Co-producing an urban mobility service? The role of actors, policies, and technology in the boom and bust of dockless bike-sharing programmes

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ABSTRACT

This paper examines the role of actors, policies and technology in the evolution of a basic urban transport service by investigating a complex range of factors shaping the inception and adaptation of the bike-sharing programme. Media data were analysed in relation to two major programmes, supplemented by further investigation into the broader discourse of the programmes. The findings reveal that an array of actors in the categories of government, citizen, business maker and investor, together with evolving policies and technology, collectively determine the sustainability of the programme. The operator-investor centred unorthodox co-production and delivery of dockless bike-sharing provides an alternative model to urban basic service provision which is currently dominated by the centralised and government-citizen centred co-production models.

1. Introduction

A controversial urban mobility service, which has not only affected the sustainability of cities but also raised specific questions about the sustainability of urban service provision, is the GPS- and smartphone-based dockless bike-sharing programme. Originating from China in 2016, the programme has experienced a boom and bust, expanding to hundreds of cities in both less developed and developed countries, then abandoning many of its service areas in less than three years between 2016 and 2018, but continued its presence in many cities up to this date. Critics have questioned the viability of such programmes, pointing to the lack of financial sustainability, fleet congestion, vulnerability to vandalism, threat to local bicycle industries through low profitability for manufacturers (Gu, Kim and Currie 2019) as well as poor management (Du and Cheng 2018). In addition, the mounting number of abandoned fleets, seen in the ‘shared bike graveyards’ (Sun 2018; Taylor 2018), has led to concerns of the programme’s negative contribution to urban sustainability. How are the boom and bust explained, and what can be learned from this popular yet seemingly problematic experiment in basic urban mobility service provision?

Dockless bike-sharing is the latest form of the fast-growing bike-sharing programmes worldwide, especially in China. According to Midgley (2011, p. 3), at the beginning of the twenty-first century, ‘there were five schemes operating in five countries (Denmark, France, Germany, Italy and Portugal) with a total fleet of 4,000 bicycles (the largest was Copenhagen with 2,000 bicycles). Today there are an estimated 375 bicycle-sharing schemes operating in 33 countries in almost every region of the world using around 236,000 bicycles (the largest is Hangzhou with an estimated 40,000 bicycles)’. The newly arrived dockless bike-sharing programme adds to the phenomenal growth. Shi et al. (2018, p. 1) noted that ‘[b]y March, 2017, the scale of the supply of dockless bikes for sharing in Chinese cities had reached over 4 million, and Shanghai alone had reached about 450,000.’

Equally remarkable to the rapid expansion of programmes and fleets is the fact that studies of bike-sharing in the China context are limited (Fishman...
Among the publications available, Si et al. (2019) found four knowledge domains in which research was focused: 1) factors and barriers associated with the provision of docking stations and the sign-up process to access the schemes; 2) system optimisation associated with bike demand and supply; 3) behaviour and impacts associated with individuals and communities; and 4) safety and health issues. New inquiries focusing on dockless bike-sharing show that researchers studied 1) user behaviour and usage patterns (Ai et al. 2018; Jia et al. 2018; Li et al. 2018; Shen et al. 2018; Liu et al. 2018), p. 2) the impact to the city, environment and society (Sun 2018; Zhang and Mi 2018; Spinney and Lin 2018; Mooney et al. 2019; Wang and Akar 2019); and, p. 3) management and operation of the fleet and the sustainability of the scheme (Chang et al. 2018; Xu et al. 2018; Pan et al. 2018; Shi et al. 2018; Zhang et al. 2019).

The fast fall of the dockless bike-sharing programme was signalled by two events in 2018, both of which are not reflected in the literature. These were the selling out of Mobike in April 2018 and the bankruptcy crisis of ofo in December 2018. To date, it is not explained why an entrepreneurial programme without a sound business model could grow at such a phenomenal speed, why an urban service causing public outcry for cluttering and vandalism could be adopted in so many cities, and why an idea which is disruptive to the existing street usage and the environment could be welcomed by entrepreneurs and governments.

This paper sheds light on the above questions by investigating how the service providers, users, policies and technology contribute to the boom and bust of the dockless bike-sharing programme through the lens of urban service co-production. The concept of service co-production has evolved for the last half-century or so, as the centralised urban basic service (e.g. health care, education, and water supply) delivery model has been increasingly questioned because of its high cost, inefficiency and massive resource and environment impact (Moretto and Ranzato 2017). A new approach that involves multiple actors as co-producers has since emerged. Studies on urban service co-production began with a focus on government-citizen collaboration in developed countries following Ostrom’s (1996) conceptualisation of the process. However, the ‘… more recent, familiar, and rather formalistic use of the term … refer[s] to any service delivery arrangement involving two or more organisations’ (Joshi and Moore 2004, p. 33). Indeed, service co-production involves a wide range of actors (Sorrentino et al. 2018). The third sector including public organisations and for-profit organisations has already entered the co-production process and played a role (Moretto and Ranzato 2017, p. 3), and the varied motivations among the participants are recognised (van Eijk and Gasco 2018, p. 72). In less developed countries such as Ghana, transport business owners and operators collaborated with the government to form a new institution (i.e. a union) in urban service delivery, which presents an unorthodox approach to the government-citizen collaboration and is seen as an ‘institutionalized co-production’ (Joshi and Moore 2004). This paper taps into the insights gained in the co-production literature to develop an understanding of the boom and bust of the dockless bike-sharing programme.

There are six sections in this paper. Following this introductory section, section two reviews the literature on co-production of basic urban services and presents a research framework. Section three outlines the methods of data collection and analysis. Section four articulates a story of the co-production of dockless bike-sharing focusing on their inception, growth and contraction phases as well as the actors’ roles and motivations in each of the phases. Section five discusses the role of actors, policies and technology in the growth and decline of the programmes. Section six concludes.

2. Producing dockless bike-sharing by multiple actors: a research framework

2.1 Literature review

Co-production is a public service delivery approach fundamentally different from the centralised model dominated by public investment. This service delivery approach was originated in the late 1970s and provided opportunities for citizens to play ‘an active role in producing public goods and services of consequence to them’ (Ostrom 1996, p1073, after Moretto and Ranzato 2017). Conceptually, co-production is different from government-civil society partnerships because co-production focuses on individual rather than organisational contributions (Brandsen et al. 2018). It is different from volunteering because it is ‘possible to coerce citizens to co-produce, even if it is
counterintuitive’ (Brandsen and Honingh 2018, p. 12–13). It is also different from co-creation, which is ‘about the initiation and/or strategic planning of a service’, whilst co-production concerns ‘the later stages of the production cycle, the design and/or implementation of a service’ (Brandsen and Honingh 2018, p14 and p10).

As an alternative to centralised production, co-production of public services is sensitive to management efficiency, environmental conditions, and affordability issues in the service area, and thus offers a possibility to bridge some of the service delivery gaps. In contrast, the centralised service delivery approach has to cope with high cost and management efficiency issues in maintaining network supply, which is often associated with shortage of service provision. The massive ecological footprint of centralised service delivery also increases the burden on resources and the environment, which demands external input from regions beyond the service area. In addition, the inability to provide affordable services to income groups in cities with ever-increasing social stratification also calls for alternative service delivery approaches (Moretto and Ranzato 2017, p. 2).

Initial applications of co-produced service delivery are observed in education, health care and policing (Ranzato and Moretto 2018). van Eijk and Gasco (2018, p. 63) list an array of the co-producers who work along with the government for service provision. Some of the co-producers are direct service recipients; others are not, including individuals with one or more identities as local community members, vulnerable people, parents, social housing residents, voluntary caregivers, and citizens. These findings shed light on the general ‘citizen’ group and demonstrate a variety of sub-groups under the umbrella term ‘co-producers’. Indeed, the co-producers play various roles in the co-production process, including as consumers, suppliers and partners (Alford 2014). The forms of their participation are observed in all the production stages such as co-planning, co-design, co-prioritising, co-financing, co-managing, co-delivering, and/or co-assessing public services alongside public employees (Moretto and Ranzato 2017; van Eijk and Gasco 2018).

In less developed countries such as Ghana, the co-production of mobility service shows that the co-producers are not the citizens who use the services but those who own or operate a vehicle in the transport business (Joshi and Moore 2004). These transport business owners and their employees are members of the Ghana Public Road and Transportation Union, which is collaborating with the government in transport service delivery. This co-production arrangement is rooted in the incapability of the state sector to provide urban transport service, and the need of the state for an agent who helps collect some road-related taxes as well as mobilise voters for political purposes. On the other hand, the co-producers (i.e. the transport businesses) obtain protection (e.g. from harassment and extortion by police) from the union. Joshi and Moore (2004) used the term ‘institutionalised co-production’ to describe the unorthodox service delivery approaches. Apparently, the transport service co-producers in Ghana are transport businesses but not individual citizens. The orthodox focus on government-citizen collaboration in the co-production literature has been extended from citizen-users to businesses.

Co-producers’ motivations were studied from a utilitarian point of view in the early 2000 s. In the last 10 years or so, however, there are new insights about these motivations from new perspectives, namely volunteerism, political participation, and public management, ‘showing that co-producers’ motivations are both extrinsic and intrinsic and that context matter[s]’ (van Eijk and Gasco 2018, p. 72). The cultural and policy contexts as well as the type of the services produced have a major impact on the specific co-production process, the participants and their motivations (ibid).

Within the growing but limited literature on dockless bike-sharing, there is no analysis of the identity of the main players and the motivations underlying their participation, though some of the actors (e.g. the government, bike-sharing companies, users, the media, industrial association and the public) are mentioned in an incidental manner (Jia et al. 2018; Sun 2018; Gu et al. 2019). However, there is no discussion about what role the observed actors play in the inception and operation of the programmes, what policies frame the actions and interactions, how technology is used in service provision and operation and how the interplay among the actors has led to the boom and bust of the bike-sharing programmes. Tapping into the insights accumulated in the co-production literature, especially those on the co-producers and their motivations of participation and interplay, this paper makes use of the co-production concept to explore answers to the above questions. The research findings will also bridge the gaps in the evolving co-
production literature, namely the institutional forms of service providers/users, and the role played by users, providers and/or possible intermediaries in operating and managing the technical systems and their resources and the power dynamics within actors’ changing practices (Jaglin 2002; van Vliet 2012; Ahlers et al. 2014; Moretto et al. 2018).

2.2 Research framework

Figure 1 shows the conceptual framework guiding the inquiry. The core idea is that dockless bike-sharing is a basic urban service co-produced by multiple actors including government, citizen, operator, industry association and investor (Jia et al. 2018; Sun 2018; Gu et al. 2019). These multiple actors may participate in one or more of the three stages (i.e. programme inception and planning, management of expansion, and management of contraction) of service production and delivery, and consequently shape the boom and bust of the programmes. Technology and policy influence both directly and indirectly on the various actors’ behaviour and shape the co-production and delivery of the service. Technology applications may foster citizenship through regulating users’ access to the service (Ahlers et al. 2014; Moretto et al. 2018); they may improve service providers’ capacity to manage the service and amend the behaviour of the intermediaries (van Vliet 2012). The policies and regulations may shape the general service delivery environment and guide programme-specific matters. The research tasks remaining are to identify and examine the roles and motivations of the main actors in each of the service production stages and to explore the changes in policy and technology as well as their impact on the boom and bust of the programmes.2

3. Data and method

The main challenge to answer the research questions is the lack of systematic and official data. Modern dockless bike-sharing programmes emerged at a phenomenal pace as a new transport service innovation, without following any plan in programme preparation and launching. There has been no authority nationwide to keep a record of the programmes. Bikeshare operators raced to increase their market coverage but were reluctant to be transparent about where and with whom they were operating. As such, this study relies upon media reports published between January
2016 and December 2018, including editorials, news stories and discussion forums in the Chinese language webpages. Data gathering began in early 2016, guided by frequent discussion with local academics about data sources and continued in 2019 when the manuscript was finalised. Relevant data entries are identified by using 共享单车 (gongxiang danche, i.e. shared bikes) as keywords from Google Search. The search results are complimented by specific media reports which were contributed occasionally by local academics who collaborated with the author in other research projects.

Table 1 shows the number of search results captured as both the most relevant (the short search raw list column) and those including the previously omitted results (the extended search raw list column). However, both lists contain webpages which do not offer the intended information because of three complications. First, some webpages include hyper-links which are relevant to the main content of that webpage, for the purpose of adding value to readers by pulling together a rich list of relevant sources of information. Thus, the keyword in a hyper-link is taken as an indicator for inclusion. Second, some webpages use the keyword indifferently between docked and dockless bike-sharing; this issue is especially prominent in relation to the first few months when dockless bike-sharing commenced. Third, some webpages are opinion posts in online forums; these posts stretch over a long time period with occasional or repeated use of the keyword. Webpages showing any of the above situations are deemed as irrelevant even though they meet the search engine criteria. Before recording any entries to the database, all entries captured by Google Search are manually scrutinised and those falling into the above three categories are removed from the dataset.

Data analysis involves the selection of reports on the TOP2 programmes – Mobike and ofo and a thematic analysis of the participants, policies, and technology applications. Keywords in the conceptual diagram (Figure 1) are used as foci of the themes to be examined. The outcomes of the analyses are presented in the dockless bike-sharing story set out in the following section, and in the discussions section where relevance of the facts to knowledge advancement is highlighted.

4. A tale of the co-production and survival of dockless bike-sharing

Four groups of actors, namely governments, citizens, business makers and investors, and three consecutive phases emerged from data analysis. Articulation of these actors and phases presents a trajectory of the production, growth and decline of dockless bike-sharing.

Figure 2 shows the three consecutive phases of the dockless bike-sharing processes, defined by key events. A night coffee shop conversation in late Autumn Beijing marked the beginning of dockless bike-sharing in China. In Phase I, Mobike along with ofo pioneered in developing the idea and their efforts saw the launch of Mobike in April 2016. In Phase II, the two pioneers grew into the largest (also known as the TOP2) while other programmes rushed in to share the market. Phase III

| Year | Month | Short search (raw list) | Short search (edited) | Extended search (raw list) | Extended search (edited) |
|------|-------|-------------------------|-----------------------|---------------------------|-------------------------|
| 2016 | January | 103 | 5 | 212 | 5 |
| | February | 105 | 5 | 208 | 5 |
| | March | 100 | 7 | 205 | 7 |
| | April | 100 | 18 | 196 | 18 |
| | May | 100 | 9 | 205 | 9 |
| | June | 100 | 11 | 207 | 16 |
| | July | 80 | 5 | 204 | 7 |
| | August | 97 | 13 | 203 | 20 |
| | September | 90 | 66 | 200 | 112 |
| | October | 80 | 47 | 207 | 112 |
| | November | 90 | 65 | 215 | 136 |
| | December | 83 | 62 | 208 | 140 |
| 2017 | January | 84 | 57 | 207 | 132 |
| | February | 74 | 51 | 212 | 142 |
| | March | 66 | 53 | 210 | 144 |
| | April | 80 | 69 | 255 | 158 |
| | May | 75 | 57 | 230 | 144 |
| | June | 76 | 43 | 218 | 129 |
| | July | 91 | 63 | 253 | 141 |
| | August | 67 | 47 | 222 | 136 |
| | September | 80 | 53 | 215 | 143 |
| | October | 81 | 44 | 218 | 122 |
| | November | 86 | 61 | 217 | 152 |
| | December | 85 | 60 | 227 | 157 |
| 2018 | January | 88 | 55 | 212 | 135 |
| | February | 94 | 51 | 214 | 116 |
| | March | 84 | 58 | 216 | 133 |
| | April | 86 | 47 | 212 | 134 |
| | May | 88 | 49 | 218 | 124 |
| | June | 80 | 51 | 218 | 126 |
| | July | 89 | 54 | 240 | 140 |
| | August | 82 | 61 | 229 | 142 |
| | September | 89 | 54 | 302 | 158 |
| | October | 85 | 65 | 224 | 154 |
| | November | 73 | 48 | 239 | 135 |
| | December | 76 | 57 | 276 | 192 |
began when the first bankruptcy was reported, followed by service withdrawal of some programmes. The entire industry shifted their management focus from expansion to contraction.

### 4.1 Actors, policies and technology in the inception and planning phase

Phase I saw the inception of the dockless bike-sharing idea in Beijing and the launch of dockless bike-sharing operations in many Chinese cities. Major activities included conception of the idea, prototyping the bikes and financing the programmes. Business makers and venture capitalists played the leading role in this phase, whilst governments and citizens were in the background though supporting the programmes. Technology was an enabler of the programme development, but relevant policies and regulations were largely absent.

Both Mobike and ofo claimed that they were the originators of dockless bike-sharing. Mobike was conceived at a night coffee meeting when the founder, Ms Hu Weiwai, introduced a bike designer to a venture capital manager in Nov 2014 to develop business collaboration. The meeting did not forge an investment relationship between the bicycle designer and the investor, but Hu herself got interested to the idea placed on table by the manager, i.e. to develop a ‘mobile’ type of ‘bike’ – thus ‘Mobike’. With enthusiasm and an Angel financing from the investor in hand, Hu registered Beijing Mobike Pte Ltd in January 2015. She mobilised talents from her journalist car-reporting network to develop the ‘Mobike’ prototype and the intelligent lock. The latter was technology intensive involving application of the Global Positioning System and smartphone networks. With the support of her Angel investor, Hu obtained further financing (the A round) in October 2015 and later the B round financing in April 2016. Her first Mobike fleet was manufactured in her newly-established bicycle plant in Wuxi, Jiangsu Province. That fleet was shipped to and launched in Shanghai in April 2016. That is the very first dockless bike-sharing fleet operating city-wide.\(^5\)

Ofo has a longer history than Mobike by registration date – it was registered on the Internet for a bicycle venture in as early as April 2014.\(^6\) Behind the registration were Mr Dai Wei and his partners who were all students of Peking University. Their bicycle venture was initially focused on customised bike tours, which was not very successful because of low demand. In May 2015, Dai and his partners decided to develop a dockless bike-sharing programme in Peking University, aiming at helping students and staff improve their campus mobility. The idea was not totally convincing to venture capitalist for its uncertain profit-making potential, but with support from alumni connections Dai was successful to secure his
Angle round financing. These initial funds supported them to gather 2000 ordinary bikes from Peking University students and equipped the bikes with combination locks. Users sent the unique ID of a specific bike to the back office via smartphone and received a code to unlock. This simple technology allowed ofo to develop their fleets much faster than Mobike. Ofo’s A round financing, secured in January 2016, helped its further expansion. By the time that Mobike launched in Shanghai in April 2016, ofo had already attracted 2 million campus bike users.

There was no direct involvement of the government in Phase I. But the overall positive tone towards entrepreneurship and innovation nationwide provided a supporting atmosphere in cities for accommodating the bike-sharing programmes. Users were not active either, but they were coerced via a security deposit, by terminology used in the co-production literature (Brandsen and Honingh 2018), to participate in the programmes in order to resolve their ‘last mile’ commuting problem.

4.2 Actors, policies and technology in the phase of expansion

Phase II saw strong growth of both the TOP2 and 70 strong new programmes. Business makers and venture capitalists continued their collaboration which played a dominant role in leading the growth. Government intervention emerged though in a sporadic manner, whilst user presence became more visible than in Phase I. There are new bike series introduced in the large programmes but no significant technology advancement was observable. Policies and regulations emerged along with the emerging intervention efforts by a few local governments.

Mobike and ofo expanded in both Chinese and overseas markets during this phase, competing against each other to be the industry number one. Mobike reached 100,000 bikes in each fleet in Shanghai, Guangzhou and Beijing in the period Dec 2016–Jan 2017. It entered Singapore in March and the UK in June 2017. Ofo launched its ‘city-wide plan’ to operate beyond university campus in November 2016 and immediately began its ambitious overseas expansion plan in December 2016, aiming at the USA, UK and Singapore as their pioneering overseas markets. At the same time, ofo quickly entered more than 30 cities in China. In May 2017, ofo claimed that its operation covered four countries and 100 cities.

The support from enthusiastic venture capitalists grew stronger in both the numbers of investors and the volume of investment in Phase II. Mobike secured four main rounds of financing in this period – the B Round (August 2016), C and C+ rounds (September/October 2016), D and D+ rounds (January/February 2017), and the E round (June 2017). The amount invested ranged from 100 to 600 USD million USD per round. Ofo obtained its multiple rounds of financing in 2016 and 2017, i.e. A+ round (August 2016), B round (September 2016), C round (October 2016), D round (Feb 2017) and E round (July 2017). The D round was reported, arguably, at 450 USD million 8 USD and the E round at 700 USD million USD. With investment support comparable to Mobike, ofo was pushed by its investors into a city-wide bike-sharing programme in November 2016.

Governments began to play a visible role, at both local and central levels and via their agencies which endorsed new policies and regulations. Their actions were in response to a range of emerging issues which were also attended by some programme operators. These issues were related to 1) the business model which was yet to prove its capability of profit-making; 2) the management of user deposit which might turn bike-sharing into another financial cheating scandal; and 3) the massive random parking problem, exacerbated by black taxi (mainly those operating tricycles, or sanbengzi) drivers who would topple shared bikes on pedestrian paths, or throw them into garden beds and rivers.

Government responses were felt in policy changes which began at the local level, followed by the creation of central government advices and guidelines. In January 2017, bicycle associations in Shanghai and Tianjin collaborated to develop an industry standard for bicycles and electric bicycles related operations. A preliminary draft was publicised for comments in April and the final form was endorsed in early July 2017. In the meantime, in February 2017, several large cities including Chengdu, Shenzhen, Beijing and Shanghai endorsed regulations to deal with vandalism and users’ minimum age.

At the central government level, ministerial officials called on cities to embrace dockless bike-sharing and introduce proper management policies. This laid down the overall tone of central government policy in the forms of advice and guidelines. In April 2017, the Ministry of Transportation publicised the first nationwide draft Guideline and asked...
programme operators to change the security deposit model so that dishonest users would be punished.\textsuperscript{15} The Guideline also requested for user registration with real names so they were all traceable. This Guideline was later endorsed for official implementation, followed by local guidelines that extended the central government principles to local contexts.\textsuperscript{16}

Citizen involvement became more visible with the emergence of several groups. The majority was regular users whose participation led to rapid membership increase (Shi et al. 2018, p. 1). Within this regular group were some users who demonstrated selfish behaviour, such as hiding a bike for personal use and/or unlocking an ofo without going through the payment system (this was possible for manual combination locks when the last user failed to dismiss the code after locking). Criminals were attracted to bike-sharing technology too – some used fake QR codes to redirect users to particular webpages and stole credits from their bank accounts.\textsuperscript{17} Other ‘crimes’ included placing needles inside bike seat to injure people (also creating fears of contracting communicable diseases), selling combination codes for monthly fees, changing bike locks so the bike could be kept for private use, making false claims as student users, and cheating users as fake custom services. On the other hand, a group of self-motivated shared bike vigilantes entered the fray.\textsuperscript{18} Some searched for shared bikes which had been chain-locked by individuals and cut the chain-lock. Some helped to move randomly parked bikes to designated locations; others put bikes upright when they were otherwise laying on the ground.

\subsection*{4.3 Actors, policies and technology in the phase of contraction}

Phase III began when bike-sharing failure was first reported in June 2017. This period saw a mixture of fleet expansion and scheme closure in its first six months, then quick contraction in venture capital investment, fleet size and number of markets. The programme operators remained as the main actor, whilst venture capitalists faded away from the programmes. Government role was strengthened through the introduction of regulatory changes, and users became more active especially in safeguarding their own interests centred on security deposits.

Several small dockless bike-sharing programmes withdrew in the mid-2017. Wukong Bike, with about 1200 bikes, was the first operation closed after being in market for less than a year. This closure was immediately followed by 3Vbike’s withdrawal the week after.\textsuperscript{19} Massive loss of bikes was reported the main reasons for the two failures. A third closure was reported in July 2017. This time a large number of users failed to get their deposit back and the case resulted in a criminal investigation.\textsuperscript{20}

Despite the increasing failures in small dockless bike-sharing programmes,\textsuperscript{21} the TOP2 continued their growth momentum especially in overseas market during the first six months in Phase III. Mobike expanded to Italy (July), Japan and Thailand (August), Malaysia and USA (September), South Korea (October), Australia and Germany (November) in 2017. Berlin became the 200th city where Mobike operated.\textsuperscript{22} In Feb 2018, Mobike entered Mexico. Ofo had a comparable expansion trajectory. In August 2017, when Mobike entered five countries, ofo started its operation in Japan – its seventh overseas market and claimed its operation coverage of eight countries, 170 cities, with a total of 8 million bikes and a daily usage of 25 million trips.\textsuperscript{23} The daily usage of ofo jumped to 35 million in October 2017, which was record breaking. In Jan 2018, ofo entered Busan, South Korea. With more than 10 million bikes, ofo’s operations by then spanned 21 countries and more than 250 cities.\textsuperscript{24}

Unlike in Phases I and II, venture capital support did not go in parallel with the continued programme expansion in Phase III. There was almost no new investment to the programmes, large or small (Hellobike was an exception after acquired by Alibaba), post mid-2017. In contrast, venture capitalists cashed out.\textsuperscript{25} Apparently, the business makers were abandoned by venture capitalists. This lack of new investment inflow, together with bankruptcies of bike-sharing schemes as well as long line-ups of users who were keen to get their security deposit back,\textsuperscript{26} accumulated to rumours about fund shortages in the TOP2 programmes.\textsuperscript{27}

A proposal to merge the TOP2 also rumoured around, but behind-door negotiations led to the acquisition of Mobike by Meituan in April 2018. As an Internet company, Meituan valued highly the massive data generated by dockless bike-sharing and hoped to use the data and customer flow to enhance its competitiveness.\textsuperscript{28} The leadership team and company structure remained until December 2018, when Mobike’s founder Hu Weiwei resigned and layoff
began. In January 2019, Meituan announced that Mobike would be renamed as Meituan Danche (literally, Meituan Bikes); in March 2019, Meituan declared that all overseas Mobike operations were to be closed.

As for ofo, its CEO Dai struggled for obtaining new funds but succeeded only in March 2018 when it mortgaged all of its bikes to Alibaba in exchange for a 1.7 billion yuan loan. However, these new funds proved to be inadequate. In July 2018 ofo decided to close its operations in India and Australia. Within a month, the list of overseas markets to be shut down included the USA, Germany, Spain, Israel, Austria and the Middle East. The fleet size in the domestic market was also scaled down. The Shanghai fleet was downsized from 1.2 million to 0.9 million bikes, while the Xi’an fleet shrunk from 700,000 to 500,000 bikes. In December 2018, CEO Dai was declared ‘legally in debt’ thus was placed on government list of people who were restricted against travel by air or first class train, among many other restrictions. In January 2019, ofo announced the closure of all its overseas operations.

Phase III also saw that government stepped up its role to intervene. From July 2017 onward, public anger regarding clutter and random parking resulted in an increasing number of areas and/or streets (e.g. alleys in Qianmen area, Beijing) where prohibitive rules were placed to stop the entry of dockless shared bikes. Twelve cities including Shanghai and Shenzhen introduced temporary bans against any further increases of fleet size. The overall allowable fleet size in Beijing was no longer unlimited, and in September 2017 a quota was introduced to check the growth of bike-sharing programmes. At the same time, local governments began to ‘clean’ the streets by deploying their urban management squads (i.e. chengguan in Chinese) to remove bikes that were not properly parked. ‘Shared bike graveyards’ where massive number of shared bikes from various programmes and usually with variety of colours were photographed and posted in the media (Taylor 2018).

Some 39 Chinese local governments endorsed new rules by the end of 2018. These include improved fine scale management focusing on programme performance (e.g. not cluttering the street). Performance evaluation is linked to fleet size. For example, ofo was asked to take 4500 bikes off its fleet in Kunming because of poor performance. Technical standards were also introduced to maintain the minimum width of pedestrian paths against encroachment by shared bike parking. The supervision of deposits received particular attention, with a new rule requiring bike-sharing programmes to set up dedicated accounts under third-party supervision.

The contraction of bike-sharing business in general and the withdrawal of some programmes in particular caused panic among users who were eager to recover their security deposits. The worry about losing deposits generated long line-ups to some bike-sharing schemes such as Xiaoming and Kuqi, in August 2017. Both schemes were later closed business. In the late 2018, ofo received massive number of requests by their users to refund deposit. Long queues were developed in front of ofo’s headquarter office in Beijing but the capacity of processing refund request on-site was limited to a small number. Ofo soon stopped on-site processing and developed an online waiting list for deposit refund. In July 2019, there were more than 16 million users on the waiting list. If daily refund reached 3500 users, 12 years would be needed to process all the refund applications.

5. Discussion

This paper sits on two literatures. One is the study of bike-sharing which has focused on the operation and impact (Si et al. 2019). The other is co-production of urban basic services which focused on either government- or citizen-led urban service provision (Moretto and Ranzato 2017; van Eijk and Gasco 2018). The bike-sharing literature noted several actors, including government, users/the public, operator/bike-sharing business, the media, and industry association (Jia et al. 2018; Sun 2018; Gu et al. 2019). However, there is no detailed discussion about the role and motivation of the actors. The findings in this research confirm that governments, citizens and programme operators all played key roles in the production and operation of dockless bike-sharing, but their importance varied among the three phases. These changing roles were not recognised in the literature until this study. Moreover, this paper discovers the active participation of venture capitalists who contributed to the inception of bike-sharing and played a detrimental role in their boom and bust.

By using the co-production literature as a benchmark for analysis, the findings provide further insights to the co-production and operation of dockless bike-sharing. The three key actors in urban basic service co-production, namely, the provider, the user and the
regulator were clearly seen in bike-sharing programmes. In contrast to the conventional co-production approach that centred on government and citizens (Ranzato and Moretto 2018), the co-producers in bike-sharing were the for-profit organisations, i.e. the bike-sharing companies and their investors, along with users who were coerced into the schemes. The bike-sharing companies played a similar role to the transport businesses in Ghana, which was seen as unorthodox service delivery approach and known as institutionalised co-production by Joshi and Moore (2004). In the bike-sharing programme, however, the Chinese government served as a regulator while the users were a part of the service co-production and delivery. Urban mobility service co-production which is dominated by the operator-investor alliance – a relationship forged between the operator and the investor on the basis of a shared interest in market expansion and continuous capital input – has never been reported anywhere in the literature. This paper is the first to recognise the core role of that alliance and has positioned it as an unorthodox service delivery model which provides a possible alternative to the government-citizen centred urban service co-production. Further, citizens demonstrate varied behaviour in their roles. Some were clients or users, while others were saboteurs or vigilantes. The latter two actors go beyond the known forms of co-producers such as initiator, co-designer, co-implanter, client, volunteer and/or citizen (van Eijk and Gasco 2018) or consumers, suppliers and partners (Alford 2014). They are intermediaries ‘working in-between this triad of provider, regulator and user’ (Moss et al. 2010, p. 2). The vigilantes tried to help the bike-sharing service delivery, while the saboteurs tried to derail the service delivery. There was a ‘darker side’ of intermediation in bike-sharing service delivery, adding to the ‘darker side’ intermediaries in infrastructure provision in Marvin et al. (2010, p. 213).

The role that government and users played in the co-production and operation of dockless bike-sharing provides another contrast to that emphasised in the co-production literature. Instead of initiators and leaders of the service production process (Ranzato and Moretto 2018), both the central and local governments as well as the users were in the background of dockless bike-sharing inception and planning. It was only in the expansion and contraction phases that both the actors became active. Nevertheless, macro business environment which was shaped by the central government policy to encourage entrepreneurship and innovation guaranteed the wide acceptance of bike-sharing ideas and fleets to business makers, the public, and the host cities. Indeed, Premier Li Keqiang’s policy of ‘dazhong chuangye, wanzhong chuangxin’, which was announced in September 2015 made it easy for fast business registration, entry to cities, and usage for public resources. On the other hand, users’ enthusiasm to benefit from the low-price mobility service, and their aggressive attitude towards safeguarding their financial interests brought devastating consequences to many programmes.

Involvement of urban management squad (or chengguan in Chinese) together with saboteurs from the citizen group formed three check-points against the growth of bike-sharing businesses. They were the ‘good’ – those urban management squads who acted on behalf of government and confiscated shared bikes because of their violation of parking rules; the ‘bad’ – those who applied private locks or hid bikes to prevent the sharing of shared bikes for their own convenience; and the ‘ugly’ – those who used the bikes to conduct criminal activities for personal gain in financial terms (e.g. cheating users in various ways) and/or in expressing an ill-defined pleasure (e.g. place needles on bike seats). The tasks that chengguan performed demonstrated the multifaceted role of the government in urban service production. The government is not only a non-initiator and regulator but also a ‘good’ saboteur to dockless bike-sharing. This multifaceted and multi-layered role has not been discussed in the literature.

Policies and regulation were largely absent but had been gradually added. Some local governments, rather than the central government, introduced regulations addressing vandalism and the minimum age of users. The policy focus was extended from users to programme operators, dealing with fleet size, operation performance, road use standards (for parking), and deposit supervision. The central government showed a welcoming attitude towards the programmes; its suggestions and guidelines were mainly concerned with matters affecting social stability, such as the supervision of deposits, the return of deposits on demand, and preventing user registration under fake IDs. Clearly, the central government played a very different role from that played by the local governments. These evolving policies present a challenge to the ‘[s]tandard way of thinking about public
organisations, their boundaries, and how they relate to “private” actors in urban service delivery (Joshi and Moore 2004, p. 45). China has reformed itself to become a modern state which is moving ‘away from direct provision of goods and services toward support for economic enterprises competing in global markets’ (ibid p45). The evolving policies have provided a stimulating environment for entrepreneurs, including the investors and operators of the bike-sharing programmes, to flourish in urban mobility service provision.

Actors’ motivations confirm what was observed in the co-production literature in terms of their intrinsic and extrinsic nature, and the relevance of context (van Eijk and Gasco 2018). Majority of the actors demonstrated a mixture of extrinsic and intrinsic motivations, reflecting their desire to seek external rewards and their mandates as businesses or public agencies. For example, the business makers were motivated by profit-making as their mandate and external influences by venture capitalists. Local governments were driven by their mandate to govern at the same time to meet upper government expectations. Users desire to secure value-for-money deals were met by promotional packages offered by dockless bike-sharing programmes to resolve their ‘last mile’ commuting problem. Two citizen actors demonstrated more purer intrinsic motivation. They were the saboteurs and the vigilantes. Their roles and activities in dockless bike-sharing, regardless evil or heroic, were driven by motivations of internal values rather than external rewards.

Technology is at the core of dockless bike-sharing, rather than add-ons for the purpose of extending the scale and ubiquity of co-production. In their first two years of operation, Mobike and ofo each filed 41 patents applications (Shi 2017). Many of the technology applications show imagination coming to fruition – the majority of the imagined technologies such as those for improved distribution, easy installation, power stations, easy tracking, pedal assistance in the fourth-generation bikeshare bicycles (DeMaio 2009) are in current use.

The bike-sharing technology applications help answer some core questions about the role of technology in service co-production, such as whether technology contributes to foster citizenship (Ahlers et al. 2014; Moretto et al. 2018), and to what extent technologies change the roles of providers, intermediaries and users (van Vliet 2012). Ofo’s upgrading of its lock system from a low-tech combination lock to an intelligent lock using the Internet-of-Things (IoT) technology helped to overcome the free rider problem. This technology upgrading fostered citizenship by making it compulsory for all users to have equal access through a standardised subscription fee. There is no room left for the intermediaries, i.e. the ‘bad’ and the ‘ugly’ saboteurs to cheat on the combination locks. Application of the GPS technology, which is a standard feature in the intelligent locks, increased providers’ capacity to manage their bike fleets. GPS helped the operators locate their bikes accurately thus the ground maintenance personnel could be dispatched to remove their bikes from undesirable locations (e.g. planting beds and rivers) and to place adequate number of bikes in locations where high demand was forecasted. Further, geo-fencing technology could change user behaviour forcefully by linking to a penalty detection method. Those bikes parked outside the designated parking areas were traced back to its last user, who would be charged for a removal fee. A number of experiments were reported during the study period. However, due to cost constraints only a few programmes adapted the geo-fencing technology very recently.

6. Conclusions

This paper advances the dockless bike-sharing literature (Si et al. 2019) by providing a longitudinal analysis of the programmes focusing on the multiple actors, policies and technologies. The analysis has been inspired by and also contributes to the urban service co-production literature (e.g. Moretto and Ranzato 2017; Sorrentino et al. 2018; van Eijk and Gasco 2018; Ranzato and Moretto 2018). Four conclusions can be drawn.

6.1 The range of co-producers is wide because there are many sub-actor groups under each general actor category

The boom and bust of dockless bike-sharing were shaped by collective efforts of multiple actors, which were noted as government, citizen, business maker and investor in the dockless bike-sharing literature (Jia et al. 2018; Sun 2018; Du and Cheng 2018; Gu et al. 2019). These actors played the roles of regulators, users and intermediaries, and providers, which were discussed in the co-production literature. However, none of the widely discussed actors acted as a single
coherent actor. Though the within group dynamics in actors’ roles and motivations should not be unique to the production and delivery of bike-sharing and could be identified in orthodox cases of co-production (e.g. the varied roles and interests of participants in the citizen group reported in van Eijk and Gasco 2018, p. 63), the empirical evidence examined in this paper has placed the multiple sub-actor groups in the spotlight.

Government actors included multi-layer (i.e. central and local) governments and multi-faceted agencies (e.g. chengguan). The central government acted on macro policies and guidelines via relevant ministries to address nationwide development opportunities and stability threats. Local governments used regulations and chengguan to attend problems relating to local order. All government agencies had the mandate to answer public concerns. However, their actions were also driven by extrinsic motivations associated with persuasion of performance reward.

Citizen actors included users, saboteurs and vigilantes. Users contributed to programme finance and their participation made the business operation possible. They were driven by utility maximisation that was both extrinsic and intrinsic in nature, and their demand for a timely refund of their security deposit added financial stress to the programmes, which led to business withdrawals. Saboteurs and vigilantes sabotaged and safeguarded the programmes, respectively. They were intermediaries who acted according to their intrinsic values. The identification of these citizen sub-groups in bike-sharing contributes to enlarge the view on intermediaries in the co-production literature.

Business makers included dockless bike-share programme operators of various sizes. They all acted to pursue business success. The latter is defined differently though, as the bigger schemes tried to succeed in market expansion, supported by their ability to attract investment and ambition to be number one of the industry, while the smaller operators were followers who were disadvantaged by inability to finance and vulnerability to disruptions (e.g. loss of bikes). The yet-to-be-proved business model handicapped their operations.

Investors included venture capitalists (VC) and non-VC companies (e.g. Alibaba and Meituan). They were both driven by the desire to accumulate capital at the fastest possible pace but approached their goals differently. VC used dockless bike-sharing to build up a business and cash out at an optimum time; the non-VC company investors used the programme to enhance their core business competency. Investment support is critical to the fate of dockless bike-sharing.

6.2 Dockless bike-sharing is an unorthodox service delivery approach evolved by following market logics rather than produced by planning

Dockless bike-sharing is not a planned outcome. Rather, it is a product of the transitional economy in China’s effort to reform itself from a planned economy to a modern state that relies on ‘economic enterprises competing in global market’ (Joshi and Moore 2004, p. 45). The process of China’s economic transformation saw the blurring of boundaries between public and private, and the emergence of ‘a wide range of quasi-public, quasi-private trends’ (Francis 2001 p266, after Joshi and Moore 2004, p. 45). The gradual development of relevant new policies and regulations reflects the nature of the transition, whilst the significant role played by the operator-investor alliance is a sign of de-politicization in favour of the market logics. There was no planning about dockless bike-sharing at any point in the three phases. Both macro policies (e.g. those for safeguarding security deposit) at central level and fleet control regulations at local level were developed in response to the emerging public concerns.

6.3 Technology is an indispensable, built-in component in dockless bike-sharing, and their applications fostered citizenship and modified the capacity and/or role and behaviour of the service providers, users and intermediaries

Technology is a physical part of dockless shared bikes and their operations. They were not value-adding instruments to extend service coverage or facilitate user interactions as discussed in the service co-production literature (Sorrentino et al. 2018). In a way which is different from Sorrentino et al. (2018), technology applications in bike-sharing provide answers to several core questions relating to the role of technology in service co-production. The use of intelligent locks fostered citizenship by eliminating the ‘darker side’ intermediaries (Marvin et al. 2010) thus achieving equal access to the services. The use of GPS navigation system strengthened the providers’ capacity to manage the programmes efficiently. The development and
application of geofencing technology helped to regulate user behaviour and brought the bike-sharing service in line with government expectations for a good street order, and with providers’ expectation for a better parking management.

6.4 Dockless bike-sharing presents an alternative governance structure in urban service co-production

The governance structure which is centred on the operator-investor alliance provides an alternative to the two established models, i.e. the centralised model and the co-production model centred on government-citizen collaboration (Moretto and Ranzato 2017; Ranzato and Moretto 2018). The dockless bike-sharing boom occurred when the operator-investor alliance was solid and grew. Their bust occurred when the alliance was weak or broken. Integrated in understanding the boom and bust is the financial pressure originated from government policies and user demand. Apparently, the importance of multiple actors is a feature shared by both dockless bike-sharing and other co-produced urban services. The co-production literature is inspiring in exploring the roles and motivations of the multiple actors, and the unorthodox service delivery approaches observed in less developed countries (e.g. Ghana) help us to explore the ways of co-production ‘in a more open-minded way’ (Joshi and Moore 2004, p. 45). It remains to be seen what other governance structures will emerge in the literature, especially with regard to the study of urban service provision in economies where unorthodox delivery approaches prevail.

Notes

1. These are widely reported in media news. For example, refer to report on 23 January 2019 ‘mobike is dead; the brand name has changed to Meituan Danche’ (http://www.sohu.com/a/290898424_532789); report on 21 December 2018 ‘ofo’s founder Dai Wei is on the list of legally in debt’ in http://www.sohu.com/a/283253823_99957087 accessed on 13 May 2019.
2. As a rapidly developing transitional economy, China is experiencing enormous changes in policies and regulations as well as technology applications. These changes are felt in the development of the dockless bike-sharing programme and are indispensable to this study.
3. The Google Search engine generates a filtered list of the most relevant webpages and omits the webpages which are judged by the algorithm as very similar to those already on the list. The omitted webpages can be included by manually selecting the function to ‘repeat the search with the omitted results included’. Google Search uses algorithms to analyse the intention of the searcher, relevance and usability of the webpage, quality of contents, and searcher’s context information (location, searching history and settings) to determine the search outcomes. For further details about how Google Search works, refer to https://www.google.com/search/howsearchworks/algorithms/.
4. See ‘Hu Weiwei the Mobike founder’ in https://www.huxiu.com/article/191835.html Accessed on 15 June 2019.
5. It is recognised that the Dutch ‘white bikes’ were the first generation dockless shared bikes (Shi et al. 2018; Gu et al. 2019; Si et al. 2019). Introduced by the radical consumer group PROMO members in Amsterdam, the Netherlands, the ‘white bikes’ were used for making a statement against motorisation. The recent dockless bike-sharing originated from China constitute more of a private, entrepreneurial and venture capital project (Du and Cheng 2018, p. 4), differing from the Dutch ‘white bikes’ in both technology and purpose.
6. See ‘Dai Wei Riding from Peking University to the world’ in http://www.nfpeople.com/article/7658 accessed on 15 June 2019.
7. There were about 77 dockless bike-sharing programmes in China nationwide at the peak of its development. Refer to ‘Ministry of Transport: 20 of the 77 dockless bike-sharing programmes closed business; we need serious policies’ in http://tech.sina.com.cn/i/2018-02-09/doc-ifyrkzqr0714712.shtml.
8. Refer to ‘ofo’s D round financing is doubtful’ in https://www.jianshu.com/p/d817461d5052 accessed on 11 December 2019.
9. Refer to ‘how to understand ofo’ record-breaking success in E round financing’ in http://www.sohu.com/a/155246722_486088 accessed on 11 December 2019.
10. For example, Mobike introduced credit rewards as an incentive to users to park in designated areas. Ofo has also started to rework its lock mechanism to their new bikes to rectify the locking problem associated with combination codes.
11. Refer to ‘The lack of clear rules about security deposit paid by users is questioned; users are alerted by potential crisis’ in http://finance.sina.com.cn/chanjing/gsnews/2016-10-12/doc-ifxwrhpm2998029.shtml accessed on 11 May 2019.
12. Refer to ‘no more users – the black tricycle taxis are forced out’ in https://daily.zhihu.com/story/9509782 accessed on 11 May 2019.
13. Refer to ‘Government put on a break: un-controlled growth of dockless bike-sharing is over’, in https://www.huxiu.com/article/211040.html accessed on 15 December 2019.
14. Refer to ‘Ministry of Transportation: governments need to strengthen their regulations and supervision to encourage and support dockless bike-sharing’ in http://finance.sina.com.cn accessed on 15 December 2019.
15. Refer to ‘The Ministry of Transportation endorsed Guidelines for Dockless Bike-sharing and called for collective action on management’ in http://www.zczj.com/column/2017-05-22/content_11853.html accessed on 15 December 2019.

16. The Guideline was officially endorsed in August 2017. Some 30 local government followed the central government principles and developed local guidelines. Refer to ‘China aims at controlling the over prosperity in dockless bike-sharing’ in https://www.lez-cc.info accessed on 15 December 2019.

17. See ‘cheating QR code appeared on Mobike; automatic funds transfer begins once scanned’ in http://news.sohu.com/20161118/n473491906.shtml accessed on 11 May 2019.

18. See ‘Unravelling the shared bike hunters’ in tech.sina.com.cn/i/2017-04-07/doc-ifyecezv2430458.shtml accessed on 11 May 2019.

19. Wukong Danche announced the cessation of operations on 13 June 2017; 3Vbike was closed on 21 June 2017. Refer to ‘Following the bankruptcy of Wukong, another bike-sharing scheme closed after opening for a mere 4 months’, in https://36kr.com/p/5081810 accessed on 8 May 2019.

20. ‘The founder of Dingding Danche was seized by police’, refer to http://tech.163.com/17/1030/07/D1VR4IG400097U7R.html accessed on 8 May 2019.

21. Refer to footnote 7.

22. See ‘Mobike marched to Berlin’ in http://www.xinhuanet.com accessed on 15 June 2019.

23. See ‘ofo claimed entry to the Japanese market’ in http://money.jrj.com.cn accessed on 15 June 2019.

24. See ‘the yellow bikes entered Busan, South Korea’ in https://36kr.com/p/5116001 accessed on 11 May 2019.

25. A widely reported venture capital investor is Mr Zhu Xiaohu, who sold out all his 5.83% holdings in ofo by January 2018. The exact amount of capital gain was not disclosed but some believed that Mr Zhu could have made billions of US dollars. Refer to ‘The harvesting season of Mr Zhu Xiaohu’ in https://finance.jrj.com.cn/people/2018/04/2006392441923.shtml accessed on 15 December 2019.

26. Xiaoming Danche became the first bankrupted bike-sharing scheme, refer to ‘xiaoming Danche is bankrupted, can users get their 199 yuan deposit back?’ in http://www.xinhuanet.com/fortune/2018-08/14/c_1123264278.htm accessed on 8 May 2019; Kuqi was sued by its users in Nov 2017, refer to ‘298 yuan deposit failed to return, the “rural-millionaire Kuqi” was sued in court’, in http://tech.sina.com.cn/i/2017-11-29/doc-ifypceiq5850394.shtml accessed on 8 May 2019.

27. See ‘Mobike and ofo both denied misuse of their 6 billion yuan deposit’ in http://www.sohu.com/a/207852765_522913 accessed on 13 May 2019. It was also reported that in March/April 2017, both Mobike and ofo had about 1 million new bikes added to their fleets but at the end of 2017 the total was about 200,000 bikes. See ‘Deposit, financing and corruption: how long could they last before merging?’ in https://www.iyiou.com/p/61626.html accessed on 7 May 2019.

28. Refer to ‘Meituan bought Mobike at low price: what’s behind the acquisition?’ in http://www.xinhuanet.com/2018-04/16/c_129850906.htm accessed on 15 December 2019.

29. The bike-sharing bubble is burst; ofo receives massive user request to refund deposit; Mobike begins to layoff in https://t.cj.sina.com.cn/articles/view/6458549062/1805fa34600100cqwJ accessed on 6 May 2016.

30. The end of bike-sharing, in http://www.sohu.com/a/304621175_118788 accessed on 6 May 2019.

31. Refer to ‘Government began to clean the shared bikes’, in https://read01.com/DGyOe5K.html#XNK3ZMza9Y accessed on 8 May 2019.

32. Refer to ‘39 cities endorsed detailed supervision measures; there will be strict control over user deposit’ in https://finance.sina.com.cn/roll/2018-12-26/doc-ihqhcis0572289.shtml accessed on 9 May 2019.

33. Refer to ‘3500 applications processed daily for the 16 million applicants on waiting list’ in http://news.iresearch.cn/content/201907/294768.shtml accessed on 11 December 2019.

34. Refer to ‘The State Council publicised guidelines to put in place platforms supporting mass entrepreneurship in order to speed up development of the “four crowds” initiative’ in http://companies.caixin.com/2015-09-26/100857591.html accessed on 9 May 2019. The ‘four crowds’ refer to zhongchuang (crowd innovation), zhongheng (crowdfunding), zhongfu (crowd supporting), and zhongbao (crowdsourcing).

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