished Raw Data (2017, May, 10-16)

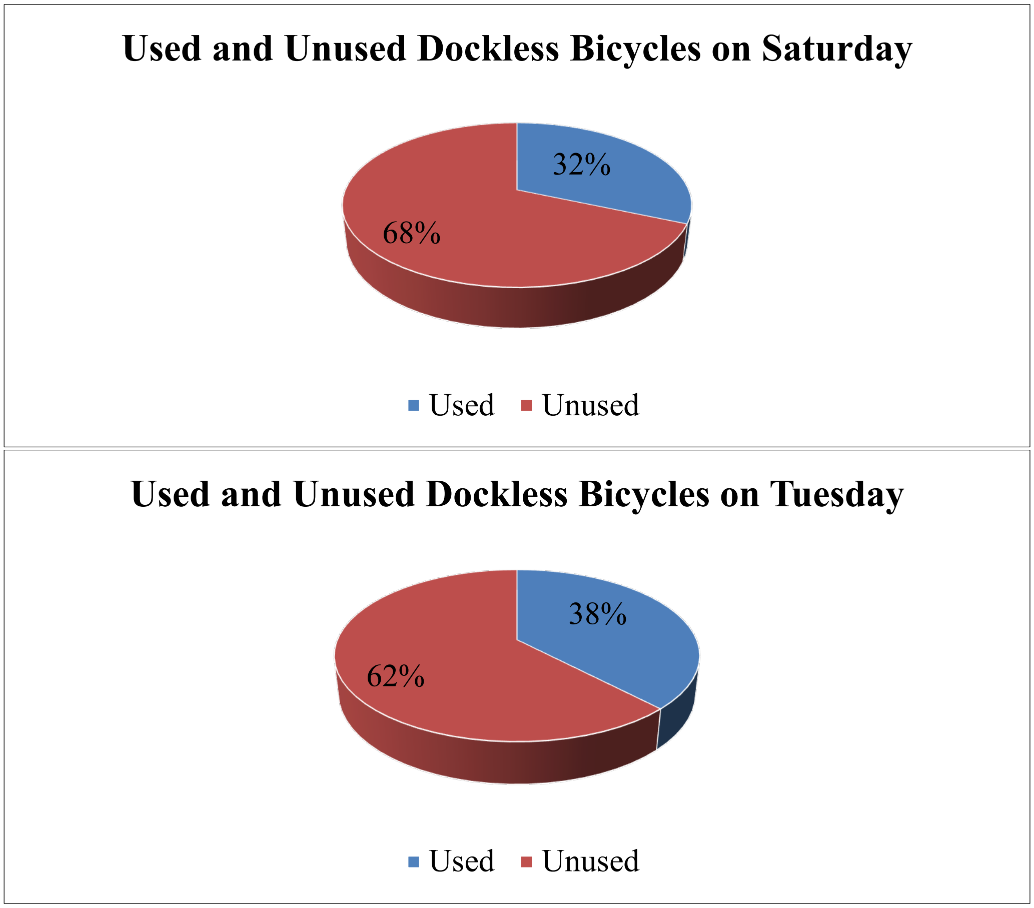

Figure 5.4 The percentage of used and unused dockless bicycles on Saturday and Tuesday.

Source: Mobike Unpublished Raw Data (2017, May, 10-16)

Only between 32% to 38% of Mobike's dockless bicycle fleet is being used on a daily basis. However, as can be seen in the figure below, with turnover considered, 84% of Mobike's fleet is being used at least once during the one-week period with the other 16% of dockless bicycles staying idle. In consideration of this, each individual dockless bicycle is being used on average .5 times. Given that this .5 Users' Average Usage per Dockless Bicycle is representative of a week in an ideal month for bicycling in Beijing, it is highly unlikely that Mobike's Beijing division is profitable.

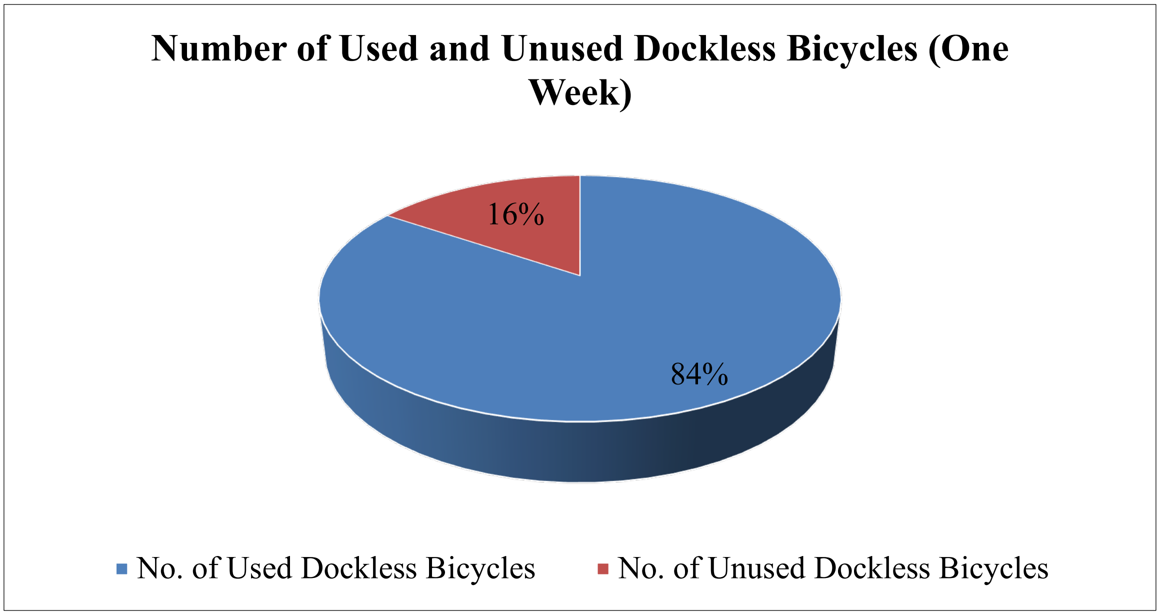

Figure 5.5 The percentage of used and unused dockless bicycles for one week (Considering turnover).

Source: Mobike Unpublished Raw Data (2017, May, 10-16).

As described previously, Mobike has two different dockless bicycle options for users. The first is type 1 which costs ¥1 every 30 minutes, and the second is type 2 which costs ¥.50 every 30 minutes; and is lighter and easier to ride **[23]**. As can be seen in the figure below, 61% of Mobike's Beijing user trips are utilizing type 1 dockless bicycles, and the other 39% of user trips are utilizing type 2 dockless bicycles. This allocation of dockless bicyles results in an Average Revenue Per Rental of ¥.81. However, this does not consider users who are utilizing Mobike's services for over 30 minutes. In order to calculate the effect that these users have on the Average Revenue Per Rental the process as stated below was applied.

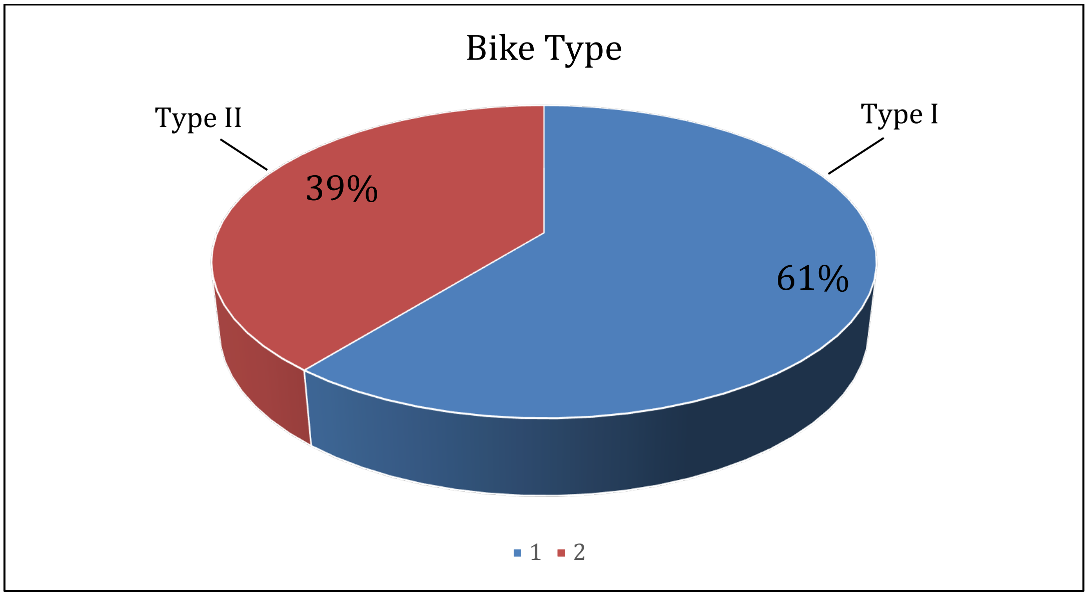

Figure 5.6 The percentages of bike type 1 and 2 utilized by Mobike's users in Beijing.

Source: Mobike Unpublished Raw Data (2017, May, 10-16)

When obtained, the Mobike data from Beijing did not originally reveal trip distances but it did have start and end locations. In Beijing, the roads are a series of ring roads connected by roads using a grid street plan. Considering this, taxicab geometry was utilized to calculate the riding distance of users' dockless bicycle trips. Samples below 300 meters were excluded as these were presumed to be the result of Global positioning system errors. The distance formula utilized to calculate user trip distance is as follows:

$$\textbf{Distance} = \textbf{(Latitude Length per Degree)} \times |\textbf{Start Latitude-End Latitude}| + \textbf{(Longitude Length per Degree on the Equator)} \times \textbf{cos(Local Latitude)} \times |\textbf{Start Longitude-End Longitude}| \quad \textbf{(5.1)}$$

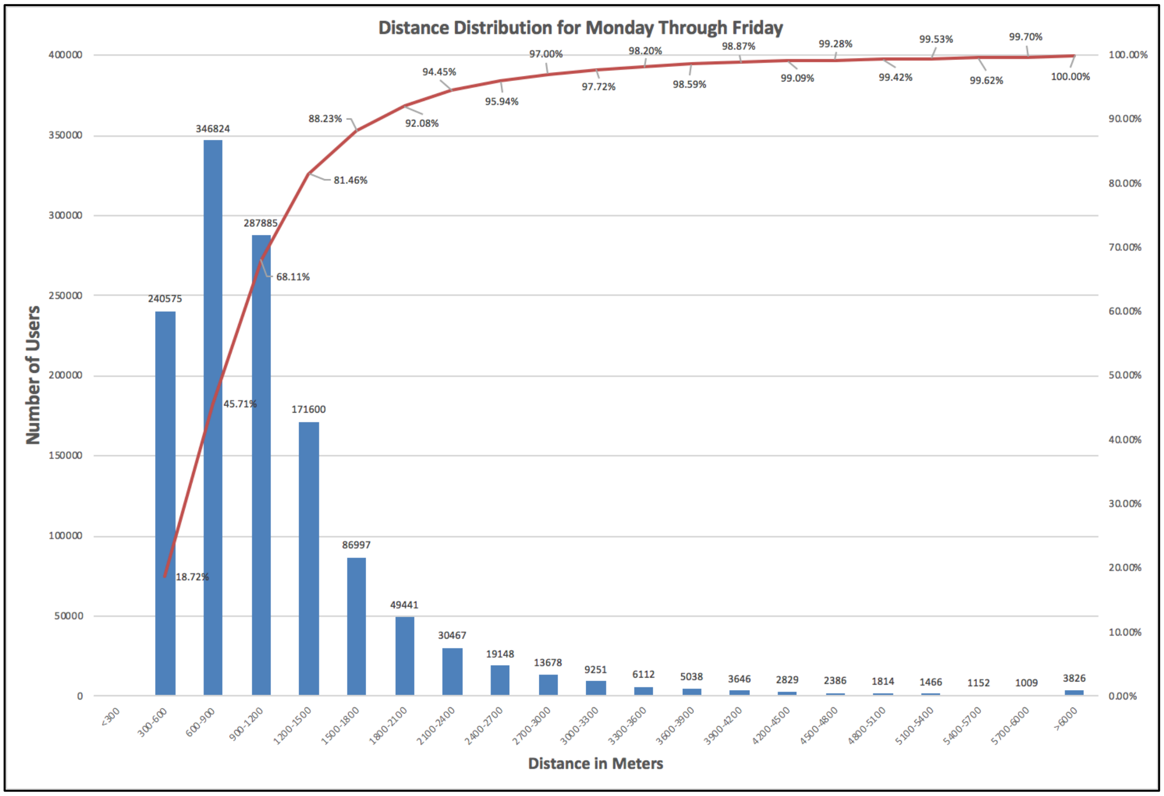

Figure 5.7 User trip distance distribution for Monday through Friday.

Source: Mobike Unpublished Raw Data (2017, May, 10-16)

From the figures above and below, it can be seen that on Monday through Friday 99.70% of users ride below a distance of 6000 meters, and on Saturday and Sunday 99.81% of users ride below a distance of 6000 meters. By utilizing the average bicycling speed of 15.5 kilometers per hour measured by the City of Copenhagen in the simple equation below, it can be realized that the large majority of user trips took place within a 30-minute time period **[59]**. These findings conform to some of the other previously mentioned studies on dockless bike-sharing which have found that dockless bike-sharing is primarily used for short-distance commuter travel **[16] [17]**.

$$\frac{15.5\ \mathrm{KM/HR}}{2} = 7.75\ {}^{\mathrm{KM}}/_{30\ \mathrm{MIN}} \times 1000\ \mathrm{M} =$$

$$\textbf{An Average Distance of } 7,750 \textbf{ Meters per 30 Minute Bicyle Trip} \qquad (5.2)$$

When the .003% of trips that are above 6,000 meters are considered, it is realized that the revenue from these users does not affect the Average Revenue Per Rental.

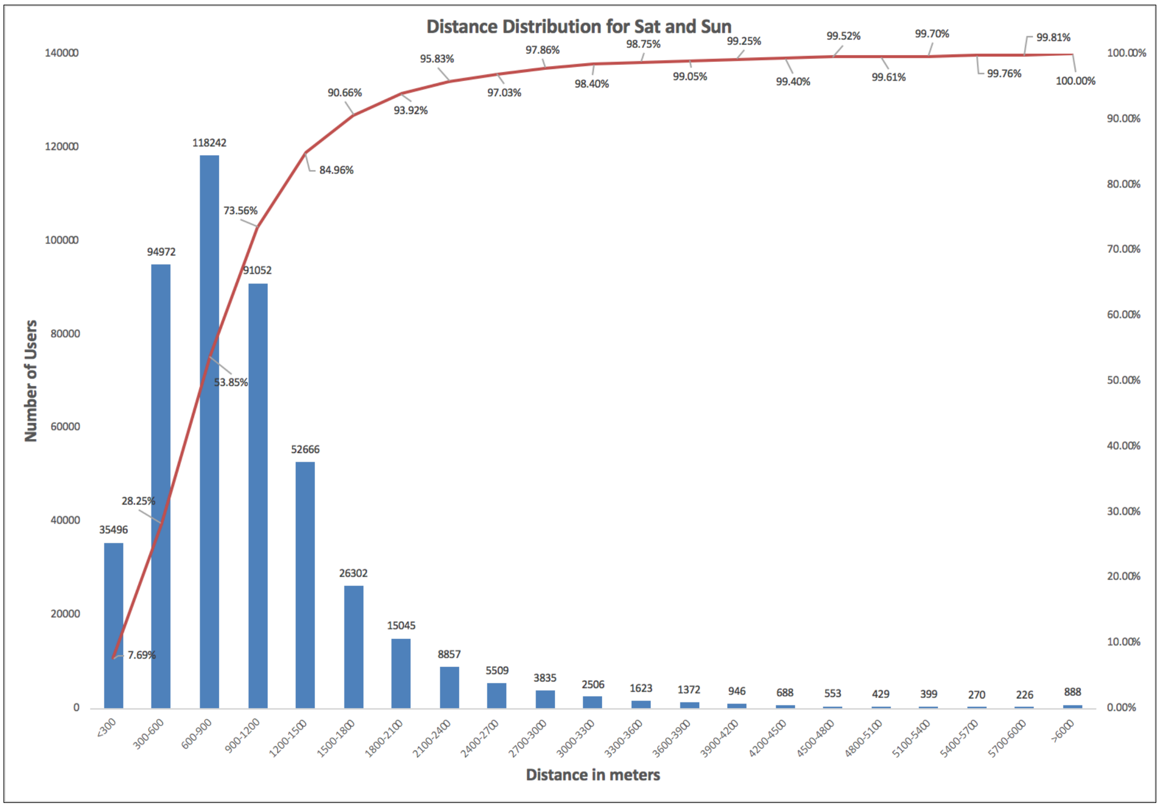

Figure 5.8 User trip distance distribution for Saturday and Sunday.

Source: Mobike Unpublished Raw Data (2017, May, 10-16)

According to the figure below, Users' Average Usage is 1.66 times per day for three out of the top four days with the highest number of individual users. When considering this figure, along with the .5 Users' Average Usage per Dockless Bicycle, it is clear that Mobike's redistribution operations in Beijing are not efficient. Even if the current number of dockless bicycles in Mobike's Beijing fleet where to be aligned with the Users' Average Usage in

Beijing, the operation would most likely be unprofitable. This is demonstrated when recalling that a Users' Average Usage per Dockless Bicycle of 2.15 times, as well as a Current Average Price Per Rental of ¥.81 yield a Break-Even Price of around 2.2 times the current price per rental when entered into the break-even equation.

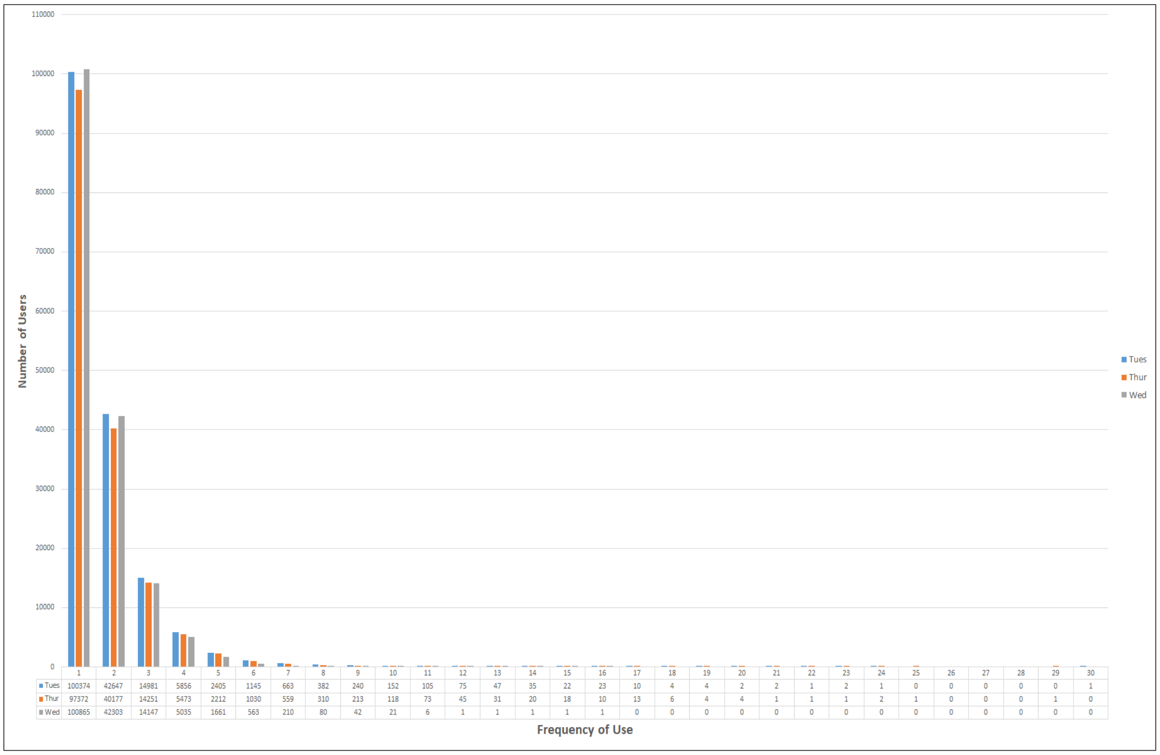

Figure 5.9 Frequency of use by number of users for Tuesday, Wednesday, and Thursday.

Source: Mobike Unpublished Raw Data (2017, May, 10-16)

CHAPTER 6
SUPPLY AND DEMAND OF SHARED BICYLES

From the previous case study, it is evident that Mobike's operations in Beijing are currently not efficient, and most likely a source of Mobike's lack of profitability as a whole. Also, if at least 16% of Mobike's dockless bicycles in the company's Beijing fleet are staying idle during a week in an ideal month for bicycling in the city, then it is feasible that the Beijing fleet size can be reduced. However, the question arises of, "What is the correct fleet size for Mobike to reduce the company's Beijing fleet to"? Unfortunately, a correct fleet size cannot be determined for Mobike's Beijing fleet considering the data available is only for one week. However, considering that more information is available for Mobike as a whole, a business model can be created and it can be utilized to provide a reasonable estimate of a correct fleet size for the entire company.

6.1 Strategy and Solutions

In order to provide an estimate of a profitable fleet size Users' Average Usage per Month must be known. This is because Mobike is a seasonal business, so Users' Average Usage will almost certainly change based on the given season. A year is determined as a reasonable estimate of profitability as it encompasses a full range of seasons. This necessity in terms of determining a profitable fleet size is exemplified in Figure 3.5 which has been re-utilized below, where the high variability of daily rides for each month can be visualized.

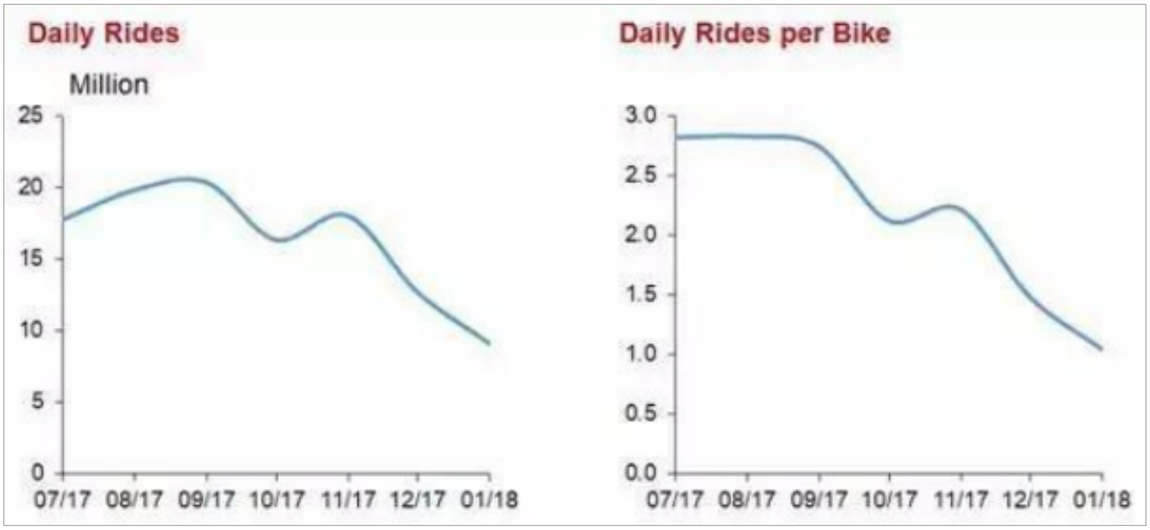

Figure 3.5 Mobike's daily rides and daily rides per bike for 07/17-01/18.

Source: Blue Whale TMT (2018, 04, 02), Figure 3

An Average User Usage per Month of 2.15 can be computed for July 2017 to January 2018 based on the figure above in order to attain a more accurate depiction of Mobike's current profitability through entering this measurement into the business model. The calculation utilized to obtain this measurement is as follows:

$$\frac{((07/17)\ 2.8 + (08/17)\ 2.8 + (09/17)\ 2.7 + (10/17)\ 2 + (11/17)\ 2.3 + (12/17)\ 1.5 + (1/18)\ 1)}{7} = \mathbf{2.15} \quad \textbf{(6.1)}$$

The first step in determining a profitable fleet size is finding the number of dockless bicycles in Mobike's fleet for each month available in Figure 3.5 above utilizing the equation below.

$$\frac{\textit{Daily Rides (Million) for the Month}}{\textit{Daily Rides per Bike for the Month}} = \textbf{The Number of Dockless Bicycles in Mobike's Fleet for that Month} \quad \textbf{(6.2)}$$

Once the number of dockless bicycles in Mobike's fleet for all available months are found, each of those individual fleet sizes can be entered into the Mobike business model below in order to test for the Users' Average Usage per Dockless Bicycle needed in order to make a profit with that given fleet size; or to make a specific profit amount with that given fleet size. Each profitable Users' Average Usage per Dockless Bicycle for each available month can then be re-entered into the same equation as it is depicted below in order to find the optimal number of dockless bicycles for that month.

$$\frac{\textit{Daily Rides (Million) for the Month}}{\textit{Profitable Daily Rides per Bike for the Month}} = \textbf{The Necessary Number of Dockless Bicycles in Mobike's Fleet for that Month to be Profitable} \quad \textbf{(6.3)}$$

In order to determine a profitable fleet size for the entire year, a fleet size for a profitable Users Average Usage per month that is higher than at least 6 of the 12 months will need to be selected: so as to ensure profitability for the majority of the 12 months. Since the other 5 months are not available in order to select the month with the 7th highest profitable Users Average Usage per Month, the best possible estimate of a profitable fleet size for the year can be provided through utilizing an average of the optimal number of dockless bicycles for the available months. The results of these calculations for the figures available for Mobike are shown in table below. This method does not consider the possibility that some users might not be able to locate a dockless bicycle given the reduced fleet size, which could lower the Users' Average Usage per Dockless Bicycle. However, when the other 5 months are incorporated it can provide the fleet size that would be necessary for Mobike to both be able to both fully cover the company's costs, and produce a profit through exclusively adjusting fleet size; assuming that Users' Average Usage per Dockless Bicycle would not be affected. Once combined with testing considering the ability of users to locate dockless bicycles given a reduced fleet size, it would be clear as to whether or not Mobike would have to make changes elsewhere in order to produce a profit. In its current state, the procedure establishes an idea of the amount by which Mobike would have to reduce the company fleet in order to produce a profit; and that is by a large amount of dockless bicycles. The profitable Users' Average Usage per Dockless Bicycle for the year is estimated at around 4.7 times, and in order to be profitable solely through a fleet size reduction, the projection is that Mobike would have to reduce its fleet size from the current 7,649,401 average dockless bicycles by an estimated 54.96% to around 3,445,266 dockless bicycles for the year.

Table 6.1 The Estimated Fleet Size Necessary for Mobike to make a profit of Around ¥1,000,000

Date	**Average Daily Rides per Day by Month**	**Profitable Average Usage per Dockless Bicycle (Monthly)**	**Optimal Number of Dockless Bicycles**	**Real Number of Dockless Bicycles**	**Variance Between Real and Optimal Number of Dockless Bicycles**
7/17	18,000,000	5.6352	3,194,208	6,315,700	-3,121,492
8/17	19,000,000	5.0717	3,746,278	7,017,500	-3,271,222
9/17	20,000,000	4.8047	4,162,591	7,407,407	-3,244,816
10/17	17,000,000	4.646	3,659,062	7,660,400	-4,001,338
11/17	18,000,000	4.3697	4,119,276	8,144,800	-4,025,524
12/17	13,000,000	4.2709	3,043,855	8,333,333	-5,289,478
1/18	9,000,000	4.1066	2,191,594	8,666,667	-6,475,073
2/18	-	-	-	-	-
3/18	-	-	-	-	-
4/18	-	-	-	-	-
5/18	-	-	-	-	-
6/18	-	-	-	-	-
Total	**-**	**32.90**	**24,116,863**	**53,545,807**	**-29,428,944**
Average	**-**	**4.70**	**3,445,266**	**7,649,401**	**-4,204,135**
		Reduce Fleet by =	54.96%		
		To =	3,445,266		

Sources: Blue Whale TMT (2018, August, 02), figures 2 and 3, Chen, Lin (2017), Griffith, E. (2017, October 11), P. 3, Mobike (2017, January, 23), Trading Economics in China (2018)

6.1.1 Costs of Mobike

In addition to the Cost per Dockless Bicycle, the Average Number of Dockless Bicycles, and the Average User Usage per Month, each cost type utilized in the Mobike business model was derived from Mobike's Profit/Loss Statement for December 2017, which was previously depicted on page 19. Each of these are reflected in the table below, and all of them except for operation and maintenance, as well as depreciation costs were multiplied by twelve months to account for the entire year. Although they are dependent upon the number of dockless bicycles in Mobike's fleet, the company's compensation and benefits as well as other costs cannot be estimated for each individual month. This is because the difference in employee salary based on each position type, as well as the number of each position type as a result of the number of dockless bicycles is not known. The insurance cost per dockless bicycle, the interest rate on each company loan, and the costs of disposing of Mobike's assets is also not accessible. Mobike's operation and maintenance costs have been estimated utilizing the operation and maintenance cost for the month of December provided on Mobike's Profit/Loss Statement for December 2017, which was previously depicted on page 19. The real numbers of dockless bicycles for each accessible month as previously seen on page 46 have also been used in the following calculations: in order to find an estimated yearly operation and maintenance cost for Mobike. The calculations utilized to find this figure are as follows:

$$\frac{\textbf{Mobike's Operation and Maintenance Costs in December}}{\textbf{The Estimated Number of Dockless Bicycles in Mobike's Fleet in December}} = \textbf{The Estimated Operation and Maintenance Cost per Dockless Bicycle} \quad \textbf{(6.4)}$$

Utilizing Mobike's figures in the above equation derives the following result:

$$\frac{\yen 283,000,000}{8,333,333} = \textbf{An Operation and Maintenance Cost of } \yen 33.96 \textbf{ per Dockless Bicycle}$$

Next, the following calculation was employed for each month with an obtainable estimate of the real number of dockless bicycles in Mobike's fleet for that month:

The Estimated Operation and Maintenance Cost per Dockless Bicycle ×

The Real Number of Dockless Bicycles in Mobike's Fleet for that Month (6.5)

= The Operation and Maintenance Cost for that Month

The average of all of the operation and maintenance costs for each month with an obtainable estimate of the real number of dockless bicycles was then utilized as the operation and maintenance costs for the months where this figure was not obtainable. Each operation and maintenance cost for all months was then totaled to find the estimated operation and maintenance cost for the year. The results of these calculations can be seen in the table below.

Table 6.2 Mobike's Estimated Operation and Maintenance Costs for each month and the Year (In 2017)

Date	Real Number of Bikes	Operation and Maintenance Cost per Month
7/17	6,315,700	¥214,481,180.58
8/17	7,017,500	¥238,314,309.53
9/17	7,407,407	¥251,555,551.78
10/17	7,660,400	¥260,147,194.41
11/17	8,144,800	¥276,597,419.06
12/17	8,333,333	¥283,000,000.00
1/18	8,666,667	¥294,320,023.09
Average	-	**¥259,773,668.35**
-	-	-
2/18	-	¥259,773,668.35
3/18	-	¥259,773,668.35
4/18	-	¥259,773,668.35
5/18	-	¥259,773,668.35
6/18	-	¥259,773,668.35
Yearly Total	-	**¥3,117,284,020.21**

Sources: Blue Whale TMT (2018, August,02), figures 2 and 3

Mobike’s depreciation costs have been estimated utilizing the depreciation cost for the month of December provided on Mobike’s Profit/Loss Statement for December 2017, which was previously depicted on page 19. Mobike’s dockless bicycle depreciation rate for each usable year was not available: so, the procedure used to calculate this cost type is the same as that utilized to calculate Mobike’s estimated yearly operation and maintenance cost. The calculations utilized to estimate Mobike’s yearly depreciation cost are as follows:

$$\frac{\textbf{Mobike's Depreciation Costs in December}}{\textbf{The Estimated Number of Dockless Bicycles in Mobike's Fleet in December}} = \textbf{The Estimated Depreciation Cost per Dockless Bicycle} \qquad \textbf{(6.6)}$$

Utilizing Mobike’s figures in the above equation derives the following result:

$$\frac{\text{¥}\mathbf{282,000,000}}{\mathbf{8,333,333}} = \textbf{A Depreciation Cost of } \text{¥}\mathbf{33.84} \textbf{ per Dockless Bicycle}$$

Next, the following calculation was employed for each month with an obtainable estimate for the real number of dockless bicycles in Mobike’s fleet for that month:

$$\textbf{The Estimated Depreciation Cost per Dockless Bicycle} \times \textbf{The Real Number of Dockless Bicycles in Mobike's Fleet for that Month} = \textbf{The Depreciation Cost for the Month} \qquad \textbf{(6.7)}$$

The results of all of these calculations can be seen in the table below.

Table 6.3 Mobike's Estimated Depreciation Costs for each month and the Year (In 2017)

Date	Real Number of Bikes	Depreciation Cost per Month
7/17	6,315,700	¥213,723,296.55
8/17	7,017,500	¥237,472,209.50
9/17	7,407,407	¥250,666,662.91
10/17	7,660,400	¥259,227,946.37
11/17	8,144,800	¥275,620,043.02
12/17	8,333,333	¥282,000,000.00
1/18	8,666,667	¥293,280,023.01
Average	-	¥258,855,740.19
-	-	-
2/18	-	¥258,855,740.19
3/18	-	¥258,855,740.19
4/18	-	¥258,855,740.19
5/18	-	¥258,855,740.19
6/18	-	¥258,855,740.19
Yearly Total	-	¥3,106,268,882.33

Source: Blue Whale TMT (2018, August,02), figure 2, P. 5

Table 6.4 The Estimated Yearly Costs of Mobike

	Mobike
Cost per Dockless Bicycle	¥2,000.00
Average Number of Dockless Bicycles	7,649,401
Fixed Costs	
Vandalism Cost	¥960,000,000.00
Marketing Cost	¥468,000,000.00
Advisory Cost	¥456,000,000.00
Total Fixed Cost Per Year	¥1,884,000,000.00
Variable Costs	
Operation and Maintenance Cost	¥3,117,284,020.21
Depreciation Cost	¥3,106,268,882.33
Compensation and Benefits	¥720,000,000.00
Other Costs	¥108,000,000.00
Total Variable Cost Per Year	¥7,051,552,902.54
Total Cost	¥8,935,552,902.54
Users' Average Usage per Dockless Bicycle	2.15

Sources: Blue Whale TMT (2018, April, 02), figures 3 and 4, Chen, Lin (2017), Griffith, E. (2017, October, 11), P. 3, Mobike (2017, January, 23)

The results of all of the previously mentioned calculations to estimate Mobike's current costs and related figures can be seen in the depiction from the business model created on the company above. In the figure below, the size of Mobike's operation and maintenance as well as depreciation costs in comparison to Mobike's other expenses can be better comprehended.

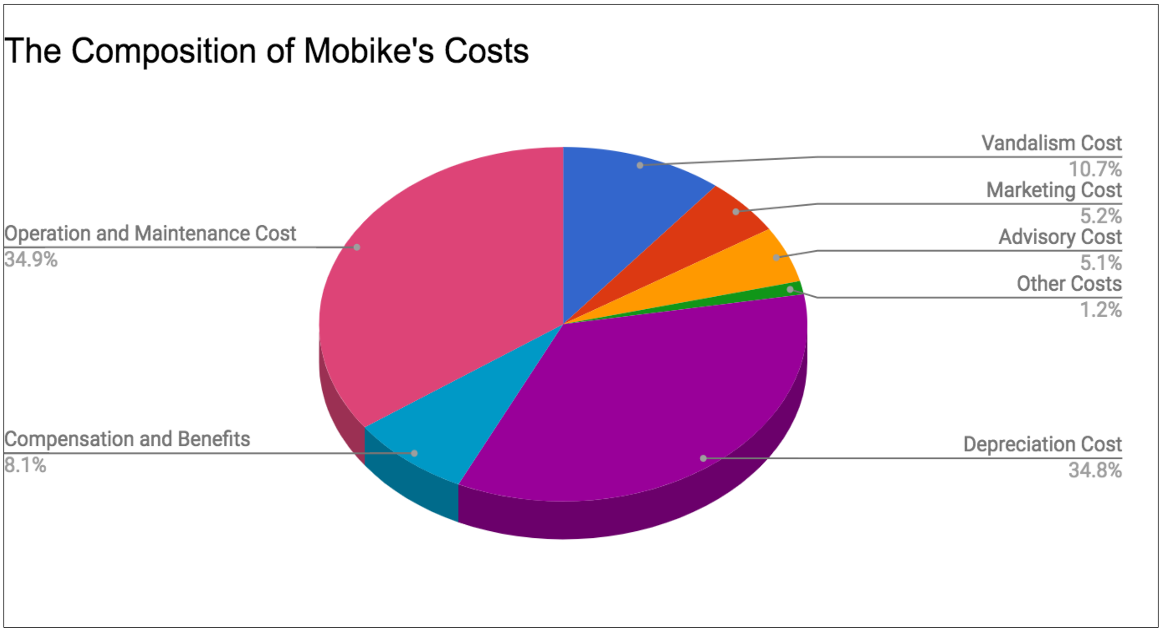

Figure 6.1 The estimated composition of Mobike's yearly costs.

Sources: Blue Whale TMT (2018, April, 02), figures 2 and 3, Chen, Lin (2017), Griffith, E. (2017, October, 11), P. 3, Mobike (2017, January, 23)

6.1.2 Revenues of Mobike

In addition to all of the previously mentioned figures related to the estimated revenues utilized in Mobike's business model, both the deposit fee per user and the effective business days considering the weather were located in a report on the company. The interest rate on invested user deposits that was utilized is the average return on a savings account in China which was multiplied by the ¥9,829,000,000 in Other liabilities (User deposits) stated on Mobike's Balance Sheet for December 2017 as can be seen in table 6.5 below, in order to derive Revenue from Interest on User Deposits. The number of active users was calculated through dividing the Other liabilities (User deposits) by the ¥299 per user deposit.

Table 6.5 Mobike's Balance Sheet on December 2017 (In Yuan)

Mobike Balance Sheet (Dec 2017)	
RMB in Million	**201712**
Total current assets	**4497**
Cash	3752
Accounts receivable	147
Prepayment	105
Inventory	493
Total non-current assets	**8503**
Total Current liabilities	**10367**
Short-term borrowings	511
Account payables	1001
Deferred Revenue (User prepaid)	623
Other liabilities (User deposits)	9829
Payroll payable	40
Taxes payable	-1637
Total long-term liabilties	**799**
Total shareholders' (deficit)/equity	**1834**
Total Net Cash (Cash-STB-AP-OL-LTB)	**-8388**

Source: Blue Whale TMT (2018, 04, 02), Figure 1

Mobike's monthly and yearly members are not reflected in the business model as the number of each of these user types is not known. The calculation used to calculate Mobike's Revenue from Operations is as follows:

$$\textbf{The Average Revenue per Usage Fee} \times \textbf{The Average Number of Dockless Bicycles} \times \textbf{Effective Business Days (Considering the Weather)} \times \quad (6.8)$$

Users' Average Usage per Dockless Bicycle = Revenue from Operations

Mobike's estimated Revenue from Advertising was calculated utilizing the previously mentioned cost-per-thousand advertising pricing method. It cannot be confirmed as to whether or not Mobike uses this pricing method, the pay-per-click advertising pricing method, or a combination of both pricing methods. However, in order to provide the best estimate of Mobike's Revenue from Advertising possible, this advertisement pricing method needed to be used. The Daily Rides Per Month were averaged and that average was utilized as the Daily Rides for each month that this figure was not obtainable for. The Daily Rides per 1,000 People was then multiplied by the previously mentioned ¥120 per 1,000 people, times six. Six advertisements were utilized in the calculation, because this is how many could be visualized on Mobike's mobile application as of November 2018. These open-screen dynamic advertisements are pictured in the figure below. The results of the calculations in order to derive the Yearly Revenue from Advertising can also be seen in the table below.

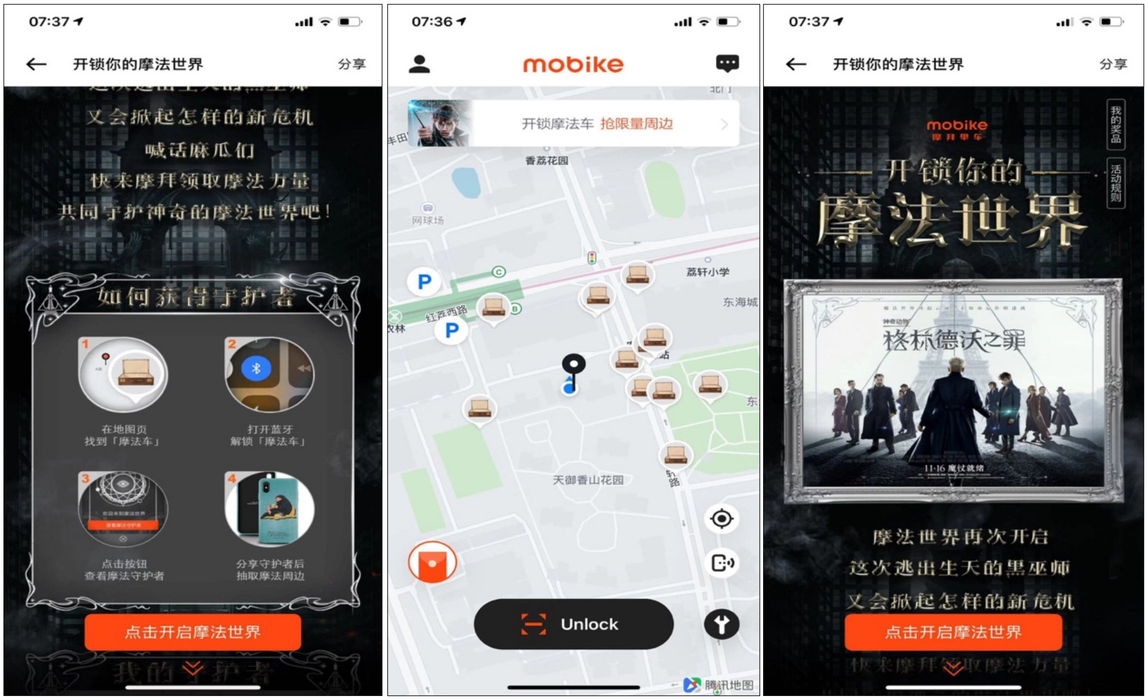

Figure 6.2 Mobike's open-screen dynamic advertisements as of November 2018.

Source: Mobike's Mobile Application (2018, November, 23)

Table 6.6 Mobike's Estimated Revenue from Advertising for each month and the Year (In 2017)

Date	Daily Rides Per Month	Daily Rides/1000 People	Revenue from Advertising
7/17	18,000,000	18,000	¥12,960,000.00
8/17	19,000,000	19,000	¥13,680,000.00
9/17	20,000,000	20,000	¥14,400,000.00
10/17	17,000,000	17,000	¥12,240,000.00
11/17	18,000,000	18,000	¥12,960,000.00
12/17	13,000,000	13,000	¥9,360,000.00
1/18	9,000,000	9,000	¥6,480,000.00
Average	**16,285,714**	-	-
-	-	-	-
2/18	-	16,286	¥11,725,714.29
3/18	-	16,286	¥11,725,714.29
4/18	-	16,286	¥11,725,714.29
5/18	-	16,286	¥11,725,714.29
6/18	-	16,286	¥11,725,714.29
Yearly Total	-	-	**¥140,708,571.43**

Sources: Blue Whale TMT (2018, April, 02), figures 2 and 3, Zhang, Dan (2018, May, 30)

Table 6.7 The Estimated Yearly Revenue and Profit of Mobike Based on Users' Average Usage per Dockless Bicycle

	Mobike
Deposit Fee Per User	¥299.00
Average Revenue per Usage Fee	¥0.81
Average Number of Dockless Bicycles	7,649,401
Effective Business Days (Considering the Weather)	300
Interest Rate on Invested User Deposits	1.50%
Active Users	32,872,910
Users' Average Usage per Dockless Bicycle	2.15
Operating Revenue	
Revenue from Advertising	¥140,708,571.43
Revenue from Operations	¥3,996,429,552.45
Total Estimated Operating Revenue Per Year (Without Offering User Memberships)	¥4,137,138,123.88
Non-Operating Revenue	
Revenue from Interest on User Deposits	¥147,435,000.00
Total Revenue Per Year	**¥4,284,573,123.88**
Profit	**-¥4,650,979,778.66**

Sources: Blue Whale TMT (2018, August, 02), figures 1, 2, and 3, Chen, Lin (2017), Griffith, E. (2017, October 11), P. 3, Mobike (2017, January, 23), Trading Economics in China (2018), Mobike's Mobile Application (2018, November, 23), Zhang, Dan (2018, May, 30)

The results of all of the previously mentioned calculations to estimate Mobike's current revenues, profit, and related figures can be seen in the depiction from the business model created on the company above. It can be clearly seen that Mobike is currently generating a large loss. In the first figure below, the size of Mobike's revenues from operations in comparison to Mobike's other sources of revenue can be better comprehended. Also, in the second figure below, the revenues and profit at the current 2.15 Users' Average Usage per Dockless Bicycle in comparison to those at a 4.6527 Users' Average Usage per Dockless Bicycle needed to generate a profit of around ¥1,050,100.84 can be seen.

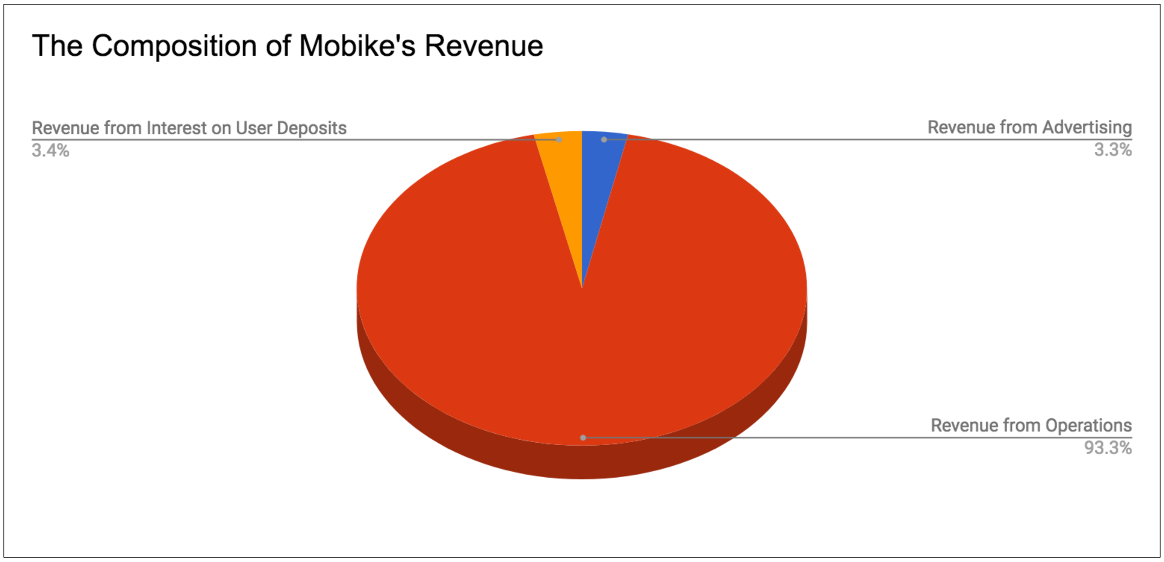

Figure 6.3 The estimated composition of Mobike's yearly revenue based on users' average usage per dockless bicycle.

Sources: Blue Whale TMT (2018, August, 02), figures 1, 2, and 3, Chen, Lin (2017), Griffith, E. (2017, October 11), P. 3, Mobike (2017, January, 23), Trading Economics in China (2018), Mobike's Mobile Application (2018, November, 23), Zhang, Dan (2018, May, 30)

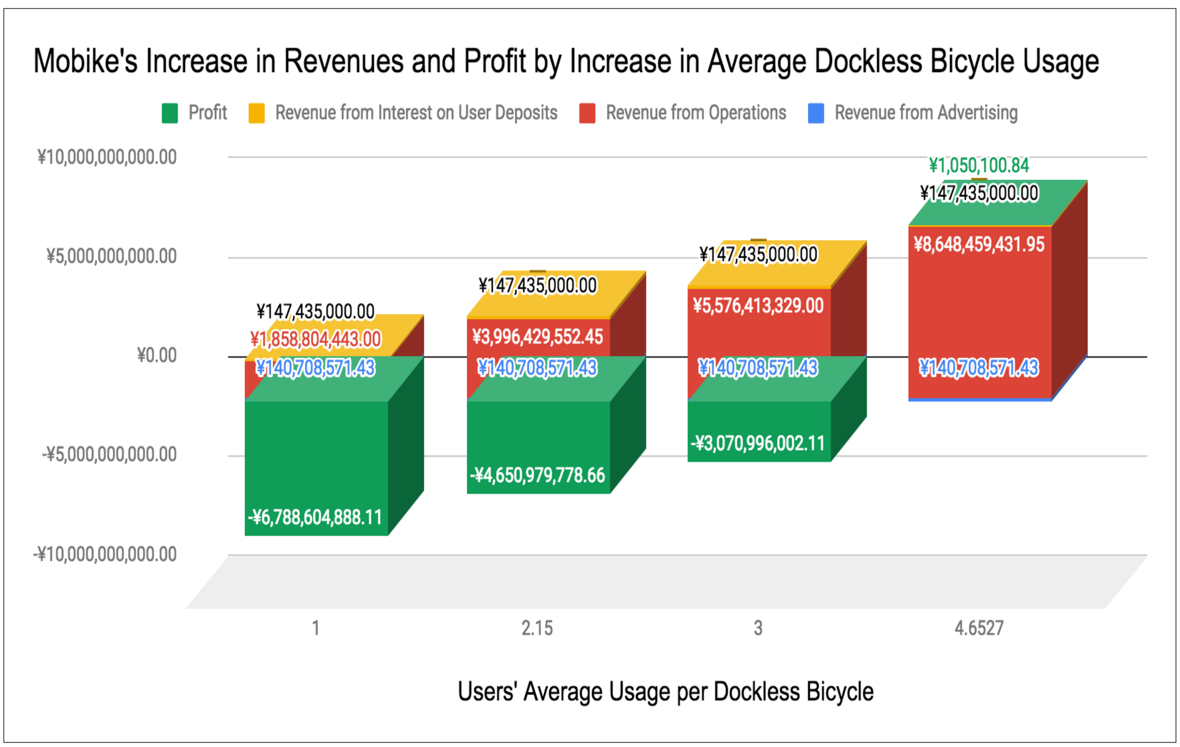

Figure 6.4 Mobike's increase in revenues and profit by increase in average dockless bicycle usage.

Sources: Blue Whale TMT (2018, August, 02), figures 1, 2, and 3, Chen, Lin (2017), Griffith, E. (2017, October 11), P. 3, Mobike (2017, January, 23), Trading Economics in China (2018), Mobike's Mobile Application (2018, November, 23), Zhang, Dan (2018, May, 30)

6.2 City Regulations

In considering the excessive levels of dockless bicycles in Mobike's fleet, many questions arise. How did the dockless bike-share industry get to this state? What can dockless bike-share providers do from this time going forward in order to sustain in the long-term? Is it feasible that this is solely Mobike's current state of operations, and not a representation of the industry in China as a whole? Many cities have begun to enforce restrictions on the number of dockless bicycles allowed to operate, demonstrating that Mobike's current state of operations is in fact a representation of the dockless bike-sharing industry as a whole. In order to further substantiate and identify the extent of the problem, population size can be utilized as a basis in order to estimate the total bike-share capacity of a city, as population is correlated with travel demand. This bike-share capacity of a given city can then be compared to the current supply of bike-sharing bicycles in that city to see the current level of overcapacity. Hangzhou was the first city to set up a bike-share monitoring platform in China, and in 2018 the Hangzhou City Government confirmed that the number of dockless bike-sharing bicycles had met capacity. At that time, the Hangzhou City Government forbid all dockless bike-sharing firms from launching more dockless bicycles, and set the goal of reducing the current number of both regular and dockless bike-sharing bicycles in the city from 770,000 to 500,000 **[11]**. The population of Hangzhou City was 9,468,000 in 2017, so by dividing the reduction goal of 500,000 bike-sharing bicycles by the population, a capacity ratio of .0528 can be derived **[61]**.

At the start of 2018 the City of Xiamen also brought forward plans to reduce the total number of both regular and dockless bike-sharing bicycles from 400,000 to 150,000 **[11]**.

The population of the City of Xiamen was 3,590,000 in 2018, so by dividing the reduction goal of 150,000 bike-sharing bicycles by the population, the capacity ratio of .0418 can be derived; similar to that of Hangzhou City **[62]**. These two capacity ratio estimates provide a range of .0418-.0528. This range can be further expanded when considering that in the prior year, around September 2017, Chinese state media reported that the number of shared bicycles in the city of Wuhan's urban districts was approaching 700,000; far exceeding the city's capacity of 400,000 **[63]**. As of the latest population estimate of Wuhan, in 2015 the population of the city was 10,061,000 **[64]**. By dividing the Wuhan bike-sharing bicycle capacity of 400,000 by the previously stated population estimate, the estimated capacity ratio range is extended to .0398-.0528. In September of 2017, four months after the week-long data sample of Mobike’s operations utilized in the case study of dockless bike-share in Beijing took place, the government of Beijing announced plans to reduce the number of bike-sharing bicycles in the city **[63]**. Representatives familiar with the issue of Beijing bike-share overcapacity from the Beijing Municipal Commission of Transport confirmed that as of the end of April 2017, 50% of shared bicycles Beijing, around 1,175,000, are being left unused **[65]**. Although the Beijing Municipal Commission of Transport’s current ideal number of bike-sharing bicycles for Beijing is not known, the around 1,175,000 bike-sharing bicycles that are being left unused as of the end of April 2017 is only 27,709 bike-sharing bicycles above previously stated capacity range results for Beijing, as can be seen in the table below. This factor further confirms the general accuracy of the previously stated capacity range at this time. When this capacity range is multiplied by the population of four major bike-sharing Chinese cities in the table below, the current number of both dockless and non-dockless bike-sharing bicycles can be seen to have already exceeded capacity by excessive amounts in all four cities.

Table 6.8 The Estimated Current Bike-Share Capacity and Levels of Overcapacity in Four Major Bike-Sharing Cities in China

City	Population (As of 2017)	Supply of Bike-Sharing Bicycles in November 2017	Estimated Bike-Share Capacity of City (.0398-.0528 × the Population Size)	Percent Overcapacity
Beijing	21,729,000	2,350,000	864,814-1,147,291	104.83%-171.73%
Shanghai	24,152,700	1,710,000	961,278-1,275,263	34.09%-77.89%
Guangzhou	14,043,500	800,000	558,931-741,496	7.89%-43.13%
Shenzhen	11,908,400	890,000	473,954-628,764	41.55%-87.78%

Sources: Google (2018), National Bureau of Statistics of the People's Republic of China (2017), BBC News (2017, September 08), Zhong, Dan (2018, February, 9)

6.3 Increasing Supplies of Dockless Bicycles

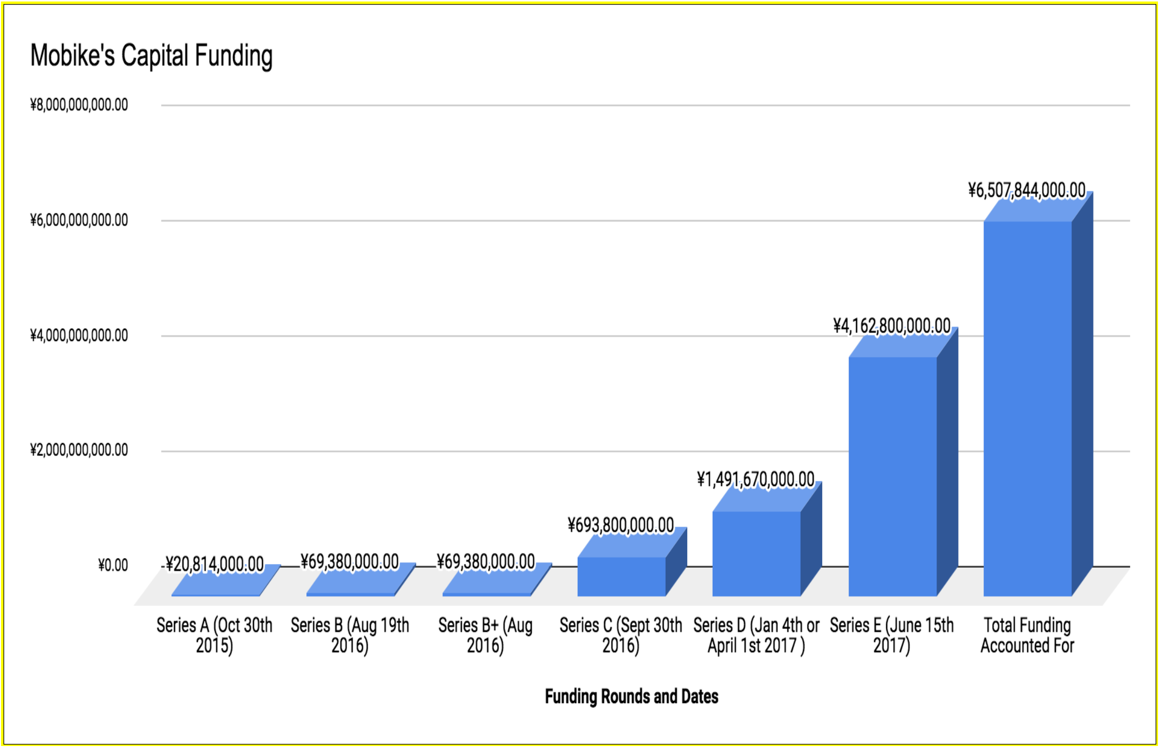

Figure 6.5 Mobike's capital funding.

Source: Mobike Company Website (2018), *Dr. Nedopil, Christoph et al (2018, August, 03) P. 1*,

So how did the Chinese dockless bike-share industry get to its current state? In addition to a lack of restrictions on the number of bike-sharing bicycles allowed to operate in Chinese cities, Mobike's capital funding as can be seen in the figure above parallels the increasing Chinese bike-sharing supply given the introduction of dockless bike-share into the market, as can be seen in figure below. In further validation of the implication that high levels of capital funding have contributed to the oversupply of bike-sharing and moreover dockless bicycles into the market, it can again be noted that both Mobike and the company's competitor Ofo account for 95% of the dockless bike-share market **[36]**. Given this fact it can be determined that high levels of capital funding have in fact contributed to the problem of an oversupply of dockless bicycles.

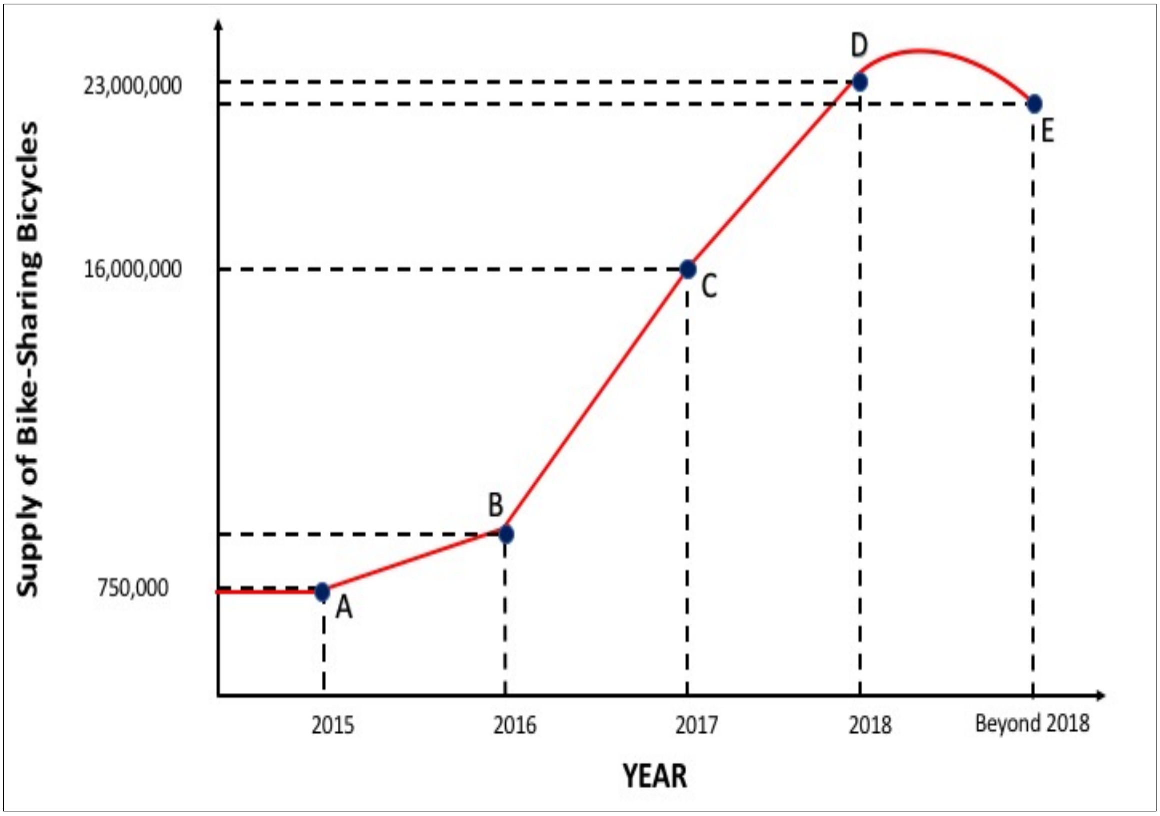

Figure 6.6 The change in Chinese bike-sharing supply given the introduction of dockless bike-share into the market.

Source: Goodyear, Sarah (2018), The Economist, (2017, November, 25) (2017, September, 07) P.3, S. (2018, Feb, 9) P. 24, *Dr. Nedopil, Christoph et al (2018, August, 03) P. 2 and 9*

The figure above portrays the supply of bike-sharing bicycles in China.

A. Before 2016, the total number of bike-sharing bicycles grew steadily from 429,969 in 2014, to around 750,000 in 2015 **[69]**;

B. By 2016, privately owned dockless bike-sharing companies entered the market in substantial numbers. The growth of the market took place mainly in 1st and 2nd tier cities during this time period **[1]**;

C. By the end of 2016 and beginning of 2017 the dockless bike-sharing industry and total number of bike-sharing bicycles grew rapidly due to high venture capital investment in dockless bike-sharing companies, and unestablished industry regulations **[1]**;

D. By the end of 2017 to the beginning of 2018, it can be clearly seen that the growth rate had reached a disequilibrium, and total industry supply exceeded user demand, which can be determined by the significant percentage of failing companies within the past year and large losses of currently operating companies. **[11] [12] [36]**. (Current situation.);

E. From 2018 and beyond, it is presumed that the Chinese bike-sharing industry may continue to expand due to increased entry into tier 3 and 4 cities. However, as government regulations continue to be put into place including cities establishing limits on the number of dockless bicycles permitted to operate, more unprofitable companies leave the industry or reduce fleet size, bike-sharing company production capacity is reduced, and as dockless bike-share funding decreases, the Chinese bike-sharing bicycle supply will eventually decrease and better align with real user demand for both regular and dockless bike-sharing **[1] [36]**. In consideration of this, the dockless bike-sharing industry is presumed to be a market bubble.

CHAPTER 7

POLICY IMPLICATIONS

So, what can dockless bike-share providers do from this time going forward in order to be sustainable in the long-term, and what can government transportation agencies do to support the sustainable long-term growth of the dockless bike-sharing industry? In addition to building upon the previously demonstrated strategies and solutions for managing dockless bicycle fleet size, the following potential solutions to the identified long-term sustainability issues, and policy implications for both dockless bike-share providers and government transportation agencies can be deduced from the findings in support of an effective profit model.

7.1 Dockless Bike-Sharing Provider Considerations

A recommended policy approach regarding sustainability for dockless bike-sharing entities is one which attempts to utilize all potential revenue sources, and reduce all controllable impediments to long-term growth. As previously stated, considering that Mobike encompasses the large majority of the Chinese dockless bike-share market, and a near totality of the Chinese dockless bike-share market when considered along with the company's competitor named Ofo, the company serves as one of the best representations of the actualities of dockless bike-sharing companies available **[71] [11]**. Also, as previously revealed, the entire dockless bike-share industry experiences similar issues such as an imbalance between supply and demand. Therefore, it is recommended that other dockless bike-share providers follow the recommendations presented utilizing Mobike as an example as follows. Pursuing all potential revenue sources is believed to be necessary in regards to profitability since the prospect of Mobike reducing the company's fleet size from the current 7,649,401 dockless bicycles by an estimated 54.96% to around 3,445,266 dockless bicycles without having an effect on users' ability to locate the company's dockless bicycles in a reasonable amount of time is highly unlikely. It is recommended that Mobike first pursue the prospect of reducing fleet size since there is clear evidence that the company's current fleet size can be reduced to some extent, and problems in relation to having an oversized fleet can be been seen to have a direct negative impact on long-term growth prospects **[36] [70]**. However, in order to reduce the company's fleet size appropriately, Mobike would first need to create a fleet elasticity model in order to test the sensitivity of Users' Average Usage per Dockless Bicycle to adjustments in fleet size. It is also recommended that Mobike pursue the opportunity to produce revenue from dockless bicycle frame advertisements as this opportunity has the largest impact on the break-even price out of the key factors impacting profitability, and it currently serves as a source of revenue for Mobike's largest competitor Ofo. It is also recommended that Mobike investigate or re-investigate the possibility of raising the company's usage fees through testing the sensitivity of a significant sample of dockless bike-sharing users to price increases with a price elasticity model.

7.2 Governmental Policy Considerations

A recommended policy approach regarding support for the sustainability of dockless bike-share entities that can be adopted by a transportation agency or organization as a statement of policy to be implemented is one which assists in guiding the growth of the dockless bike-share industry in a sustainable direction. Some recommended actions that can be taken in order to ensure the effectiveness of the approach stated above include, developing legislation requiring city governments in tier 1 and 2 cities to establish restrictions on the number of dockless bicycles allowed to operate in order to reduce the negative effects of overcapacity including high levels of illegal parking and sidewalk congestion, as well as to allow the currently high levels of capital funding to drive the expansion of dockless bike-sharing into tier 3 and 4 cities: where there is still room to realize the beneficial aspects of this sustainable transportation mode.

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