



Evaluating Chinese government WeChat official accounts in public service delivery: A user-centered approach

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ABSTRACT

WeChat official accounts have been increasingly adopted by Chinese government agencies to deliver public services, in response to the “Internet + Public Service” reformation. While previous studies depended heavily on the expert-oriented approach to evaluate the accounts, this paper presents a user-centered study based on a mixed methods research design in which an unobtrusive clickstream data analysis was complemented by a card sorting study, stakeholder interviews, and a focus group. A 2-month server log file containing 42,188,760 clickstream records was obtained from an active government WeChat official account and analyzed at the movement level, which found that the account was mainly used as a lookup tool with most services underutilized and its home portals failed to support effective wayfinding to needed services. Deficiencies in information architecture, operation strategy, and interaction design of the account were identified in the complementary studies. This study not only enriches the knowledge about social media use in the Chinese government for public service delivery, but also introduces innovative methods to generate new research insights. The findings can inform government WeChat official accounts of how to improve service quality and user experience.

1. Introduction

WeChat Official Accounts Platform (<https://mp.weixin.qq.com/>) is a popular type of social media in China which enables individuals, enterprises, and organizations to reach target audiences through their official accounts. Subscription accounts and service accounts, respectively, focus on publishing information and providing services. The former is similar to online media, sending group messages to followers on a regular basis. The latter features stronger interactivity that helps enterprises and organizations enhance their customer management abilities, resembling mobile applications to a great extent^{1,2}. Users are allowed to visit and/or follow WeChat official accounts by logging into their personal accounts on WeChat (<https://www.wechat.com/en/>), a messaging and calling application. By the end of 2017, the total number of WeChat official accounts has exceeded 10 million, including 3.5

million active accounts with 797 million monthly active followers^{3,4}. Top account rankings have been created based on their operation and usage and are being updated on a daily basis. The most influential WeChat official accounts mainly fall into such domains as media, recreation, lifestyle, and government.⁵

Chinese government agencies have started to appear on WeChat Official Accounts Platform since 2011. Many agencies, such as social security, transportation, and taxation, have adopted service accounts to deliver public services online. Differently, the governments of most developed countries are relying on portal websites as well as mobile applications for the same purpose (Okunola, Rowley, & Johnson, 2017; Sharma, Al-Badi, Rana, & Al-Azizi, 2018). Government WeChat official accounts support convenient access to public services anywhere anytime in the same way as government mobile applications do. However, the latter need to be downloaded and installed to mobile devices (Eom &

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¹ https://kf.qq.com/faq/120911VrYVrA150918fMZ77R.html?scene_id=kf3386

² https://kf.qq.com/faq/120911VrYVrA15091832Qzqq.html?scene_id=kf3384

³ <https://www.thewechatagency.com/898-millions-users-10-millions-official-accounts-discover-the-latest-trends-on-wechat/>

⁴ <https://blog.wechat.com/2017/11/09/the-2017-wechat-data-report/>

⁵ <https://data.wxb.com/rank>

Kim, 2014). The latter instead are directly available on the WeChat application which has accumulated more than 1.2 billion users⁶ and thus able to reach a considerable proportion of Chinese citizens. In addition, WeChat Pay, a mobile payment solution integrated with the WeChat application, helps complete the processes of many public services by enabling users to pay a bill, a fine, or a fee (Wang & Gao, 2014).

For government WeChat official accounts that focus on delivering public services, systematic evaluation of their performance is vital to their sustainable growth (Song, Guan, Zhang, & Zhu, 2019). The evaluation of WeChat official accounts has been taking an expert-oriented approach, i.e. depending on experts to establish a weighted indicator evaluation system and rate the accounts against a series of indicators, as will be reviewed in Section 2.2.

However, user-centered design (UCD) is nowadays the prevailing methodology for creating any information products (Ding, Lin, & Zarro, 2017). The goal of UCD is to support usability, findability, and understanding for users in their interaction with an information product (Rosenfeld, Morville, & Arango, 2015). The UCD process often employs mature user research methods, e.g. surveys, interviews, focus groups, diaries, card sorting, and usability testing, to understand what users need from the product, how they use it, and whether they like it (Goodman, Kuniavsky, & Moed, 2012). These methods are widely seen in recent evaluation of various online systems, such as algorithm-driven news services (Shin, 2020), digital libraries (Xie et al., 2020), mobile health applications (Moizer et al., 2019), and educational games (Biduski, Bellei, Rodriguez, Zaina, & Marchi, 2020).

Despite their usefulness, most user research methods are obtrusive in essence. That is, users are consciously involved in the research, either reporting their experiences or performing tasks as requested (Mellenbergh, 2019). In obtrusive research, the participants may say or act differently from usual for being studied, which is known as the observer effect (DeCarlo, 2019). Meanwhile, the researchers may be driven by their goals and pay excessive attention to expected phenomena of interest while ignoring others, resulting in the observer bias (Fritzsche & Linneweber, 2004). Both problems are absent from unobtrusive research in which user behavior occurs naturally, rather than a reaction to research (DeCarlo, 2019). There is an increasing trend of utilizing online trace data to investigate user behavior. It can be the photos, videos, ratings, or comments contributed by users or the transaction logs generated automatically on Web servers to record users' interaction with websites or applications (Hine, 2011). Such data is not only superior in naturalness, but often costs little to collect from a large number of users (DeCarlo, 2019).

This study introduced unobtrusive clickstream data from Web servers to analyze how real-world users interact with a government WeChat official account to satisfy their everyday needs. The clickstream data analysis was complemented by a card sorting study, stakeholder interviews, and a focus group, which reflected a mixed methods design. The goal is to evaluate account performance in public service delivery. This study is guided by the two research questions below:

- (1) How did users find and make use of the services provided by the government WeChat official account?
- (2) How can clickstream data analysis support the government's efforts to evaluate the performance of the WeChat official account in public service delivery?

The rest of the paper is organized as follows. Section 2 provides an overview of the background and literature that motivates this study. Section 3 describes the methodology, including the research setting and data collection, preparation, and analysis. Section 4 divides into two subsections which present the data analysis results in response to the

first research question. The findings of this study and their implications for policy, practice, and methodology are discussed in Section 5. Section 6 concludes the paper. Section 7 presents the limitations and future direction.

2. Literature review

2.1. Social media use in governments

The use of social media in governments is a worldwide trend. Social media provide an efficient and economical communication channel via which governments at different levels disclose information to the public as well as collect opinions and ideas from the public, thus improving transparency and participation (Hofmann, Beverungen, Räckers, & Becker, 2013; Kim, Chun, Kwak, & Nam, 2014). In Western countries, Facebook and Twitter are the two most popular social media adopted by governments. The former is a social networking service that supports reciprocal social interaction among "friends", while the latter a micro-blogging service where micro-bloggers share information with their "followers" (Davenport, Bergman, Bergman, & Fearrington, 2014).

Researchers have investigated how Facebook or Twitter facilitated information communication between the government and the public. The model of "public information", one of the four models of public relations, was found to be used the most widely on Twitter, i.e. releasing accurate information about goings-on and reminding followers of upcoming events (Waters & Williams, 2011). Facebook users were more interested in issues closely related to their everyday lives than in reports on government activities (Hofmann et al., 2013). It has been found that using pictures and photos in the posts and getting a response from the government would provoke higher levels of user engagement (Bonsón, Perea, & Bednárová, 2019; Gintova, 2019). Overall, Facebook had a higher engagement rate (e.g. more likes, comments, and shares) than Twitter, probably because of their difference in the type of user relationships (Haro-de-Rosario, Sáez-Martín, & del Carmen Caba-Pérez, 2018). Besides routine communication, social media also play an important role in crisis management, disaster early warning, and event spotting and monitoring (Chatfield, Scholl, & Brajawidagda, 2013; Graham, Avery, & Park, 2015; Kavanaugh et al., 2012).

In China, the government is also attaching great importance to the adoption of social media, such as Weibo (<https://weibo.com/>) and WeChat. The former, which is a micro-blogging service similar to Twitter, has been more widely investigated in government-related studies. The rising interests of Chinese citizens in participating in public affairs have driven government agencies to adopt Weibo for self-promotion (Zheng, 2013; Zheng & Zheng, 2014). However, government accounts on Weibo were found to be used much less frequently in all types of interactions, e.g. following, commenting, and reposting, than other categories of accounts (Medaglia & Zhu, 2017). They might consider increasing interactive activities (e.g. replying to comments and sending private messages) or raising questions to stimulate public dialogue via surveys or votes for the purpose of enhancing user engagement (Chen et al., 2020; Wang & Luo, 2019). It is believed that the sentimental or emotional characteristics of micro-posts also played their parts in information diffusion, especially in public crises (Tang, Li, Gu, & Tan, 2019; Chen et al., 2020).

Besides information communication, how social media may facilitate public services has attracted some attention. First, social media can be used to gather citizens' demands and expectations of what and how public services should be provided. Involving citizens in the design and delivery of public services is more likely to result in citizen-friendly services (Hofmann et al., 2013). Second, governments can "advertise" their services on social media just as companies employ social media as a marketing tool. It is important to inform citizens about their services and to provide easier access to the services (Gao & Lee, 2017). Last but not least, governments may consider delivering services on social media, which is though subject to legal restrictions for now. Companies have

⁶ <https://www.statista.com/statistics/255778/number-of-active-wechat-messenger-accounts/>

pioneered in enabling transactions (e.g. booking flights) on Facebook, and governments could also benefit from offering partly transactional services and redirecting citizens to their official websites (Sobaci & Karkin, 2013).

2.2. Investigations of WeChat official accounts

There has accumulated a large volume of studies on WeChat official accounts, which mainly fall into four categories. The first category comprises a series of survey studies which revealed the status quo of WeChat official accounts owned by libraries (Gan, 2016; Huang & Guo, 2017; Xu, Kang, Song, & Clarke, 2015), journals (Huang, Xin, & Huang, 2016; Xie, 2015), and government agencies (Li, Chai, Long, & Xu, 2017; Wang & Zhang, 2014), etc., including account profiles (e.g. type, identification, avatar, history, and introduction), content and patterns of information publishing, types and quantities of services provided, and so forth. The second category is interested in how system-related (e.g. perceived quality of information, system, and/or services), user-related (e.g. demographics, motivations, and awareness), and/or environment-related (e.g. network externality and context of use) factors influenced users' adoption, stickiness, engagement, trust, and satisfaction, etc. (Chang, Bi, & Fei, 2017; Guo, Zhang, Kang, & Hu, 2017; Liang & Yang, 2018; Qin, 2018; Song, Wu, & Shi, 2015; Tian & Xu, 2017; Tong & Shen, 2019; Tsai & Men, 2018; Wei, Huang, & Zheng, 2018; Xie & Peng, 2017; Yang, 2017; Zhang, Liu, & Deng, 2017). The third category focuses on the impacts of WeChat official accounts' operation strategies (e.g. time, frequency, and order of publishing) and content production (e.g. choice of topic, title attractiveness, article interestingness, and use of multimedia and emotions) on their effectiveness in information communication, i.e. the quantities of reads, likes, comments, and shares (Lv, Shi, & Zheng, 2017; Cao, Fang, & Du, 2018; Li, 2016; Kuang & Wu, 2019).

The last category, also the largest one, relates to WeChat official account evaluation in terms of influence, effectiveness, and/or quality. Most studies in this category are characteristic of a three-stage process: (1) creating a weighted indicator system for evaluation; (2) inviting evaluators to rate a group of accounts against the indicators; and (3) calculating a total score according to the weights for each account and sometimes further establishing the ranking. The creation of an evaluation system involved two different approaches. First, an initial system was built based on literature survey and then improved with experts' or users' opinions (Guo, Zhang, & Li, 2016; Huang, Huang, Hu, & Li, 2018; Li & Zhang, 2016; Song et al., 2019; Wang et al., 2018). Second, an existing evaluation system from related domains, e.g. E-commerce users' satisfaction evaluation and library service quality evaluation, was modified or expanded to make it applicable to the evaluation of WeChat official accounts (Di, Hou, & Ying, 2017; Yan, Zhang, Sun, & Song, 2017; Zhang & Ji, 2017). The indicators in the evaluation systems can be divided into several dimensions, including account operation, general usage, information publishing, service delivery, interface and interaction design, technical performance, and related policies and regulations. While a couple of evaluation systems included exclusively objective indicators (Zhang, Zhang, Wei, & Yin, 2019; Zhao & Wei, 2017), such as the quantities of reads and likes displayed explicitly on article pages, the others consisted of both objective and subjective indicators, with the latter referring to those depending on evaluators' personal judgement, e.g. comprehensiveness and conciseness of functions. Most studies invited expert evaluators, and users were infrequently involved (Li & Zhang, 2016; Song et al., 2019).

WeChat Official Accounts Platform excels many other social media in service delivery through service accounts that enable direct transactions (Cao, Wang, & Yang, 2016). At present, a wide range of services have reached maturity on service accounts, especially government accounts, including reminders, lookups, payments, appointments, and complaints, etc. (Cao et al., 2016; Li et al., 2017; Wang & Zhang, 2014). It is believed that UCD is vital to the success of government accounts (Lin, 2017; Wang, Guo, & Wang, 2019). However, little user research has been

conducted on their performance in service delivery, and there lacks evidence indicating whether the services satisfy users' needs in practice.

2.3. Clickstream data analysis

As found above, previous studies depended mainly on experts' knowledge to establish account evaluation systems and their subjective ratings to determine the account service quality. A more reliable alternative is to investigate how users are actually using the services delivered on the accounts and whether their goals are achieved through the services. The clickstream data on the Web servers of WeChat official accounts can provide direct evidence for such unobtrusive investigation. It is a typical type of trace data automatically generated as a result of users' interaction with websites or applications for their own purposes in the real world (Jansen, 2009). One can extract from clickstream data all the clicks or page requests made by users in sequence from entering a site or an application. Each clickstream record basically informs us which user performs which type of action on which page at what time (Sen, Dacin, & Pattichis, 2006).

The past two decades have witnessed the rapid growth of user behavior studies based on clickstream data analysis in various contexts, such as E-commerce (Koehn, Lessmann, & Schaal, 2020), social media (Kumar, Salo, & Li, 2019), online learning (Li, Baker, & Warschauer, 2020), Web portals (Iwanaga, Nishimura, Sukegawa, & Takano, 2019), search engines (Jeziorski & Moorthy, 2017), and so forth. A general framework for analyzing clickstream data, consisting of three levels – footprint, movement, and pathway, has gradually taken shape (Chi, Jiang, He, & Meng, 2017). When a user visits a site, each click causes a *movement*, the change of location from one page to another, and leaves a *footprint*, a mark showing the user's presence on a page. All clicks that occur during a visit constitute a *pathway*, indicating the process in which the user navigate through the site or application. The *footprint level analysis* is interested in footprint distribution (i.e. which pages are requested) and footprint depth (i.e. how much time is spent on pages), with an aim to provide a basic understanding of user traffic. The *movement level analysis* concerns whether and how users' goals are achieved, thus mainly involving the analysis of "pivotal movements" that lead users to the destination pages where intended information is provided or intended tasks are enabled. The *pathway level analysis* focuses on characterizing users' navigation paths in terms of length, duration, width, and capacity as well as visualizing individual and/or aggregated paths. This framework has been successfully applied in the studies of users' information behavior in academic library OPAC systems (Jiang, Chi, & Gao, 2017) and in online news portals (Jiang, Guo, Chen, & Yang, 2020). To the best of our knowledge, however, clickstream data analysis has never been involved in mixed methods research. It is useful for describing users' behavior but falls short of explaining the reasons why they behave that way (Hew, 2018).

3. Methodology

3.1. Research setting – a government WeChat official account

This study focused on an active government WeChat official account which is owned by the Traffic Management Bureau (TMB) of a capital city in central China. The TMB account has accumulated approximately three million followers since its establishment in 2013. It stands out from more than 700 TMB accounts nationwide for pioneering two services, illegal driving record lookup and online fine payment (Wang & Gao, 2014). The TMB account now allows drivers and the general public of the city to look up various records, make appointments for offline services, report accidents and road conditions, learn traffic regulations and pay fines, and so forth. It has been ranked top three among the best

WeChat official accounts of local government agencies for 6 consecutive years.⁷

Also, the TMB official account has been deemed a successful case in previous E-government studies. Zhang, He, Li, and Ma (2016) divided the evolution of this account into four stages: (1) simple one-way communication – sending personalized reminders (e.g. driver license renewal alerts) to individuals and publishing traffic-related information; (2) simple two-way interaction – allowing users to look up vehicle or driving records, traffic conditions, and service guide of the TMB; (3) simple transactions – enabling users to report accidents and directing them to nearby offices to file insurance claims; and (4) advanced transactions – the TMB working with the financial department to support online fine payment through WeChat Pay. It was believed that the success of the TMB official account could be attributed to the importance attached to information infrastructure construction as well as social media adoption by the local government (Wang & Gao, 2014).

3.2. Data collection

This study obtained from the above-mentioned TMB official account a transaction log file containing 42,188,760 clickstream records generated on the server from 00:00:00 May 30th to 23:59:59 July 28, 2018. The researchers had permission to access the data as a result of being invited to provide strategic consulting services for the TMB. Since the original log file was received with user identities encrypted and all sensitive privacy information removed, the clickstream data analysis need not undergo the ethical review.

Following the commonly used NCSA extended/combined log format, the transaction log contains five basic fields which are:

- *User-IP* – IP address of the client who made the request, e.g. “113.57.247.***”;
- *Date/Time* – date and time stamp of the request, e.g. “18/Sep/2017:19:18:28-0400”;
- *Request* – including type of client to server request, URL of the resource requested, and HTTP protocol version, e.g. “GET/menu2018/service HTTP/1.1”;
- *Status* – HTTP status code returned by server, e.g. “200”; and
- *Referrer* – URL of the page on which the request was made.

3.3. Data preparation

3.3.1. Data cleaning

The log file was cleaned to eliminate corrupted and redundant records in the first place. Corrupted records were errors produced when the server performed logging incorrectly and were easily recognizable for not fitting the patterns of the normal data in the same field. Redundant records were those irrelevant to the objective of this study, including unsuccessful requests (i.e. status code not belonging to the 200 class), data submission requests (i.e. type of request not being “GET”), and requests for pictures, styles, scripts, and other resources that users have no direct interaction with (e.g. URLs of the resources requested ending with “jpg”, “gif”, “css”, and “js”, etc.). Data cleaning was completed with Python 3.6, and 5,260,421 clickstream records were retained in the log file, involving 607,278 distinct IP addresses.

3.3.2. Data parsing

The next step was to identify user sessions. Each session contains all the records produced during one visit of the TMB account. Different users were identified with their IP addresses; and for the same user, if the time interval between any two consecutive records exceeded 5 min, they would be divided into different sessions. A low threshold was chosen because it usually takes a short time to perform the task or consume the

content on a mobile page. As a result, a total of 3,430,018 sessions were extracted. A manual examination was made on the 9 robot-like sessions, i.e. containing more than 100 records. But they were all determined to be human sessions as their records followed a logical sequence of page requests within a reasonably long duration.

3.3.3. Data coding

A coding system was created according to the structure of the TMB account for the purpose of translating structured records into tangible actions. As shown in Table 1, there are seven major categories of pages, including *Home*, *User*, *Appointment*, *Lookup*, *Reporting*, *Online*, and *Information*. Except that the three home portals mainly play a navigational role, each of other page categories enables a series of tasks. Each task is assigned a task code in uppercase. A full version of the coding system can be found in the appendix. It further includes the pages that one needs to visit in sequence in order to complete each task. Each page is assigned a page code in lowercase and identifiable in the clickstream data with a specific string in the URL. Some tasks (e.g. binding vehicle to account and lookup of bridge/tunnel traffic control information) may be completed on one page, while most tasks involving multiple pages which are displayed in sequence.

3.4. Data analysis and complementary studies

Although a clickstream data analysis can be conducted at the footprint, movement, and/or pathway levels, this study mainly relied on the movement level analysis to understand how and whether users attained their goals. For most users, their goals of visiting the TMB account are to satisfy various traffic-related needs via the services provided. They made use of the services by performing various tasks enabled on different categories of pages. A total of 51 tasks are enabled on this account (Appendix). It is common that a task is divided into two or more steps and each of the steps is enabled on one page, with one-step tasks in the minority ($N = 13$, 25.49%). In other words, each task corresponds to a page bundle containing at least one page.

As seen in Fig. 1, the movement level analysis was composed of two stages: analysis of wayfinding to tasks and analysis of task performing and completion. *Stage One* focused on the movements from the three home portals to various tasks since the former are responsible for displaying the buttons for executing the tasks. *Stage Two* dived deeper into within-task movements and between-task movements, which respectively aimed to reveal how individual tasks were performed step by step and how related tasks were co-performed during one visit. In particular, different visualizations were employed to present the results in a more intuitive way.

As a matter of fact, this study adopted a mixed methods design by further introducing qualitative research methods to provide more insights into the quantitative results deriving from the clickstream data analysis (Fig. 1). *Stage One* was complemented by a *card sorting* study that helps appraise the organization and labeling of the task buttons on the home portals; and *Stage Two* was complemented by *stakeholder interviews* and a *focus group* to identify the potential problems that impeded task performing and completion, from the perspectives of account operation strategy and interaction design respectively.

3.4.1. Card sorting

Card sorting is a simple way to understand how people group, sort, and label tasks and content in their mind. While open card sorts allow participants to write their own cards and category labels, closed card sorts involve pre-labeled cards and categories and are useful for validation (Rosenfeld et al., 2015). In order to determine whether the buttons on the home portals were appropriately labeled and grouped, this study recruited ten participants randomly at a local office of the TMB with small incentives to participate in closed card sorts. It was required that they had been driving for at least 5 years and had never visited the TMB account, which ensured that the participants could understand the

⁷ <http://www.tmwcn.com/html/news/8/201908/t202151.html>

Table 1
Coding of tasks enabled on different categories of pages.

Page category	Task code	Task
Home <i>The three portals that provide access to various services</i>	/	/
User <i>Users' personal account for driver and vehicle information management</i>	UT1	User identity verification
	UT2	Binding vehicle to account
	UT3	Binding driver to account
	UT4	Electronic driver license application
	UT5	Electronic vehicle license application
Appointment <i>Making appointments for offline services, e.g. driver license renewal and vehicle registration</i>	AT1	Appointment for driver license un-registration
	AT2	Appointment for driver license renewal
	AT3	Appointment for nonlocal driver license transfer
	AT4	Appointment for new vehicle registration
	AT5	Appointment for vehicle inspection exemption
	AT6	Appointment for temporary plate number application
	AT7	Appointment for vehicle record inquiry
	AT8	Appointment for military driver license transfer
	AT9	Appointment for overseas driver license transfer
	AT10	Appointment for vehicle change registration
	AT11	Appointment for vehicle annual inspection
Lookup <i>looking up various records, e.g. accident records and illegal driving records</i>	LT1	Lookup of time for vehicle annual inspection
	LT2	Lookup of driver license expiration date
	LT3	Lookup of traffic accident records
	LT4	Lookup of electronic insurance policies
	LT5	Lookup of one's own illegal driving records
	LT6	Lookup of other's illegal driving records
	LT7	Lookup of lost vehicle license plate information
	LT8	Lookup of bridge/tunnel traffic control information
	LT9	Lookup of traffic violation codes
	LT10	Lookup of electric bicycle license plate information
	LT11	Lookup of vehicle detention records
Reporting <i>Reporting accidents, road conditions, and illegal behaviors to the TMB</i>	RT1	Reporting malfunctioning traffic facilities
	RT2	Reporting a fake-plated vehicle
	RT3	Reporting disciplinary violation
	RT4	Reporting road water
	RT5	Reporting road ice
	RT6	Reporting illegal parking
	RT7	Reporting a traffic accident
	RT8	Requesting traffic emergency rescue
	RT9	Reporting an obstructing vehicle
Online <i>Online services delivered directly on the TMB account</i>	OT1	Traffic regulations learning
	OT2	Driver qualification check
	OT3	Subject 1 practice test for driver license
	OT4	

Table 1 (continued)

Page category	Task code	Task
Information <i>News, notifications, and other information published by the TMB</i>	OT5	Subject 3 practice test for driver license
	OT6	First violation penalty exemption
	IT1	Paying a fine
	IT2	Parking lots
	IT3	Ferry schedule
	IT4	Travel guide for special events
	IT5	Weekly summary of traffic conditions
	IT6	TMB news
	IT7	Traffic notifications
	IT8	Weibo updates
	IT9	Office locations
		Sample photos

traffic-related labels but would not be affected by any previous experiences with the labels. In the card sorting study, each participant was shown a total of 38 cards, i.e. the textual labels of the buttons on all home portals, and asked to sort them into three categories, i.e. the three navigation options which are “verified user”, “public services”, and “information lookup” respectively.

3.4.2. Stakeholder interview

Stakeholders are the people within an organization who are involved in or affected by a design project, such as directors, customer services, marketing, project team, and so on. Stakeholder interviews are an important tool for gaining insights into business context, including the goals to be achieved, resources available, and funding and technological constraints, etc. (Allen & Chudley, 2012). This study conducted two stakeholder interviews, one with the director of the TMB's propaganda department and the other with the leader of the account development team, with an aim to elicit their understanding of the quantitative results and assessments of account performance at the strategic and tactical levels respectively. Each interview was guided by three open-ended questions: (1) *What is your primary goal of creating or developing a WeChat official account for the TMB?* (2) *What is your means of achieving this goal?* (3) *Do you think the goal was achieved according to the results of our clickstream data analysis? If not, why?* Both interviews were conducted face to face for the convenience of presenting the results of the clickstream data analysis to the interviewees and fully taped with their permission.

3.4.3. Focus group

Focus groups are formally organized, structured groups of individuals brought together to discuss a topic or a series of topics under moderation. Focus groups for user experience design can be scheduled early in product development to understand what users need and expect or introduced during the redesign cycle to find out where users feel the product fails and what regularly bothers them (Goodman et al., 2012). This study conducted a focus group to examine more closely the interaction design of eight multi-step tasks selected based on the clickstream data analysis results. To be more specific, seven postgraduate students were recruited on a university campus using convenience sampling and instructed to independently perform the tasks on a prototype system that exactly simulated the TMB account and then sit down together to discuss the problems encountered when performing the tasks as well as possible solutions. All participants had taken courses in user experience design, and their domain knowledge enabled them to provide more insightful opinions than average persons. The discussion of each task addressed two basic questions: (1) *Is the task properly connected to related tasks? If not, how to improve the connection?* (2) *Is each step in the process of performing the task properly afforded? If not, how to improve the affordance?*

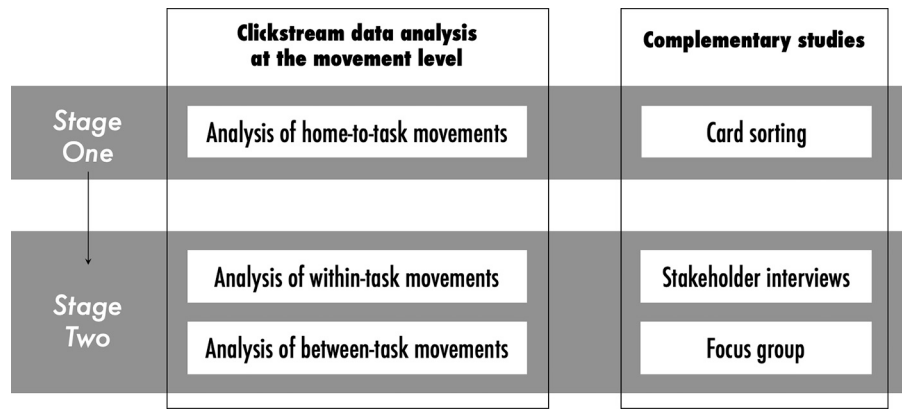


Fig. 1. Mixed methods design of this study.

4. Results

4.1. Stage One: analysis of wayfinding to tasks

4.1.1. Visualization of home-to-task navigation

Fig. 2a, b, and c are the screenshots of the three home portals of the TMB account respectively, i.e. *Verified users* (hp1), *Public services* (hp2), and *Information lookup* (hp3). It is obvious that they share the same page layout: a banner on the top, a global navigation bar at the bottom, and two sets of task buttons in between. The top banners are there mainly for aesthetic purposes, while the bottom bars all contain the same navigation options (enclosed in rectangles in Fig. 2) hyperlinked to the three home pages. The buttons on each portal are distinguished with two different sizes: larger buttons for 4 primary tasks arranged in a 2*2 grid and smaller buttons for secondary tasks arranged in a 4-column grid. Each button is labeled with an icon and text. Users' interaction with the portals were visualized with the bubbles on the screenshots: the size of the bubble attached to a button is proportional to the number of clicks it received. In order to avoid clutter, only the bubbles indicating more than 20,000 clicks were shown and those indicating more than 50,000 clicks were labeled with the exact numbers of clicks.

It is unexpected that the three home portals accounted for 55.43% of the total traffic; and the home traffic was unevenly distributed among the portals, i.e. *Verified user* (hp1, 30.93%), *Public services* (hp2, 18.69%), and *Information lookup* (hp3, 5.82%). According to Fig. 2, the clicks on each portal highly concentrated on a few buttons. On *Verified user* (hp1), the second primary button that executes the lookup of one's own illegal driving records (LT5) received the most clicks ($N = 709,576$), followed by the first primary button ($N = 258,568$) for UT1 (i.e. user identity verification); and the first three secondary buttons aroused much more interest than the rest. The most prominent button on *Public services* (hp2) and *Information lookup* (hp3) are the first primary button ($N = 429,608$) and the first secondary button ($N = 113,697$), respectively. A closer look at the buttons would lead one to find that they both execute LT5 though labeled differently. In other words, the TMB account provides multiple entries to lookup of one's own illegal driving records. The large bubbles attached to the global navigation bars on all three home pages indicate that the users did switch among the portals very frequently.

4.1.2. Card sorting: evaluation of information architecture

Based on the above analysis, the home portals of the TMB account seemed to trap the users in a chaotic hub. It's undesirable that wayfinding to tasks was the dominant user activity on the account. This study further conducted a card sorting study to probe into the problems causing such failure. Among the 38 cards shown to them, all participants agreed on the sorting of only 12 cards. If a card is deemed belonging to a particular category when more than 50% of the participants agree so,

then there were 34 cards each falling into one of the three categories and 25 of them consistent with the actual categorization on the TMB account.

The three categories, i.e. "verified user", "public services", and "information lookup" contained 6, 18, and 10 cards respectively. As found in post-interviews, "verified user" (abbreviated "V user" on the home pages) aroused the most confusion. The participants said they did not understand this label very well and would place in this category the cards which they did not understand either or they thought not relevant to the other two categories. Some of them also felt confused about using the same label "V user" for both a category and a card. The cards under "public services" widely involved appointment, lookup, reporting, and online tasks because the participants had different understanding of what public services should cover. They had little problem with "information lookup" as the cards went into this category naturally for including the word "lookup". When asked to merge similar cards, most participants picked out at least two of the three cards "my illegal driving record", "illegal driving record processing", and "vehicle illegal driving record lookup" which were used to label the same button for LT5 (i.e. lookup of one's own illegal driving records) on different home portals.

Overall, the three home portals need to improve the current labeling system in order to reflect a clear and logical information architecture. The problematic use of vague or broad labels for navigation options could result in magnified negative influence through repeated exposure. The frequent switch among the three home pages implies the possibility that users were bouncing back and forth to explore where to find desired services. Less self-explanatory or inconsistent button labels could decrease users' motivation to click on the buttons and utilize the services.

4.2. Stage Two: analysis of task performing and completion

4.2.1. General analysis of top tasks

On the TMB account, individual pages were bundled for each task and the pages in a bundle must be requested in a fixed order. Whenever the first page in a bundle is requested, the corresponding task is performed; and when all the pages in a bundle have been requested in sequence, the task is completed. The frequency of performing a task indicates its popularity, while the rate of completing a task reflects the effectiveness of the account in supporting the task.

Fig. 3 demonstrates the top 10 tasks performed the most frequently. Surprisingly, LT5 (i.e. lookup of one's own illegal driving records) was performed 1,664,221 times, far exceeding the second most popular task, OT6 (i.e. paying a fine). It is interesting to notice that LT5 and OT6 are two related tasks: if the lookup returns an illegal driving record, the user may want to pay a fine for it. The rest of the tasks in Fig. 3, though all performed more than 20,000 times, are almost ignorable when compared to LT5.

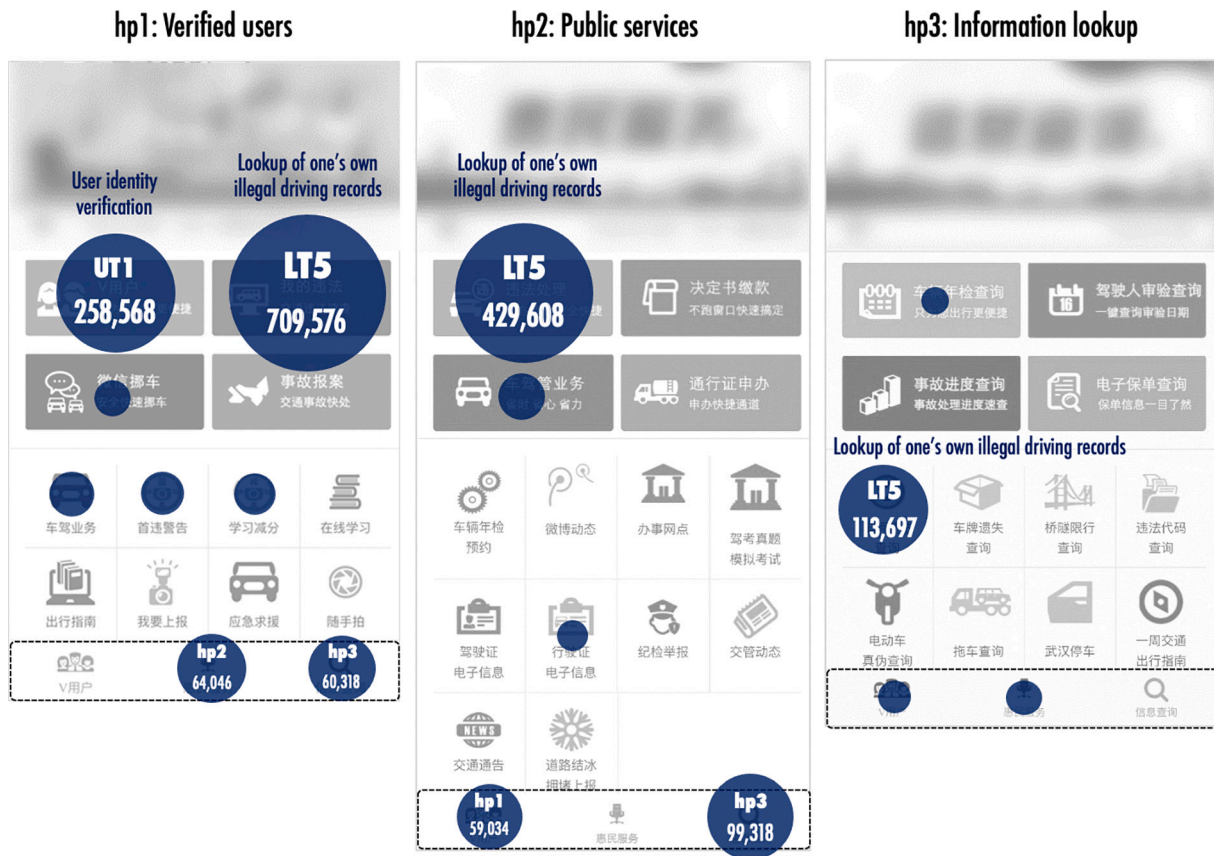


Fig. 2. Clicks on the buttons on the three home portals.

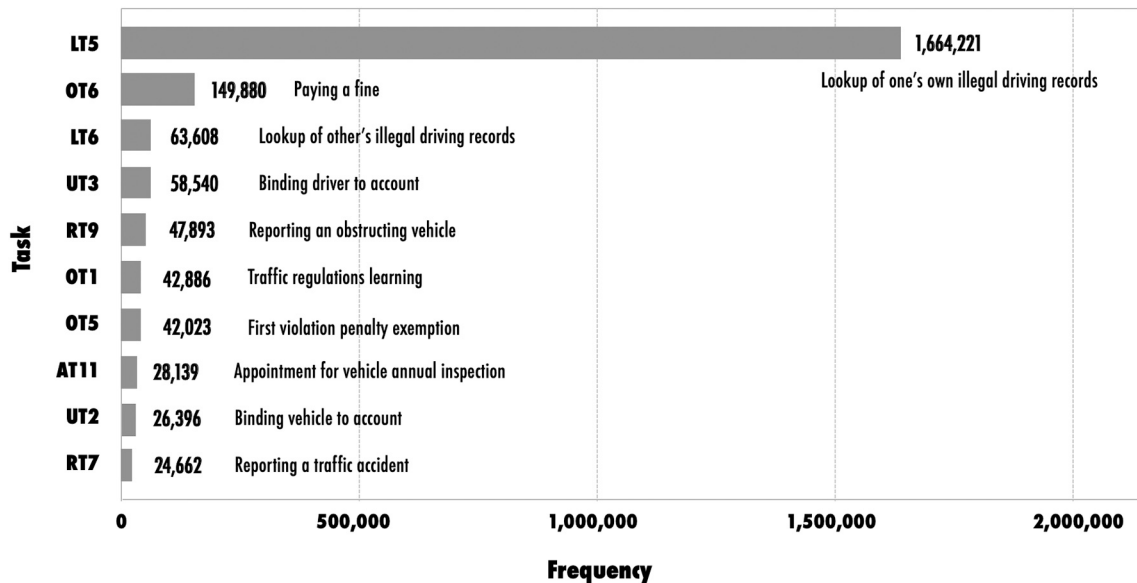


Fig. 3. Top 10 tasks performed the most frequently.

The top 10 multi-step tasks (i.e. involving two or more steps/pages) with the highest completion rates can be found in Fig. 4. The completion rate of a multi-step task was obtained by dividing the frequency of completion by that of performing. It is comparable with E-commerce conversion rate which is defined as the ratio of sessions with purchases to total sessions on a site (Fatta, Patton, & Viglia, 2018), because making a purchase can be considered as a task and the task may be performed

without completion. LT10 (i.e. lookup of electric bicycle license plate information) had a completion rate of 59.36%, which stands out among all the tasks. Figs. 3 and 4 only have two tasks in common, i.e. RT9 (i.e. reporting an obstructing vehicle) and LT6 (i.e. lookup of other's illegal driving records), suggesting the poor completion of most popular tasks. Except UT1 (i.e. user identity verification) that consists of four steps, the other tasks in Fig. 4 all comprises only two steps.

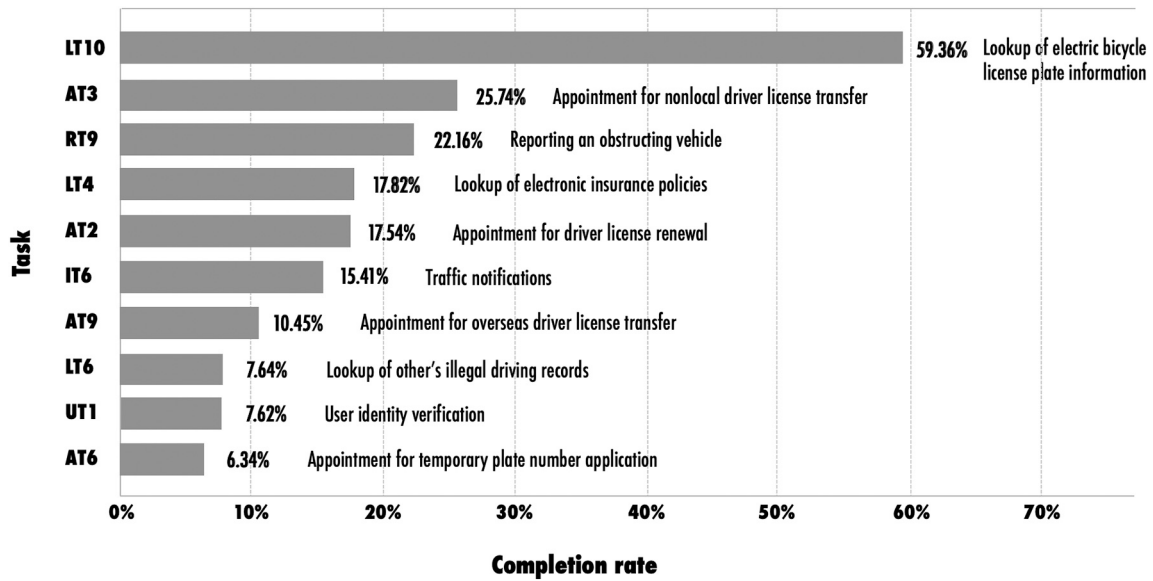


Fig. 4. Top 10 multi-step tasks with the highest completion rates.

4.2.2. Visualizations of step-by-step task performing

All multi-step tasks were examined in greater detail, i.e. step by step, and the results were visualized with funnel graphs. The funnel graph has been widely used to demonstrate the flow of customers through a business or sales process in which the number of customers at each step is indicated with the funnel's width as it narrows. It is useful for identifying the steps responsible for customer loss.⁸ In a similar way, this study adopted the visualization to present the process of task performing. Specifically, the widths of horizontal edges are proportional to the frequencies of requesting the pages in a task. When there is a significant or unexpected decrease in width, that specific page deserves a deeper investigation to understand what problems possibly prevented users from proceeding to the next step.

A small number of tasks actually achieved quite high completion rates. The most satisfactorily completed task, LT10 (Fig. 5), is in fact a tool for traffic police officers who need to inspect the authenticity of suspicious electric bicycle license plates. It is also easy to complete, i.e. inputting the type and number of a license plate (lp16) and then viewing the result (lp17). RT9 (Fig. 6) is the most satisfactorily completed popular task. It targets drivers whose vehicles are obstructed by other vehicles. Once they submit the type, license plate number, location, and picture of an obstructing vehicle (rp19), an alert will be sent to its owner asking him or her to drive it away (rp20). It can be inferred that a task was more likely to be completed when performed by professional users or in conditions of urgency.

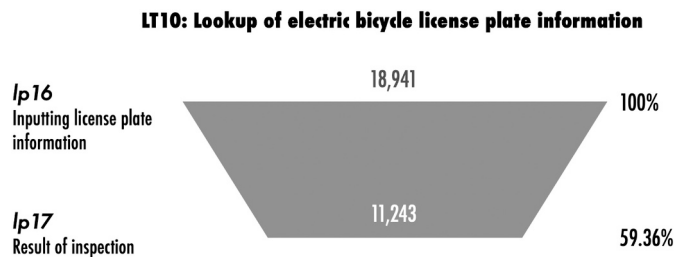


Fig. 5. Stepwise performing of LT10.

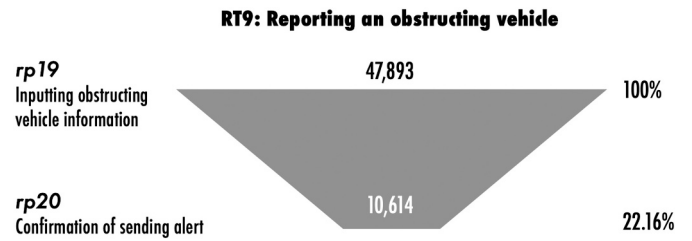


Fig. 6. Stepwise performing of RT9.

As shown in Figs. 7–9, the most poorly completed popular tasks were OT5 (i.e. first violation penalty exemption), AT11 (i.e. appointment for vehicle annual inspection), and OT1 (i.e. traffic regulations learning). Their completion rates were all lower than the average E-commerce

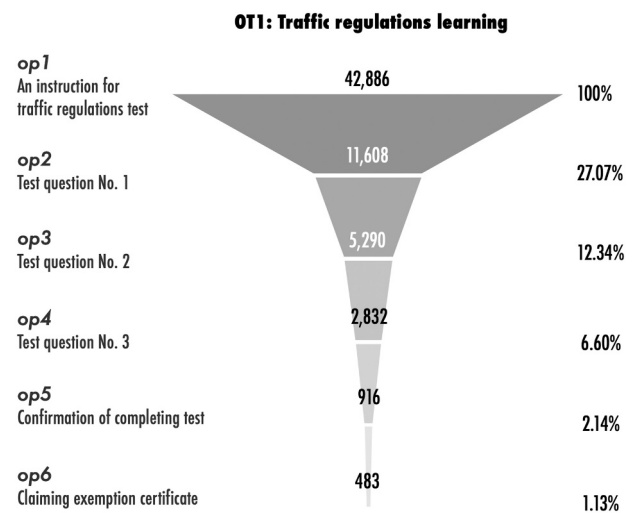


Fig. 7. Stepwise performing of OT1.

⁸ <https://chartio.com/learn/charts/funnel-chart-complete-guide/>

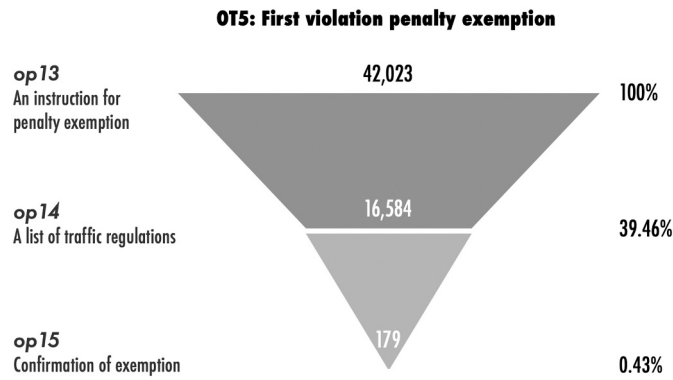


Fig. 8. Stepwise performing of OT5.

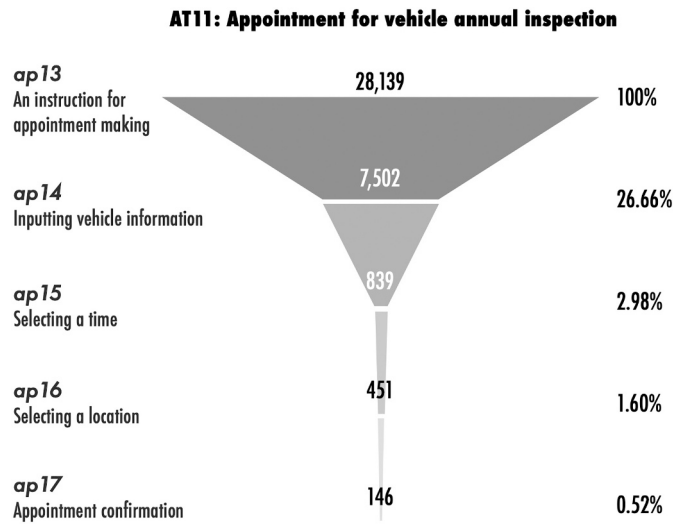


Fig. 9. Stepwise performing of AT11.

conversion rate, 2.04%.⁹ The three tasks involve 3, 5, and 6 steps respectively. In addition to more steps, they also require a lot of input and/or selection in each step. For example, to complete AT11 (Fig. 9), users need to read an instruction on how to make an appointment (ap13), input vehicle information (ap14; including license plate number, vehicle information number, and owner's mobile number), select a time (ap15), select a location (ap16), and view a confirmation (ap17) in sequence. 26.66% of the users finished reading the instruction that is quite a long one, and 2.98% of them successfully input all the vehicle information. Traffic loss was obviously associated with the first two steps. Therefore, the low probability of completing these tasks could be attributed to their high complexity, i.e. the large number of steps and/or the great effort required for each step, to a considerable extent.

OT6 (i.e. paying a fine) and LT6 (i.e. lookup of other's illegal driving records) were the two most frequently performed multi-step tasks. The former task consists of three steps: reading penalty details (op16), paying the fine with WeChat Pay (op17), and viewing payment confirmation (op18). Fig. 10 indicates that only 35.23% of the users actually proceeded to payment. The rest might just want to check if a fine had occurred, or they could pay the fine offline at the TMB offices. If one chose to pay with WeChat Pay, the payment would be processed after password authentication. LT6 (Fig. 11) is a typical lookup task, i.e. inputting driver license information (lp9) and viewing the result (lp10). Compared to the above poorly completed tasks (i.e. OT5, AT11, and

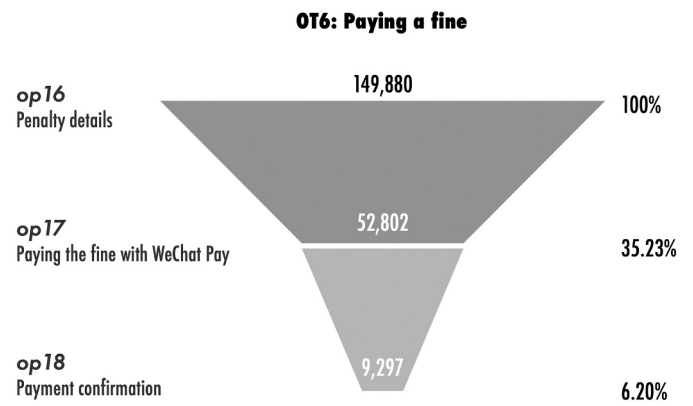


Fig. 10. Stepwise performing of OT6.

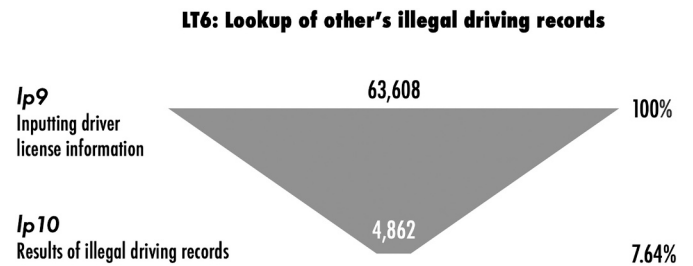


Fig. 11. Stepwise performing of LT6.

OT1), OT6 and LT6 exhibited lower complexity, demanding less inputting effort from users, and thus had higher completion rates, which is reasonable.

4.2.3. Visualization of task co-performing

Finally, the focus of analysis shifted to multi-task sessions which reflected the scenarios in which users visited the TMB account with more than one need. Nevertheless, it was a little surprising to find that 44.63% of the 3,430,018 sessions ended with no task performed. Among the remaining 1,899,067 sessions, 83.33% contained only one task and 13.89% two tasks, and the longest session contained 9 distinct tasks. On average, the users only performed 0.62 tasks and completed 0.09 tasks during one visit. As a whole, the services provided by the account were actually underutilized. This study created a network visualization of task co-performing in the multi-task sessions (Fig. 12). In this visualization, nodes represent tasks. While node sizes are proportional to the frequencies of performing the tasks, textures help distinguish different types of tasks (e.g. dotted for lookup tasks). Directed edges are used to indicate the immediate co-occurrence between two tasks: an edge originates from the preceding task node and ends in the succeeding task node. Each edge is labeled with the frequency of task co-performing.

In Fig. 12, it is obvious that LT5 (i.e. lookup of one's own illegal driving records) is the core task in the network for its connections with all other tasks via either inbound or outbound edges. It preceded OT6 (i.e. paying a fine) 104,428 times, making $LT5 \rightarrow OT6$ the most frequently co-performed pair of tasks, which confirms the above guess that the users might pay a fine for the illegal driving record returned in the lookup. Though less frequent, $LT5 \rightarrow OT5$ ($N = 7169$) and $LT5 \rightarrow OT1$ ($N = 6539$) also deserve some attention. The TMB allowed the users to be exempt from paying a fine if they were willing to learn traffic regulations (OT1) or if they claimed the illegal driving to be their first violation (OT5). Moreover, it was common that the users returned to LT5 after performing OT6, OT5, and OT1, probably to check if their illegal driving records had been processed and removed. The second most frequently co-performed pair of tasks is $LT5 \rightarrow LT6$ ($N = 59,974$). The needs to look

⁹ <https://www.growcode.com/blog/ecommerce-conversion-rate/>

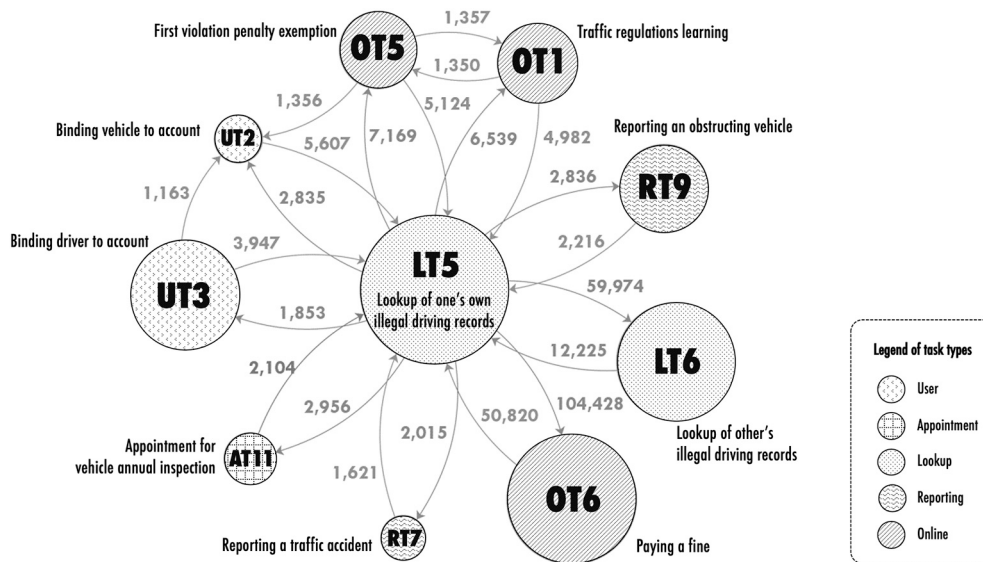


Fig. 12. Task co-performing network.

up illegal driving records both for oneself (LT5) and for others (LT6) accord with the fact that many Chinese urban families own two or more vehicles.

4.2.4. Stakeholder interviews: evaluation of operation strategy

Although the TMB official account enables users to perform a series of tasks on six categories of pages to utilize various services, LT5 (i.e. lookup of one's own illegal driving records) was the most frequently performed task while the performing of other tasks almost neglectable. In fact, 28.81% of the total traffic flowed to *lookup* pages, only second to *home* pages. This account was basically used as a lookup tool. Stakeholder interviews were conducted to see whether such results were intended.

According to both interviewees, the primary goal of the account is to allow users to receive traffic-related transactional services in an easy manner anywhere anytime. The means of achieving this goal includes: (1) providing online alternatives to simple services that were previously delivered on site or over phone, e.g. lookup, reporting, and payment; (2) providing online assistance to complex offline services that require drivers or vehicles to be present, e.g. appointment making and instructions on offline service processes; and (3) providing innovative online services made possible on mobile phones, e.g. traffic regulations learning and practice tests for driver licenses.

They acknowledged that illegal driving record lookup and processing were among the core services of the TMB official account but did not anticipate them to be used about ten times more frequently than the total of all other services. The development team had found in a field study that the entire traditional process of resolving an illegal driving record would on average take 110 min which excluded the time spent on the road to TMB offices. Now one can complete this within a couple of minutes on the account. What made the interviewees concerned was that the full use of illegal driving record lookup could not compensate for users' ignorance of other services which the TMB also invested a lot of money and resources to deliver. They had no reasonable explanation for such imbalanced use of services on the account, but the director of the TMB's propaganda department mentioned the insufficiency of advertising the available services. The TMB had been depending mainly on word of mouth to attract followers to its WeChat official account.

4.2.5. Focus group: evaluation of interaction design

Despite that being unaware of the available services could be a reason for their underutilization, the above analysis of task performing

and co-performing also implies potential deficiencies of the TMB account's interaction design that might undermine user experience. Eight multi-step tasks were selected for discussion in a focus group, given their low completion rate (OT1, OT5, and AT11), high popularity (LT5, OT6, and LT6), or great importance to the account as suggested by the stakeholder interviewees (RT7 and LT1).

The focus group indicated several logic defects in the relationships between tasks. It was agreed by the participants that the early termination of performing OT1 (i.e. traffic regulations learning) and OT5 (i.e. first violation penalty exemption) was mainly caused by qualification issues. Both tasks were deemed driver-friendly alternatives to OT6 (i.e. paying a fine) in dealing with illegal driving records, but drivers could not be exempted from punishment if they failed to meet certain requirements, e.g. having no traffic accident record or possessing a local driver license. A smoother way is to allow exemption in the process of OT6 if the user is qualified and automatically direct him or her to the alternatives. The participants were also confused with the relationship between LT5 (i.e. lookup of one's own illegal driving records) and LT6 (i.e. lookup of other's illegal driving records) since they could not find the entry to LT6 until LT5 was completed. Most of them advocated that looking up one's own and other's illegal driving records are two separate tasks which should be enabled in parallel.

The focus group also raised the concern of the behavioral overload internal to individual tasks. As the participants suggested, the completion of AT11 (i.e. appointment for vehicle annual inspection), RT7 (i.e. reporting a traffic accident), and LT1 (i.e. lookup of time for vehicle annual inspection) could be encouraged in several ways. First, user input should be minimized, e.g. replacing the input of an address for RT7 with GPS positioning. When input from users is necessary, it is important to reduce their effort through auto-completing known information about drivers and vehicles stored in the database or input history. Moreover, some steps in such long tasks as AT11 and RT7 can be combined into one to shorten the overall process. Less steps often mean less page loading and less cognitive load in terms of memory. The risks of losing input information in case of bad Internet connection will be lower in shorter processes. It will be helpful to provide a process indicator to make users feel in control.

5. Discussion

Given the increasing trend of delivering public services through government WeChat official accounts in China, the evaluation of

account performance has become an important research focus. Different from the expert-oriented approach dominating previous account evaluation, this study took a user-centered approach which featured a quantitative analysis of unobtrusive clickstream data complemented by three qualitative studies. A series of findings were obtained for the TMB official account of interest to this study in terms of the two research questions.

For the first research question, this study found that the users actually experienced great difficulties in finding needed services on the TMB account. According to the clickstream data analysis, more than half of the total traffic flowed to the three home portals where users' clicks highly concentrated on a few buttons. Obvious deficiencies in button labeling were revealed by the card sorting study. Improvement needs to be made on the current labeling system by increasing the unambiguity and comprehensibility of individual labels as well as the consistency of label use. The home portals should be committed to directing users to their expected destinations instead of retaining them. It was also found that most services provided by the TMB account were underused and the users were inadequately supported in using the services. The clickstream data analysis indicated that the account was used mainly for lookup purposes, especially the lookup of one's own illegal driving records. The imbalanced use of services might be due to the insufficiency of advertising the available services, as inferred by the stakeholder interviewees. The results of stepwise task performing and task co-performing obtained from the clickstream data analysis were further discussed in a focus group which attributed the unsatisfactory task completion rates to either the logic defects in the relationships between tasks or the behavioral overload internal to individual tasks.

For the second research question, this study successfully conducted a clickstream data analysis as part of a mixed methods approach to evaluating a government WeChat official account's performance in public service delivery. The unobtrusive nature of this method helped engender reliable results because the usage of the services for real-world purposes was able to provide objective, accurate, and complete information, eliminating the possible personal bias in the traditional expert-oriented evaluation. The utilization of clickstream data or online trace data is indispensable to user-centered design and is critical to the improvement of user experience. Meanwhile, the combination of clickstream data analysis and qualitative user research methods in the same study was an effective mode of evaluation. While the former identified the problematic components in public service delivery, the latter helped dig into the reasons for the problems. Such mode is conducive to generating useful next steps that government agencies can take to improve their WeChat official accounts.

5.1. Policy implications

Facebook and Twitter for western countries and Weibo for China have been adopted by governments mainly for communication purposes. Hence, most related studies basically shared the same research focus, i.e. how to boost citizen engagement in the communication with the government on social media (Chen et al., 2020; Gintova, 2019; Haro-de-Rosario et al., 2018). In contrast to Weibo, WeChat Official Accounts Platform is still alien to researchers and readers worldwide for lack of focused studies appearing on international journals. To the best of our knowledge, only a couple of government-related studies involved WeChat official accounts which were compared with Weibo accounts, and government websites and/or applications (Jia, Liu, & Shao, 2019; Yang, 2017). As momentous innovation in the development of E-government for enabling public service delivery in addition to information communication, WeChat official accounts deserve dedicated research.

This study is one of the first focusing on WeChat official accounts. The in-depth systematic investigation of the TMB official account as a typical case engendered fresh understanding of the benefits and opportunities this special type of social media can bring to the government. Beyond the discussion of collecting service demands, advertising

services, and redirecting citizens to external services via social media (Gao & Lee, 2017; Hofmann et al., 2013; Sobaci & Karkin, 2013), China has pioneered the delivery of public services right on WeChat official accounts. The government is able to reach a broad range of citizens in virtue of the huge user base of WeChat. The rapid growth of government WeChat official accounts in China can be credited to the central government's urge for the "Internet + public services" reformation: "prompt services, online services, handy services, and one-pass services".¹⁰

It should be noticed that many developed countries are still depending on portal websites to provide public services, such as the United Kingdom (<https://www.gov.uk>) and South Korea (<http://www.minwon.go.kr/>). As online transactions often involve important citizen private information, e.g. personal identity, property status, and social connections, etc., these countries may hesitate to use Facebook or Twitter, owned by American companies, for the sake of privacy and security protection. In contrast, the most popular social media in China, e.g. WeChat and Weibo, are owned by influential domestic companies, e.g. Tencent (<http://www.tencent.com/>) and Sina (<https://www.sina.com.cn/>). These companies have been deeply involved in E-government construction, and their operation may be under the guidance or supervision of the government. An established trustful relation with the companies prompts government agencies to adopt social media without extra worries. Therefore, public service delivery on social media is an issue depending more on the legal and policy environment than on technology readiness.

5.2. Practical implications

Nevertheless, there is no denying that the growth of government WeChat official accounts is still in a preliminary phase. The TMB account, i.e. the case of this study, was designed to be a general platform for all traffic-related services but turned out to be a lookup tool. The underutilization of most services on the account could be attributed to the insufficiency of propaganda and the deficiencies of design on the surface. These problems actually originated from the absence of a professional team who should take full responsibilities of designing, developing, and operating the account. Resembling a mobile application, the TMB account demands systematic user experience design and strong marketing which are hardly achievable if relying on the TMB itself.

The success of government WeChat official accounts calls for external participants like professional companies and individuals, because of the internal constraints in experience, knowledge, and technology, etc. (Wang, 2019). The public-private partnership (PPP) already proved effective in government website construction should be also applicable to WeChat official accounts (Song & Sun, 2017). It refers to the collaboration between a government and a private party, utilizing the funds and skills of the private sector to enhance the quality, speed, and efficiency of services delivered by the public sector (Sharma, 2007). Given proper supervision, government agencies can invite qualified companies to dominate the life cycle of their WeChat official accounts, which will safely ensure the return on investment in social media adoption.

The major findings of this study have immediate implications for improving the service quality and user experience of government WeChat official accounts. On the one hand, the user-centered approach needs to be emphasized in the design and evaluation of the account. The development team should work with user experience designers who are skilled in observing user needs and behavior. Existing mobile design principles can be followed to make the accounts easier to learn and to use. On the other hand, since the target users are ordinary citizens who vary greatly in demographics as well as Internet skills and media literacy, the government should devote efforts to making them aware of

¹⁰ http://www.gov.cn/zhengce/content/2018-06/22/content_5300516.htm

what services are available and how they can utilize the services on the accounts. It is important to establish their confidence in the convenience of receiving public services on their mobile phones.

It is interesting to notice that the above implications demonstrate potential value to the internationally popular government mobile applications which share similar problems with government WeChat official accounts. Many governments have attached more importance to the inclusiveness of services available on their mobile applications while placing less emphasis on user-centered functions (Eom & Kom, 2014). The intention to use government applications is greatly affected by the public's performance expectancy and effort expectancy (Sharma et al., 2018).

5.3. Methodological implications

This study introduced clickstream data analysis to the investigation of social media use in governments, which is an unprecedented attempt. The unobtrusiveness of the research ensures both the reliability and accuracy of the results. The clickstream data was produced naturally as a result of the real interaction between users and the TMB account and thus more reliable than the ratings and comments by human evaluators whose subjective judgement could be influenced by many factors. The clickstream data analysis involved the population of the TMB account users during the 2 months and was conducted on an incomparable size of trace data they left, which was able to reveal accurately the overall trends and detailed patterns of user behavior.

While most previous studies based on clickstream data analysis only resort to the description of statistics in text or tables to present results (Kumar et al., 2019; Li et al., 2020), this study employed a series of visualizations. All the details of accessing and performing tasks on the TMB account are communicated in an explicit and accurate manner, enabling stakeholders and readers to grasp the trends and patterns more effectively and efficiently. Such research effort is a meaningful step to advocate the urge of utilizing data science and designing visualizations to extract new insights from government data that can be structured or unstructured, open or closed (Matheus, Janssen, & Maheshwari, 2018).

Despite its ubiquity on Web servers, clickstream data is still underused in social media studies. Social media companies are often very cautious about releasing their server logs for fear of offending users' privacy. This study was made possible by collaborating with the TMB which invited the researchers to provide strategic consulting services, and the original log file was received with user identities encrypted and all sensitive privacy information removed. Clickstream data analysis is useful in examining user behavior, but insufficient in engendering interpretation. This was taken into full consideration in this study that introduced three qualitative methods to explain user behavior. As a matter of fact, clickstream data is not unique to WeChat official accounts but available on the servers of any types of information products (Jiang, Yang, Yu, & Sang, 2018). The mixed methods approach is therefore directly applicable to evaluating the government portal websites and government mobile applications which prevail in developed countries. The resulting insights into user satisfaction will be more reliable and more accurate and useful for the update or redesign of E-government platforms.

6. Conclusions

As more and more Chinese government agencies adopt WeChat official accounts to deliver public services, there arises an urgent need to

evaluate the accounts' performance in service delivery. This study employed a mixed methods research design to evaluate the performance of a WeChat official account owned by a Traffic Management Bureau at the municipal level. As indicated by a quantitative analysis of 42,188,760 clickstream records, the home portals of the TMB account failed to support effective wayfinding to needed services and the account was mainly used as a lookup tool with most services underutilized. Then three complementary qualitative studies further provided the reasons for such unsatisfactory results in terms of information architecture, operation strategy, and interaction design.

This study features a user-centered approach to the evaluation of a government WeChat official account in public service delivery. It contributes to the current literature on social media use in governments. On the one hand, the focused study of WeChat official accounts enriches the knowledge about how Chinese government agencies are adopting different types of social media for different purposes. On the other hand, it fills the gap in the empirical research on public service delivery via social media, while the existing studies of Facebook, Twitter, or Weibo are limited to the information communication between the government and the public. The fresh findings of this study are useful for the practice of improving the TMB account and enhancing government account construction. The methodological contribution of the study is significant. The successful application of unobtrusive clickstream data analysis engenders more reliable and accurate understanding of the account's performance which was in fact not satisfactory, as opposed to its high ranking and positive appraisal based on the traditional expert-oriented evaluation.

7. Limitations and future research

This study has several limitations. First, there exist some inherent challenges in analyzing clickstream data, such as the lack of effective techniques for distinguishing different users who share a same IP address (Kaushik, 2009). Second, the major findings of this study may have limited generalizability to other government WeChat official accounts given the possible differences in type, goal, and audience. Third, the practical implications deriving from this study need to be incorporated into the TMB's coping strategies to realize their value. The researchers plan to introduce the action research methodology into future research to achieve data-driven redesign of the TMB official account and make iterative analysis of clickstream data after each upgrade of the account.

Declaration of competing interest

Information behavior, user experience, data analytics, and information visualization (Tingting Jiang).

Information behavior (Ying Wang).

Data analytics (Tianqianjin Lin).

E-government (Lina Shangguan).

There is no state of conflict in the publication of this article.

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Appendix A. Clickstream data coding system

Page category	Task code	Task	Page code	Page URL string
Home (H)	–	–	hp1	/menu2018/index
	–	–	hp2	/menu2018/service
	–	–	hp3	/menu2018/infosearch
User (U)	–	–	up0	/user/indexnew
	UT1	User identity verification	up1	/smrz/input
			up2	/smrz/smrzsuccess
			up3	/smrz/checkphone
			up4	/smrz/success
	UT2	Binding vehicle to account	up5	/user/bindvehiclenew
	UT3	Binding driver to account	up6	/user/binddriver
	UT4	Electronic driver license application	up7	/license/active;/license/GetElectronicDriver
	UT5	Electronic vehicle license application	up8	/license/renzhen
			up9	/drivecar/active
			up10	/drivecar/query
Appoint-ment (A)	–	–	ap0	/menu2018/driver
	–	–	ap1	/bespeak/index
	–	–	ap2	/bespeak/tartan
	AT1	Appointment for driver license un-registration	ap3	/bespeak/driving/ctype/10
			ap18	/bespeak/finish
	AT2	Appointment for driver license renewal	ap4	/bespeak/driving/ctype/9
			ap18	/bespeak/finish
	AT3	Appointment for nonlocal driver license transfer	ap5	/bespeak/driving/ctype/8
			ap18	/bespeak/finish
	AT4	Appointment for new vehicle registration	ap6	/bespeak/needdata/ctype/1
			ap18	/bespeak/finish
	AT5	Appointment for vehicle inspection exemption	ap7	/bespeak/needdata/ctype/11
			ap18	/bespeak/finish
	AT6	Appointment for temporary plate number application	ap8	/bespeak/needdata/ctype/4
			ap18	/bespeak/finish
	AT7	Appointment for vehicle record inquiry	ap9	/bespeak/needdata/ctype/5
			ap18	/bespeak/finish
	AT8	Appointment for military driver license transfer	ap10	/bespeak/driving/ctype/6
			ap18	/bespeak/finish
	AT9	Appointment for overseas driver license transfer	ap11	/bespeak/driving/ctype/7
			ap18	/bespeak/finish
	AT10	Appointment for vehicle change registration	ap12	/bespeak/needdata/ctype/3
			ap18	/bespeak/finish
	AT11	Appointment for vehicle annual inspection	ap13	/Examined/index;/Examined/detail
			ap14	/examined/Information
			ap15	/Examined/Nextinfo
			ap16	/examined/nextDetail
			ap17	/Examined/confirm
Lookup (L)	LT1	Lookup of time for vehicle annual inspection	lp1	/inspection/index
			lp2	/inspection/result
	LT2	Lookup of driver license expiration date	lp3	/static/Jszyrq
	LT3	Lookup of traffic accident records	lp4	/accident/query
			lp5	/accident/accidentdetail
	LT4	Lookup of electronic insurance policies	lp6	/policyinfo/query
			lp7	/policyinfo/policylist
	LT5	Lookup of one' own illegal driving records	lp8	/trafficbreak/infoquery
	LT6	Lookup of other's illegal driving records	lp9	/trafficbreak/index
			lp10	/trafficbreak/detail
	LT7	Lookup of lost vehicle license plate information	lp11	/lookplate/platesearch
			lp12	/lookplate/norepeatinput
	LT8	Lookup of bridge/tunnel traffic control information	lp13	/xianxing/weihao/type/7
			lp14	/illegalcode/querycodeinput
	LT9	Lookup of traffic violation codes	lp15	/illegalcode/querybycode
			lp16	/electriccars/showCardInfo
	LT10	Lookup of electric bicycle license plate information	lp17	/electriccars/showcardinfo?hplx=
			lp18	/tuoche/index
	LT11	Lookup of vehicle detention records	lp19	/tuoche/detail
Reporting (R)	–	–	rp0	/menu2018/report
	RT1	Reporting malfunctioning traffic facilities	rp1	/fault/indexnew
			rp2	/fault/success
	RT2	Reporting a fake-plated vehicle	rp3	www.whjg.gov.cn:8089/whhttp/clx/wx/tpba/notice
			rp4	www.whjg.gov.cn:8089/whhttp/clx/wx/tpba/show
	RT3	Reporting disciplinary violation	rp5	jw.whjg.gov.cn:8090/jw/wx/index.html?lwfl=wx
			rp6	jw.whjg.gov.cn:8090/jw/wx/report.html?lwfl=wx
	RT4	Reporting road water	rp7	/backwaterreport/index
			rp8	/backwaterreport/success
	RT5	Reporting road ice	rp9	/freezereport/index

(continued on next page)

(continued)

Page category	Task code	Task	Page code	Page URL string
Online (O)	RT6	Reporting illegal parking	rp10	/freezereport/success
			rp11	/suishoupai/index?&ctype=weiting;suishoupai/index?ctype=weiting
			rp12	/suishoupai/confirm
	RT7	Reporting a traffic accident	rp13	/suishoupai/reportsuccess
			rp14	/quickwithdrawal/index
			rp15	/quickwithdrawal/input
			rp16	/quickwithdrawal/uploadimg/acId/
			rp17	/quickwithdrawal/finish/acId
	RT8	Requesting traffic emergency rescue	rp18	www.sinoassistance.com/ClientCustomerAction.do?appCode=WUHANJG2016
	RT9	Reporting an obstructing vehicle	rp19	/luo/index;/luo/
			rp20	/luo/success
			op1	/answerquestion/xuzhi
	OT1	Traffic regulations learning	op2	/answerquestion/datione
			op3	/answerquestion/datitwo
			op4	/answerquestion/datithree
			op5	/answerquestion/showvolume
			op6	/answerquestion/receivevolume
			op7	wcg.whjg.gov.cn/study/net/check/form
	OT2	Driver qualification check	op8	/Examination/index/type/1
	OT3	Subject 1 practice test for driver license	op9	/Examination/Exam
			op12	/examination/share
			op10	/Examination/index/type/4
	OT4	Subject 3 practice test for driver license	op11	/Examination/Examkm4
			op12	/examination/share
			op13	/shouwjpg/index
			op14	/shouwjpg/list
	OT5	First violation penalty exemption	op15	/shouwjpg/success
			op16	/penalty/carnumpenalty
			op17	/weixinpay/penalty
			op18	/penalty/success
			ip0	/menu2018/trip
			ip1	wh027.leway.com.cn:9090/BackgroundAppExtend/h5/index.html
Informa-tion (I)	IT1	Parking lots	ip2	www.whlundu.com/Wap/FerryLine?plg_nld=1&plg_uin=1&plg_usr=1&plg_vke y=1&plg_dev=1
	IT2	Ferry schedule		
	IT3	Travel guide for special events	ip3	/static/lineguide/static/artinfo
			ip4	mp.weixin.qq.com/s
	IT4	Weekly summary of traffic conditions	ip5	/static/zhinan
			ip4	mp.weixin.qq.com/s
	IT5	TMB news	ip6	/jgmsg/listjgdt
	IT6	Traffic notifications	ip7	/jgmsg/listjgtg
			ip8	/jgmsg/detail?id=
	IT7	Weibo updates	ip9	weibo.com/wuhanjiaojing
	IT8	Office locations	ip10	wcg.whjg.gov.cn/clx/wechat/bratype/listBranch
	IT9	Sample photos	ip11	demo/index.html

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