Usage pattern analysis of academic articles from Chinese journals

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Abstract. Usage metrics have become increasingly popular in scientometric with the advent of electronic resources. While most current researches relied on the usage data retrieved from English publishers. In this study, the usage data was extended to Chinese publishers. We collected and analyzed the usage data of six well-known Chinese OA (Open Access) journals in different fields from journals' official websites and Chinese Academic Journals Full-text Database (CJFD) in China National Knowledge Infrastructure (CNKI). It was found that websites' information architecture affected usage pattern. "Progressive rule"-based site guided users to view full-text articles more than download them and "parallel rule"-based site guided users to download full-text articles more than view them. CNKI proved its popularity in China. Although CNKI is a non-OA platform and has a time delay in indexing full-text articles, but they still attracted a large number of users. PDF tended to be the preferred format than HTML in most journals in the study. Also, CNKI citation were more skewedly distributed than usage data in most journals and it showed strong or moderate correlation between CNKI citation and CNKI full-text downloads in most journals. Finally, it depicted that usage data of most articles was at their peak around pagination month and at the bottom at very earlier or later months.

Keywords: Article usage; Usage metrics; Altmetrics; Chinese journal; CNKI.

1. Introduction

Usage metrics have become increasingly popular in scientometric analyses beyond librarian practices [14]. However, most researches up to now were based on the usage data retrieved from English publishers (e.g. Elsevier, Springer-Nature, IEEE Xplore, PLoS and PeerJ) or English citation index databases (e.g. Web of Science and Scopus). In reality, publishers and citation index databases of other languages also began to provide academic usage data. What's the usage pattern of non-English academic articles? Whether non-English academic articles share the same pattern with English ones? What's the unique pattern of non-English academic articles? Answering these questions could extend the vision from English platform to non-English platforms, which would provide a new perspective to promote the research on usage metrics. So, the purpose of this study was to explore the usage pattern of non-English academic articles by analyzing the usage data of several well-known Chinese OA journals.

2. Literature Review

In general, ''usage'' often refers to HTML views and PDF downloads. Therefore, most publishers classify views and downloads into ''usage metrics'' [36]. In fact, usage metrics are even older than citation metrics, because librarians have been tracking usage since the beginning of their profession, ranging from basic user surveys to the usage tracking of physical journal issues and monographs to library loan statistics to the sophisticated analysis of e-media usage (e-metrics) [14].

Different from the librarian practices, usage metrics in scientometrics mainly focused on the following topics. Firstly, the obsolescence of articles [15, 18, 19, 20, 21, 22, 25, 26, 38, 40]and the correlation between specific usage types, especially downloads and citations [27, 29, 30, 31]. Secondly, usage metrics were introduced as an alternative to traditional citation metrics[4, 6, 13, 28], in fact they should rather be regarded as supplementary metrics jointly with altmetrics measures [2, 1, 33]. Thirdly, usage metrics were perceived as the indicator to evaluate the performance of journals, authors, groups and countries [4, 27] and to identify the latest research trends [41].

Besides, usage metrics were used as the approach to explore user behaviors [39, 41, 42]. In recent research, it was found that there was positive correlation between WoS usage data and funding [44].

All the researches above were mostly based on the usage data from English publishers or English citation index databases, only Wan et al. (2010) proposed the journal download immediacy index (DII) based on CJFD in CNKI to evaluate the performance of journals. On the whole, current researchers ignored non-English publishers and citation index databases. For this reason, this study focused on Chinese usage data to explore their usage pattern. In this study, we were interested in following research questions in the context of six selected Chinese journals in different fields:

(1) Whether the selected Chinese journals share the same usage pattern? And whether the journals share the same usage pattern with English journals?

(2) What's the correlation among different usage data in the same journal?

(3) What's the pattern of usage data before and after the issue/pagination date?

3. Data

3.1. Sampling method

In order to acquire the reasonable sample data, a comprehensive survey of Chinese journal usage data was conducted. Journal lists of most representative citation database between global countries and local China (SCIE[1], SSCI[2], A&HCI[3], EI[4], CSCD[5] and CSSCI[6]) were examined one by one from December 1st to December 25th, 2017. The results showed that 39 Chinese language journals (Open Access) in all the journals lists above had dynamical usage data in article-level. During the 39 Chinese language journals, most journals provided dynamical usage data since 2017 or provided dynamical usage data in recent 12 months. Because the usage counts, especially citations, accumulate to a steady level in the first 2 or 3 years after publication [23]. Only 6 Chinese language journals that provided dynamical usage data since 2016 were kept in the study. The selected journals published academic articles on their official websites and their full-text articles were also indexed by CJFD in CNKI. So, the usage data in this study were collected both from their official websites and CJFD.

CSSCI is short for *Chinese Social Sciences Citation Index*, issued by *Institute for Chinese Social Sciences* Research *and Assessment*, is the most influential index for Chinese social science journals. Founded in June 1996 by Tsinghua University and Tsinghua Tongfang Holding Group, CNKI project has been dedicated to promote large-scale digitization of China knowledge resources and establish a platform for global dissemination and value-added services. With complete coverage of China journals, doctoral dissertations and master theses, newspapers, conference proceedings, yearbooks, reference books, encyclopedias, patents, standards, scientific and technological research findings, laws and regulations, "China Integrated Knowledge Resources Database" is the most comprehensive knowledge system that integrates 90% of China knowledge and information resources[7]. CNKI is a non-OA platform, authorization is required to use its service. CNKI provided the total downloads information (full-text downloads) of each articles, along with other metadata (e.g., article titles, authors, total cited frequency, keywords, etc.).

The six selected Chinese journals are *Cotton Science* (CS for short)[8], *Chinese Science Bulletin* (CSB for short)[9], *Data Analysis and Knowledge Discovery* (DAKD for short)[10], *Journal of*

[1] http://mjl.clarivate.com/publist_sciex.pdf
[2] http://mjl.clarivate.com/publist_ssci.pdf
[3] http://mjl.clarivate.com/publist_ah.pdf
[4] https://www.elsevier.com/solutions/engineering-village/content
[5] http://sciencechina.cn/cscd_source.jsp
[6] http://cssrac.nju.edu.cn/a/xwdt/zxdt/20170116/2805.html
[7] http://oversea.cnki.net/kns55/UserGuide/en/index.html
[8] http://journal.cricaas.com.cn/Jweb_mhxb/CN/1002-7807/home.shtml
[9] http://engine.scichina.com/publisher/scp/journal/CSB
[10] www.infotech.ac.cn

Aeronautical *Materials* (JAM for short)[11], *Journal of Materials Engineering* (JME for short)[12] and *Scientia Geographica Sinica* (SGS for short)[13].

3.2. Usage data of CSB

CSB, a ten-day international journal, provided monthly downloads data in recent 12 months for each article starting from April 2016. In the study, only those issues (from issue 11 to 36) that were published from April 2016 to December 2016 were selected because CSB launched its new official site in April 2016 and its legacy site no longer updated new issues after April 2016. And the usage data of the two sites were different and it was hard to integrate them.

We crawled monthly usage data (full-text and abstract views of HTML formats, full-text downloads of PDF format) of these articles from the journal official website and total downloads information (full-text downloads) along with other metadata (e.g., article titles, authors, total cited frequency, keywords, etc.) from CJFD in CNKI. CSB updated its usage data daily, so all the data were downloaded on March 31, 2017 and January 8, 2017. We found that CSB provided "early access" to their content and published some articles online as soon as they were reviewed. Then they were given pagination and assigned to an issue in later dates. Therefore, for CSB, each article had two dates, i.e., ''publication date'' (early access date) and "current version date" (pagination date/issue assigned date). After deleting the editorials, interviews, news and invalid records, 299 articles were kept.

3.3. Usage data of other journals

CS, a bimonthly academic journal in cotton science, started to provide monthly downloads data for each article starting from February 2015. DAKD, a monthly academic journal in library and information science, started to provide monthly downloads data for each article starting from November 2015. JAM, a bimonthly journal in the field of aeronautic and astronautic materials, started to provide monthly downloads data for each article starting from August 2015. JME, a monthly journal in the field of materials engineering and applications, started to provide monthly downloads data for each article starting from October 2015. SGS, a monthly journal in the field of geography, started to provide monthly downloads data for each article starting from January 2016.

Because the usage data before 2016 were incomplete in the above journals, only those issues which were published from January 2016 to December 2016 were selected. We crawled monthly usage data (full-text and abstract views of HTML formats, full-text downloads of PDF format) of these articles from the journal official websites and total downloads information (full-text downloads) along with other metadata (e.g., article titles, authors, total cited frequency, keywords, etc.) from CJFD in CNKI. CS, JAM and JME updated its usage data daily and all the data were downloaded on January 8, 2018 (the usage data in January 2018 were excluded in the study). DAKD and SGS updated its usage data monthly and all the data were downloaded on January 8, 2018. After deleting the editorials and news, the final data set were kept below, shown in Table 1.

Table 1 Data set

Journal	Type	Indexed by	Time Span	Number of Papers
CS	Bimonthly	CSCD	2016.01-2016.12	77
CSB	Ten-day	EI, CSCD	2016.04-2016.12	299
DAKD	Monthly	CSCD, CSSCI	2016.01-2016.12	139
JAM	Bimonthly	CSCD	2016.01-2016.12	87
JME	Monthly	EI, CSCD	2016.01-2016.12	225
SGS	Monthly	CSCD, CSSCI	2016.01-2016.12	231

[11] http://jam.biam.ac.cn/CN/1005-5053/home.shtml
[12] http://jme.biam.ac.cn/CN/1001-4381/home.shtml
[13] http://geoscien.neigae.ac.cn/CN/1000-0690/home.shtml

4. Results

4.1. Basic statistics of usage data

In Table 2, it showed that users preferred to view full-text articles more than downloading them on official site in journal CSB but users preferred to download full-text articles more than viewing them on official site in other journals. After visiting the official websites of different journals, it was found that the differences of websites' information architecture maybe the main cause to the opposite user preference. On CSB site, the easiest way to read each article is to click the title. After you click the title of each paper, the default link is the full-text html page. But on the official site of other journals, you can directly click any link (abstract, full-text in HTML or PDF format) you want at first glance in a page. In other words, CBS site mainly follows "progressive rule" and other journals' sites follows "parallel rule". They revealed user preference of OA journals in a different way. Wang et al. (2014a) proposed that PDF tended to be the preferred format if researchers wanted to print the article or just save in hard discs for later study. User preference on the "parallel rule"-based sites, confirmed the viewpoints above.

Also, it showed that users preferred to download articles on CNKI than its official site in journal CSB, JME and SGS. Conversely, users preferred to download articles on its official site than CNKI in journal CS, DAKD and JAM. CNKI proved its popularity in China. Because CNKI is a non-OA platform and has a time delay in indexing full-text articles, but its average downloads were more than official sites' downloads in half sample journals.

Table 2 Basic statistics of usage data in different journals

Name	Type	Mean	Median	Name	Type	Mean	Median
CS	CNKI_Download	93.49	83	**JAM**	CNKI_Download	191.22	86
	Site_HTML_View	0	0		Site_HTML_View	0	0
	Site_PDF_Download	202.55	194		Site_PDF_Download	203.94	197
	Site_Abstract_View	92.35	90		Site_Abstract_View	69.48	60
CSB	CNKI_Download	208.76	153	**JME**	CNKI_Download	181.21	94
	Site_HTML_View	156.35	117		Site_HTML_View	0	0
	Site_PDF_Download	**36.15**	28		Site_PDF_Download	98.23	80
	Site_Abstract_View	11.51	4		Site_Abstract_View	58.78	50
DAKD	CNKI_Download	182.99	153	**SGS**	CNKI_Download	486.62	381
	Site_HTML_View	7.69	5		Site_HTML_View	0.35	0
	Site_PDF_Download	288.9	247		Site_PDF_Download	225.85	181
	Site_Abstract_View	46.27	41		Site_Abstract_View	315.58	301

4.2. Skewness of usage data

Fig. 1 offered a different look at the skewness of the usage data and citation distributions in different journals. In a first step, articles in each journal were sorted by descending number of usage counts. Next, the functional relationship was calculated between the cumulative percentage of articles in each journal and the cumulative percentage of its usage counts. The same was done for citations. The four or five functional relationships were plotted in Fig. 1 It showed that CNKI_Citation were more skewedly distributed than usage data in most journals except the journal SGS. This finding was in accordance with Chen (2017), the citations were more skewedly distributed than usage counts in most journals indexed by *Web of Science* and *Springer*. It also showed that Site_PDF_Download were less skewedly distributed than CNKI_Download in all the journals.

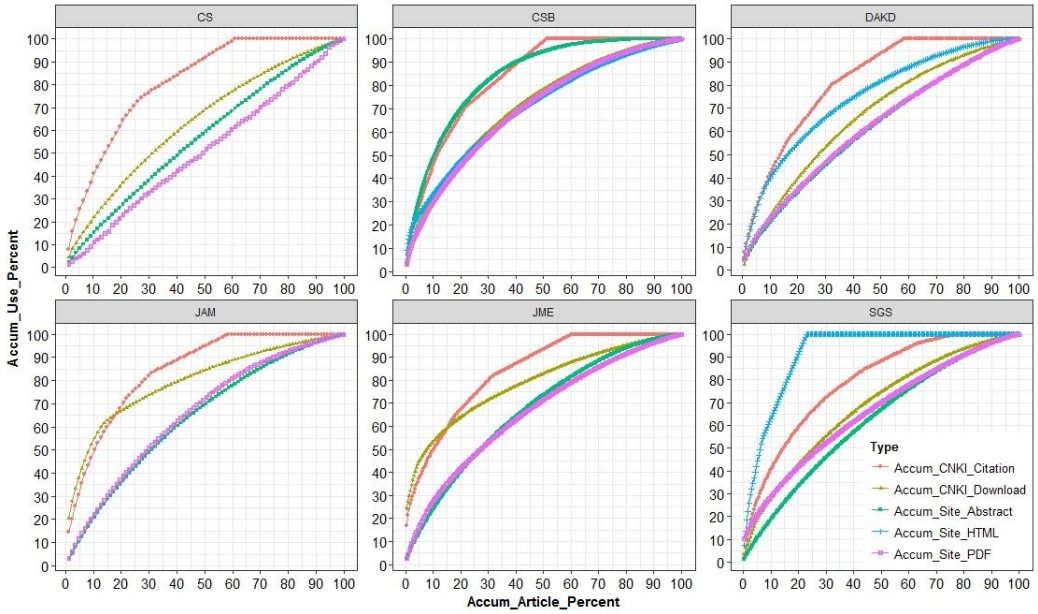

Fig. 1 Cumulative percentage of usage data as a function of the cumulative percentage of article per journal

4.3. Correlation analysis of usage data

Table 3 Spearman's correlation coefficient in different journals

Journal		CNKI_Citation	CNKI_Download	Site_HTML	Site_PDF	Site_Abstract
	CNKI_Citation	1	0.25	NULL	0.26	0.15
	CNKI_Download		1	NULL	0.43***	-0.02
CS	Site_HTML			NULL	NULL	NULL
	Site_PDF				1	0.14
	Site_Abstract					1
	CNKI_Citation	1	0.39***	0.04	0.04	-0.05
	CNKI_Download		1	0.26***	0.22***	0.04
CSB	Site_HTML			1	**0.89****	0.27***
	Site_PDF				1	0.40***
	Site_Abstract					1
	CNKI_Citation	1	0.57***	0.27**	0.17	-0.07
	CNKI_Download		1	0.33***	0.43***	0.03
DAKD	Site_HTML			1	0.22**	0.02
	Site_PDF				1	0.12
	Site_Abstract					1
	CNKI_Citation	1	0.60***	NULL	0.39***	0.20
	CNKI_Download		1	NULL	0.55***	0.44***
JAM	Site_HTML			NULL	NULL	NULL
	Site_PDF				1	0.45***
	Site_Abstract					1
	CNKI_Citation	1	0.42***	NULL	0.46***	0.30***
	CNKI_Download		1	NULL	0.52***	0.45***
JME	Site_HTML			NULL	NULL	NULL
	Site_PDF				1	0.45***
	Site_Abstract					1
	CNKI_Citation	1	0.67***	0.15	0.47***	0.52***
	CNKI_Download		1	0.20	0.54***	0.55***
SGS	Site_HTML			1	0.17	0.14
	Site_PDF				1	0.65***
	Site_Abstract					1

** p value<.01; *** p value<.001

From Table 3, Spearman's correlation coefficient among different usage data in the same journal were investigated. There was very significant correlation between full-text HTML view and PDF download data in CSB site (in bold font style). It further revealed the effects of "progressive rule", the more full-text views, the probably more full-text downloads. Also, it showed moderate correlation between CNKI_Download and Site_PDF in most journals except the journal CSB. Probably they shared the similar user interests. Besides, it showed strong or moderate correlation between CNKI_Citation and CNKI_Download in most journals except the journals CS and CSB. The results were similar to the previous research conducted by other researchers. It was found that usually most of the downloads take place in the first 2 years after publication [31]. The datasets in the study ranged from January 2016 to December 2016. When they were accumulated more 12 months, probably their Spearman's correlation coefficient would be better.

4.4. Distribution of accumulated monthly usage

The Fig. 2, 3 and 4 depicted the accumulated monthly usage distribution (full-text view, pdf download and abstract view) of articles in six journals respectively. Each curve represented one paper and the starting point of each curve represented its published month. The red lines represented most viewed and downloaded articles. For most papers, the growth of accumulated usage showed slowly upward trend after the initial rapid growth period. Only a few papers continued to represent a new jump after the initial rapid growth. Among the most viewed and downloaded articles (denoted by red lines), most of them were published in earlier months than later months. The reason was obvious that articles published in earlier months complete more month accumulations than later months. But Attention should be paid to the most viewed and downloaded articles in later months because after several months they might receive more views and downloads. Besides, Fig. 2, 3 and 4 showed the effects of websites' information architecture on usage pattern between CSB and other journals in the perspective of time series.

It was mentioned that in Fig. 2, in order to reveal more details about the accumulated monthly HTML view, the accumulated HTML view more than 1400 were excluded. In Fig. 3, the accumulated PDF download more than 900 were excluded.

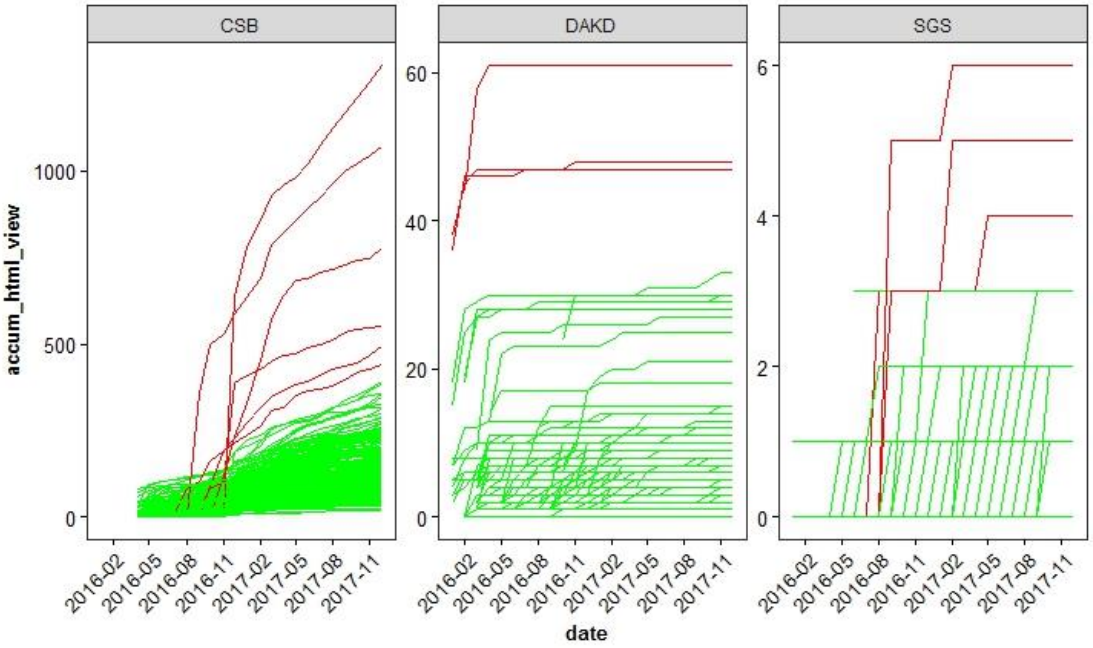

Fig. 2 Distribution of accumulated monthly HTML view

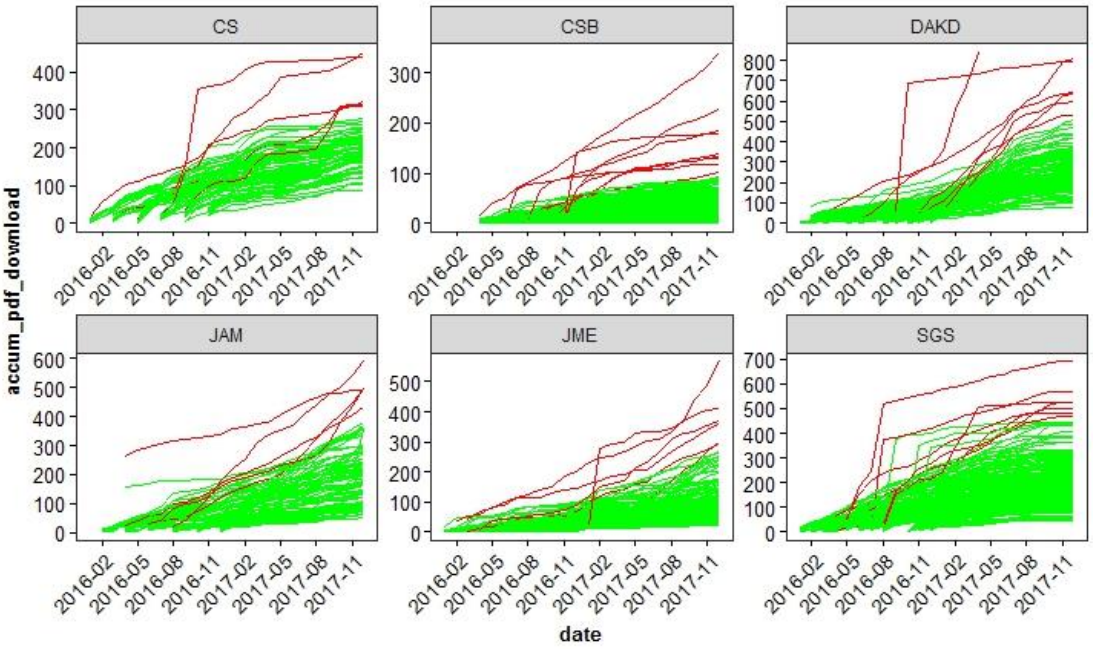

Fig. 3 Distribution of accumulated monthly PDF download

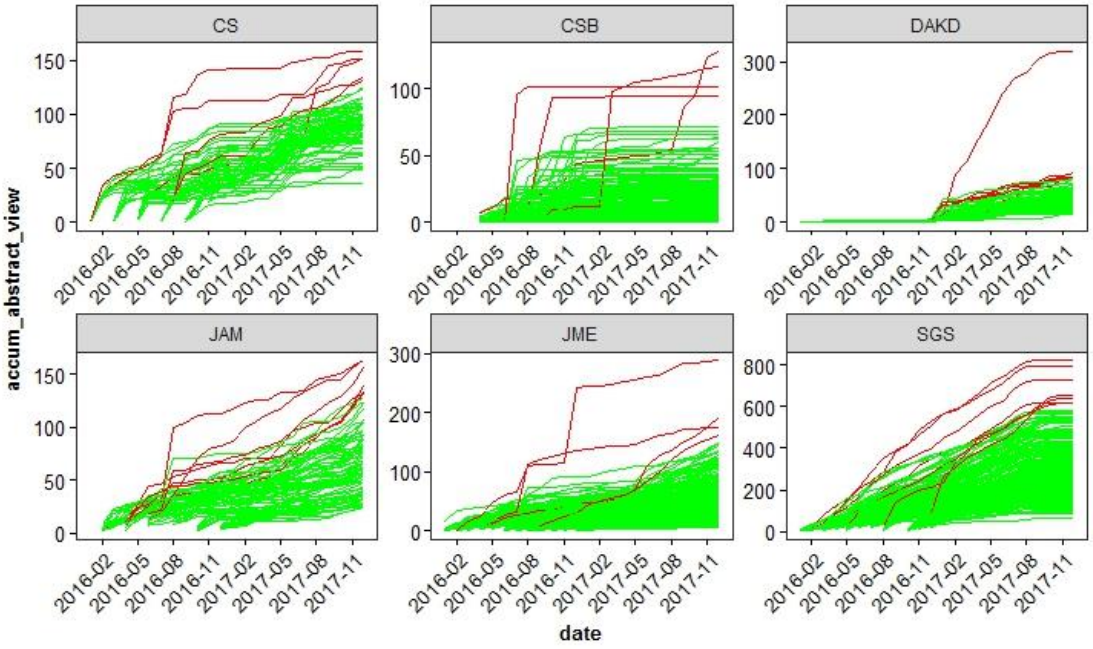

Fig. 4 Distribution of accumulated monthly abstract view

4.5. Average usage distribution in the month of pagination

To understand the trends both prior and posterior to the pagination month, we aligned the usage data of articles with respect to their respective pagination months. Fig. 5 showed the average usage distribution of articles with respect to pagination month for journal CSB. It depicted that usage data of most articles was at their peak around pagination month and at the bottom at very earlier or later months.

Moreover, it showed that even articles were published online as soon as they were peer reviewed, but they did not get the attention of the community unless they were assigned to an issue. This finding was in accordance with Wang et al. (2014b) and Khan &Younas (2017), where authors found a rise in average usage data of new ‘‘issued’’ articles as compared to early access articles. The authors suggested that this might be due to the fact that publishers send email alerts to their subscribers which ultimately lead to more attention to newly issued articles. This reason seemed to be true in the case

of CSB. It was interesting that journal CSB also send alerts by journal "WeChat Subscription"[14], a popular public platform for any person or organization to promote themselves in China. Journal "WeChat Subscription" alerts maybe another way to attract their subscribers to newly issued articles.

Besides, the average usage data overall started to decline after pagination month and then continued to sustain a steady level for several months. This finding was also in accordance with Khan & Younas (2017), where authors suggested that alerts services might be the cause of growth in downloads in pagination month and its subsequent month. Another reason might be that users consider pagination as a kind of quality attribute that articles are fully reviewed and edited.

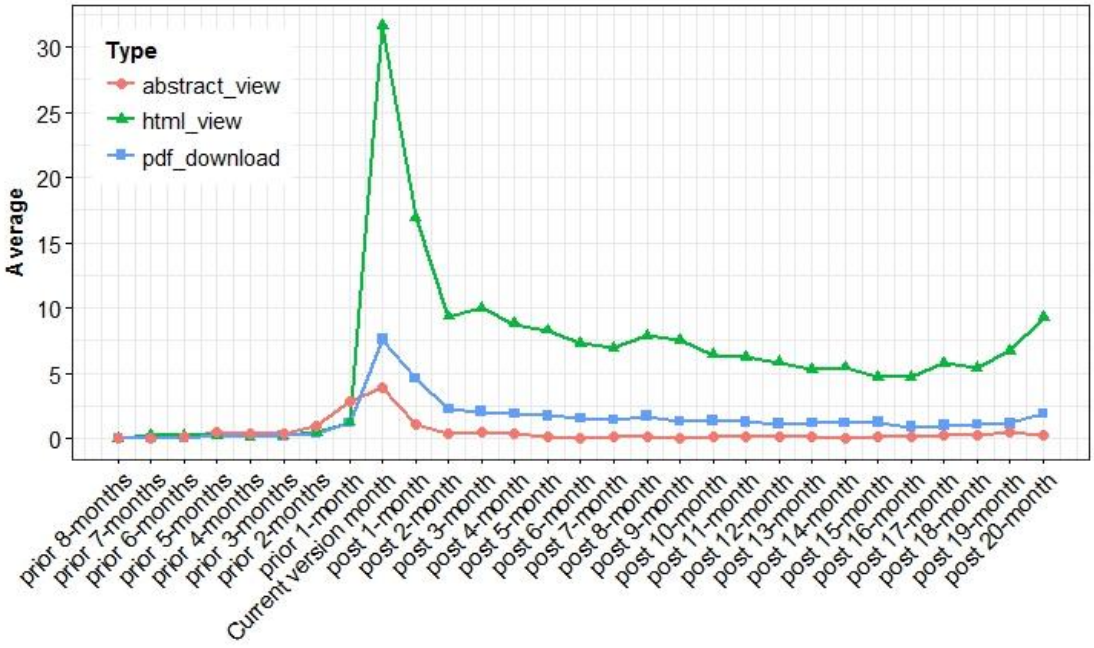

Fig. 5 Usage data distribution in the month of pagination

5. Conclusion and Discussion

In this study, we analyzed the usage data of six Chinese OA journals in different fields. It was proved that usage data are more sensitive to manipulation: the websites' information architecture affected the usage pattern. "Progressive rule"-based site guided users to view full-text articles more than download them and "parallel rule"-based site guided users to download full-text articles more than view them. Different from most English journals, most Chinese journals were owned by Chinese institutes and universities. So, almost every Chinese journal has its own official website, the unique website architecture, different webpage technology and operational budgets affects the users' visiting patterns.

Also, CNKI proved its popularity in China. Although CNKI is a non-OA platform and has a time delay in indexing full-text articles, but they still attracted a large number of users. It was mentioned that most Chinese journals were owned by Chinese institutes and universities, but the Chinese commercial publishers could also disseminate their full-text articles by their paid copyright transfer. The situation caused the same scholarly articles acquired different full-text usage data between journals' official sites and the Chinese commercial publishers. CNKI is the leading Chinese commercial publisher and almost every university in China paid to access its service. Compared with most Chinese journal websites, CNKI platform is more stable and easy to use. So, CNKI still attracted a large number of users although it is a pay-for-access platform.

PDF tended to be the preferred format than HTML in most journals in the study. It confirmed the same results in the English publisher. Maybe researchers wanted to print the article or just save in hard discs for later study, PDF was the best choice up to now. It showed that CNKI citation were

[14] https://mp.weixin.qq.com/?lang=en_US

more skewedly distributed than usage data in most journals except the journal SGS, which also confirmed the same results in the English publisher. Besides, it showed that full-text PDF downloads in official sites were less skewedly distributed than CNKI full-text download in all the journals. Probably the users of the official sites were more professional and familiar with the journal and its fields than CNKI users, the "loyal fans" browsed the journals regularly and comprehensively.

It showed strong or moderate correlation between CNKI citation and CNKI full-text downloads in most journals except the journals CS and CSB. Besides, there was very significant correlation between full-text HTML view and PDF download data in CSB site. It further revealed the effects of "progressive rule", the more full-text views, the probably more full-text downloads. The effects of websites' information architecture on usage pattern in different journals were further confirmed in the perspective of time series analysis.

Finally, it depicted that usage data of most articles was at their peak around pagination month and at the bottom at very earlier or later months. It also showed that articles published online as soon as they were peer reviewed did not get the attention of the community unless they were assigned to an issue. Besides, the average usage data in both journals overall started to decline after pagination month and then continued to sustain a steady level for several months. The results were also in accordance to the previous study about the English publishers.

There were some limitations in this study. It showed moderate correlation between CNKI full-text downloads and full-text PDF downloads of official sites in most journals except the journal CSB. As the most similar kinds of usage data, their usage similarity in indicator-level and content-level should be further investigated. Also, the usage data in the study had a limited accumulation period of 13-24 months. A long-term dataset should be tracked and investigated to support the conclusions. It was also very well known that different types of users used the literature differently, and the relation of citations with usage was very different for the different user types. Hopefully Chines publishers could release more details about the usage count, such as specific time, IP address and referrals links, which would provide the researchers a better opportunity to investigate academic user behaviors.

Last but not least, this study focused on only six Chinese journals. Compared with previous research on international journals, the study was local and relatively limited. Although these limitations exist, we hope that this different try to explore the usage pattern of Chinese journals would provide a new perspective to promote the research on usage metrics.

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