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Online Customer Satisfaction about Sharing Bike Market in China

LI CHEN

Master in Marketing

Supervisor: Helena Maria Correia Neves Cordeiro Rodrigues,
Marketing, Operations and General Management Department
ISCTE Business School.

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Acknowledgements

The final dissertation has been through more than one year, from the decision of the theme to collect the data to the final, it is a long process. Especially in 2020, everyone in the world faces a huge difficulty. The COVID-19 seems to change our life. We cannot have a party, cannot hang out with friends, even we are afraid of being outside, but I believe we will overcome the virus hands in hands eventually. So first, I would like to thank you for the government, thank you for every doctor and nurse who fights in the front line, thank you for everyone who obeys the rules of epidemic prevention. Finally, we will win in this war. Therefore, my parents' support, cares, worries, and advice are so precious, keeping me strong, calm, and warm. Thanks, and love you, mom and dad. Never give me up and always encourage me.

Secondly, I want to thank my friends. I have been very grateful to meet your guys. Thanks for being with me in the joyful and challenging time. I am so lucky to learn all the best and extraordinary things from you and become a better person.

Last but most important, I appreciate that my supervisor Helena Rodrigues who is busy, spent quantities of time helping me revise the dissertation to make my dissertation go to a higher level. She is pretty kind and professional, and I am so lucky to have her as my supervisor.

All in all, I want to thank myself. Though life is hard, you are keeping trying. I know you feel frustrated and depressed most of the time, but you will get through all of it. Do not worry too much, and you will be fine, Chen.

Abstract

Sharing bike, which makes the replacement of private car travel possible, solved the “last mile” problem and changed people’s travel idea from individual ownership to sharing service. It is an environmentally friendly way of travel, which is quite popular in China. Users' satisfaction with sharing bicycles is essential in determining whether users continue to use these bicycles. The Internet is an important place for users to evaluate sharing bicycles. It is significant for developing public transportation in China to study sharing bike satisfaction by collecting online public opinion data.

This paper takes the satisfaction of sharing bicycles in China as the research object, collects the public opinion information about sharing bicycles on the Internet, and obtains the satisfaction data of sharing bicycles by using text mining. In addition, the descriptive statistical analysis and comparative study were carried out on four major brands in China (Didi, Meituan, Hello, and Ofo). It is found that Didi's satisfaction with sharing bicycles is the highest, and Ofo is the lowest. The price increase of sharing bicycles does not affect its satisfaction in most cases, and only a few cases will reduce the satisfaction.

This paper also studies the correlation between weather and sharing bicycles satisfaction using descriptive statistics, correlation analysis and factor analysis. Chengdu and Beijing were the two cities that selected to analyze the correlation between the weather conditions and sharing bikes satisfaction. In the research on the satisfaction of sharing bicycles in Beijing, it is found that there is a specific correlation between weather conditions, air temperature, and air pressure and the satisfaction. The satisfaction on sunny days is higher than that on cloudy days. In the research on the satisfaction of shared bicycles in Chengdu, it is found that the weather conditions do not affect user satisfaction of sharing bikes, and the public opinions, maximum temperature, and wind speed are related to the satisfaction.

Keywords: Sharing bikes, Customer Satisfaction, Public Opinions, Web 2.0

Resumo

Bicicletas compartilhadas, que representam uma substituição da viagem em carro privado, resolveram o problema da "última milha" e mudou meios de transporte de propriedade individual para serviço de compartilhamento. É uma forma de viajar amigável ao ambiente, bastante popular na China. A satisfação dos usuários com bicicletas compartilhadas é essencial para determinar se os usuários continuam a usar essas bicicletas. A Internet trata-se de um lugar onde os usuários avaliam bicicletas compartilhadas. É significativo para o desenvolvimento do transporte público na China estudar a satisfação com bicicletas compartilhadas por meio da coleta de dados online da opinião pública.

Esta dissertação tem como objeto de investigação a satisfação de bicicletas compartilhadas na China, coletando informações da opinião pública sobre bicicletas compartilhadas na Internet e usando mineração de texto. Além disso, a análise estatística descritiva e o estudo comparativo foram realizados em quatro grandes marcas na China (“Didi”, “Meituan”, “Hello” e “Ofo”). Verificou-se que a satisfação para a Didi é a mais alta e para Ofo é a mais baixa. O aumento do preço de bicicletas compartilhadas não afeta o nível de satisfação na sua maioria, e apenas em alguns casos reduziram a satisfação.

A dissertação também estuda a correlação entre o clima e a satisfação com bicicletas compartilhadas usando estatística descritiva, análise de correlação e análise fatorial. As cidades de Chengdu e de Pequim foram escolhidas para analisar a correlação. Na pesquisa sobre a satisfação de bicicletas compartilhadas em Pequim, verificou-se que existe uma correlação específica entre as condições meteorológicas, a temperatura do ar e a pressão do ar e a satisfação. A satisfação em dias de sol é maior do que em dias nublados. Na pesquisa em Chengdu, foi descobrido que as condições climáticas não afetam a satisfação do usuário em compartilhar bicicletas, e a opinião pública, temperatura máxima e velocidade do vento relacionam-se à satisfação.

Palavras-chave: Bicicletas compartilhadas, Satisfação dos clientes, Opiniões públicas, Web 2.0

1. Introduction

Today, the sharing economy has become one of the most popular business models for modern people. The sharing economy is a scalable socio-economic system that employs technology-enabled platforms that provide users with temporary access to tangible and intangible resources that may be crowdsourced (Eckhardt et al., 2019). According to a document, the revenue generated by the sharing economy is expected to keep at an annual growth rate of 35% until 2025 (Davies et al., 2017). The PrincewaterhouseCoopers (2016) also pointed out just within Europe, the revenues of the sharing economy are projected to grow to €80 billion by 2025 from €4 billion in 2015.

As a rental business, the appearance of sharing bikes is an innovation of the sharing economy model, allowing consumption sharing and providing temporary resource access (Yubo & Tarry, 2019). With the Internet, high technology as well as the increasing prevalence of mobile payment, dockless sharing bikes have been adopted in most cities across China and overseas and solved the "first and last mile[1]" problem efficiently (Pal & Zhang, 2017).

Statistics show that, since 2014, the number of bike-sharing programs in operation worldwide has more than doubled and exceeds 1600 as of 2018, where the total number of public-use bicycles worldwide also more than doubled to 18.2 in the same period (Bhardwaj & Gal, 2014). Generally speaking, there is a wide range of benefits on cycling as research suggests, such as preventing various diseases (e.g., diabetes and obesity) and deaths by promoting physical activities (Johanson et al., 2017; Lindsay et al., 2011; Shaheen et al., 2013; Otero et al., 2018; Huy et al., 2008; Rojas-Rueda, 2011; Woodcock et al., 2014), reducing traffic congestion by reducing car dependency to curtail greenhouse gas emissions (Fishman et al., 2013; Zhang & Mi, 2018; Johansson et al., 2017; Lindsay et al., 2011; Shaheen et al., 2013; Shaheen et al., 2013), providing alternative for car commuting (Wang & Zhou, 2017; Hamilton & Wichman, 2018), decreasing

[1] The first and last-mile problem: the challenges caused by the built and social environment and public transport service availability in the first and last trip generally exist in different worldwide cities (Tilahum et al., 2016).

noise pollution (Martens, 2007), increasing public transit use (Mont, 2004), having the lower injury and fatality outcomes compared to non-sharing environments (Woodcock et al., 2014; Fishman et al., 2016), allowing cities to function more efficiently by realizing a multifaceted sharing economy (Bullock et al., 2017; Qiu & He, 2018; Cohen & Kietzmann, 2014). For individuals, cycling is healthy, cheap, and sometimes faster than other transport modes (Jiang et al., 2016). Therefore, cycling has been recognized and extended by the Chinese government.

Since users can access a bike, use it, and leave it practically anywhere, they choose, nearly without penalty, sharing bikes is greater in popularity (Merlyn et al., 2019). In China, Ofo, once was the country's first dockless bicycle-sharing company, had grown into a $2 billion business (Sino Finance, 2018). Along with Mobike, the main competitor of Ofo, these companies operate in 21 countries and 250 cities across China, Singapore, Italy, Japan, the U.K., and the U.S (Campbell, 2018), offering 50 million rides per day (Lamer. 2017). The Chinese government regards sharing bikes as one of China's "great new inventions" (Lamer, 2017), which provides these enterprises with multiple benefits, including tax breaks (Campbell, 2018; Larmer, 2017), resulting in a significant increase in sharing bike industry in a short period. For instance, including Ofo and Mobike, over 70 sharing bike companies, supported by over $1 billion in financing (Hernández, 2017), make 12 million sharing bicycles available to the Chinese market (Lipton, 2017). In 2018, Beijing had 2.4 million sharing bikes and 11 million registered users (Campbell, 2018), while, in Shanghai, there were 16 users per sharing bike in the market (Rotterdam School of Management, 2017).

However, the outcomes of sharing bikes have been barely satisfied. The random distribution of sharing bikes increases the consumption of environmental resources (Faghih-Imani et al., 2017b). Evidence shows that the "locust-like" development of sharing bicycles has led to many social issues that aggravate the environment's burden. For example, massive investment and limited distribution of bikes truly bring serious interference and pressure to urban governance (Ma et al., 2018). Over 30 sharing bike companies were operating in China. Over 16 million bikes were installed in first-tier and second-tier cities.

Moreover, dockless sharing bikes can be parked anywhere due to the shortage of legal parking and lack of regulations. In many cities, it resulted in randomly parked problems (Yu &

Shang, 017). In 2017, six companies went bankrupt because they did not obtain and maintained enough users (Yin, 2017). In 2018, Mobike was acquired by Meituan due to its debt crisis (Sina Finance, 2018) in April. In July, Ofo announced the closure of its Australian operations (Ifeng News, 2018). In August, it announced its withdrawal from the US Seattle market (Sina Finance, 2018). In September, Mobike decided to give up the Manchester market (Sina Finance, 2018). In December, Ofo fell into a bankruptcy crisis (Sina Tech, 2018).

As mentioned before, many problems have been exposed in the rapid development of sharing bikes, such as bicycle damage, difficulties in finding a bike, and failures in using bikes. The destination of bicycle deposits is unknown so far (Yu & Shang, 2017). These problems reduce users' satisfaction with sharing bikes and then affect sharing bikes' sustainable development. In this circumstance, identifying and resolving these problems can help share bike providers' competitiveness (Liang et al., 2019). Improving users' experiences as much as possible becomes an essential thought for the next stage of developing the sharing bike industry. The degree of customer satisfaction is a crucial influence on companies' profits (Feifei et al., 2018), so exploring customer satisfaction is an indispensable step to maintain vitality and competitiveness in such a highly competitive industry. Therefore, it is currently an exciting issue for researchers and practitioners to understand the factors influencing sharing bike usage (Yong et al., 2019).

Specifically, to survive in competitive environments and encounter rapid changes in market environments, such as globalization of economy and escalating expectation level of customers, corporations have to pay more and more attention to customers' needs and expectations. (Kavoosi & Saghai, 2005). However, the sharing bike industry's customer satisfaction (CS) has been rarely explored in the existing literature (Zhiying & Zuopeng, 2018).

Recent studies have somehow shown the evaluation of satisfaction with sharing bikes by survey data (Heictor et al., 2019; Yong et al., 2020). However, the survey method has disadvantages like sampling limitations, possible bias embedded (Kim et al., 2017). Therefore, this research studies from a different perspective: it applied text mining analysis to overcome the limitations of the widely-used surveys methods.

The present research’s has two main goals:

- First, to analyze online comments and reviews in the context of sharing motilities by text mining.
- The second objective consists in identify the satisfaction level for four major sharing bike brands and analyzing the relation between the satisfaction and weather variables.

We extracted online comments and reviews about sharing bikes from February 2019 to February 2020 from the Internet by using the method of text mining. Then we introduced four brands of shared bicycles in China: Didi, Meituan, Hello, and Ofo, and analyzed the satisfaction degree of the four brands by using the data of the online public opinions. Besides, we summarized the satisfaction of sharing bicycles in Beijing and Chengdu through the online public opinion data. We carried out descriptive statistics, correlation analysis, and factor analysis to study the correlation between weather and satisfaction of shared bicycles and the impact of weather on satisfaction and studied the differences in the development of shared bicycles between cities due to different environmental factors.

The study is organized as follows. It examines the literature review of the sharing economy and bike industry, customer satisfaction, and public opnions. Section 3 outlines text mining and sentimental analysis are the research methods, and the results of satisfaction level of sharing bikes are given in Section 4. Finally, the study's implications and its contribution to the knowledge in the field are described in Section 5.

2. Literature review

In this section, a literature review is given. The review presents the relevant studies that have been done covering the various facets involved in the study. For sake of clarity, we divided the review into three sub-sections. The first one is devoted to the sharing economy and the sharing bike industry. The second focuses on the user generated content and e-WOW. Finally, the web 2.0 and social media is discussed.

2.1 The Sharing Economy and the Sharing Bike Market

The sharing economy is "an economic system based on sharing underused assets or services, for free or for a fee, directly from individuals" (Botsman, 2015). After the global recession, the sharing economy reached growth and prosperity in 2008. Consumer confidence has declined, unemployment has risen, and customers' purchasing power has reduced, forcing people to cut spending and find new ways to make money (Goudin, 2016). The recession has given birth to well-known platforms such as Airbnb and Uber (Selloni, 2017).

Sharing bike, a mobility business model in the sharing economy, has become widespread across specific regions, attracting many entrepreneurial startups and established firms (Merlyn et al., 2019). Sharing bike systems, which are typically situated in commercial, business, and urban areas, attract a range of users, including students, residents, errand users, leisure users, professionals, and tourists (O'Brien et al., 2014). With 430 bike-sharing programs, China is the clear frontrunner in terms of bike sharing" (Richter, 2018). The Chinese government posits sharing bikes as one of China's "great new inventions" (Larmer,2017). Until 2018, only Beijing has 2.4 million bike-sharing bicycles and 11 million registered users (Campbell, 2018). There are 16 users per shared bicycle in the market in Shanghai (Rotterdam School of Management, 2017). So, the penetration of sharing bikes in China is very high. Within this market, two types of sharing models exist; docked and dockless. Docked consists of a central station platform for retrieving

and returning bikes; dockless, stationless, free-floating pickup and return "wherever" system. Both systems operate using smartphone apps as the mechanism through which users subscribe, find, select and pay for use (Merlyn et al., 2019).

Sharing bikes has been touted to have many positive externalities, including the creation of more cyclists (adds to daily exercise), encouraging transit use (provides access to routes not covered by public transit), decreasing greenhouse gases (minimizes exhaust emissions from automobile traffic congestion), improving public health (DeMaio, 2009), and extending the existing international connectivity (bus, train, ferry) in cities thereby adding to the transportation mobility of consumers. At present, over 700 cities are operating bike-sharing programs, which proves their perceived positive contribution to sustainable mobility. How to pursue sustainable mobility in urban areas has become a priority goal of city policies in the transport and environmental fields (Chao-Che et al., 2018). The service quality of a transportation system is a critical factor that affects people's willingness to use public transportation system rather than their own private vehicles (Liou et al., 2014). To improve service quality to attract more passengers to use public transportation is an essential concern for municipal governments around the world (Chao-Che et al., 2018). Some scholars also found that sharing bike usage is significantly determined by trip distance, temperature, precipitation, and air quality (Campbell et al, 2016).

However, sharing bike are rising question for users and providers. (Merlyn et al., 2019; Leonardo et al., 2019; Nikitas, 2019). When a user arrives at a station with no bike available, or vice-verse if they find a total station when returning the bicycle shows a bike-sharing system may lack resources (Leonardo et al., 2019). Many dockless systems; face more and significantly bigger theft, misuse, and vandalism problems than dock-based schemes, which led to many recent scheme closures and a full-scale retreat of mega-startup companies, the Chinese Ofo and Mobike from Europe (Nikitas, 2019). Users are often without helmets, as this is not an ancillary component that comes with a bike (Merlyn, 2019), as the Centers for Disease Control and Prevention (CDC) said: "Any bicyclist who does not wear a bicycle helmet is at increased risk of head injure" (CDC.gov, 2015). The safe issue also leads to insurance and liability consideration.

For instance, helmet use is not mandatory for most bike-sharing programs, which may conflict with insurance liability laws (Shaheen et al., 2010). For providers, they release amass bikes in cities and then abandon them as these companies fail to retrieve them, which in many cases create overwhelming inefficiencies and constraints on governments, residents, the social community, and the natural environment (Merlyn et al., 2019).

Regarding research on sharing bikes, Mor et al. (2017) modeled the users' quality of service in terms of their satisfaction from the system. They demonstrated the significant effect of the presence of unusable bicycles on the level of user dissatisfaction, which emphasizes the need to have accurate real-time information regarding bicycle usability. Sharon et al. (2019) believed one of the significant issues for the bike-sharing system is nonhomogeneous asymmetric demand processes. These demand processes create an inherent imbalance, thus leading to shortages when renting or returning. So, the authors focused on determining the correct target level for repositioning according to a well-defined objective. Yin et al (2016) investigated the antecedents and mechanisms of consumer's adoption of a public bicycle-sharing scheme (PBSS) as a form of shared sustainable consumption. They suggested that a desirable sustainability program needs to not only cater to consumers' cultural and psychological motivations but also reflect the social norms and social context in which sustainability practices and consumers are embedded.

2.1.1 Sharing Bike Satisfaction

Satisfaction is a psychological phenomenon, which originates from an individual emotional state, is affected by individual internal and external factors (Locke, 1967). Compared with the buyer's value expectation, customer satisfaction can indicate how good the product experience is (Razak & Shamsudin, 2019), which is the expectation perceived by customers and consumers before purchasing and experiencing products or services (Shamsudin et al., 2018). Customer satisfaction is the crucial factor affecting enterprise profits. Many researchers have developed theories and methods of customer satisfaction (Feifei et al., 2018).

In the field of transportation, public transit passengers’ satisfaction has attracted extensive attention in recent years. Several studies have been conducted in terms of user

satisfaction with sharing bikes. Kim et al. (2019) demonstrated reliability, accessibility, mobility, connectivity, and perceived value can influence customer satisfaction of sharing bikes. Lee et al. (2016) and Caulfield et al. (2017) analyzed the use patterns of public bicycles based on rental data, while Corcoran et al. (2014) studied the use patterns of public sharing bicycles and weather and calendar events in Australia. Karki and Tao (2016) reviewed the convenience and accessibility of sharing bike projects in Suzhou, China.

The above studies try to find solutions to the inherent problems of the bicycle environment and provide some physical and policy improvement suggestions. However, they found it challenging to determine various user needs in real-time because they mainly use the data collected based on the survey for statistical analysis.

2.2 Public Opinions (User Generated Content) and e-WOM

Communications to consumers have traditionally come from manufacturers or retailers, who have a vested interest in portraying their offerings positively. Not surprisingly, consumers have grown increasingly skeptical of traditional advertising (Forehand & Grier, 2003). The proliferation of information on the Internet from various sources has heightened concerns about credibility (Chung & Buhails, 2008). Earlier, Senecal and Nantel (2004) pointed out that many consumers are cynical about any form of information, which promotes the interest of information creators, so they may be more willing to rely on other consumers to obtain their evaluation of services and products. Some scholars also reckoned that non-commercial information is considered more objective and credible (Litvin et al., 2008; Chung & Buhails, 2008). As a result, data from the third party has become more valuable (Edward, 2018). Understanding user generated content (UGC) is critical for marketers because most consumers, up to 81% (Deloitte 2016), rely on UGC when making purchase decisions (Shiri et al., 2019).

User generated content comes from ordinary people who voluntarily provide data, information, or media on the Internet, such as restaurant ratings, wikis, and videos (John et al., 2008), enabling diverse opinions, experiences, and knowledge to be combined and distributed. Gupta and Kim (2004) described such websites as “coffee shops” where people can “find and

then electronically 'talk' to others with similar interests" (p.2679). Also, people "meet and discuss on forums and bulletin forms or exchange information on social networking sites" (Chung & Buhalis 2008, p.1.). The contemporary media environment's ability to promote, maintain and sustain collective endeavors among separated individuals is significant (Andrew & Miriam, 2013). In recent years, there has been a rapid growth in the use of such content, partly because of its relatively low acquisition cost (which users usually provide for no charge). For content providers, this process is worthwhile because it allows their contributions to be recognized. For consumers, in addition to providing information or entertainment, it also allows them to see accurate data from others (John et al., 2008). The potential unconstrained and experiential nature of UGC contrast with the traditional organizational data, which is often centralized and transaction-based. Organizations can use UGC to understand better their customers, competitors, products, and services, or social and political environments (Brabham 2013; Goodman & Paolacci 2017; Khatib et al. 2011; Prpić et al. 2015).

The valence (positive or negative) of UGC can drive consumer purchase behavior (Pavlou & Dimoka, 2006). Importantly, positive and negative reviews appear to have differing degrees of impact on consumer responses. While positive reviews are more prevalent (Fowler & Avila, 2009), negative reviews are better predictors of evaluations (Herr et al., 1991; Mizerski, 1982) and sales (Baruroy et al., 2003; Chevalier & Mayzlin, 2006) due to the perception of negative information as diagnostic. For example, Mizerski (1982) found that negative reviews are more likely to be credited to the product's performance, whereas positive reviews are often credited to social norm dynamics. Schweidel (2012) found that more experienced users are more likely to post more negative comments because they are more critical. Negative UGC can lead to unfavorable attitudes towards brands (Lee et al., 2008). It can negatively impact purchase intention (Christodoulides et al., 2012; Lee, 2009) and detrimentally affect sales (Corstjen & Umblijs, 2012). Not only that, negative UGC may have been more believed, as negative cues tend to be more informative than positive or neutral comments (Ahluwalia, 2002; Green & Peloza, 2014; Rim & Song, 2016).

Indeed, it is not hard to notice that with the growth of digital media and online communication, systems of rating and reviewing, and peer-to-peer mass communication between non-specialists, UGC has come to play a significant role in the travel industry (Judith & Camilla, 2016). Furthermore, through the capabilities provided by web 2.0, UGC reviews represent important narratives that enable broad sharing and are transformed into a trustworthy source of e-WOM, influencing other customers' decisions (Chu & Kim, 2011; Lange-Faria & Elliot, 2012).

Customers' buying decisions are influenced to a greater extent by the suggestions or references given by their friends and near ones than the information obtained using advertising or any other medium (Harsh, 2007). Over the last 20 years, the rapid growth of Internet usage has sparked a dramatic increase in the volume of electronic word of mouth (eWOM) (Mark &Tomoko, 2015). The term 'eWOM' describes "any positive or negative statement made by potential, actual or former consumers" outside traditional buyer-seller relations (Hennig-Thurau et al., 2004). EWOM is publicly available via the Internet and offers numerous ways to analyze, interpret, and manage consumers' influence on one another (Litvin et al., 2008), posting new challenges and possibilities for marketers. Online platforms have become the main way for people to express their opinions and search for information. People are gradually used to sharing their shopping experiences on various platforms and expressing their positive or negative emotions via words post online, whether support or against. EWOM occurs on review sites (RS) and online travel agencies (OTAs) (Sven-Olaf et al., 2019). For example, posting book and movie reviews on Douban.com, giving comments after checking out a hotel on Ctrip.com, or talking about the experience of using an electronic device on Weibo. Moreover, eWOM provides an original, unbiased data source (Schuckert et al., 2015; Zhou et al., 2014). Netizens also can get information or suggestions from many online platforms to find more referential solid opinions for their decision-making.

In terms of research on eWOM, Tong & Guo (2015) collected online reviews for restaurants and encoded phase of eWOM senders. They examined the decoding process of eWOM readers. They then found that text analysis indicators (e.g., Negations and Money) can

explain additional variance in eWOM communicator's attitudes above and beyond the star ratings and may become a promising supplement to the widely-used star ratings as indicators of eWOM valence. Chern et al. (2015) analyzed online review properties, reviewer characteristics, and review influences and understood how eWOM affects product sales. Chiang et al. (2014) used a text mining technique to analyze the movie reviews, including word of mouth (WOM) for the box office in the American film market. They provided a reference for movie producers to manipulate WOMs. He et al. (2018) emphasized customer satisfaction is mainly determined by the perceived quality of products and established a new method to evaluate the perceived quality by combining text mining with a fuzzy comprehensive evaluation method.

2.3 Web 2.0 and Social Media

Web 2.0 is the second phase of the World Wide Web (Web or WWW). This stage allows more user interaction than the first stage of the web, known as Web 1.0. Web 2.0 enables users to share information and collaborate with other interactive sites through social media (Salem Press Encyclopedia of Science, 2019).

In 2004, a brainstorming meeting was held by the American company O'Reilly Media and the Media Live international company. In this meeting, O'Reilly noticed that although many people think the Internet has a "breakdown," at the same time, many unprecedented new applications and websites were emerging unexpectedly and regularly. What's more, those companies who have initially been exempt from the Internet bubble often have something in common. The following year, Tim O'Reilly (2005) summarized the term "Web 2.0" effectively: Web 2.0 refers to a perceived second-generation of Web-based services - such as social networking sites, wikis, communication tools, and folksonomies - that emphasize online collaboration and sharing among users. It is a model that is genuinely interactive, where end-users upload as well as download. Since then, the term "Web 2.0" has gradually spread and become famous. Concurrently, Eijkman (2008), O'Reilly (2005), Freedman (2006), Hinchliffe (2006), and Anderson (2007) express Web 2.0 as 21st-century web-based social networking sites

and applications of participation and collaboration. Although the precise demarcation and description of Web 2.0 are still a little vague, it is clear that Web 2.0 is not created by business or economy but by millions of users. Web 2.0 is a participatory medium (Rolft, 2011).

In today's business world, the competitive advantage of companies mainly comes from intangible assets, especially the new technologies, such as Web 2.0 and the social. They have become vital tools for internal information and knowledge management of enterprises (Colomo-Palacios et al., 2010; Lopez-Nicolas & Soto-Acosta, 2010; Soto-Acosta, Casado-Lumbreras, & Cabezas-Isla, 2010a; Valencia- García et al., 2010), and required tools for competition and interaction with customers across many industries (Soto-Acosta & Meroño-Cerdan, 2008). As a result, this new media affects traditional business promotion and advertising (Levy, 2007). Therefore, more and more companies are forced to adopt Web 2.0 to enhance communication, customer service, and productivity to remain competitive and survive in the market (Janice et al., 2014).

In this sense, companies are increasingly using social networks for brand activities to gain more reputation and market share (Colomo-Palacios, Fernandes, Soto-Acosta, & Sabbagh, 2011; Soto-Acosta, Martínez-Conesa, &Colomo-Palacios, 2010b). These potential benefits bring new Internet technologies to the level of organizational competitive advantage (O'Reilly & Battelle, 2009). For instance, the Economist (2007) interviewed Anthony Christie, executive vice president, and chief marketing officer of Global Crossing., Ltd. He explained that blogging is a powerful, efficient, and low-cost approach to build a company's brand. Also, Simmons (2007) mentioned firms could bring organization branding strategies by using Web 2.0. Bjørn-Andersen and Hansen (2011) argued that the most exciting use of Web 2.0 technology is to create an innovative online environment that may enhance its company's brand.

According to Allsop et al. (2007), for customers, the researchers stress that consumers continue to be online due to the popularity of smartphones, tablets, and the Internet, so they share comments and information about products, brands, and services online. With Web 2.0 technology development, the progressive social media environment and its subsystems enable consumers to have new opportunities, such as creating, editing, sharing, and displaying online

information (Cormode & Krishnamurthy, 2008). An increasing number of people use Web 2.0 technologies (such as online forums, websites for consumer comments, blogs, and social networking sites) to share opinions and experiences or search for information about products (Gupta & Harris, 2010; Parameswaran & Whinston, 2017).

Individuals publishing blogs and other information on the Internet enjoy an increasingly popular way of sharing product information among people. After all, they often act as producers of their contents. In turn, they provide companies with a lot of voluntary and non-intrusive consumer feedback without administering cumbersome, expensive, and slow surveys (Rolf, 2011).

Furthermore, all citizens can and share their public service experiences in real-time through SNS (Social Networking Services) due to the explosive growth of social technologies (Lee & Lee, 2020). The wide availability of smart devices has empowered citizens' in the public service sector, as people can easily express their opinions or demands. Public service providers can also use this communication channel to collect data on citizens' needs and perceptions regarding various services and subsequently develop strategies to improve service quality (Na & Soon, 2020).

Therefore, social media platforms generate a large amount of data, enabling big data analysis to extract valuable information for various purposes (Ghani et al., 2019; Ragini et al., 2018). The social media platform's role has expanded from simple communication channels to valuable sources of citizen's views on current and future public services (Na & Soon, 2020). Social data are the best source of public opinions because citizens express them voluntarily rather than generated in controlled environments such as surveys or interviews (Lee 2018a, b). As such, an analysis of social data helps distinguish the likes and dislikes of citizens and uncover the deep-rooted reasons for such opinions (Na & Soon, 2020). For example, Das et al. (2019) extracted patterns by studying Twitter channels to understand the factors that affect people's cycling. Colin et al. (2013) also used sentiment analysis of Twitter data to evaluate transit riders' satisfaction in Chicago.

3.Methodology

In this section, firstly, we propose the main research method: text mining to collect data and analyze the user's attitude towards sharing bikes. Then, we introduce the data collection process. Finally, we define all the weather variables appearing in this study and measurement of customer satisfaction.

3.1 Research Method

In terms of research on the satisfaction of sharing bikes, most of the literature uses a questionnaire as the primary research method. Usually, the sample size of this kind of method is below 1000. So the sample size is not large, and some specific differences in the research results can exist. This project collected extensive data about public opinions on the internet by using text mining technology. The sample size has reached more than 3 million, reflecting users' attitudes towards sharing bikes.

The steps involved in the overall process of text mining are shown as below:

1) Text gathering. The primary collection method is text data import, but it is not easy to obtain in practice, so generally, we will use python to obtain web text. Python needs to write programs and to the web page to capture information.

2) Text preprocessing. Tokenization and the Part-of-Speech and the application of a stopword list are adopted here (Brigette & Silke, 2004). Tokenization is the division of the text into words or terms. According to the grammatical context of the words in the sentence, Part-of-Speech (PoS) tagging tags words are marked, divided into nouns, verbs, and so on (Shatkey & Feldaman, 2003). The stop word removal is removing stop words like "a," "of," etc.

3) Data analysis. This is the most diverse and optimized step of four. Many text mining and data mining techniques are suitable because they are actual information extraction (Brigitte & Silke, 2004).

4) Visualization. It is useless to extract information that no one sees ((Brigitte & Silke, 2004). So, to show the results of text analysis more intuitively, the data is often visualized.

3.2 Data Collection

This paper uses Sina Yuqingtong to capture the 365-day online public opinions of sharing bicycles from February 15, 2009, to February 14, 2020. These text data include microblog forwarding but not comments.

Sina Yuqingtong can collect and analyze the data all over the Internet for an online event and automatically generate an analysis report, containing 11 dimensions: event profiles, event trends, website statistics, data types, keyword clouds, popular information, netizens with hotpots, communication paths, related words, Internet users' views, and public opinions.

The extraction process (the whole flow showed in Figure 3):

By searching the "sharing bicycle" field, the amount of text information and negative information about sharing bicycles on the whole Internet in 365 days was extracted.

By searching the "sharing bicycle + Beijing" field, the amount of text information and negative information about sharing bicycles on the whole Internet in 365 days was extracted.

By searching the "sharing bicycle + Chengdu" field, the amount of text information and negative information about sharing bicycles on the whole Internet in 365 days was extracted.

By searching the "(Hello|Alipay) + (bike|bikes)" field, the amount of text information and negative information about sharing bicycles of Hello on the whole Internet in 365 days was extracted.

By searching the "(Meituan|Mobike) + (bike|bikes)" field, the amount of text information and negative information about sharing bicycles of Meituan on the whole Internet in 365 days was extracted.

By searching the "(Didi) + (bike|bikes)" field, the amount of text information and negative information about sharing bicycles of Meituan on the whole Internet in 365 days was extracted.

By searching the "ofo|OFO|oFo" field, the amount of text information and negative information about sharing bicycles of Ofo on the whole Internet in 365 days was extracted.

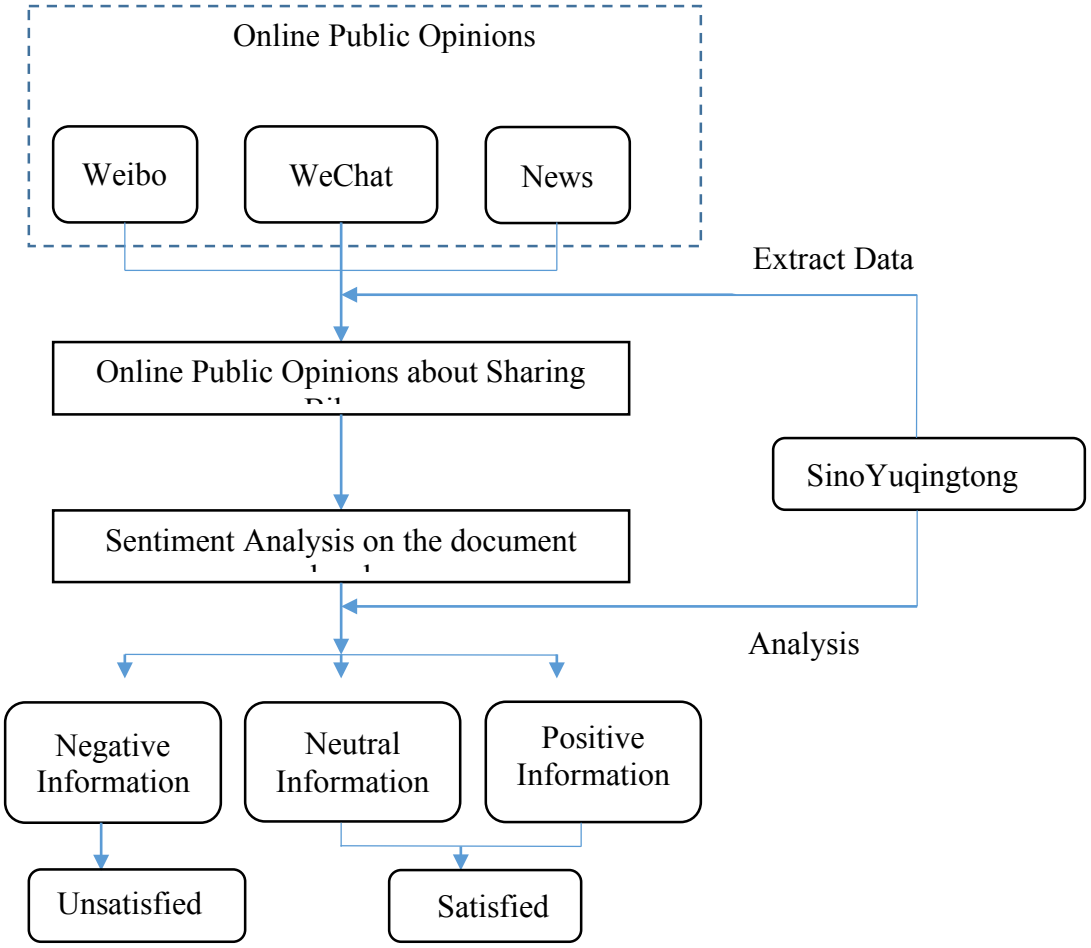

Figure 1 Data Extraction Process

Negative information refers to bad and negative information about sharing bicycles. For example, "sharing bicycles are parked and placed disorderly". Positive information refers to good and positive information, such as "sharing bike maintainer returns to the lost owner after picking up the money". Neutral information refers to the objective description of the status of sharing bicycles, such as 4500 bikes will launch in Shaoxing.

3.3 Weather Variables Descriptions

After searching the weather conditions in Beijing and Chengdu in 2019 and 2020 on the website China Weather (http://www.weather.com.cn), we decided to choose the following 10 variables as explanatory variables.

- ***Minimum temperature (℃)***: the daily minimum temperature, which is observed from 8 p.m. of the first day to 8 p.m. of the next day within 24 consecutive hours. The lowest temperature is usually around sunrise in the morning.
- ***Maximum temperature (℃)***: the daily minimum temperature, which is the temperature reaches by the surface of the measurement site on the day usually occurs from 2:00 to 3:00 p.m.
- ***Average temperature (℃)***: means the daily average temperature, which is the average temperature in 24 hours. It is calculated by dividing the sum of the average temperatures at 2:00, 8:00, 14:00, and 20:00 of the day by 4.
- ***Humidity (%)*** : it indicates the degree of dryness and wetness of air, which is the percentage of water vapor contained in the air and saturated water vapor under the same conditions.
- ***Wind speed (m/s)***: the speed at which air moves relative to a fixed point on the earth.
- ***Wind scale***: according to the size of the wind, it is divided into 17 levels.
- ***Air Pressure (hpa)***: the atmospheric pressure acting on a unit area.
- ***Visibility (km)***: the maximum distance that a person with normal vision can recognize an objective. Usually determined by the atmospheric transparency.
- ***Total precipitate (mm)***: Precipitation refers to the depth at which solid or liquid water falls from the sky to the horizontal plane and accumulates there without loss. The unit of measurement is mm.
- ***Total average cloud amount (%)***: Cloud amount refers to the proportion of the sky covered by clouds, and total cloud amount refers to the proportion of the sky covered by all types of clouds.

3.4 Customer Satisfaction Measure

In this research, Satisfaction refers to the total amount of text information except negative text information divided by the total amount of all text information. The value obtained is a percentage with two decimal places.

If set the number of negative information as A, the number of neutral information as B, the number of positive information as C, and the satisfaction as m, then:

$$m=\frac{B+C}{A+B+C}\times 100\%$$

Where m is the percentage and two decimal places are reserved.

4. Results

4.1. Satisfaction Analysis with Sharing Bikes Based on Brands

According to the Ministry of Transportation's report, by August 2019, there are 15.5 million sharing bicycles in China, with more than 300 million registered users, all over 360 cities in the country. In 2019, the three most prominent companies in China's bicycle-sharing industry were Meituan, Didi, and Hello, which we will study here. Since Ofo sharing bike is the first to rise, it is also included. Specially, we focus on the situation of the sharing bike in 2019.

a. Didi

Didi travel was founded on July 10, 2012. Didi travel has a wide range of businesses. In addition to a series of taxi businesses such as taxis and free rides, Didi travel also operated two sharing bicycles. On January 9, 2018, Didi travel cooperated with Xiaolan bicycle, and Xiaolan bicycle was entrusted to Didi. On January 25, 2018, Didi travel's brand shared bicycle was used and named Qingju bicycles.

The following figure (Figure 2) was obtained by making a line chart and a histogram of Didi's satisfaction and public opinions in one year. It can be seen that the satisfaction level of Didi's sharing bicycle is concentrated at 80% every day, and there are abnormal values in several days. The satisfaction percentage suddenly dropped to about 60% or even 40%. The daily amount of public opinion of Didi sharing bicycle is about 2000, of which the public opinion volume is abnormally high in several days, reaching about 5000.

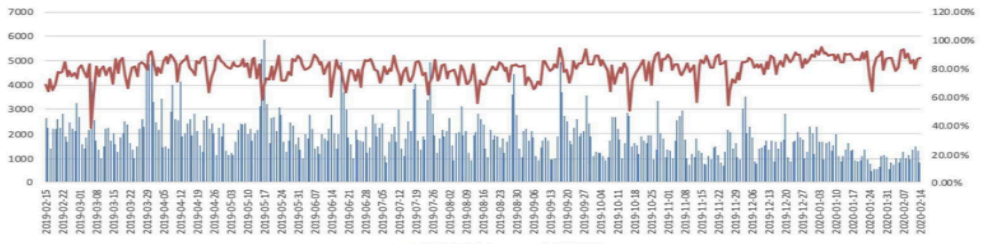

Figure 2 Didi's Satisfaction and Public Opinions in a Year (“Blue colour” represents the total amount of public opinions of Didi, “Red colour” represents the satisfaction level)

In terms of time, from February to August 2019, Didi's satisfaction with sharing bicycles fluctuated at about 70%. From November 2019 to February 2020, Didi's satisfaction with sharing bicycles remained at about 80%. This phenomenon shows that in 2019, Didi bike-sharing made efforts to improve customer satisfaction and reached some achievements.

From March 21, 2019, the price of the Xiaolan bicycle rose to 1 yuan / 15 minutes.

On May 16, 2019, more than 3000 green orange sharing bicycles were launched in Shangdi, Haidian District, Zhongguancun Software Park, Xierqi subway station, and other areas. As a result of this incident, the Ministry of Transportation of Beijing interviewed Didi and ordered it to retrieve the illegally placed sharing bicycles. The Beijing Municipal Department of transportation said that Didi, against following the Beijing Regulations on the administration of non-motor vehicles, illegally released sharing bicycles, disrupting operations. So, they ordered Didi to complete the retrieve process on May 16 and 17. At the same time, Didi would be punished.

On November 26, 2019, the Didi raised the charge for sharing bicycles from the original 1 yuan for the first 15 minutes to 0.5 yuan for more than 15 minutes. The adjustment fee was 1.5 yuan for the first 15 minutes of cycling and 1.5 yuan for more than 30 minutes. In addition, if the user parked the sharing bicycle in the no parking area, an additional dispatching fee of 5 yuan would be charged. If the vehicle stopped outside the parking spot, 2 yuan would be charged an additional management fee.

To understand the reasons that caused Didi's user satisfaction level to reduce, we summarized some events of Didi's bikes in 2019 (Appendix 1). Didi sharing bicycle price increased has reduced the user's satisfaction to about 60%.

Observing the price increase's continuous impact on Didi's sharing bicycle user satisfaction, we extracted the sharing bicycle satisfaction about ten days before and after the price increase. From the Appendix 2, we can see that the negative impact of the price increase on Didi's user satisfaction only lasted for six days. When the price was just increased, user

satisfaction declined very low. After six days, satisfaction recovered by about 80%. This trend shows that the price increase harmed the user satisfaction of Didi sharing bicycles, but the impact was light and only lasted for a short time.

To observe the continuous impact of illegal parking on Didi's sharing bicycle user satisfaction, we extracted the shared bicycle satisfaction 18 days before and after illegal parking (Appendix 2), which negative impact of illegal parking on Didi's user satisfaction lasted 13 days. On May 16, user satisfaction decreased to 57.89%. In the following 13 days, the satisfaction had been meager, about 72%. Then after 13 days, the satisfaction had recovered to about 80%. This phenomenon shows that illegal parking hurt the user satisfaction of Didi's sharing bikes and extended maintenance duration. The negative impact lasted about two weeks.

b. Meituan

In April 2018, Meituan wholly acquired Mobike with $3.7 billion. On January 23, 2019, the Mobike was fully connected to Meituan app, and Mobike was renamed the Meituan bike. At the end of February 2019, the Mobike team was moved to the headquarters office of Meituan.

We took the satisfaction level and public opinion volume of Meituan sharing bicycles for one year as a line chart and histogram to get the following figure (Figure 3). From it, the satisfaction level of Meituan sharing bicycles is concentrated at 80% every day, but it fluctuates wildly. The satisfaction can reach 90% at most and only 50% at least. The public opinion volume of Meituan sharing bikes fluctuates very much every day. There are several points with unusually high public opinion volume, of which the highest public opinion volume has reached 14000.

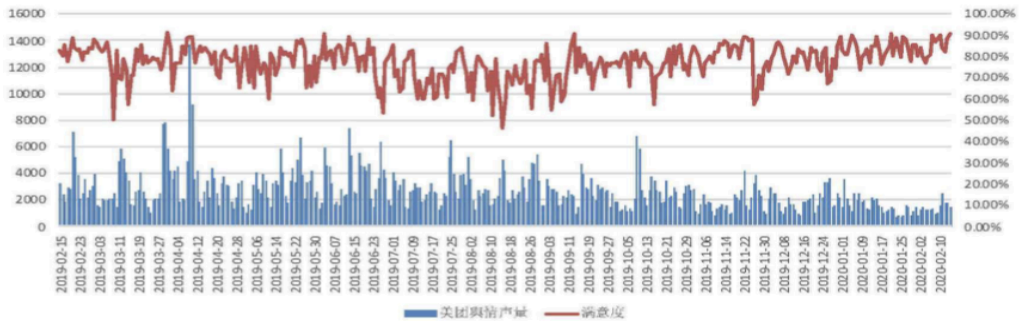

Figure 3 Meituan's Satisfaction and Public Opinions in a Year ("Blue colour" represents the total amount of public opinions of Meituan, "Red colour" represents the satisfaction level)

In terms of time, the satisfaction level of Meituan sharing bicycles fluctuates around 80% from February 2019 to June 2019, around 75% from July 2019 to September 2019. Moreover, from December 2019 to February 2020, the satisfaction percentage is close to 85%. This phenomenon shows that the satisfaction of Meituan sharing bicycles is very unstable, and the correlation of satisfaction is very complex, which may be related to a variety of factors.

On March 12, 2019, Singapore's land transport authority said that Mobike applied to revoke its sharing bike license in Singapore on March 11.

On April 8, 2019, the price of Mobike in Beijing was adjusted. The starting price was 1 yuan for 15 minutes, and the duration fee was 0.5 yuan per minute.

On May 21, 2019, the price of Mobike in Shenzhen was adjusted. The adjusted starting price was 1 yuan per 15 minutes, and the duration fee was adjusted to 0.5 yuan per 15 minutes. On July 26, 2019, the price of Mobike in Shanghai and Shenzhen was adjusted, of which the starting price in Shanghai was 1.5 yuan within 15 minutes, and the duration fee was 0.5 yuan per 15 minutes. The starting price in Shenzhen was 1.5 yuan for 30 minutes, and the duration fee was 1 yuan per 30 minutes.

From October 9, 2019, the price of Mobike in Beijing would rise, with the starting price of 1.5 yuan and the duration fee of 1.5 yuan per 30 minutes (This rule was limited to Beijing).

To explore what caused the sharp decline in Meituan's satisfaction with sharing bicycles, we summarized some events of Meituan's bicycles in 2019 (Appendix 3). The average satisfaction of the Meituan bicycle was 77.59%, and from the table below, we can find that Meituan's four price increases in 2019 did not have a strong connection with user satisfaction. On March 12, 2019, Meituan bicycle revoked its Singapore license, which reduced the user satisfaction of Meituan bicycle to 69.09%.

To observe the continuous impact of the price increase on the user satisfaction of Meituan sharing bicycles, we extracted its satisfaction level about 12 days before and after the price increase. From the table below (Appendix 4), it is not difficult to notice that the negative impact of the price increase on Meituan user satisfaction lasted for up to two days. On April 8, 2019, the price of Meituan sharing bicycles increased in Beijing. On April 9, 2019, and April 10, 2019, the volume of public opinion increased significantly, but the satisfaction level remained at about 89%, which was quite a high level. These data showed that after Meituan's price rise on April 8, people increased the discussion on Meituan sharing bicycles and increased the satisfaction of Meituan sharing bicycles.

The above analysis shows that the satisfaction of Meituan sharing bicycles is hardly affected by the price rise. The increase in the price of Meituan sharing bicycles will increase user satisfaction even in a short time.

c. Ofo

Ofo sharing bike, also known as Xiaohuang bike, is the earliest dockless shared bike in China. In 2014, five partners jointly founded ofo. As early as June 2015, Xiaohuang was put into use at Peking University.

We took the satisfaction level and the volume of public opinions of Ofo sharing bicycles for one year to get a line chart and a histogram (Figure 4) as following. It can be seen that the satisfaction level of Ofo sharing bicycles is concentrated at 70% for each day. Sometimes up to 90% and down to 30% under a significant fluctuation. In the few days when the satisfaction decreased significantly, the volume of corresponding public opinions also increased, which showed that the sudden decline of user satisfaction of 0fo sharing bicycle was due to some unexpected public opinion events or negative news.

If we look at the whole year, the satisfaction of 0fo sharing bike fluctuates significantly from the end of February 2019 to the beginning of July 2019. Mainly from June 12, 2019, to June 30, 2019, the fluctuation range of its satisfaction level reached 60% (i.e., the maximum minus the minimum of satisfaction during this period).

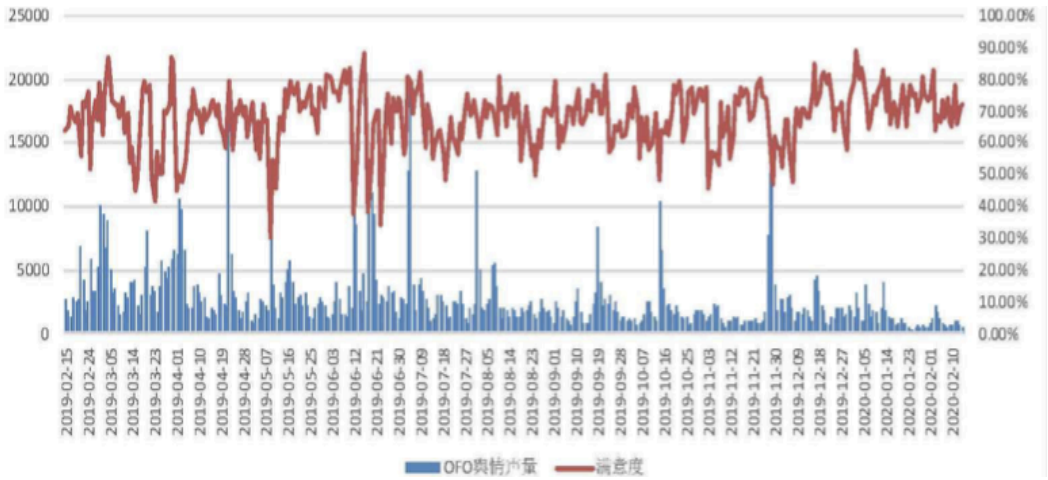

Figure 4 Ofo's Satisfaction and Public Opinions in a Year ("Blue colour" represents the total amount of public opinions of Ofo, "Red colour" represents the satisfaction level)

We summarized some events of Ofo in 2019 (Appendix 5). The controversial behavior of Ofo sharing bikes in 2019 negatively impacts user satisfaction.

In March 2019, Ofo launched an online discount store. Users could upgrade the deposit that had not been refunded into gold coins, which could be used as a discount in the mall. Moreover, upgraded users could permanently waive the deposit.

On July 5, 2019, some media reported that the average daily refund of ofo was 3500 people, and it took 12.5 years for Ofo to return all the deposits. From September 18 to 28, 2019, ofo moved for the fifth time. In November 2019, ofo and Tiantian anti-money forced users to consume without refund.

d. Hello

Hello bike, was founded in September 2016. In October 2017, Hello bike merged with Yong'an Xing. On May 31, 2018, the Ant increased its investment in Hello (including Yong'an bicycle), accounting for 36% of the shares.

The following figure (Figure 5) was obtained by making a line and a bar chart of Hello's satisfaction and public opinion for one year. It can be seen that the satisfaction of Hello fluctuated wildly every day, up to 100% and down to 40%. Unlike Ofo, while Hello's satisfaction had

increased significantly for several days, the corresponding public opinion volume increased once the satisfaction was as high as 100%. The more users paid attention to the Hello bike, the faster the Hello satisfaction increased. Still, the satisfaction dropped to the average value within two days, or even lower than the average value. This phenomenon showed that the satisfaction of Hello always rose suddenly because of some emergencies or news, which proved that this kind of attention could not make the satisfaction of Hello bike sustainable.

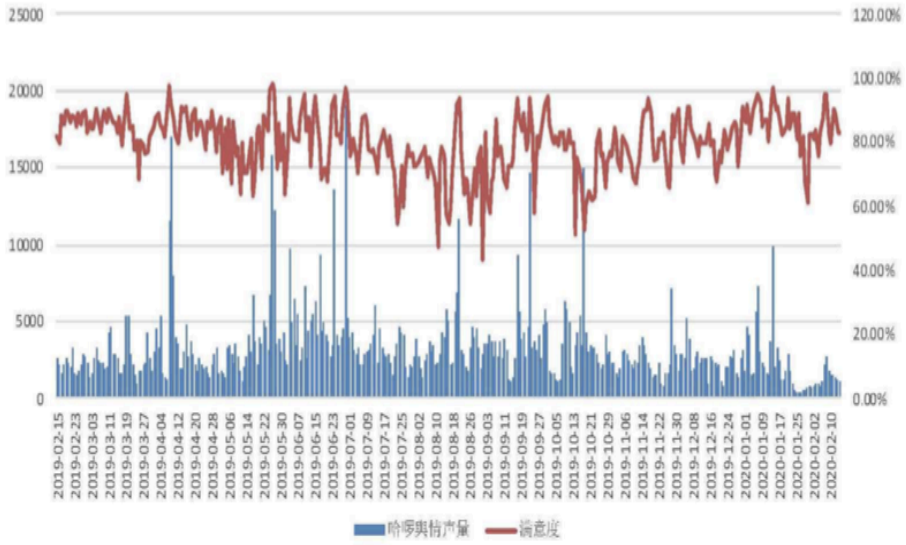

Figure 5 Hello's Satisfaction and Public Opinions in a Year ("Blue colour" represents the total amount of public opinions of Ofo, "Red colour" represents the satisfaction level)

From the perspective of the whole year, the satisfaction of Hello fluctuated greatly from the end of July 2019 to the beginning of October 2019, and the satisfaction was also unstable in other periods.

On April 15, 2019, the price of the Beijing Hello bikes increased to 1 yuan per 15 minutes. On May 16, 2019, the Beijing municipal traffic law enforcement department fined Hello 50000 yuan for illegally throwing sharing bicycles. On August 9, 2019, the price of the Guangzhou Hello bikes increased. Before increasing, the price was 1 yuan for the first 30 minutes, up to 1.5 yuan for every 30 minutes, an increase of 50%.

On September 11, 2019, Appstore was taken off the Hello app. On the morning of October 18, 2019, the Hello system was abnormal.

We summarized some events of Hello in 2019 (Appendix 6). The two price increases of Hello sharing bicycles in 2019 did not strongly impact user satisfaction. On October 18, 2019, the abnormal behavior of the Hello travel system increased its number of public opinions to 14920, and user satisfaction decreased to 52.90%. It indicates that users were very concerned about the abnormal events in Hello's system and expressed strong dissatisfaction. The reason for users' dissatisfaction was that users couldn't ride a sharing bike when they went to work in the morning due to system failure, which made it inconvenient for users to go to work or even be late. Therefore, their satisfaction was reduced.

To observe the continuous impact of news on Hello's user satisfaction, the sharing bicycle satisfaction was intercepted about 12 days before and after the price increase (Appendix 7). The price increase has no noticeable continuous negative impact on Hello's user satisfaction. On May 16, 2019, the illegal launch of Hello sharing bicycles in Beijing significantly reduced the satisfaction. After about five days, the satisfaction returned to the average level. On September 11, 2019, the Apple store removed Hello, significantly reducing satisfaction. After about five days, the satisfaction returned to the average level. On October 18, 2019, due to the abnormality of the Hello bike system, the public opinion increased significantly, and the satisfaction decreased to 52.9%. The satisfaction was at a low level for six consecutive days.

The above analysis shows that the satisfaction of Hello sharing bike is hardly affected by the price increase. Besides the price increase, other negative news of Hello can seriously reduce users' satisfaction, and it would last for about five days before it returned to normal.

A total of five factors are used for correlation analysis between the satisfaction of sharing bicycles of four brands and the satisfaction of sharing bicycles of all brands. We used Python software to generate the thermodynamic diagram of the correlation coefficient. If the correlation coefficient of satisfaction of four brands is equal to one, the user's satisfaction with these four brands is the same, which means that the user's satisfaction with the sharing bike has nothing to

do with the brand. When the correlation coefficient of the satisfaction of the four brands is equal to zero, which means that the user's satisfaction with the four brands is entirely different, and the brand factor ultimately determines the user's satisfaction (Gogtay & Thatte, 2017).

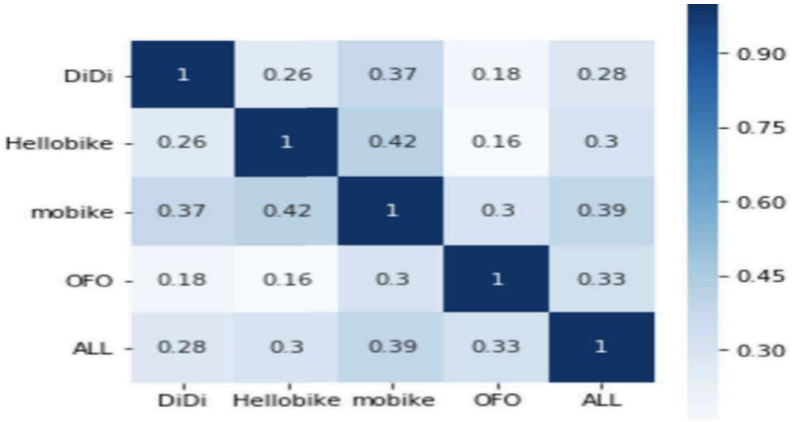

Figure 6 Thermodynamic diagram of Correlation Coefficients of Sharing Bike Satisfaction

The result shows a weak correlation between the satisfaction of Mobike (Meituan) bicycle and the other three brands, whose correlation coefficient is bigger than 0.3. Therefore, except for the brand influence, other factors affect the satisfaction of sharing bicycles. Since the data of the four brands were extracted from February 15, 2019, to February 14, 2020, the correlation between time and sharing bicycle satisfaction can be excluded. The remaining factors related to user satisfaction are external factors, such as weather conditions.

4.2 Satisfaction Analysis with Sharing Bikes Based on Weather

China has a vast territory, and the weather conditions in many cities are very different. To explore how the weather affects users' choice of sharing bikes, we selected two cities with significant climate differences to analyze the satisfaction and weather conditions of sharing bicycles in the two cities and find out the relationship between satisfaction and weather.

Both Chengdu and Beijing are big cities with good sharing bikes development. The urban area of Beijing and Chengdu is similar, and the population density of Chengdu is slightly smaller

than that of Beijing. The climate of Chengdu is relatively humid, and the climate of Beijing is relatively dry. Chengdu and Beijing represent typical southern and northern climates. Therefore, Beijing and Chengdu were selected as the analysis objects to analyze the relationship between climate and shared bicycle satisfaction based on online public opinions (National Statistics Bureau, 2019).

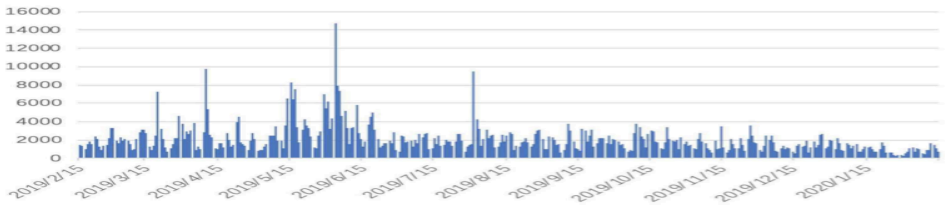

Figure 7 Public Opinions about Sharing Bikes in Beijing

By summing up the public opinions of 365 days in Beijing from February 15, 2019, to February 14, 2020, it is found that there were 760000 data about Beijing sharing bicycles, and the average satisfaction of 365 days was 77.85%. We made a bar chart (Figure 7) of the public opinion of sharing bikes in 365 days, and it can be observed that the daily amount of public opinions is about 2000. June 3, 2019, is an abnormal value, which reached 14714. As can be seen from the Figure 8, the volume of public opinion of Beijing's sharing bikes fluctuates wildly.

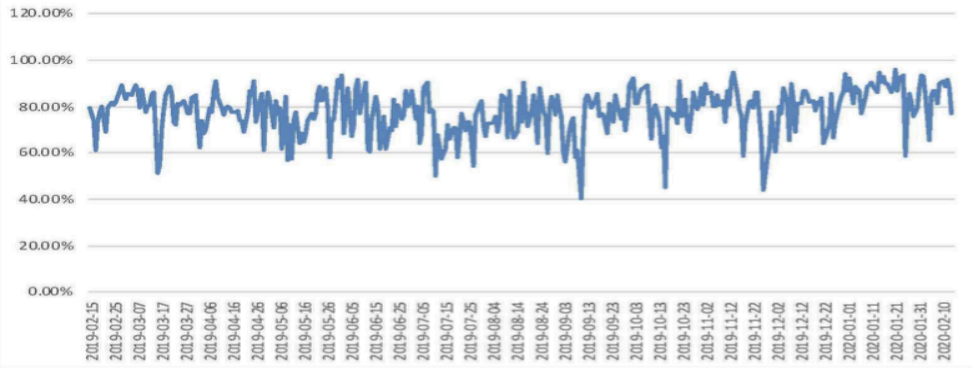

Figure 8 Daily Satisfaction about Sharing Bikes in Beijing

As can be seen from the Figure 8, the daily satisfaction of sharing bikes in Beijing is 60% - 90%. If we take a look at the whole year, there is no apparent fluctuation.

By summing up the public opinion volume of 337 days in Chengdu from March 15, 2019, to February 14, 2020, it is found that 190000 data are about sharing bicycles in Chengdu, and the average satisfaction of 337 days is 79.64%. We made a bar chart (Figure 9) of the public opinion of sharing bikes in 337 days, and it can be observed that the daily amount of public opinions is about 500. May 9, 2019, is an abnormal value, which reached 6565. As can be seen from the figure below, the volume of public opinions of sharing bikes in Chengdu fluctuates wildly.

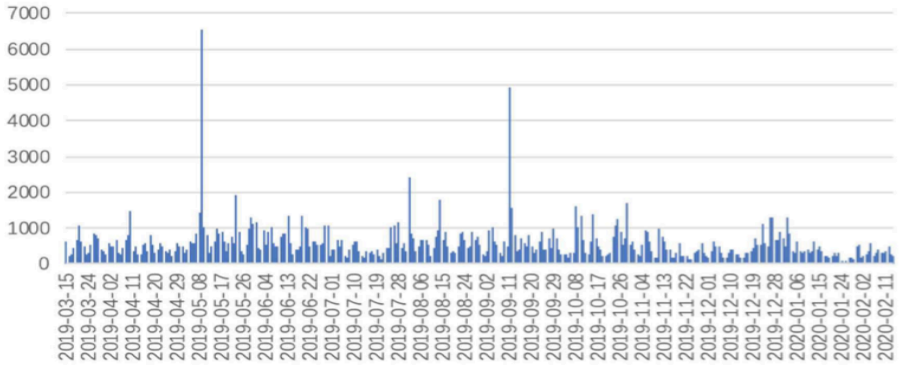

Figure 9 Public Opinions about Sharing Bikes in Chengdu

As can be seen from the Figure 10, the daily satisfaction of sharing bikes in Chengdu is 60% - 90%. If we take a look at the whole year, there are many apparent fluctuations.

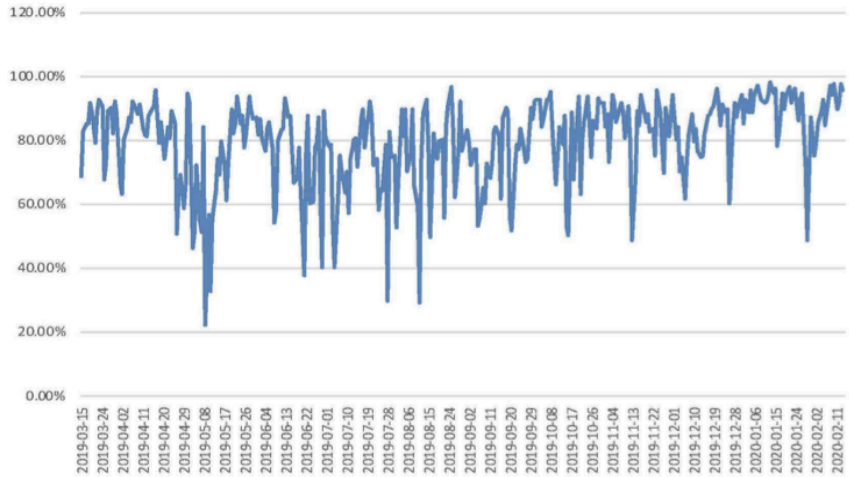

Figure 10 Daily Satisfaction about Sharing Bikes in Chengdu

To study whether there is an interdependent relationship between weather factors and the satisfaction and the public opinion of sharing bicycles in Beijing and Chengdu, the method of

calculating correlation coefficient is used for correlation analysis, and the correlation coefficient is calculated between each variable and other variables. Then the thermodynamic diagram of the correlation coefficient is made by Python software.

The correlation between the satisfaction of sharing bicycles in Beijing and each variable is shown. the correlation coefficient between the satisfaction of sharing bicycles and the minimum temperature is -0.28, indicating that people are more satisfied with sharing bicycles in winter. The correlation coefficient between the volume of public opinions of sharing bicycles and the air pressure in Beijing is -0.3, indicating that people increased discussion about sharing bicycles when the air pressure is slight. Moreover, the correlation coefficient between the volume of public opinions of sharing bicycles and the average temperature in Beijing is 0.3, indicating that people are more actively discuss sharing bicycles in summer.

The satisfaction of sharing bicycles in Chengdu strongly correlated with the minimum temperature, average temperature, and maximum temperature. All the correlation coefficients are -0.35, indicating that people would be more satisfied with sharing bicycles when the temperature was low. The correlation coefficient between the volume of public opinions of sharing bikes in Chengdu and air pressure is -0.25, indicating that people would increase discussions of shared bicycles when the air pressure was low. The correlation coefficient between the volume of public opinions in Chengdu sharing bicycles and the average temperature is 0.19, indicating that people would be more actively discuss sharing bicycles when the temperature was high.

Since the correlation coefficients of minimum temperature, maximum temperature, and average temperature are very high. The following analysis only retains the average temperature to avoid a significant error. Because the correlation analysis cannot explain the correlation degree of multiple variables, further analysis is needed.

First, we used the SPSS software to make descriptive statistics (Appendix 8 & 9).

Then, to judge whether the selected variables were suitable for factor analysis, we performed KMO and Bartlett's Test is to check whether each variable is independent. If they are

independent, factor analysis cannot be used. If the p value is less than 0.05 (i.e., the significance is less than 0.05), it indicates a correlation between variables, and factor analysis can be used. KMO test is mainly used for factor analysis. When KMO is closer to 0, the correlation between variables is very weak, and these variables are not suitable for factor analysis. If the range is (0, 1). KMO, values are suitable for factor analysis. A value more than 0.9 means very suitable, 0.8 means appropriate, 0.7 means average, and less than 0.5 means inappropriate.

The KMO test results in this project are shown in Appendix 10:

Both values of KMO are bigger than 0.5, and of the significance probability are less than 0.05. Therefore, the two group of variables can be studied by factor analysis.

If we observe the Percentage of the variance of the initial variables explained by the extracted PCs, in the Appendix 11, the 4 PCs account for 77.929% while it is 75.549% in the Appendix 12, passing 70%. Thus, we choose the first four main components in the two groups to make continue analysis.

From Appendix 13 & 14, we can see:

- Component 1: “Minimum temperature”, “Maximum temperature”, “Average temperature” and “Air pressure” account more, so these four variables can be combined a new variable, named “Temperature and air pressure factor”.
- Component 2: “Humidity”, “Visibility”, “Total average cloud” account more, so these three variables can be combined a new variable, named “Air quality factor”.
- Component 3: “Wind speed”, “Wind scale” account more, so these two variables can be combined a new variable, named “Wind speed factor”
- Component 4: there is no obvious variables that occupy more.

Since the factor analysis method could not directly reflect the correlation between factors and the satisfaction of sharing bicycles. We transformed the original twelve factors into four new factors obtained by factor analysis and calculated the correlation coefficient to conduct the correlation analysis. Then the thermodynamic diagram of the correlation coefficient was made by Python software.

From Appendix 15, The value of correlation coefficients from Component 1 until Component 4 approach zero, indicating that the previous factor analysis effect is significant since all these factors are independent of each other. Because Component 4 includes the satisfaction factor, it will not be considered here. Regarding the correlation analysis, it can be found that Component 1 strongly correlates with sharing bicycle satisfaction among the other three components. The correlation coefficient reaches -0.34, indicating that air temperature and air pressure are the most relevant factors for sharing bicycle satisfaction among the weather factors. When the air temperature is higher or the air pressure is lower, the satisfaction of sharing bicycles is lower. From the public opinions of sharing bicycles in Beijing, Component 1 has the most significant correlation with sharing bicycles, whose correlation coefficient reaches 0.41. The higher the air temperature and pressure, the more people discuss sharing bicycles.

From Appendix 16, the value of correlation coefficients from Component 1 until Component 4 approach zero, indicating that the previous factor analysis effect is significant since all these factors are independent of each other. Because Component 4 includes the satisfaction factor, it will not be considered here. Regarding the correlation analysis, it can be found that Component 1 strongly correlates with sharing bicycle satisfaction among the other three components. The correlation coefficient reaches -0.31, indicating that air temperature and air pressure are the most relevant factors for sharing bicycle satisfaction among the weather factors. When the air temperature or the air pressure is lower, the satisfaction of sharing bicycles is lower. From the public opinions of sharing bicycles in Chengdu, the sharing bike satisfaction has a strong correlation with the amount of public opinions, as the correlation coefficient is -0.25. So, the lower the satisfaction people have, the more discussion about sharing bikes will happen. Surprisingly, the correlation coefficient between the amount of public opinions and the air temperature or air pressure is pretty low, indicating that there is almost no correlation between the temperature and the discussion on sharing bikes.

5. Discussion

Today, brands are prevalent in every facet of human life, such as production and consumption, food and clothing, personality lifestyle etc. In the words of Kahan (cited in Hall, 1999), brands are now standing for a share of consumers' inner lives, their value, their beliefs, their politics, even their souls. In terms of the satisfaction of sharing bikes and bike companies, we studied four major sharing bike brands: Didi, Hello, Meituan and Ofo. Didi had the highest satisfaction among the four brands while Ofo had the lowest satisfaction.

For Didi sharing bicycles, the price increase would lead to a rapid decline in satisfaction. However, usually, after the price increased for six days, the satisfaction would return to normal. In short, the price increase has a particular impact on Didi's satisfaction with sharing bicycles. For Meituan sharing bikes, the price increase would lead to a decline in satisfaction, but not so much, indicating that the price increase would not significantly impact its satisfaction. For Ofo sharing bikes, some negative news from the company would lead to a rapid decline in satisfaction. For Hello sharing bike, the satisfaction was hardly affected by the price increase. However, due to system errors and some negative news, the satisfaction of Hello decreased rapidly in a short time.

Price is one of the most sensitive user indicator (Xuedong etal., 2021). So, all these sharing bike companies can adopt reasonable, flexible pricing methods and maintain a higher availability in order to have higher use and service level. Alexandros (2019) also provided a key recommendation in his study that bike operators should focus on offer fair and affordable fares and member subscriptions.

Regarding the satisfaction of sharing bikes and the weather, in recent years, with the rise of sharing bike services, factors affecting the use of bicycle, especially environmental factors, such as weather, is considered to be essential factors affecting users' satisfaction (El-Assi et al., 2017; Du & Cheng, 2018; Zhang et al., 2017; Mateo-Babiano et al., 2016). In this study, the result of the correlation analysis shows that the correlation coefficient between the satisfaction of sharing bicycles and the average temperature in Beijing is -0.27 and the correlation coefficient

with air pressure is 0.17. The correlation coefficient between satisfaction and the average temperature of Chengdu shared bicycle is -0.35 and the correlation coefficient with air pressure is 0.25. It is not hard to say that the correlation between weather factors and sharing bikes' satisfaction in Chengdu is higher than in Beijing.

From the factor analysis, the correlation coefficient between the satisfaction of sharing bicycles in Beijing and the temperature and the air pressure is -0.34. The correlation coefficient with other factors is about 0.1. The correlation coefficient between the satisfaction of sharing bicycles in Chengdu and the temperature and air pressure factor is -0.31, with public opinions is -0.25. And the correlation coefficient with the wind speed factor is -0.0049, approaching zero.

From the above conclusions, it can be seen that if the weather conditions in Beijing are bad, the satisfaction level of sharing bicycles will also decline. In contrast, the weather conditions in Chengdu have little correlation with the satisfaction of sharing bicycles. However, the more dissatisfied uses with sharing bicycles in Chengdu, the more they will discuss sharing bicycles on the Internet, or the more people discuss sharing bicycles in Chengdu on the Internet, the more dissatisfied they will be with sharing bicycles in Chengdu.

Some scholars also have studied the association of weather conditions to sharing bike ridership (El-Assi et al., Gebhart & Noland, 2014), and the conclusion is that the likelihood of using a sharing bike and the duration of trips are affected by cold, rain, and high humidity, so weather events seriously affected sharing bike industry. People are less likely to choose bike to go out on rainy and snowy days (Hor et al., 2005; Gebhark et al., 2013). Kim (2018) shows evidence that temperatures over 30℃ reduce bicycle usage in general. Moreover, the effect of the weather was measured by the statements, “In the spring I will use bike-sharing more often” and “My use of bike-sharing decreases in the winter” (Wang et al., 2020). The amount of sharing bikes is also strongly affected by time-limited events, climate (environment), and calendar (season) (Sathishkumar & Yongyun, 2020).

6. Conclusion

Our first objective was to analyze online comments and reviews about sharing bikes by text mining. We extracted millions of online comments including microblogs and news. According to the analysis of 3.8 million public opinions, the satisfaction level of sharing bicycles is concentrated between 60% - 80%. Regarding the data analysis of the extracted 93 days, the public opinion of sharing bicycles presents a certain periodicity. On average, people have a little discussion on sharing bicycles online on Saturday and Sunday compared with Monday to Friday, and it is far less than that from Monday to Friday.

The second objective consists in identify the satisfaction level for four major sharing bike brands and analyzing the relation between the satisfaction and weather variables.

It is found that Hello was the most discussed while Didi bike was the least discussed. In terms of satisfaction, Didi had the highest satisfaction among the four brands, followed was the Hello bikes. Ofo had the lowest satisfaction, which existed a large gap compared with the other three brands. For Didi sharing bicycles, the price increase would lead to a rapid decline in satisfaction. However, usually, after the price increased for six days, the satisfaction would return to normal. In short, the price increase has a particular impact on Didi's satisfaction with sharing bicycles. For Meituan sharing bikes, the price increase would lead to a decline in satisfaction, but not so much, indicating that the price increase would not significantly impact its satisfaction. For Ofo sharing bikes, some negative news from the company would lead to a rapid decline in satisfaction. For Hello sharing bike, the satisfaction was hardly affected by the price increase. However, due to system errors and some negative news, the satisfaction of Hello decreased rapidly in a short time.

Among all-weather factors, air temperature and air pressure have a high correlation with the satisfaction of sharing bicycles in Beijing and Chengdu. However, the difference is that the correlation between the public opinion of sharing bicycles and the satisfaction in Chengdu is the

highest. Moreover, the wind speed in Chengdu does not correlate with the satisfaction of sharing bicycles.

6.1 Theoretical Contribution

This study firstly contributes to the existing literature on satisfaction of sharing bike by examining the satisfaction level for four major sharing bike brands and analyzing the relation between the satisfaction and weather variables in the context of shared mobility services. This study proposes that the customer satisfaction should be emphasized in research on the sharing economy. This emphasis would also expand research on consumer behavior especially in the sharing economy era.

Second, to better analyze and understand customer satisfaction, this study extracts millions of online comments including microblogs and news by using text mining creatively, which provides a different way to study the satisfaction of sharing bikes while most of the current studies are using questionnaires as the research method.

Third, this study further empirically the relationship between satisfaction level and weather variables by applying correlation and factor analysis. Understanding weather factor is more comprehensive in predicting user satisfaction in the context of shared mobility. At the same time, weather belongs to external factor in the context of sharing bikes while vast studies are focusing on internal factors of sharing bikes such as price, design and comfort level.

6.2 Practical Contribution

In addition to theoretical implications, this study makes several contributions to practice. On the one hand, for sustainable development, sharing bike service companies should endeavor to pay attention on brand images. They may gradually increase their market shares by optimizing important factors like riding comfort, rent, picking up/returning convenience in order to improve

the word of mouth of users. As the word of mouth of cyclists can have a significant effect on the brand choice, therefore, sharing bike companies should focus more on value-added services. On the other hand, this study provides evidence that sharing bike firms should build strong relationships with their customers, since the loyal user is more like to be involved in extra-role participation, which is a cost-efficient way to lead customers engaging in using sharing bikes (Liguo et al., 2021). In a word, sharing bikes should continuously strive to improve service quality (Mocioszek et al., 2020). Sharing bike firms can design customer loyalty program tactics to provide different rewards for users so that the customer satisfaction can be promoted as well.

6.3 Limitations

Without exception, several limitations of our study can provide future research venues. Although we analyzed the satisfaction of shared bicycles, not only weather and brand factors affect the satisfaction, there still are many places that need to be improved in this paper:

a. We only studied the satisfaction of sharing bikes in Chengdu and Beijing. With more time and energy, we can study the bicycle sharing satisfaction of all cities in China, analyze all the cities in China, and check which cities are not suitable for bicycle sharing.

b. In this paper, the research period is less than or equal to 365 days. During this period, extreme weather happened in few times, which is not enough for analysis. If permitted, we can study the satisfaction of sharing bicycles for a longer time to make a detailed analysis of extreme weather.

c. We only considered the relationship between weather and brand factors and sharing bicycle satisfaction. We have not considered environmental factors other than weather, such as traffic conditions, the total number of cars, population density, etc. These factors deserve further study.

6.4 Future research

Firstly, our data is confined to Chinese sharing bike users. Given the prevalence of sharing bike systems operating in a number of cities across the world, to generalize our findings deserve more supporting evidence from other regions or countries in the future.

Secondly, bike usage changes may occur daily, weekly, monthly, or quarterly. Thus, another future work will focus on multi-seasonal time series feature extraction.

Lastly, since brand is a very broad topic depends on various factors such as the characteristics of sharing bike system and the characteristics of the cycling facilities which are not studied in this research. Further investigation of brand among various systems is recommended.

7. References

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8. Appendix

Appendix 1 Events of Didi Sharing Bikes in 2019

Time	Events	Total Amount of Public Opinions	Satisfaction Level
March, 21 2019	Price Increasing	2385	66.83%
May, 16 2019	Parking Violation	5087	57.89%
November, 26 2019	Price Increasing	2151	54.21%

Appendix 2 Satisfaction Level during Didi Bike Events

Time	Didi News	Total Amount of Public Opinions	Satisfaction Level
March, 18 2019	Price Rising	1830	85.08%
March, 19 2019		2039	87.44%
March, 20 2019		2499	74.67%
March, 21 2019		2385	66.83%
March, 22 2019		1647	73.10%
March, 23 2019		1347	80.55%
March, 24 2019		993	81.57%
March, 25 2019		1494	75.10%
May, 13 2019	Illegal Parking, Penalization	2031	87.89%
May, 14 2019		2174	73.64%
May, 15 2019		3106	82.78%
May, 16 2019		5087	57.89%
May, 17 2019		5845	66.95%
May, 18 2019		3202	72.92%
May, 19 2019		1614	72.37%

May, 20 2019		2660	81.80%
May, 21 2019		2666	72.32%
May, 22 2019		2132	79.97%
May, 23 2019		3074	88.94%
May, 24 2019		2767	71.70%
November, 24 2019		716	84.08%
November, 25 2019		1278	85.13%
November, 26 2019	Price Rising	2151	54.21%
November, 27 2019		2066	63.84%
November, 28 2019		1409	72.60%
November, 29 2019		1650	70.61%
November, 30 2019		1040	77.40%
December, 1 2019		948	72.47%
December, 2 2019		3055	84.52%
December, 3 2019		3545	84.82%
December, 4 2019		2034	85.30%

Appendix 3 Events of Meituan Sharing Bikes in 2019

Time	**Events**	**Total Amount of Public Opinions**	**Satisfaction Level**
March, 12 2019	Singapore License Revoking	5882	69.09%
April, 8 2019	Price Rising in Beijing	4867	89.01%
May, 21 2019	Price Rising in Shenzhen	4419	74.99%
July, 26 2019	Price Rising in Shanghai and Shenzhen	3934	72.90%
October,9 2019	Price Rising in Beijing	6749	83.12%

Appendix 4 Satisfaction Level during Meituan Bike Events

Time	**Events**	**Total Amount of Public Opinions**	**Satisfaction Level**
March, 6 2019		2001	86.56%
March, 7 2019		2115	83.07%

March, 8 2019		2036	71.27%
March, 9 2019		2506	50.32%
March, 10 2019		1496	82.95%
March, 11 2019		4895	69.85%
March, 12 2019	Singapore License Revoking	5882	69.09%
March, 13 2019		5118	79.02%
March, 14 2019		4065	73.38%
March, 15 2019		3433	57.12%
March, 16 2019		1665	71.71%
March, 17 2019		1578	71.10%
March, 18 2019		2553	83.47%
March, 19 2019		2752	77.73%
March, 20 2019		4033	85.52%
April, 4 2019		4437	76.65%
April, 5 2019		1890	77.14%
April, 6 2019		2108	85.06%
April, 7 2019		2027	81.06%
April, 8 2019	Price Rising in Beijing	4867	89.01%
April, 9 2019		13654	89.53%
April, 10 2019		9134	89.19%
April, 11 2019		3544	76.98%
April, 12 2019		4164	80.86%
April, 13 2019		1855	84.47%
April, 14 2019		1439	82.14%
May, 19 2019		1750	80.34%
May, 20 2019		3424	81.25%
May, 21 2019	Price Rising in Shenzhen	4419	74.99%
May, 22 2019		3339	80.68%
May, 23 2019		4968	87.68%
May, 24 2019		6669	86.20%
May, 25 2019		3861	88.19%
May, 26 2019		2096	83.49%
July, 24 2019		5230	74.67%
July, 25 2019		6422	76.02%
July, 26 2019	Price Rising in Shanghai and Shenzhen	3934	72.70%
July, 27 2019		2614	82.48%
July, 28 2019		2097	83.12%

July, 29 2019		3887	83.87%
July, 30 2019		3995	78.80%
July, 31 2019		3175	72.44%
August, 1 2019		5190	62.99%
August, 2 2019		3534	72.13%
August, 3 2019		2012	59.15%
August, 4 2019		1291	76.99%
August, 5 2019		2747	80.49%
October, 7 2019		1156	82.35%
October, 8 2019		2084	78.07%
October, 9 2019	Price Rising in Beijing	6749	83.12%
October, 10 2019		5886	74.79%
October, 11 2019		2711	78.31%
October, 12 2019		2140	81.64%
October, 13 2019		1540	78.51%
October, 14 2019		2658	76.34%
October, 15 2019		3720	75.20%

Appendix 5 Events of Ofo Sharing Bikes in 2019

Time	**Ofo Events**	**Total Volume of Public Opinions**	**Satisfaction Level**
March, 2019	Online Discount		
March, 26 2019	Promotion Agent Mode	5729	50.53%
April, 2 2019	Media Reported: Ofo Bankruptcy	10614	49.82%
July, 5 2019	Daily Returned Deposits to 3500 People	19229	78.79%
September, 18 2019	The fifth Times to Move Offices	3189	74.76%
October, 2019	Force Customers to Consume		

Appendix 6 Events of Hello Sharing Bikes in 2019

Time	Events	Total Volume of Public Opinions	Satisfaction
April, 15 2019	Price Rising in Beijing	2994	89.55%
May, 16 2019	Illegal Launch in Beijing	3034	81.28%
August, 9 2019	Price Rising in Guangzhou	3454	70.12%
September, 11 2019	Apple store removed Hello app	3821	68.25%
October, 18 2019	Abnormal System	14920	52.90%

Appendix 7 Satisfaction Level during Hello Bike Events

Time	Events	Total Volume of Public Opinions	Satisfaction
April, 12 2019		1939	79.69%
April, 13 2019		1942	84.86%
April, 14 2019		1952	90.98%
April, 15 2019	Price Rising in Beijing	2994	89.55%
April, 16 2019		4778	90.81%
April, 17 2019		2770	83.21%
April, 18 2019		3761	80.72%
April, 19 2019		2805	87.99%
April, 20 2019		2215	90.16%
April, 21 2019		1794	82.16%
April, 22 2019		2599	86.53%
April, 23 2019		2244	86.36%
May, 13 2019		2065	70.17%
May, 14 2019		2755	70.31%
May, 15 2019		4144	74.06%
May, 16 2019	Illegal Launch in Beijing	3034	81.28%
May, 17 2019		6755	63.09%
May, 18 2019		3660	67.84%
May, 19 2019		2143	83.62%
May, 20 2019		3993	84.97%
May, 21 2019		3510	71.60%
May, 22 2019		5072	88.60%

May, 23 2019		4707	87.25%
May, 24 2019		3170	83.63%
May, 25 2019		6654	96.20%
August, 6 2019		2853	69.30%
August, 7 2019		3718	74.88%
August, 8 2019		3052	73.10%
August, 9 2019	Price Rising in Guangzhou	3454	70.12%
August, 10 2019		2194	67.41%
August, 11 2019		2306	47.48%
August, 12 2019		2844	74.33%
August, 13 2019		4282	78.70%
August, 14 2019		3907	76.02%
August, 15 2019		5698	57.67%
August, 16 2019		5006	54.95%
August, 17 2019		2135	58.97%
August, 18 2019		2264	70.05%
August, 19 2019		5609	84.54%
August, 20 2019		6885	91.78%
August, 21 2019		11646	93.31%
September, 7 2019		3646	86.83%
September, 8 2019		2716	75.74%
September, 9 2019		3741	78.43%
September, 10 2019		2623	74.27%
September, 11 2019	Apple Store Removed Hello App	3821	68.25%
September, 12 2019		3194	65.59%
September, 13 2019		1280	72.42%
September, 14 2019		1151	72.28%
September, 15 2019		1340	74.18%
September, 16 2019		2635	83.98%
September, 17 2019		9274	93.28%
September, 18 2019		5585	87.54%
September, 19 2019		3881	83.84%
September, 20 2019		4215	88.75%
September, 21 2019		2754	77.78%
September, 22 2019		4613	80.66%
October, 16 2019		5315	71.16%
October, 17 2019		3390	67.76%
October, 18 2019	Abnormal System	14920	52.90%
October, 19 2019		4302	60.53%
October, 20 2019		3050	64.85%

October, 21 2019		3392	63.09%
October, 22 2019		3312	61.75%
October, 23 2019		3336	63.76%
October, 24 2019		2935	79.97%
October, 25 2019		2263	83.52%
October, 26 2019		1846	75.51%
October,27 2019		2242	76.54%

Appendix 8 Descriptive Statistics of Sharing Bikes Satisfaction in Beijng and Weather Variables

	N	Minimum	Maximum	Mean	Std. Deviation
Sharing Bikes Satisfaction	361	40.05%	96.05%	77.77%	9.75%
Online Public Opinions (Beijing)	361	315	14714	2101.14	1537.435
Minimum temperature (℃)	361	-13	27.8	9.157	10.6324
Maximum temperature (℃)	361	-4.2	37.3	19.083	11.1806
Average temperature (℃)	361	-8.5	32.2	14.238	10.9138
Humidity (%)	361	10	91	49.65	17.881
Wind speed (m/s)	361	0.3	4.6	1.616	0.786
Air Pressure (hpa)	361	993	1038	1012.85	10.094
Visibility (km)	361	0.7	30	14.647	8.2561
Total precipitate (mm)	361	0	37.5	1.236	4.5005
Total average cloud amount (%)	361	0	100	62,91	36.907
Wind Scale	361	1	3	1.48	0.563
Valid N (listwise)	361				

Appendix 9 Descriptive Statistics of Sharing Bikes Satisfaction in Chengdu and Weather Variables

	N	Minimum	Maximum	Mean	Std. Deviation
Sharing Bikes Satisfaction	333	22.27%	98.20%	79.49%	13.51%
Online Public Opinions (Chengdu)	333	58	6565	578.81	524.544
Minimum temperature (℃)	333	-0.8	25.4	14.362	6.585
Maximum temperature (℃)	333	6.7	35.9	21.223	7.4802
Average temperature (℃)	333	5.1	28.6	17.498	6.6902

Humidity (%)	333	51	100	83.46	8.866
Wind speed (m/s)	333	0	3.1	0.902	0.4365
Air Pressure (hpa)	333	936	969	950.96	7.269
Visibility (km)	333	1.5	25.7	9.728	5.4822
Total precipitate (mm)	333	0	138.5	3.136	10.4156
Total average cloud amount (%)	333	2	100	86.23	22.912
Valid N (listwise)	333				

Appendix 10 KMO Test of Sharing Bikes Satisfaction in Beijing and Chengdu and Weather Variables

		Beijing	Chengdu
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,687	,707
Bartlett's Test of Sphericity	Approx. Chi-Square	4,779,316	3,569,682
	df	66	55
	Sig.	0	0

Appendix 11 Total Variance Explained of Sharing Bikes Satisfaction in Beijing and Weather variables

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Compone	Total	% of Variance	Cumulative	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.26	38.688	38.688	4.26	38.688	38.688	3.78	34.37	34.37
2	1.81	16.434	55.121	1.82	16.434	55.121	1.79	16.285	50.655
3	1.19	10.793	65.915	1.19	10.793	65.915	1.46	13.29	63.945
4	1.06	9.634	75.549	1.06	9.634	75.549	1.28	11.603	75.549
5	0.81	7.402	82.951						
6	0.72	6.58	89.53						
7	0.53	4.84	94.37						
8	0.38	3.454	97.825						
9	0.21	1.878	99.977						
10	0.03	0.274	99.977						
11	0	0.023	100						

Extration Method: Principal Component Anal

Appendix 12 Total Variance Explained of Sharing Bikes Satisfaction in Chengdu and Weather Variables

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Compone	Total	% of Variance	Cumulative	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.16	34.693	34.693	4.16	34.693	34.693	3.99	33.248	33.248
2	2.95	24.558	59.251	2.95	24.558	59.251	2.217	18.475	51.723
3	1.28	10.684	69.935	1.28	10.684	69.935	2.13	17.751	69.475
4	0.96	7.994	77.929	0.96	7.994	77.929	1.015	8.454	77.929
5	0.93	7.773	85.702						
6	0.7	5.809	85.702						
7	0.43	3.581	95.092						
8	0.28	2.35	97.442						
9	0.16	1.288	98.73						
10	0.12	0.985	99.715						
11	0.03	0.268	99.982						
12	0	0.018	100						

Extration Method: Principal Component Anal

Appendix 13 Rotated Component Matrix of Sharing Bikes Satisfaction in Beijing and Weather Variables

	Component			
	1	2	3	4
X1 Sharing Bikes Satisfaction	-0.338	0.157	0.146	0.54
X2 Online Public Opinions (Beijing)	0.413	0.075	0.207	0.462
X3 Minimum temperature (℃)	0.958	0.124	0.022	-0.106
X4 Maximum temperature (℃)	0,974	-0.001	-0.009	-0.048
X5 Average temperature (℃)	0.983	0.047	0.016	-0.065
X6 Humidity (%)	0.125	0.778	-0.387	-0.146
X7 Wind speed (m/s)	0.053	-0.238	0.9115	-0.009
X8 Air Pressure (hpa)	-0.898	-0.191	-0.073	-0.024
X9 Visibility (km)	0.058	-0.753	0.412	-0.099
X10 Total precipitate (mm)	0.052	0.506	0.279	-0.667
X11 Total average cloud amount (%)	0.201	0.786	-0.016	0.054
x12 Wind Scale	0.04	-0.176	0.908	0.109

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization

a. Rotation converged in 5 iterations

Appendix 14 Rotated Component Matrix of Sharing Bikes Satisfaction in Chengdu and Weather Variables

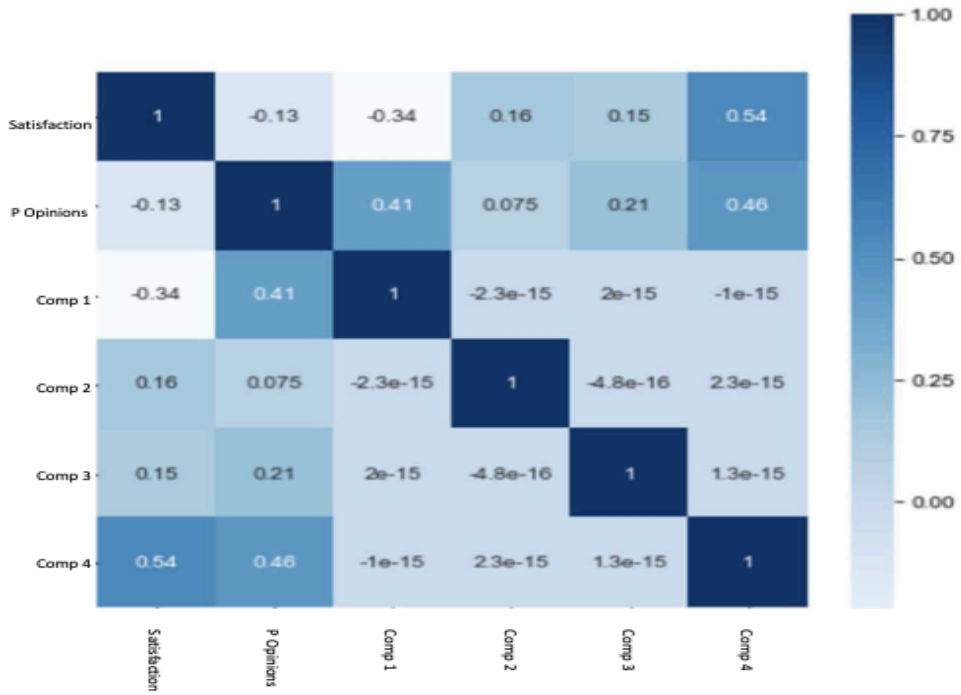
	Component			
	1	2	3	4
X1 Sharing Bikes Satisfaction	-0.308	-0.1	-0.005	-0.655
X2 Online Public Opinions (Beijing)	0.03	-0.03	0.058	0.861
X3 Minimum temperature (℃)	0.929	0.187	0.147	0.159
X4 Maximum temperature (℃)	0.947	-0.195	0.095	0.142
X5 Average temperature (℃)	0.968	-0.024	0.131	0.15
X6 Humidity (%)	0.088	0.888	-0.137	0.041
X7 Wind speed (m/s)	0.092	0.065	0.876	0.066
X8 Air Pressure (hpa)	-0.869	0.006	-0.149	-0.053
X9 Visibility (km)	0.408	-0.364	0.582	0.122
X10 Total precipitate (mm)	0.164	0.444	0.491	-0.099
X11 Total average cloud amount (%)	-0.157	0.764	0.151	0.065

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization

a. Rotation converged in 5 iterations

Appendix 15 Thermodynamic diagram of Correlation Coefficients of Sharing Bike Satisfaction in Beijing after factor analysis



Appendix 16 Thermodynamic diagram of Correlation Coefficients of Sharing Bike Satisfaction in Chengdu after factor analysis