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Naidong Zhao

Beijing Institute of Fashion Technology, sxyznd@bift.edu.cn

Xihui Zhang

University of North Alabama, xzhang6@una.edu

M. Shane Banks

University of North Alabama, mbanks@una.edu

Mingke Xiong

Beijing Normal University, xiongmkbnu.edu.cn

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Naidong Zhao

Beijing Institute of Fashion Technology
sxyznd@bift.edu.cn

Xihui Zhang

University of North Alabama
xzhang6@una.edu

M. Shane Banks

University of North Alabama
mbanks@una.edu

Mingke Xiong

Beijing Normal University
xiongmk@bnu.edu.cn

ABSTRACT

This paper systematically explicates the historical developmental stages of China's bicycle sharing economy including current and future business models. This paper also identifies problems that exist in the evolution of China's bicycle sharing and provides potential solutions. Furthermore, it proposes a fifth-generation bicycle sharing model, the "intelligent dock-less bicycle sharing" model and analyzes its characteristics and development. The paper concludes with a discussion on the limitations of the study and future research directions.

Keywords

Bicycle sharing, China, intelligent dock-less bicycle sharing, mobile payment, sharing economy

INTRODUCTION

China was known as the "kingdom of bicycles" in the 1980s. Over the last few decades the widespread use of motor vehicles and public transportation has significantly decreased the use of bicycles. Issues such as a dense urban population, traffic jams, and environmental pollution have led to a resurgence in the use of bicycles for basic transportation. The advent of new technologies such as mobile Internet and mobile payment systems has enabled the emergence of short-distance transportation services called "dock-less bicycle sharing" focused on solving the *last mile* problem of daily travel. As a result, China is reemerging as a bicycle kingdom, but this time it is "the kingdom of intelligent bicycles."

Founded in Beijing, China in 2014, OFO is widely considered the world's first dock-less bicycle sharing company (OFO website, 2017), although some scholars identify Germany's *Call a Bike* as the earliest adopter of this sharing model (Dell'Olivo et al., 2011). In 2015, the world's first "intelligent" bicycle sharing company, Mobike, was founded (Mobike website, 2017). Intelligent dock-less bicycle sharing has become an integral part of China's new sharing economy. An in-depth literature review of Chinese and international literature, however, found very few studies on the historical development of bicycle sharing in China, and these studies primarily focus on the traditional docked station bicycle sharing model. Our research addresses a gap in the sharing economy literature by examining the evolution of docked and dock-less bicycle sharing models in China. Using inductive and deductive methods, this paper systematically explicates the past, present, and future of bicycle sharing in China.

This paper proceeds with three main sections. The first section presents an overview of the history and evolution of bicycle sharing. The second section explores the historical development and present state of bicycle sharing in China. The third section discusses problems in China's bicycle sharing model, potential solutions, future development, and examines the fifth generation bicycle sharing model called "intelligent dock-less bicycle sharing."

BICYCLE SHARING: AN OVERVIEW

Shaheen et al. (2010) investigates the history of shared bicycles, but the focus is primarily on the traditional docked station bicycle sharing model. Fishman (2016) elaborated on the current status of the research on bicycle sharing stating that "no country has the bike share scale of China, yet research activity does not reflect this. A much greater focus on Chinese bike share needs to occur, as the sheer scale of their systems may provide important insights not just for China but for bike share generally" (p. 109). Similar work has been done by DeMaio (2009) and by Zhang et al. (2014), but the Chinese market has not been adequately studied by scholars researching docked station public bicycle systems.

We searched through CNKI in December 2017 and found 3,356 articles (including a large number of news articles) of various types with the theme of "bicycle sharing." In 2016, there were approximately 24 academic journal articles with the phrase "bicycle sharing" in their titles and approximately 800 in 2017 including five masters/doctoral dissertations. These

results show that bicycle sharing is becoming an increasingly popular research area, but few academic articles systematically explore the history and future of China's bicycle sharing market.

Since the first German bicycle was devised by Carl Deres in 1817 (Canada Science and Technology Museum, 2014), it has become a globally accepted means of transportation. Bicycles have experienced an evolution from private transportation bicycles to public citizen bicycles, and then to bicycle sharing utilizing information and communication technologies such as the Internet.

Public bicycle systems are the predecessors of bicycle sharing systems. The first generation of bicycle sharing systems, unlocked public bicycles, was born in Amsterdam in the 1960s. Since then, the bicycle sharing model has experienced several stages of evolution including coin-deposit systems, IT based systems, demand-responsive systems, and multi-modal systems (DeMaio, 2009; Shaheen et al., 2010). Table 1 describes the four historical generations of bicycle sharing.

Generation	Project Name	Year	Place of Birth	Components	Characteristics
First	White Bikes or Free Bikes	1965	Amsterdam, Netherlands	Bicycles	Distinct Bicycles (Color); Located Haphazardly; Unlocked; Free of Charge
Second	Coin-Deposit Systems	1991 1993 1995	Farsø&Grenå, Denmark; Nakskov, Denmark; Copenhagen, Denmark	Bicycles; Docking stations	Distinct Bicycles (Color or Special Design); Docking Stations; Deposits to Unlock; Anonymity
Third	IT-Based Systems	1996 1998 2000 2005	Portsmouth University, England; Rennes France; Munich, Germany; Lyon, France	Bicycles; Docking Stations; Kiosks/User Interface Technology	Distinct Bicycles (Color, Special Design, Advertisements); Docking Stations; Smart technology to Unlock; Theft Deterrents; Pay for Rides; Telecommunication Systems; Mobile Phone Access; On-board Computers
Fourth	Demand-Responsive, Multi-Modal Systems	2009	Montreal, Canada	Bicycles; Docking Stations; Kiosks/User Interface; Bicycle Distribution Systems	Distinct Bicycles/Electronic Bicycles; Docking Stations; Improved Theft Deterrents Mechanism; Touch Screen Kiosks/User Interface; Bicycle Redistribution Systems; Linked to Public Transit Smartcard

Table 1. Bicycle Sharing Generations (based on DeMaio, 2009 & Shaheen et al., 2010)

With the development of IT technologies such as wireless communications, mobile Internet, Internet of Things (IoT), and big data, the sharing of bicycles has risen in popularity all over the world. As of December 2017, there are at least 1,525 sharing programs with approximately 18,880,500 self-service public use bicycles and pedelecs (pedal electric cycle) using either station based docks or non-station based free-floating dock-less sharing models (Meddin & DeMaio, 2017). While bicycles sharing systems outside of China are still primarily “docked,” “dock-less” bicycle sharing has rapidly developed as the new model in large and medium sized cities in China.

BICYCLE SHARING IN CHINA: HISTORY AND PRESENT STATE

China's shared bicycle economy has evolved from the initial introduction of foreign public bicycle systems, to the emergence of specialized companies operating public bicycles, and then to the rise of intelligent dock-less bicycle sharing utilizing Internet and mobile technologies. China's bike sharing economy has experienced more than 10 years of development and has become the world largest intelligent bike-sharing market. The development of China's shared bicycle economy has four primary stages of evolution including four business models: Government-led (GL) model, business-led (BL) model, public-private partnership (PPP) model, and enterprise Internet (EI) model (see Table 2).

Stage	Years	Business Models	Representative Companies	Representative Cities
First Stage Germination	2005-2007	GL; BL	Shanghai Forever; Beike Lantu; Jiayimu	Shanghai; Beijing
Second Stage Development	2007-2010	GL; BL	Hangzhou Transport Group ; Fangzhou; Longqi Tianji	Hangzhou; Beijing; Nanjing
Third Stage Bottleneck	2010-2014	GL; BL; PPP	Gongjiao Jianning; Wuhan Xinfeida; Shanghai Forever ; Youon	Zhuzhou; Wuhan; Shanghai; Taizhou
Fourth Stage Outbreak	2014-present	EI	OFO; Mobike; Hellobike	Beijing; Shanghai; Xiamen

Table 2. History of Bicycle Sharing in China

According to statistics from China's Ministry of Transportation, as of July 2017, nearly 70 bicycle sharing companies were in operation throughout China sharing more than 16 million bicycles. Table 3 lists the most prominent bicycle sharing companies in the Chinese market. As of June 2017, the number of bicycle sharing users in China reached 106 million (CNNIC website, 2017).

Company Name	Founded	Headquarters	First Operation City	Notes
Mobike	January, 2015	Beijing	Shanghai	200 cities in 12 countries, November 2017
OFO Sharing Bicycles	2014	Beijing	Beijing	250 cities in 20 countries, December 2017
Bluegogo	November, 2016	Tianjin	Shenzhen	stopped operation, November 2017
Kuqi bike	November, 2016	Beijing	Beijing	stopped operation, November 2017
Hellobike	September, 2016	Shanghai	Xiamen	Merged with Youon, October 2017
Youon	2010	Changzhou	Taizhou	220+ cities, docking and smart sharing bicycle company

Table 3. Bicycle Sharing Companies in China

BICYCLE SHARING IN CHINA: CURRENT PROBLEMS, SOLUTIONS, AND FUTURE DIRECTIONS

Current Problems and Solutions

Bicycle sharing industry research has identified five areas that present significant challenges to success: (1) loss and vandalism; (2) bicycle redistribution issues; (3) IT technical innovations; (4) insurance and responsibility; and (5) ineffective project planning. Primary obstacles for bicycle sharing in the future include: lack of public infrastructure, loss, technical costs, funding support, and security (Shaheen et al., 2010). One key to successful operation of the bicycle sharing economy is bicycle friendly infrastructure including special bicycle lanes (Pucher & Buehler, 2006). Studies also found that significant barriers to bicycle sharing include convenience, entrenched competitive advantage, and security (Fishman, 2016).

According to Zhang et al. (2014), the key challenges in China's bicycle sharing projects are: (1) public land problems limit the project development; (2) lack of long-term financial support; (3) bicycle redistribution and maintenance problems affecting customer satisfaction; (4) integration with public transportation; (5) initial free riding may be the most effective price policy.

In the following section we summarize existing problems and explore possible solutions for bicycle sharing economy in China.

Capital Investment is Overheated, Enterprises are Expanding Blindly, Industry Homogenization

In response to business failures and disorderly development (e.g., Bluegogo and Kuqi bike in Table 3), the state should promulgate laws and regulations to help avoid market overheating and uneven investment. In addition, the state should increase the threshold for market access, strengthen market supervision, regulate the use of funds such as shared bicycle deposits, and establish a system of corporate integrity. In August 2017, the "Guidance on Encouraging and Regulating the Development of Internet Rental Bicycles" was released by China's Ministry of Transport in an effort to begin to address these industry issues.

Lack of Technological Innovation, Poor Urban Management

Bicycle sharing enterprises should focus on core "innovation." This includes innovation in technology and innovation of business models. For example, Mobike's smart lock was combined with mobile payments (GPS + GPRS + Bluetooth + QR Code), and along with LBS and GIS technology as well.

We suggest that enterprises and city managers work closely to implement innovative technologies and regulations. The following actions can be taken: promote electronic virtual parking and electronic fence technology, take advantage of IoT, AI, and big data analysis technologies, establish real-time transmission and shared data systems among users, enterprises, and governments, analyze distribution and damage reports, and improve the social credit mechanism.

Lack of Bicycle Sharing Intelligence and Substandard User Interfaces

A key success factor for bicycle sharing is the user experience. In this regard, OFO has been working with Didi Chuxing and mobile access platforms such as Alipay to improve the user experience. This allows the users to avoid downloading a new app or learn new or complex features. Mobike has partnered with WeChat to add the largest IM and SNS software portal in China to their service. It is also establishing a "Mobike+" strategy of the "living circle" including Baidu and China UnionPay to enhance the user experience, provide intelligent search and intelligent location functions.

Outdated Policies and Regulations, Bicycle Safety and Insurance Issues Need Attention

Although some researchers do not regard bicycle sharing as part of the sharing economy (e.g., Liu & Xia, 2017), we take the position that bicycle sharing meets the characteristics of a product service system (PSS) and should be included in sharing economy research. Bicycle sharing emphasizes the infrastructure rather than ownership and provides intelligent products and services. Laws and regulations need to be updated, the insurance mechanism for riders should be clarified, and special bicycle lanes should be established to increase the rights and safety of riders.

Regional Differences and Laws Affect Expansion

China's bicycle sharing projects are expanding at home and abroad, but have encountered some resistance. For example, Japan, the United States, and other developed countries have relatively strict legal access systems and different user travel habits. In cities such as Chongqing, China, roads and slopes are difficult for bicycle riders to navigate. In this regard, laws and regulations should take into account of the habits of local users. For instance, the installation of helmets, night riding lights, bicycle sharing auxiliary facilities, and in the introduction of electric power-assisted bicycles and other new models can be impacted by regional preferences as well as differing legal systems.

Bicycle Redistribution, Production and Maintenance Costs

Bicycle sharing enterprises should strengthen technical research and development, and use analysis of information and communications technology to guide the rational distribution of the bicycles. Incentive mechanisms can also be introduced to encourage users to redistribute bicycles voluntarily. Bicycle sharing enterprises, whether they are using original design manufacturers (ODM) or original equipment manufacturers (OEM), should focus on increasing the robustness of their bicycles to reduce maintenance costs.

Establishment of Bicycle Sharing Infrastructure and the Integration of Public Transport

Enterprises should work closely with the local government to make full use of the existing public infrastructure and lands. Intelligent access facilities should be set up in densely populated areas such as subways and bus stations to provide quick and easy access to bicycle sharing systems.

Future Directions

The success of China's bicycle sharing economy is dependent not only on a favorable external environment including politics, economy, and societal issues, but also from continual innovation in the bicycle sharing models. Technological innovations lead to innovation in business models which, in turn, attracts the support of venture capital necessary for enterprises to succeed.

According to Shaheen et al.'s (2010) criteria for the intergenerational division of bicycle sharing, we classify the latest model of China's bicycle sharing as the fifth generation or "intelligent dock-less bicycle sharing" model. The former generations belong to the traditional "docked station" model. Unlike the western smart card/credit card bicycle sharing model, the proposed fifth generation model integrates Chinese mobile payment and other technology models making it smarter and more convenient including anytime, anyplace, and all-weather service features which greatly improve the user experience. China's intelligent dock-less bicycle sharing model will also have the following features and trends: (1) smart-to-intelligent evolution (integrated IoT and AI technology); (2) shared bike + public transport + mobile payment one-stop service system using smartphone NFC capabilities to seamlessly access public transport systems and enable intelligent traffic systems; and (3) new concepts such as sharing smart electric bicycles and new business models.

CONCLUSIONS

This paper systematically elaborates the past, present, and future of bicycle sharing in China and presents the concept of the fifth generation or "intelligent dock-less bicycle sharing" combined with mobile Internet. China is experiencing increasingly serious traffic congestion and environmental problems as well as increased pressure on transportation systems due to rapid economic development. China has a rich cultural heritage of bicycle use as well as the development of technological solutions such as mobile Internet and AI. This combination is enabling the creation of the rapidly developing intelligent dock-less bicycle sharing model. This new model is certain to impact transportation in China and the world.

Based on our data collection methods, scope, time constraints, and the rapidly changing dock-less bicycle sharing system in China, this article only represents a snapshot of the state of the bicycle sharing economy, and, therefore, this topic deserves further study. We firmly believe that the impact of bicycle sharing has the power to significantly change transportation models in China and the rest of the world. We hope that this paper can serve as a stepping stone on this research topic.

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