From Renting Economy to Sharing Economy: How Do Bike-Sharing Platforms Grow in the Digital Era?

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Abstract

How can bike-sharing platforms achieve sustained growth in the digital era where digital technologies such as artificial intelligence and big data are integrated? Existing studies have overlooked the critical role of digital intelligence technology in the transformation and breakthrough of such platforms to a certain extent. They have failed to analyze the impact of the particularity of resources in the bike-sharing platforms from a system level. Based on the multiple case study method, we explored the growth process of bike-sharing platforms. This process includes two core growth mechanisms: (1) digital intelligent technology reshapes the dominant growth logic of the organization. In other words, bike-sharing platforms have formed the leading logic of the growth of sharing economy and reshaped the organization's growth direction, control concept, and inter-organization relations. (2) Digital intelligent technology reconstructs the platforms' resource management ability. In other words, under the growth logic of sharing economy, bike-sharing platforms have reconstructed their organizational structure, production mode, and cooperation mode. Our study brings new insights into the growth process of bike-sharing platforms, deepens the research in the field of resource arrangement, and further responds to scholars' appeals.

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Introduction

The rapid development of digital technology has ushered in a new era of digitalization, characterized by volatility, uncertainty, complexity, and ambiguity. Some called the environment today a "VUCA" world (Millar et al., 2018), which is short for these four characteristics, and brought new changes to the business environment (Mack et al., 2015). For instance, new economic forms such as the sharing economy and platform economy are emerging rapidly. Many platforms based on the logic of these new economic forms such as Uber, DiDi, and Airbnb achieved tremendous growth and success within a decade (Garud et al., 2022). Many of them became the "unicorn company" (a company that has reached a valuation exceeding $1 billion within 10 years) and received attention worldwide. On the other hand, digital technologies (e.g., multi-sided digital platforms, artificial intelligence, big data, the Internet of Things, and blockchain) profoundly changed the way firms create value and unlock vast growth opportunities (Jovanovic et al., 2022).

The bike-sharing industry has emerged quickly in this context. Within a few years, many bike-sharing platforms have appeared, changing people's travel habits and growing into a public travel mode alongside the bus and subway worldwide. Especially in China, bike-sharing is known as one of the country's "New Four Great Inventions," and it has spawned and influenced overseas bike-sharing brands such as Limebike and oBike, becoming a hallmark of China's sharing economy. The concept of bike-sharing comes from dockless public bicycles, which started with the government-led docked bike program. With the development of the sharing economy and digital technology, it was not until 2015 that the industry began to rapidly develop in China, leading to the global expansion of the bike-sharing industry. And now the bike-sharing industry pattern is relatively stable; the exploration of the bike-sharing platform is ongoing.

Based on a review of studies, a great number of scholars try to uncover the bike-sharing platforms' development "blackbox" from the perspective of the sharing economy. Till now, studies related to the sharing economy's *conceptual meaning* (Bardhi & Eckhardt, 2012; Belk, 2014; Botsman & Rogers, 2011; Scaraboto, 2015; Schor, 2016), *motivations for participation* (Celata et al., 2017; Hamari et al., 2016; Möhlmann, 2015; Tussyadiah & Pesonen, 2016), and *business and organization model* (Amit & Han, 2017; Muñoz & Cohen, 2017; Perren & Kozinets, 2018) are relatively sufficient. At the same time, more scholars begin to view the sharing economy dialectically and focus on *the outside effects on the environment, labor market, and so on* (Martin, 2016; Schor & Attwood-Charles, 2017). Besides, in recent years, the organizational issues are gradually received more attention. A few studies contributed to answering how and why platforms in sharing economy could get remarkable growth (Garud et al., 2022; Paik et al., 2019). This research stream offers new insights into bike-sharing platforms. Unfortunately, either these studies are focusing on the whole system, or deep enough on the inside mechanisms used by bike-sharing platforms. *In a word, we still know little about the questions regarding the growth of the bike-sharing platforms.*

Furthermore, unlike general internet platforms, bike-sharing platforms not only connect two-sided markets and minimize information asymmetry between supply and demand by reducing search and transaction costs (Nadeem & al-Imamy, 2020; Perren & Kozinets, 2018) but also promote interactions among users with existing resources in society, improve resource utilization by using rather than owning, and create value through user participation in production (Eckhardt et al., 2019; Gerwe & Silva, 2020). So as we see, the growth logic of bike-sharing platforms differs from the general internet platforms. According to Penrose's the theory of the growth of the firm, the firm can be viewed as a collection of productive resources. Following this opinion, through successfully orchestrating these resources, platforms could be flexible to the environmental changes and gain competitive advantages (Sirmon et al., 2011). Yet views from organizational growth focus more on the resource management process (Sirmon et al., 2007), how bike-sharing platforms cope with the increasingly complex economic, institutional, and technical environment remains largely unexplored. *Therefore, the exploration of the growth logic and resource management process of the bike-sharing platform is still far from enough.*

Another research gap closely related to bike-sharing platforms is the neglect of the critical role of digital intelligence technology in the transformation and breakthrough of such platforms to a certain extent. Emerging digital technologies such as artificial intelligence, machine learning, big data, blockchain, and digital platforms have diverse effects, and the different ways in which technologies are designed and deployed can fundamentally reshape key organizational processes (Bailey et al., 2022). But the study of new relationships between technology and organizational systems is often overshadowed by technological progress (Alaimo & Kallinikos, 2022). Although academic analysis has long studied how organizations coordinate complex, multifaceted tasks (Okhuysen & Bechky, 2009). How to use digital technology as a coordination mechanism and match specific organizational activities in contemporary organizations is still a challenge for organizational research (Murray et al., 2021).

Considering the above research insufficiencies, it is clear that the following research question remains unanswered: *How can bike-sharing platforms grow in the digital era amidst a complex environment?* To address this research question, we develop new theoretical insights into the growth process of bike-sharing platforms. Since bike-sharing platforms go beyond the primary two-sided market and network effect, more in-depth research needs to be conducted from a system level. The complexity perspective is beneficial in understanding the evolutionary logic of organizations and strategies in a complex environment (Grobman, 2005; Houchin & MacLean, 2005) and provides a theoretical framework for our study. Specifically, we employ the multiple case study method, which is valuable for theoretical construction (Eisenhardt, 1989). Our study draws on rich data from four platform enterprises from the bike-sharing industry. Through a comparative analysis, our findings address two key mechanisms affecting the growth of bike-sharing platforms: (1) digital intelligence technology reshapes the underlying dominant logic of the platforms, and (2) digital intelligence technology reconstructs the resource management capabilities of the platforms. In each mechanism, we analyzed different factors and discuss the interactive relationships among different factors. We highlight the importance of reconfiguring organizational resources and growth logic inside the bike-sharing platform system, explore the growth process from an empirical level, and further respond to scholars' appeals.

Theoretical Background

Review of the Research on Bike-Sharing Platforms

Bike-Sharing as a Type of Shared Mobility

Shared mobility contains shared modes which are intermediate modes between private modes and mass transit (Drut, 2018), and bike-sharing is one of the major representatives. An increasing number of topics focus on bike-sharing system optimization and design (e.g. Li et al., 2016; Ho et al., 2017; Caggiani et al., 2018). However, the bike-sharing platform concerned in our study is the fifth generation of the evolution of the bike-sharing systems, which is different from former generations (Shaheen et al., 2010; Si et al., 2019). "As the new generation of dockless bike-sharing programs emerged and gained popularity in Chinese cities, these large-scale data-driven commercial bike-sharing operations have brought new cycling booms in hundreds of cities around the world" (Si et al., 2019).

Bike-Sharing Platforms as the Iconic Programs of the Sharing Economy

More importantly, bike-sharing platforms gradually become the iconic programs of the sharing economy; a great number of scholars try to uncover the bike-sharing platforms' development "blackbox" from the perspective of the sharing economy. As mentioned above in the introduction part, studies emerged related to the sharing economy's conceptual meaning, motivations for participation, business and organization model, and outside effects on the environment and labor market. Although the effect of technological progress on bike-sharing research is significant (Si et al., 2019), the critical role of digital intelligence technology in the transformation and breakthrough of bike-sharing platforms is still be neglected. Depending on how people and technology are conjoined, digital technologies play different roles in organizations that may enable or inhibit specific organizational capabilities (Murray et al., 2021; Sirmon et al., 2007). This directly affects the enterprises' competitive advantage to obtain and maintain (Sirmon & Hitt, 2009). Especially in the digital era, the competitive environment of enterprises has undergone great changes. The characteristics of the VUCA greatly shorten the retention time of competitive advantages for enterprises. Enterprises usually try to find new technological, organizational, and strategic solutions to achieve growth (Dagnino et al., 2021).

Review of the Growth Mechanism of Internet Platform

In order to study the growth process of bike-sharing platforms, it is necessary to review the relevant research on the growth mechanism of Internet platforms. The concept and connotation of platform enterprises have been widely discussed and agreed upon by scholars. Generally, platform enterprises are economic organizations that exhibit bilateral architecture and network effects (Hagiu, 2014). By building platform networks and promoting user interactions and transactions, they provide information or services for

bilateral or multilateral user groups (Ciborra, 1996). Scholars have mainly conducted research on platform enterprises from three perspectives: industrial organization, strategy, and technology management (Mcintyre & Srinivasan, 2017). Industrial organization economists focus on analyzing bilateral and multilateral markets and addressing the network effect of platform enterprises (Hagiu, 2014). Strategy scholars concentrate on gaining competitive advantages (Eckhardt et al., 2018). Technology management researchers explore the organizational design of platform enterprises and develop modular systems (Gawer & Cusumano, 2014). With the deep integration of platform enterprises, information technologies such as the Internet and mobile Internet and new economies such as sharing economy, platform economy, digital economy, and gig economy, Internet platform enterprises have become the dominant organizational form at present.

The rise of platforms in the sharing economy has occurred in this context. These platforms are a new form of organization with unique characteristics (Bailey et al., 2019; Murray et al., 2021), such as mass production (Wei et al., 2021), sharing economy structure (Gerwe & Silva, 2020), and a combination of producers and consumers (Eckhardt et al., 2019; Ritzer & Jurgenson, 2010). Despite this, research on the growth of such platforms is still in its early stages (Mont et al., 2020), with studies focusing mainly on two topics: organizational model and business model. The first type of research examines the basic organizational structure of these enterprises (Amit & Han, 2017; Perren & Kozinets, 2018), while the second type studies how such platforms enhance their adaptability to environmental changes through business model innovation (Garud et al., 2022; Han et al., 2021).

In summary, while research on the growth of platforms in the sharing economy has advanced, there is still a need for further investigation. Specifically, current studies often overlook the intricate interactions among stakeholders in the whole system. Moreover, resource management tends to be viewed solely as the responsibility of managers, with the scope of action limited to resources and capabilities. In this perspective, the platform is viewed as an inanimate collection of resources (Helfat et al., 2007; Sirmon et al., 2011), rather than a dynamic entity shaped by ongoing interactions. Finally, many studies take a static approach to their analysis, without accounting for the evolving nature of the whole system. Therefore, it is necessary to re-examine the resource management logic that contributes to platform growth, with a focus on dynamic and systemic considerations. As the bike-sharing platforms perform iconic programs of the sharing economy, a systematic study regarding the bike-sharing platforms' growth logic and resource management process is further needed.

Complexity Perspective and Research Framework

The research trends related to bike-sharing tended to move from foundation to complexity (Si et al., 2019). The complexity perspective offers new understandings for our study. The rise of complexity problems in various fields in the face of increasingly complex economic and social systems has led to a shift in the trend of thought from natural science to social science (Anderson, 1999). The complexity perspective is gaining prominence as a way to understand and transform organizations among academics and practitioners (Burnes, 2005) and has evolved into a

research paradigm. Complexity research focuses on the self-organizing mechanism of dynamic ordered things, with particular emphasis on complex physical systems (CPS) in the natural world and complex adaptive systems (CAS) in the life world, leading to the development of new ideas and methods. As a result, the perspective of complexity is expanding into the field of organization growth. However, research on new forms of organization in the digitalization context still requires further exploration.

After incorporating the conceptual tools and methods of the complexity perspective, organizational management research has produced significant results, mainly developed from the following dimensions. Firstly, research on organizational and strategic change. Grobman (2005) and Houchin and MacLean (2005) suggested that the complexity perspective is beneficial in understanding the evolutionary logic of organizations and strategies in a complex environment and, secondly, research on knowledge management. Chiva et al. (2010) and Buijs (2003) observed the interactive learning characteristics between the subject and the environment in complex systems, triggering new thinking in this field. Thirdly, Rosenhead et al. (2019) introduced the complexity perspective into the field of leadership research and proposed the research potential of complex leadership in the knowledge economy through in-depth literature analysis. Additionally, the combination of complex systems and information technology has been studied. Okwir et al. (2018) integrated the complexity perspective into the management and optimization process of the performance management system and differentiated the transformative impact of an organization's internal and external environment complexity.

From the perspective of complexity, combined with literature review, the theoretical framework is proposed as Fig. 1. Specifically, three core opinions from the complexity perspective guide our study (Anderson, 1999; Burnes, 2005; Holland, 2014; Ladyman et al., 2013). *First*, members of a complex system are not bound by fixed rules but follow basic stimulus–response mechanism. These members are self-adaptive agents, are able to interact with the environment and other agents, and constantly learn and accumulate experience in this continuous interaction and, based on this, change their own structure and behavior, which leads to the evolution of the whole complex system. *Second*, small local changes may have a great impact on the whole system, which is difficult to predict and control at the system level, but
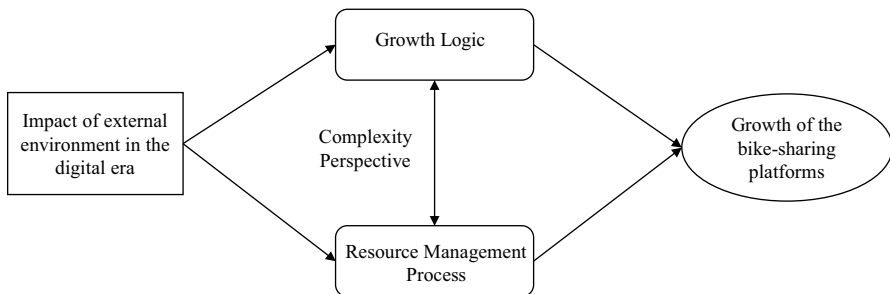
Fig. 1 Framework of the study

the short-term behavior of the system can be mastered to a certain extent. *Third*, complex systems tend to be self-organized, symbiotic evolution and dynamic equilibrium at the edge of chaos.

Based on this, various stakeholders within the bike-sharing platforms system may have new interaction modes and inter-organizational relationships. Bounded rationality, local prediction and marginal innovation are becoming more important to the growth of bike-sharing platforms. The bike-sharing platforms can promote the self-organization of the platforms from the top-level design by adjusting the business model, strategic direction, organizational structure, and product functions. In conclusion, conducting case studies that fully consider the complexity of organizations is necessary.

Methods

Research Setting

Figure 2 illustrates the overall development of the bike-sharing industry, which started with the government-led docked bike program. However, the commercialization of the bike-sharing concept in 2010 did not gain much traction initially. It was not until 2015 that the industry began to rapidly develop in China, leading to the global expansion of the bike-sharing industry. By 2018, many bike-sharing operators had been eliminated from the industry, and the industry has since entered a relatively stable state with a clear industry pattern. Nonetheless, there is ongoing exploration of the potential of the bike-sharing model.

Based on the multiple case study method, two groups of bike-sharing operators were chosen as units for analysis (see Table 1). Following is the basic information about each bike-sharing operator: (1) Ofo Bike was founded in March 2014. At first, it carried out a bike-sharing program among teachers and students on the campus of Peking University. Later, it gradually stepped out of the campus and developed into a leader in the industry. Ofo Bike has struggled to survive after suffering a setback
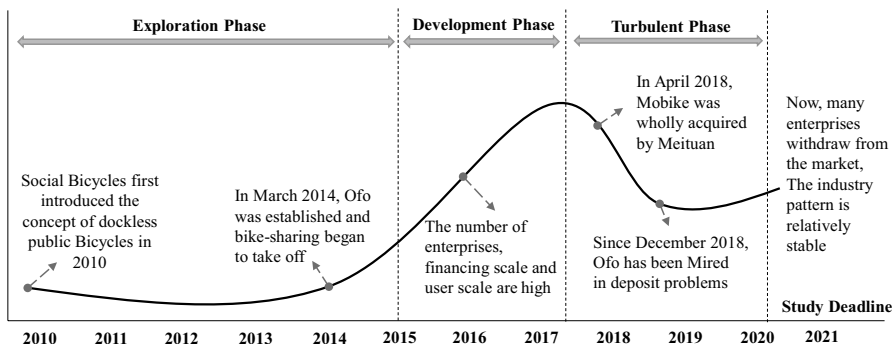
Fig. 2 Overview of the development of the bike-sharing industry. Source: it is arranged according to the archival documents we collected (see Table 2)

Table 1 Introduction to the case units

Grouping	Vertical comparison (Group 1)	Vertical comparison (Group 2)	Explanation
Parallel comparison (Group 1)	**Ofo Bike** (http://www.ofo.so/#/) 1. In June 2015, Ofo was officially launched and operated on the campus of Peking University 2. In November 2016, urban services were officially opened 3. In May 2017, the band was upgraded to Ofo 4. In December 2018, more than 10 million people queued for deposit refunds online	**Hello Bike** (https://www.hello-inc.com/) 1. In November 2016, Hello Bike was officially launched 2. In June 2017, the new strategy of Hello Bike was established 3. In March 2018, first is opening the national credit deposit free 4. In September 2018, the brand was upgraded to Hello Travel 5. In October 2018, the ride-hailing service was officially launched	Focusing on two-wheeler business
Parallel comparison (Group 2)	**Meituan Bike** (**The original Mobike**) (https://rules-center.meituan.com/rules-detail/183) 1. In April 2016, the bike-sharing business was officially launched 2. In April 2018, Meituan wholly acquired Mobike 3. In January 2019, it was renamed Meituan Bike 4. In December 2020, Mobike stopped its service and was fully connected to Meituan	**Didi Bike** (**The original Bluegogo**) (https://www.didiglobal.com/travel-service/bike) 1. It was fficially launched in November 2016 2. In January 2018, Didi announced to host Bluegogo and launch Didi Bike 3. In April 2020, the bike-sharing industry received $1 billion in the financing, which was the first financing of the year	In the form of business divisions
Explanation	Leaders in the early stage of the bike-sharing industry focus on first-tier and second-tier cities	The second echelon in the early stage of the industry focuses on the third and fourth-tier cities	Comparison

in 2018. (2) Mobike was founded in January 2015 and developed into a duopoly competition with Ofo Bike in 2017. Later, it was acquired by Meituan in 2018. Currently, Mobike has been fully connected to Meituan APP and has become one of Meituan's business divisions. And Mobike was renamed Meituan Bike. (3) Hello Bike was founded in September 2016. It is currently the market leader in the bike-sharing industry. The business includes shared bikes, shared electric bikes, and hitch rides. Hello Bike has developed into a professional mobility platform. (4) Bulegogo was founded in November 2016. Its bikes are well received by users for their high comfort and once rank among the top three in the bike-sharing market. After Bulegogo's funding chain broke in 2018 and it was acquired by Didi, Didi launched its own bike-sharing business.

Vertically, Ofo and Mobike were the leaders in the bike-sharing industry during the development period, leading the development of the bike-sharing model, and their businesses were concentrated in China's first and second-tier cities. Hello Bike and Bluegogo were second-tier operators at the time, focusing on the third and fourth-tier cities in China. Horizontally, the two-wheeler business was the core of Ofo and Hello Bike, while Meituan Bike and Didi Bike were embedded in the two platform ecosystems of Meituan and Didi in the form of business divisions. Comparative analysis between different analysis units helped to comprehensively and deeply understand the growth logic of bike-sharing platforms.

Data Collection

Based on the multi-source data collection method (Eisenhardt, 1991), we extensively collected primary and secondary data related to the case company to form an evidence triangle (Yin, 2009). We list the types and sources of data in Table 2. The first type is archival data. This kind of data mainly includes interviews with founders of enterprises, internal documents of enterprises, and direct network data. Second is the semi-structured interviews and divided into two categories, in-depth interviews and informal interviews. Mainly involving senior and middle-level managers, scholars, and user representatives. Finally, the third type is field observation. Our research team visited different cities in China, e.g., Beijing, Shanghai, Dalian, Shenyang, Jinan, Qingdao, Chongqing, Haikou, Changsha, and Zhengzhou, to experience the operation of shared bikes in various places.

Data Analysis

We conducted a rigorous analysis process by continuously collecting multi-source data and reviewing relevant literature. Through iterative comparative analysis, we identified significant aggregate dimensions that influence the growth of bike-sharing platforms (Gioia et al., 2013). To ensure the reliability of our analysis, we employed a joint coding approach involving multiple researchers and appointed a devil's advocate role. Any disagreements in the coding process were resolved through negotiation and discussion (Denzin & Lincoln, 2011).

Table 2 Main data sources

Data sources	Specification and coding of collected data
Archival documents	• Founder public interviews and presentations (84 thousand words, D1A-D) • Direct material from inside and outside of the company (103 thousand words, D2A-D) • Media releases (394 papers, D3A-D)
Interviews	*In-depth interviews* Senior management team: • The vice president of Hello used to be the director of shared two-wheeler service device (F1a) • Director of Didi development research institute (F1n) • Middle and first-line employees: • Hello: general manager of e-bike sharing business (F1b) • Hello: general manager of bike-sharing business (F1c) • Hello: director of public relations (F1d) • Hello: director of government relations (F1e) • Hello: regional leader of bike-sharing business in Northeast China (F1f) • Meituan: regional leader of Meituan bike in Northeast China (F1l) • Didi: regional leader of Didi bike in Northeast China (F1m) • Didi: director and employee of Didi development research institute (F1o) • Didi: HRM employee (F1p) Relevant regulatory authorities: • Ministry of housing and urban–rural development in Shenyang (F1g, F1h) • Department of Transportation in Shenyang and Jinan (F1i, F1j, F1k) *Informal interview* • Expert and user representatives in the domain (F2A-D)
Field observation	Visit the exhibition hall of corporate headquarters; visit Beijing, Shanghai, Dalian, Shenyang, Jinan, Qingdao, Chongqing, Haikou, Changsha, and Zhengzhou, to observe and experience the operation of bike-sharing services (S)

Coding rules: archival data is *D* the semi-structured interview is *F* field observation is *S* Hello is *A* Ofo is *B* Meituan is *C* and Didi is *D*. In the in-depth interview, each interviewee was individually numbered from a to p

Figure 3 shows the entire data structure that resulted from the data analysis. The 1st order concepts are based on repeated combing of interviews and archival materials; the 2nd order themes are the combination of descriptive coding sorted out in the first step. Then, through the cross comparison of the original data, coding results, and existing literature, aggregate dimensions were summarized.

Case Study and Findings

Reshape the Dominant Growth Logic

Reshaping the Direction of Growth

In China, the bike-sharing industry started with the concept of campus bikes, with Ofo being the first operator to adopt the "sharing economy + intelligent hardware" model on university campuses. Initially, Ofo's mission was to promote

1st Order Concepts   **2nd Order Themes**   **Aggregate Dimensions**
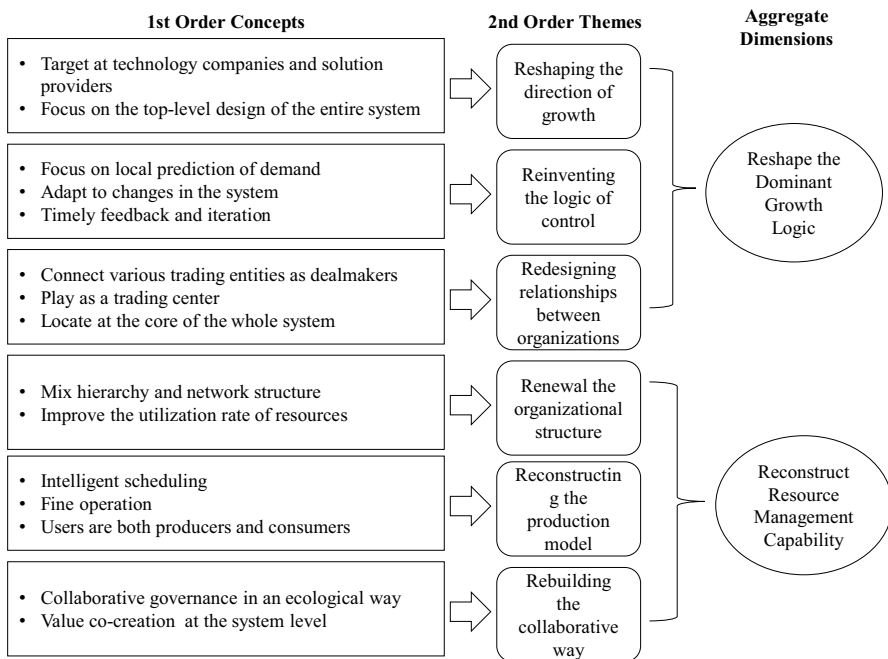
Fig. 3 The data structure

environmental protection and the sharing economy by connecting bikes instead of producing them (D1B). Their innovative business model quickly spread to universities all over China. In 2016, when faced with stiff competition from Mobike, Ofo expanded their services to urban areas and launched the "city sharing" program, while still staying true to their original mission of promoting sustainability.

"[Ofo] is aimed at urban users and encourages them to share their idle bikes. By connecting to a digital platform, they can get the right to use all the bikes on the platform, and then exchange one for N. At the same time, Ofo welcomes global bicycle brands and manufacturers to integrate bicycle hardware and bicycle services into the platform, so as to jointly provide differentiated and personalized travel services for users." (D1B, D1C).

However, in contrast to Ofo's approach, Mobike "built its own factory, established an R&D team, and produced its own smart shared bikes" (D1C). Ofo faced some challenges in terms of product quality, service standards, and level of intelligence compared to Mobike, which was considered better by some sources (F2B, F2C). However, both companies continued to rapidly expand their businesses, releasing large numbers of bikes in a short time, and the trend of a duopoly in the bike-sharing field began to emerge. This increased recognition of the bike-sharing model by the market, leading to various capital inflows into the industry.

With the emergence of bike-sharing, there was no clear regulatory body overseeing the industry, and there were no clear standards for access and licensing. As a result, many bike-sharing companies flooded the market, leading to intense

competition and oversupply. According to one source, "The cost of ofo bikes confiscated and to be destroyed by the regulatory authorities is up to several billion RMB every year" (D2B). This unsustainable model ultimately led to many bike-sharing companies experiencing broken capital chains and causing losses to users. As a result, the few remaining bike-sharing operators in the industry have had to reevaluate their development strategies and focus on achieving long-term sustainable operations.

> "Although it seems that the threshold of entry into this[bike-sharing] industry is very low, it requires a lot of fine operation if you really want to complete the life cycle of a vehicle to achieve a profit." (F1c); "Mobike needs to find a new direction and get back to the essence of business... To provide better services and make the cash flow gradually positive, it will be more practical to do shared bikes." (D1C, D3C)

Reinventing the Logic of Control

Actively developing digital technology and promoting delicate operation has become the consensus of the bike-sharing industry to achieve healthy growth. As one expert notes, "What you see on the road is a bicycle, but the operation behind it is the real technology" (F1c). Compared to the earlier on-campus operations, predicting user needs and controlling user behavior in the current context is more challenging. Successful management experiences on campuses are no longer sufficient, and new management capabilities are required to deal with the complexities of the environment. Therefore, bike-sharing operators are gradually introducing precise positioning, big data-assisted decision-making, electronic fence, and other technologies to enhance their operation and maintenance scheduling capabilities. The focus is now on the pursuit of local prediction; i.e., accurately predicting demand changes in a specific area and timeframe.

> "Although most of the operation and maintenance staff are outsourced, under the guidance of Mobike's self-developed big data system, everyone can know exactly what they want to do next... The whole process is similar to completing quests in the game." (F1l); "At that time[2016] we[Hello Bike] were the first in the industry to [apply] electronic fence technology." (F1f); "We[Didi bike] overcame technical difficulties to achieve high-precision positioning with GPS+ Beidou dual-mode, which has been launched in some cities." (F1m)

Hence, the future development direction for bike-sharing platform enterprises is to achieve precise local prediction. However, Ofo's development philosophy still centers around scale and believes that only by expanding can shared bikes be saved from destruction. As a result, Ofo's operational intelligence has been lacking and mainly relies on human resources, leading to high operational costs and ultimately causing a financial crisis.

Redesigning Relationships Between Organizations

Bike-sharing platforms now seek to establish a more collaborative relationship with stakeholders, including users, local governments, and regulatory authorities. This change in approach is driven by the recognition that sustainable growth in the bike-sharing industry requires a more nuanced understanding of local user habits and the development of partnerships with key players in the market. As Hu Weiwei, founder of Mobike, notes, "The worldwide promotion [of bike-sharing] is not a process of simply throwing bikes on the road, but needs to study the user habits of local people and negotiate with local governments, which takes time" (D1C). By forging cooperative relationships with stakeholders, bike-sharing platforms can better navigate regulatory challenges, ensure the optimal allocation of resources, and deliver value to users over the long term.

To integrate shared bikes into the urban transportation system and make them a part of daily life, it is crucial to shift users' perception from a mere rental concept to a public service. Otherwise, shared bikes may become a burden on urban travel as their numbers increase. However, by promoting the public nature of shared bikes and highlighting their role in promoting green travel and urban management, it is possible to form partnerships with regulatory authorities and achieve co-governance. From a government supervision perspective, enterprises' participation in urban governance is highly desirable, and such collaborations can yield significant benefits for all stakeholders involved. For example:

> "We[Shenyang] will share the amount of bike-sharing enterprises with its service evaluation and product quality indicators linked, every year through the score to dynamically adjust the quota of each bike brand, if a brand is not good enough, [we] will give the quota to others." (F1g); "Xiamen and other cities require intelligent technology to solve the problem of urban shared bike parking management." (F1d); "Some city authorities asked us[Didi bikes] to link up with data... Every bike we launch has a corresponding number, and after uploading it to the data system, we can know the specific launch situation." (F1m)

Reconstruct Resource Management Capability

Renewal the Organizational Structure

As the bike-sharing platform enterprises continue to grow and expand, a new organizational model that combines hierarchy and network structures has emerged. This model is characterized by blurred organizational boundaries, with digital technology platforms serving as the core. These platforms connect multiple markets and create a network structure centered on digital technology, linking many users through technical means. This shift in organizational structure did not happen suddenly but was the result of ongoing optimization and exploration.

After suffering a financial crisis in 2018, "[Ofo] adjusted and upgraded its organizational structure, establishing strategic financial and legal centers, R&D and big data centers, and product and growth centers to survive in the industry." (D2B); After deciding to build a two-wheel travel ecosystem, "We[Hello bike] adjusted the internal personnel structure, and Peng, the former head of the bike-sharing business division, will focus on the exploration and development of new business... By combining similar businesses, we create synergy." (F1a, D2A); After integrating Mobike into Meituan, "Based on Meituan travel business division, Meituan has full access to Mobike's resources, combined with bus, map services, and other businesses." (D2C); On the basis of digesting Bluegogo's existing resources, "Didi announced the integration of its bicycle and e-bike divisions to form a new bike-sharing brand, which is Didi bike." (D2D)

This new organizational structure brings about a revitalization of existing resources. As a trading center, bike-sharing platforms have the ability to mobilize resources from various parties, redefine originally scattered resources outside the system, provide new usage scenarios, and improve resource utilization efficiency. Furthermore, bike-sharing platforms connect external operation and maintenance personnel to maintain system stability and create new job opportunities.
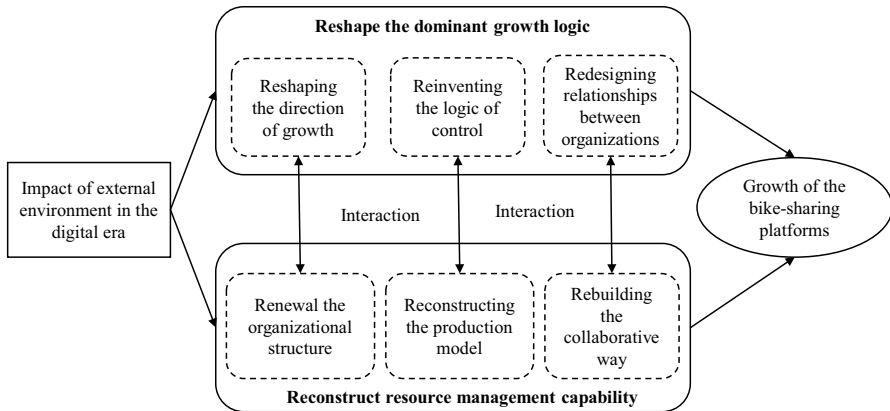
Reconstructing the Production Model

Following the new control concept, bike-sharing platforms have implemented measures to achieve precise operations by reconstructing their original modes at both the production and user ends. Specifically, they promote the servitization of products at the production end and uncover the identity of prosumers at the user end. Through this, they have successfully transformed bicycle factories from suppliers to service providers. The bike-sharing platform employs an intelligent production mode where it undertakes technology research and development as well as exploration tasks. Meanwhile, the demand side determines the product specifications and quantity standards. These changes are a result of mining feedback data from numerous users of the product. In fact, this has "forced China to introduce a new national standard for shared bikes and e-bikes" (F1b).

Furthermore, users are not only highly valued in terms of their demands and involvement in product design, but they are also involved in the operation of enterprises. They have multiple identities as consumers, producers, and operators. To regulate users' behavior, bike-sharing platforms have implemented a series of reward and punishment systems. This strengthens users' awareness of "sharing" and subtly guides them to pay for the bike-sharing system. For instance, users can report faulty shared bikes through the platform's mobile application. Meituan Bike has implemented a red envelope system that encourages more than 200 people per second to participate in scheduling and maintaining bikes during peak periods. This has significantly alleviated the operational and maintenance pressures of the enterprise. Additionally, Hello Bike has pioneered electronic fence technology, where users are penalized with extra dispatch fees if they fail to park in designated areas.

Table 3 Effect evolution of bike-sharing platforms' reform action

Comparison	Standard					
	Change on the concept level			Change on the capability level		
	Reshaping the direction of growth	Reinventing the logic of control	Redesigning relationships between organizations	Renewal the organizational structure	Reconstructing the production model	Rebuilding the collaborative way
Hello bike	*High* — Application of digital intelligence technology to reshape the two-wheeler travel business format	*High* — Intelligent dispatching of bikes to guide hot spots	*High* — Comply with quotas and create new jobs	*High* — It is manifested as a new organization that blends hierarchy and network structure	*High* — Intelligent production, delicate operation	*High* — Collaborative governance, value creation
Ofo	*Low* — Focusing only on a single business unit of shared bikes, excessive pursuit of scale and valuation	*Low* — Big data system focuses more on government-enterprise cooperation governance, which is insufficient in operation	*Low* — Big data system focuses more on government-enterprise cooperation governance, which is insufficient in operation	*Low* — Continue to deepen the field of bike-sharing area	*Low* — Insufficient product upgrade, extensive operation	*Low* — Actively participate in urban governance and construction
Meituan bike	*Medium* — As a section embedded in the life service scene	*High* — Intelligent dispatching of bikes to guide hot spots	*High* — Comply with quotas and create new jobs	*Medium* — Increasing the importance of the bike-sharing business in the overall structure	*High* — Intelligent production, delicate operation	*High* — Collaborative governance, value creation
Didi bike	*Medium* — As a section embedded in the life service scene	*High* — Intelligent dispatching of bikes to guide hot spots	*High* — Comply with quotas and create new jobs	*Medium* — Upgraded the original structure, after fusion launched a new brand	*High* — Intelligent production, delicate operation	*High* — Collaborative governance, value creation

Fig. 4 Bike-sharing platforms' growth process model

Rebuilding the Collaborative Way

Lastly, bike-sharing platform enterprises make full use of their cooperative relationships with multilateral entities to allocate resources in an ecological manner. Through collaborative governance among multiple entities, the value of co-creation is realized, and a win–win symbiosis is achieved at the system level, forming a dynamic and stable self-organization system. Bike-sharing is not merely a bike rental service but a crucial component deeply embedded in intelligent city governance. Regulators can use the basic travel data collected by the Internet of Things to dynamically coordinate and allocate urban public transport resources, thereby achieving a dynamic balance with a targeted view. Similarly, bike-sharing platforms can use urban public data to assist in the operation process. This use of public data helps bike-sharing platforms provide better services, coordinate connected resources, and ultimately achieve value co-creation among enterprises, governments, and users. For example:

> "We[Hello bike] are recently making a big data department the automatic generation of operation area, it involves some of the internal data, more is the external data, because if we are new to enter a city, we may buy these data from providers like Baidu and Alibaba." (F1c)

Discussion and Conclusions

Constructing the Process Model

The case studies show that the growth paths of each analysis unit are unique, and two inferences can be drawn from them (see Table 3 for details). Firstly, if the evaluation of the action effect is positive, the result tends to form a self-organizing

system, and the enterprise achieves sustainable growth. For example, Hello Bike has established a dynamic and stable complex self-organization system. By the end of 2019, when the survey was carried out, the market share from the order volume of bike-sharing industry was about 55%, surpassing Meituan Bike and Didi Bike combined. Because Meituan Bike and Didi Bike are embedded in the larger business ecology, limited by their own positioning, the effect of reform is discounted to a certain extent. Conversely, if the action is inadequate, it tends to form another-organizing system. Although the enterprise may achieve short-term explosive growth with continuous external energy inputs (such as capital), it is difficult to sustain it. The typical representative is Ofo Bike, which has obtained the most rounds of financing in the bike-sharing industry since its establishment. However, a series of operational problems have broken out, and the founder has been restricted from high consumption for many times. At present, the company is still struggling to survive.

Next, we present the growth process model of bike-sharing platforms (see Fig. 4). Generally, bike-sharing platforms are impacted by the complex external environment in the digital era, making it challenging for them to adapt to changes during their initial stage. They explore new business forms of bike-sharing through trial and error, leading to inevitable mistakes. In this context, bike-sharing platforms gradually realize the significance of establishing a dynamic and stable self-organizing system and begin to focus on improving resource management efficiency.

At a conceptual level, the platform decides to reshape its growth direction, leading to a corresponding reconstruction of its organizational structure. As the platform reconstructs the control concept, it fully develops and utilizes digital technology for intelligent production and delicate operation. This results in new inter-organizational relationships, leading to changes in collaboration between principals within the system.

Theoretical Implications

The main theoretical insights of this study are that the growth and evolution of bike-sharing platforms is an organizational design at the level of the social and economic exchange system and that the goal is to achieve dynamic stability among the various entities in the system. The study also highlights the importance of frequent interaction within the system to realize a self-organizing state and how this can significantly utilize the connected resources, which is consistent with the core of the sharing economy. The study extends the research results on the core of the sharing economy and introduces a complex perspective to expand the study of sharing economy from the system level, providing a better understanding of the influence brought by the particularity of resources in the bike-sharing system. Additionally, the study identifies two core mechanisms of action in the growth of bike-sharing platforms and deepens the research in the field of resource arrangement, particularly in the resource management process of bike-sharing platforms as the ecological construction of enterprises with a digital platform as the core.

First, the aim of this study is to explore the growth mechanism of bike-sharing platforms from an empirical perspective and address the theoretical question of

achieving sustainable growth in the digital era. Existing research tends to overlook the transformative impact of digital technology and struggles to explain the novel organizational characteristics of bike-sharing systems. Therefore, our study builds upon the findings of Gerwe and Silva (2020) and Eckhardt et al. (2019) on the core of the sharing economy by introducing a complex perspective to expand the study of the sharing economy at the system level. Specifically, we analyze the influence brought by the particularity of resources in the shared bike system. As a result, we partially resolve the debate on whether shared bikes deviate from the core of the sharing economy.

Second, the study identifies two key mechanisms of action that contribute to the growth of bike-sharing platform enterprises, which addresses the call from scholars to study organization theory from a complex perspective. Firstly, the research findings of this paper extend the perspectives of Holland (2014), Ladyman et al. (2013), Burnes (2005), and Anderson (1999) on the complexity perspective. This study proves the applicability of the complexity perspective in studying organizational growth and change empirically. On the other hand, the study expands on Sirmon et al. (2011)'s research in the field of resource arrangement. It shows that the resource management process of bike-sharing platforms is the ecological construction of enterprises with a digital platform as the core.

Managerial Implications

In the face of the complex competitive environment in the digital age, bike-sharing platforms should pay more attention to the growth logic and the resource management ability. If bike-sharing platforms want to achieve sustainable growth, several measures need to be applied in time. Such as the top-level design of the whole system, timely adjust platforms' own structure to adapt to the changes in the external environment, constantly improve the digital technology level, in-depth mining and understanding of all kinds of data collected through the Internet of Things, improve platforms' own complex decision-making and forecasting ability, and so on. Taking Hello Bike as an example, it positions itself as a technology company, dedicates itself to reshaping the two-wheel travel business format, timely carries out structural adjustment, recruits R&D personnel to continuously upgrade products and services, and makes complex decisions relying on the data mining ability of Hello Brain (implications of digital technology), thus achieving sustainable growth as a whole.

Future Research and Limitations

A more refined research model may be obtained by incorporating different research perspectives to conduct further empirical analysis on a broader range of bike-sharing platforms. This can include using the research perspective of an entrepreneurial ecosystem. Additionally, qualitative comparative analysis, social network analysis, meta-analysis, and other experimental methods can be comprehensively used to carry out mixed research.

Data Availability Data available on request.

Declarations

Conflict Interests The authors declare no competing interests.

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