



Exploring the motivations and obstacles of the public's garbage classification participation: evidence from Sina Weibo

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Abstract

China has been implementing garbage classification to improve resource recycling for many years. Since garbage classification is essentially a social activity, it needs the active participation of the public. However, the phenomenon of "high practice, low effect" is widespread in most cities. Therefore, this paper uses the data from Sina Weibo to analyze the reasons for the poor garbage classification effect. First, the key factors affecting residents' willingness to participate in garbage classification are identified based on the text-mining method. Further, this paper analyzes the reasons that promote or hinder the residents' intention of garbage classification. Finally, the resident's attitude towards garbage classification is explored by the score of the text's emotional orientation, and further the reasons for the positive and negative emotional orientation are analyzed, respectively. The main conclusions are as follows: (1) The proportion of residents holding negative sentiment towards garbage classification is as high as 55%. (2) Residents' positive emotions are mainly caused by the public's sense of environmental protection inspired by publicity and education, and the incentive measures taken by the government. (3) The main reasons for negative emotions are imperfect infrastructure and unreasonable garbage sorting arrangements.

Keywords Garbage classification · Text Mining · Sina Weibo

Introduction

China has experienced substantial economic growth in the last decades. However, this spectacular economic performance is at the expense of the natural environment and ecological resources, resulting in heavy consequences [1]. Achieving carbon peaking and carbon neutrality is an extensive and profound economic and social systemic change, they should be incorporated into the overall layout of ecological civilization construction [2–4]. In the context of carbon neutrality, garbage classification is one of the effective ways to alleviate resource and environmental constraints [5, 6]. The predicament of "urban garbage siege" is one of the

environmental pollution problems in the majority of Chinese cities [7]. According to the data from the Ministry of Ecology and Environment of the People's Republic of China, 196 large and medium-sized cities generated more than 235 million tons of domestic waste in 2019.

Considerable quantity of waste is stacked on the land surface without disposing for a long time [8]. After suffering a variety of chemical reactions or fermentation, the garbage will produce poisonous gas and liquid [9]. The emissions of gas will contaminate the air, and the liquid will permeate into groundwater together with the rain, which causes great damage to the ecological environment [6, 10]. The garbage classification addresses the waste disposal predicament, facilitate garbage recycling, and finally turns garbage into treasure [10]. It is noteworthy that the household sector is one of the major waste sources. The successful enforcement of garbage classification is closely connected with the wide cooperation and participation of household members [11].

Essentially, garbage classification is a social behavior and entails public participation [12, 13]. Researches have pointed out that the unsatisfactory state of garbage classification is led by the low level of household residents' participation [14, 15]. Theoretically, to encourage

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waste sorting at the source is an effective way to escape the current predicament of waste management [2, 16]. In 2019, a mandatory garbage classification policy was first implemented in Shanghai. Since then, garbage classification caused a great deal of repercussion in society [17–19]. By the end of 2020, 46 key cities are selected as the first batch of pilot mandatory garbage classification cities. These cities basically completed garbage classification and treatment systems. The waste is requested to be separated into four categories, recyclable, hazardous, wet and dry waste [20]. Although policies have been released from the national level, a series of incentive and punishment rules are adopted by the local government to promote the residents to participate in the garbage classification [21]. Such as one of the first pilot city Suzhou, has issued regulations on the management of household garbage classification in 2022.

The garbage classification work has been enforced in 46 trial cities, the effect is emerging in major cities, such as Beijing and Shanghai. However, other pilot cities have space to improve. With the processed of garbage classification, a series of issues has gradually appeared, which can be roughly summarized as facility convenience, responsibility of the residents, and government work. To be specific, residents living in community with more supporting facilities are more willing to participate in garbage classification [12]. However, in some cities, such as Beijing, Shanghai, Guangzhou, and Shenzhen, the garbage classification willingness of the residents is hindered by inappropriate facilities [9]. As for the responsibility of the residents, their education level, sex and age determining the results of garbage classification greatly [22]. In addition, the government of the cities also issued a series of measures to promote public garbage classification. In Shanghai, incentive measures including Green Points Policy, the distribution of garbage bag, and punitive measures, such as fine not achieve satisfactory results. The reasons for the bad results of garbage classification remain to be explored.

In existing research, most of them apply the method of questionnaire or interview to investigate the residents' attitudes and opinions [23, 24]. Fewer studies used objective machine learning methods to explore residents' emotion towards garbage classification [17]. Garbage classification comments residents published on the internet contain their perceptions and emotions [25, 26]. Their attitudes directly affect the garbage classification behavior, thus determining the waste management results [7, 27, 28]. The machine learning method has emerged and widely applied in emotion analysis [29]. It can extract vital information in big text data, which is suitable for analysing resident's attitudes toward garbage classification [30, 31]. Thus, providing in-time feedbacks to governments. Machine learning methods have been used in the study of pro-environmental behaviors. It has

been widely accepted as an effective investigative methods [32–34].

Attitudes refer to the assessment individual given to the regulations they are required to perform. It is generally separated into positive and negative emotions. The positive emotions will promote the resident's garbage classification behavior. On the contrary, negative emotions will deter resident's garbage classification behavior. It is difficult to accurately investigate resident's garbage classification behavior. Extracting residents' emotions from a large amount of text data and using machine learning methods for analysis is an effective way to reflect residents' willingness to classify garbage. In addition, factors affecting garbage classification behavior can be summarized. Social media, represented by Sina Weibo, has billions of users in China [35, 36]. The public can browse real-time news and even ask for help [37]. A large amount of data is produced by internet users on social platforms [38]. Accordingly, the test data generated on online social platforms could be used to understand the public garbage classification perception.

Based on text data clawed on Sina Weibo, this paper explores the residents' attitudes towards garbage classification, and analyse the reasons for residents' positive or negative emotions. The main contributions of this paper are primarily reflected in the following aspects: (1) Data on the Sina Weibo platform was used to analyze public's attitude toward garbage classification measures. (2) Web crawler technology was applied to collect public's comments on Weibo posts related to garbage classification. (3) Text mining method was used to evaluate public's sentiment toward garbage classification.

The remainder of this paper is arranged as follows: [Sect. 2](#) is the literature review. [Section 3](#) delineates the method used in this paper. [Section 4](#) displays and explicated the results. [Section 5](#) summarized conclusions and put forward suggestions. [Figure 1](#) presents the frame diagram of this paper.

Literature review

Studies on garbage classification behavior

Like most environmentally responsible activities, household garbage classification behavior can be classified into pro-environmental behaviors. It requires basic knowledge and skills, including identifying waste categories, followed by correctly throwing them into the corresponding container for each category [39, 40]. Meng et al. [41] noted that the lack of garbage classification knowledge is one of the most important reasons caused the residents' weak participation. Li et al. [42] argued that garbage classification action is unsuccessfully due to the public's low engagement. Pothitou et al. [24] highlighted that the public's active engagement

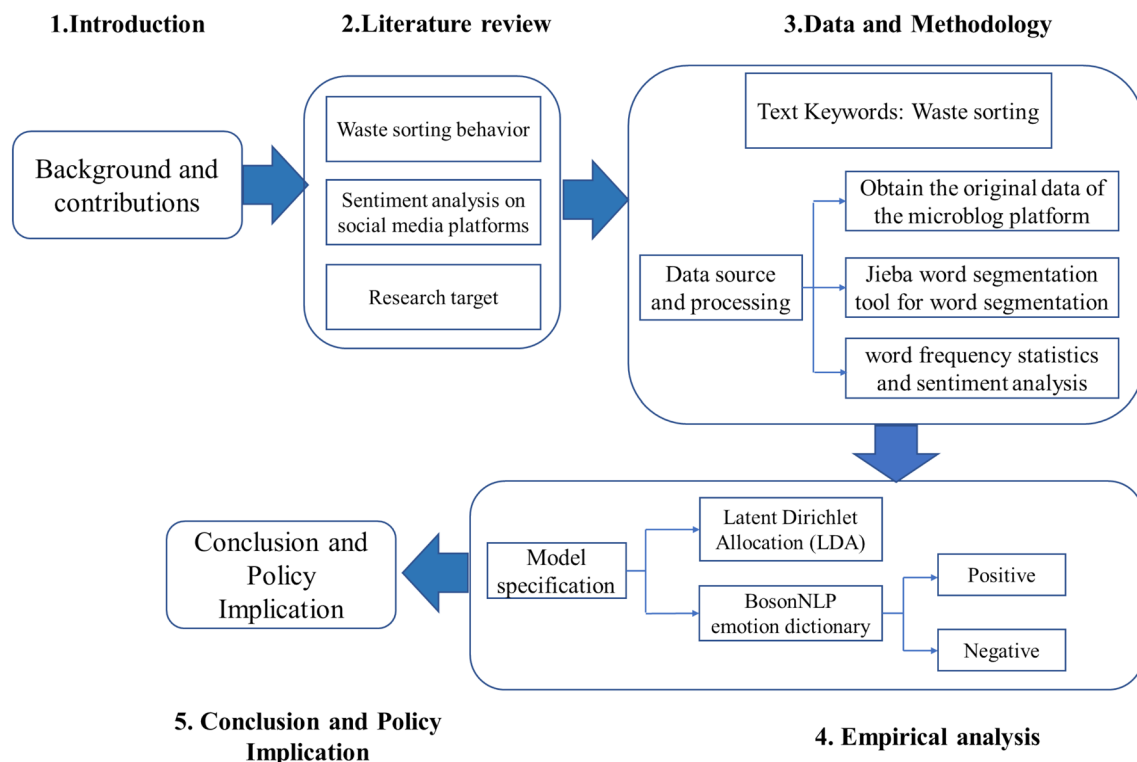


Fig. 1 Frame diagram of the paper

plays a decisive role in the success of waste management. Furthermore, Zhang et al. [28] point out that inaccurate garbage classification impedes the effects and progress of waste management. Governments at all levels take all kinds of measures to promote the public's garbage classification participation, such as green account points card [43]. Garbage classification performance among cities demonstrates obvious differences [26]. To sum up, the public's garbage classification attitude and performance directly determine the success of waste management. Hence, it is urgent to grasp the obstacles people encountered in their garbage classification action.

In existing literature, behavioral science theory is used to analyse the process of the public's garbage classification intention into behavior. They all improved with the integration of the additional factors. The Theory of Planned Behavior (TPB) is the most used method to explicate citizen's pro-environmental behavior. Wang et al. [26] added personal moral norms and garbage classification knowledge into the TPB to explore the formation process of garbage classification intention and behavior. Their research found that personal moral norms and garbage classification knowledge are directly and significantly related to residents' garbage classification intention. Norm Activation Model (NAM) put forward by Schwartz [44]. Its emphasis on the importance of the cognitive consequences of behavior, and positive

outcomes will encourage responsible behavior. Wittenberg et al. [45] improved and applied the NAM to the investigation of household garbage classification behavior. And found problem awareness, consequence awareness and subjective norms can significantly predict personal norms. In addition, Behavioral Decision Theory [46], Trust Model [47] and Learning Theory [48] are applied to explain resident's garbage classification behavior choice and expression form.

Studies on garbage classification engagement factors

It is generally acknowledged that demographic attributes, such as gender, correlate with individual garbage classification motivations. Many researches generally assumed that females are more willing to engage the pro-environment behavior [49]. Education is an important factor has been studied in many researches, such as Peng et al. [50] noted that an individual's education has significant impact on a resident's garbage classification behavior, and a better education experience will have the promote effects. Some literatures focus on the resident's income. They concluded that income has an indirect effect on an individual's garbage classification behavior, and higher wealth meaning higher cost [12, 51]. More and more scholars start to pay more attention to social ties [16, 52–54]. Zheng et al. [55] explored

the influence of the dynamic spread of household garbage classification information on their intention. Results show that others' advice significantly affecting their garbage classification intention.

In addition to internal factors, external factors also play important role in resident's garbage classification behavior. Zhang et al. [56] found infrastructure, and government publicity significantly influence the transformation between resident's intentions to behavior. Wang et al. [19] noted that any individual has the desire to pursue convenience and simplicity, and always hopes to achieve maximum benefits at the least cost. They clarify that infrastructure construction is one of the important factors to promote garbage classification. Trivedi et al. [57] delineated the pivotal motivated role media played in the public's attitude towards environment-friendly packaging. Previous studies have affirmed the positive effect of the incentive machine on garbage classification [58, 59]. Existing literatures also explored the effect of garbage classification knowledge [26], house prices [60], and propaganda [61].

Sentiment analysis on social media platforms

Sentiment analysis, also known as sentiment orientation analysis or opinion mining, is a process to extract information from users' opinions [7]. It analyzes text, audio and images to learn people's opinions, attitudes and emotions [62]. The sentimental satisfaction degree of the public with government management is an important issue concerned by academic and political circles [63]. It provides a reference for the further implementation of government work. At present, there are two major schemes to carry the government satisfaction research: One is the traditional evaluation model based on a questionnaire survey or interview, and the other is the evaluation model based on network public opinion data.

The research method based on a questionnaire survey is currently the most widely used method in the survey of residents' attitude and sentimental tendencies at home and abroad. Escario et al. [15] used the questionnaire survey data of 2487 Spanish residents over the age of 17 as the sample to study residents' willingness to use the recycle waste. Based on the databases of the Chinese General Social Survey 2010–2013 and 2015, Zeng et al. [61] extracted the issues reflecting environmental attitudes to investigate the public's environmental sentimental tendencies at the present stage. Song et al. [18] randomly selected 265 residents in the Baohe and Shushan District of Hefei to study the residents' attitude towards environmental protection payment using the questionnaire.

With the advent of the big data era, more and more scholars started focusing on the large-scale user behavior data generated on the network. Many researchers utilized text mining techniques to analyze some issues, such

as biomedicine [4, 6, 64], risk management [3] and public sentiment [65]. Kolyshkina and Rooyen [66] employed text mining technology to assess the impact of text information in claim cost prediction and clarify the new risk management factors. Renganathan [67] collected a large number of published papers in the medical field and used text-mining techniques to obtain valuable information. Liu and Hu [65] collected green building-related hot posts and comments published by Sina Weibo users through text mining to analyze the public's willingness to pay for green buildings.

Social media platforms are commonly used by people to exchange views, and discuss real-time news [35]. Sina Weibo is one of the most influential social media platforms [65]. Monthly active users of Sina Weibo have reached 516 million persons. More and more people begin to learn about the world through Sina Weibo. Therefore, Sina Weibo has become an important medium for people to communicate and express their feelings. Microblogs published by users are filled with a large number of comments and opinions with sentimental color, which makes these microblogs have important economic and social values in both business analysis and public opinion monitoring [7]. Therefore, it is an appropriate platform to study the Chinese public's attention towards garbage classification.

In summary, although previous studies [17, 19, 28] have discussed residents' attitude towards garbage classification from the data of questionnaire surveys or interviews, the analysis data used is subjective. Moreover, the method of questionnaire survey is subject to time and space constraints in the process of implementation, which requires a lot of data input and statistical work. Its evaluation system is difficult to measure the dynamic changes in people's feelings towards government departments. To fill these gaps, this paper uses a web crawler combined with text mining technology to analyze the public online discussion on garbage classification strategy, so as to understand residents' attitudes more objectively. Based on the micro blog text data mining, we use the Linear Discriminant Analysis (LDA) topic model to compare the topic proportion of micro blog text and use the sentiment dictionary method to get the positive sentiment tendency score and negative sentiment tendency score.

Methodology

Web crawler technology

With the popularity and prevail of the internet, online information resources have experienced explosive growth. To dig out valuable information from enormous network resources, web crawler technology has appeared. Web crawler technology is a method that automatically accessing required information from one or more web pages according to a certain

strategy and is a path to acquire online resources through a simulated browser., web crawlers are generally divided into four types based on the diversities in target objects, system structures and fulfilment techniques. The names of these four types are the generally service web crawler, the target web crawler, the incremental web crawler, and the deep web crawler, respectively. In this paper, we mainly used the target web crawler technology to collect the information needed. Python is a mature general-purpose programming tool, we used Python3.9 to clawer the micro-blog text data. In addition, Visual Studio Code is a mature application software used widely on web crawler technology. Thus, we collected the required text information based on Visual Studio Code. The steps for accessing text information on Sina Weibo were as follows:

- (1) Simulated login. Using the username and password of a Sina Weibo account, we implement simulated login in Sina Weibo through Google.
- (2) Web page downloading and data filtering. After the simulated login, the initial link that defined the information collection was <https://m.weibo.cn/>. Based on the concept of garbage classification and the research target of this paper, “garbage classification” was set as predefined keywords to collect information on Weibo users and Weibo posts.
- (3) Key content collection. When collecting the personal information of Weibo users, we collected the username, content of the post, number of collections, number of reposts, number of comments, number of likes, and post time.
- (4) Information storage and export. After all information and texts were collected, a repetition test was conducted until all the years’ data finished, and then all the contents were exported.

We protect the personal privacy of internet users, and adhere to strict confidentiality by withholding individual information. It also guarantees that this information will never be disclosed to any organization or individual.

Text mining technology

Texting mining refers to extracting valuable information and knowledge from big text files using computer processing technology. Through text mining, the residents’ attention status and changing trends toward garbage classification can be accessed and analyzed. Text sentiment analysis, also called opinion mining, refers to a series of processes, such as analyzing, processing, inducing, and reasoning aimed at the subjective text with sentiments. Based on the Sina Weibo text collected, we chose the sentiment dictionary method to analyze the sentiment of public garbage classification. As

the BosonNLP Sentiment Dictionary was constructed based on the microblog, news, forum and other data sources, we conducted the research with this dictionary. Instead of media Weibo, the text data used in this paper only contains Weibo published by personal accounts to ensure that all texts reflect the opinions and opinions of residents. Thus, it can be concluded that the Chinese public’s sentimental orientation and attention to garbage classification. The steps were as follows:

(1) Denoising

We have deleted text data with the disordered format and missing content. There are also some repetitive and meaningless information in the microblog, such as advertisements, retweets, information with too few words, and information without practical significance. In addition, the content of Weibo that is not related to the topic of garbage classification will be further cleaned up. Therefore, the arrangement of the text data is basically completed, and the next step is to analyze the text content.

(2) Application of the BosonNLP Sentiment Dictionary

The sentiment dictionary contains a word segmentation dictionary and a word sentiment weight dictionary. The word segmentation dictionary is employed to segment sentences of text into individual words and emoticons, while the sentiment word segmentation, and assigns sentiment values according to the sentiment strength of words and emoticons. BosonNLP Sentiment Dictionary is a sentimental polarity dictionary automatically constructed from millions of sentiment annotation data from data sources such as Weibo, news, and forums. Since the annotations include Weibo data, the dictionary includes many Internet terms and informal abbreviations, and it also has high coverage of non-standard texts. The sentiment dictionary is very suitable for building social media sentiment analysis engines, negative content discovery, etc.

(3) Sentiment analysis

Word segmentation. After segmenting the Weibo sentences with the word segmentation dictionary, the words and phrase in the sentences were recognized.

Calculation of sentiment score. Based on the sentiment weight of words and sentiments, the modifying relation between different parts of the sentence, the mood of the sentence, and so on, the sentiment value of the sentence was calculated based on the given word sentiment weight dictionary. In the BosonNLP sentiment weight dictionary, each line is a sentiment word and its corresponding sentiment score, separated by spaces, including 114,767 Chinese words in total. Among them, negative numbers represent negative words, and non-negative numbers rep-

resent positive words. The degree of positive or negative can be reflected by the magnitude of the value.

The classification of the sentiment. In this paper, sentiment orientations are classified into positive sentiment and negative sentiment based on the positive and negative sentiment value of comment sentences. Besides, according to different sentiment degrees, positive sentiments are further classified into two categories of sentiments- goodness and pleasure. In the meanwhile, negative sentiments are classified into five categories of sentiments with successively increasing sentiment degree: shock, disgust, fear, depression, and anger.

Topic focus analysis. Through the word frequency analysis of the text, the focus of the public's attention is obtained, and the reasons for the public's sentiment tendency are analyzed accordingly.

Results and analysis

In this paper, we obtained the text data with the predefined term Chinese word “garbage classification” on Sina Weibo from 2015 to 2020 to dig out the problems related to garbage classification that are of great concern to the residents. A total of 9,433,330 posts are collected. Through the analysis results of text mining, we can grasp the residents’ attitude towards garbage classification and understand what motivates or hinder the residents’ garbage classification action. All these results will give a reference to the government on how to promote garbage classification work.

Public attention status toward garbage classification

Sina Weibo users have two categories, institutional and individual users. Considering that the microblog of institutional users cannot reflect resident’s attitude, we only use the individual authenticated users’ microblog in sentiment analysis.

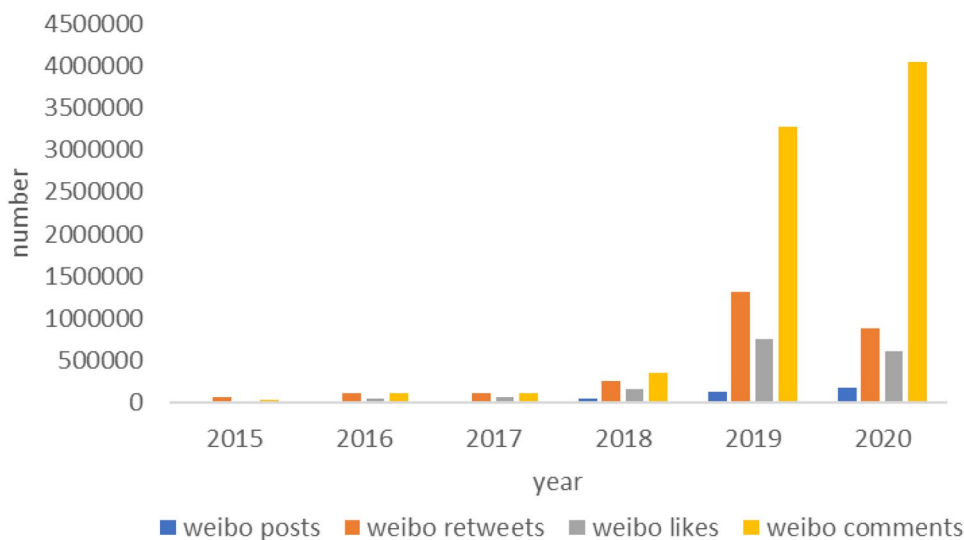
Public attention at the national level

Due to the domestic Sina Weibo users account for 93.5%, the microblogs can reflect the current situation in China. In terms of the number of microblogs, the sum of the number of collections, reposts, comments, and likes of a microblog post was defined as the amount of attention the post received. As shown in Fig. 2, it presents an increasing trend. It is noteworthy that visible rise occurred in 2019. It may be due to the implementation of a mandatory garbage classification policy.

Regional analysis

Registration for a Sina Weibo account only needs a cell-phone number. Most of the Sina Weibo users have not completed their basic profiles information. In our data collected, more than half do not fill in their location information. As the serious data loss of users’ profiles, the gender and regional difference have little value. Therefore, this paper will not display the gender difference. In the word frequency analysis section, some cities received outstanding attention, we analysis the regional heterogeneity from the word frequency perspective. In 2015, Guangzhou, Shenzhen and Hangzhou list in the top 100 keywords. The three cities Shenzhen issued measures for the administration of household garbage classification

Fig. 2 The number of microblogs with the predefined search terms “garbage classification”

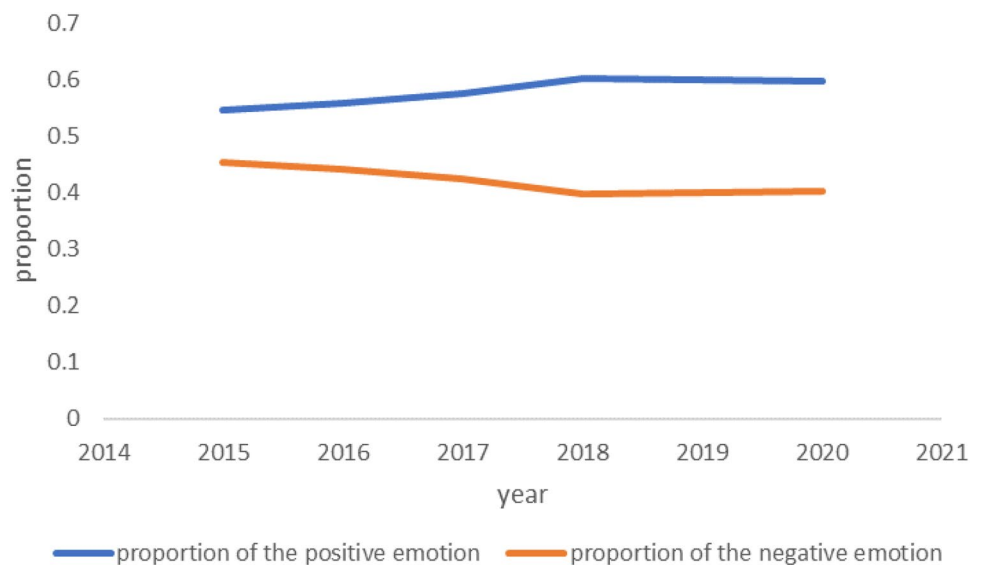


and reduction. And Hangzhou started to fully implement garbage classification. In 2019, Shanghai attracted the most attention, word frequency is 20,832. Shanghai becomes the first mandatory garbage classification city and arouse enormous reaction. Xi'an also received plenty of concern, rank the second. In 2020, garbage classification in Beijing and Shanghai is discussed most. It is related to Beijing carry out a garbage classification policy formally in 2020.

Sentiment orientation analysis

Based on the data collected from Sina Weibo's comments and sentiment orientation analysis adopting the NLP-Parser platform, results show that positive sentiment accounted for 54.6, 55.8, 57.5, 60.3, 60 and 59.7% from 2015 to 2020, respectively. It indicates that there is half of the residents have a positive attitude towards garbage classification. However, resident's proportion have negative attitude is nearly the same as positive emotions. As shown in Fig. 3, the positive score and proportion are increasing from 2015 to 2020, while the negative tends to decrease. It reflects the residents' garbage classification recognition rising and the government work achievements emerging preliminary. From the perspective of the citizens, propaganda of garbage classification policies and the improvement of national cultural quality will promote their recognition. However, the recognition level is not high on the whole. It remains to be further pushed. In the initial stage of garbage classification, due to the long-term thinking habit and lifestyle, they are hard to adapt to the new regulation.

Fig. 3 Proportion of sentiment tendencies to garbage classification from 2015 to 2020



Word frequency analysis

In this section, the top 100 Chinese words with the highest frequency are summarized from the mining of microblog texts from 2015 to 2020, and the result displayed has all been translated into English. Through the analysis of keywords, the hot 100 topic people are concerned about can be grasped. Thereby, to adjust the policy in time. As for the limited length, we display the top 10 keywords for analysis. From Fig. 4-a, it can be seen that the topic people discussed most in 2015 is the garbage classification activities carried out by communities and work units. The major motivation for the public to carry out garbage classification is the psychological fulfillment to participate in pro-environmental behavior. It is owing to the increasing environmental awareness. The harm of environment pollution gradually emerged the public has become increasingly focused on human beings and nature. Especially the improved education level, which is directly related to the increasing awareness of environmental protection among the public. Garbage recycling is also an important topic of garbage classification that the public is concerned about. In summary, it can be seen that the publicity work of garbage classification has been carried out has increased the public's awareness to classify garbage to a certain extent.

From the results that not displayed 20th to 100th keywords, we can conclude the public showed great enthusiasm for the knowledge learning of garbage classification, which is related to the enforcement of mandatory garbage classification measures. The change of garbage cans also receives lots of attention, which is due to the trash bin has become more diverse. In addition, the disposal of kitchen garbage is a hot topic. As kitchen garbage occupies a major position in domestic garbage, mainly leftover meals and soup, etc.,

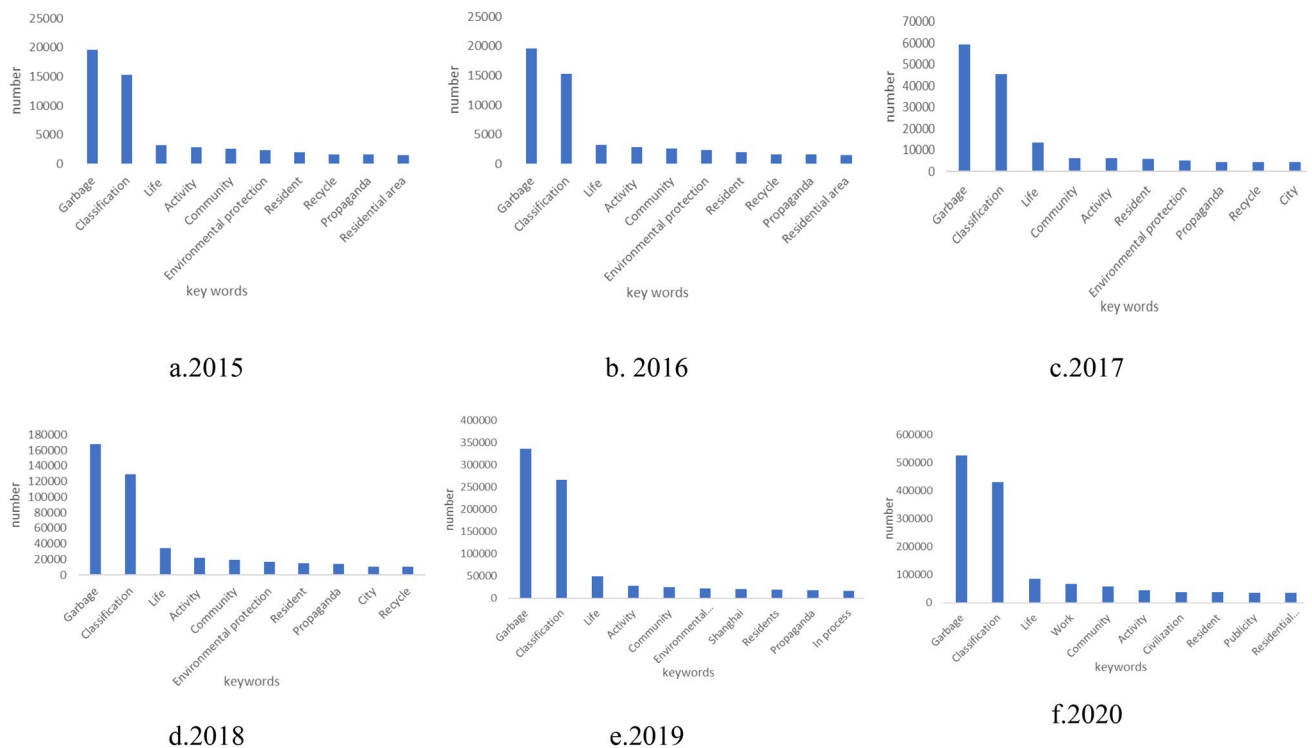


Fig. 4 Word frequency analysis

it has a strong smell and is more troublesome to collect and dispose of. At present, the most urgent garbage classification work in China is to separate wet garbage from kitchen garbage. The classification of food waste still largely depends on the consciousness of residents.

Garbage classification education has been embodied in children's daily learning, and volunteers are an important force to promote garbage classification. Volunteers distribute garbage classification-related leaflets, manual in the community. They set good examples, which have greatly increased the enthusiasm of residents to participate in civilized activities, and also increased people's support for garbage classification regulations. As for the garbage category, the classification of glass is a key issue of public concern. After the outbreak of COVID-19 in 2020, the classification of masks has become an important topic again. The public's hope for a green, environmentally friendly, beautiful and civilized society is an important internal factor that drives the public to carry out garbage classification, which is related to the government's publicity of garbage classification knowledge.

Sentiment foci

Negative sentiment foci

As for the limited space, we only display the LDA results of the nearest year 2020. Table 1 shows the feature words

of the Weibo text data of garbage classification negative orientation in 2020. From the results both displayed and non-displayed, we can summarize the main reasons for the negative sentimental orientation of garbage classification are: (1) The mandatory implementation of the garbage sorting policy is too sudden to accommodate. Among the punishment rules, fine is the residents' most resistant measures. (2) Garbage classification infrastructure is not perfect, such as the location of trash cans. In addition, the dispense of biodegradable trash bags suffers from irregularity. (3) At the beginning of the implementation of the policy, all departments worked very enthusiastically. However, garbage sorting lost its enthusiasm after a long time. It shows that the garbage classification work is superficial at present, not as a long-term work. Some people even think that garbage classification work is a form. (4) The promotion of garbage classification has not formed a scientific, orderly, unified system structure. As mentioned in the text, "My garbage is classified, the community is not classified, the city is not classified, the society is not classified... I've classified it and it's not worth it". If the work of a certain link is not in place, the garbage classification work is not completed.

Figure 5 displays the feature words in a visual form as an example. We can identify the public sentimental focus by the keywords on the right side of the picture. The blue bar chart on the right side of the picture indicates the total frequency of occurrence of a certain keyword in the text.

Table 1 Topics of negative attitude in 2020

Topic	Feature words
1	garbage, classification, work, community, propaganda, resident, in process, carry out, residential quarter, activity, days, month, street, throw in, life, environment, inspect, staff, problem, bin, action, situation, participate, certified property, volunteer, area, promote, knowledge, point, spot
2	garbage, classification, trash can, throw, say, one, community, eat, inside, do, today, Shanghai, now, know, again, time, two, true, point, small, throw away, see, everyday, take out, late, aunt, go, down, carry on, only
3	garbage, classification, life, community, dispose, city, resident, throw in, year, emoji, already, month, day, construct, work, intelligent, nationwide, recycle, journalist, credit, achieve, facility, collect, pilot, current, cover, new, demonstrate, city, start
4	garbage, classification, recycle, plastic, dispose, harmful, kitchen waste, environment, utilize, life, recyclable, recyclable waste, pollution, belong, bag, use, resource, barrel, reduce, in, package, environmental protection, throw in, produce, discard, battery, in process, glass, green, little
5	COVID-19, prevention and control, staff, work, management, enterprise, enhance, complete, community, in process, strict, sterilize, measure, sanitation, practicable, requirement, situation, safety, community, detection, responsibility, report, should, area, service, mask, quarantine, in time, temperature
6	garbage, classification, life, month, management, law enforcement, Beijing, day town, rules, throw in, regulate, emoji, Shenzhen, enforcement, department, fine, city, punish, as from today, enterprise, community, formal, year, end, ten thousand, in process, collect, put into force, food waste
7	mask, staff, discarded, sterilize, use, wear, protection, COVID-19, time, put on, medical, clinical, garbage, pneumonia, new type, should, in process, health, hygiene, prevention and control, coronavirus, clean, ventilate, contact, infection
8	garbage, classification, frequent, already, Weibo video, Beijing, emoji, kitchen waste, barrel, Shenzhen, tableware, civilization, throw in, environment, habit, after, form, month, challenge, video, Xi'an, do, new, Mcdonald's, bring the bag, protect, rules, separate, life, day
9	garbage, classification, emoji, Beijing, day, link, barrel, webpage, community, month, release, tomorrow, publicity, attract, 2020, meteorological, environmental protection, year, level, spread, together, Haidian, today, item, temperature, guidance, life, article, low-carbon

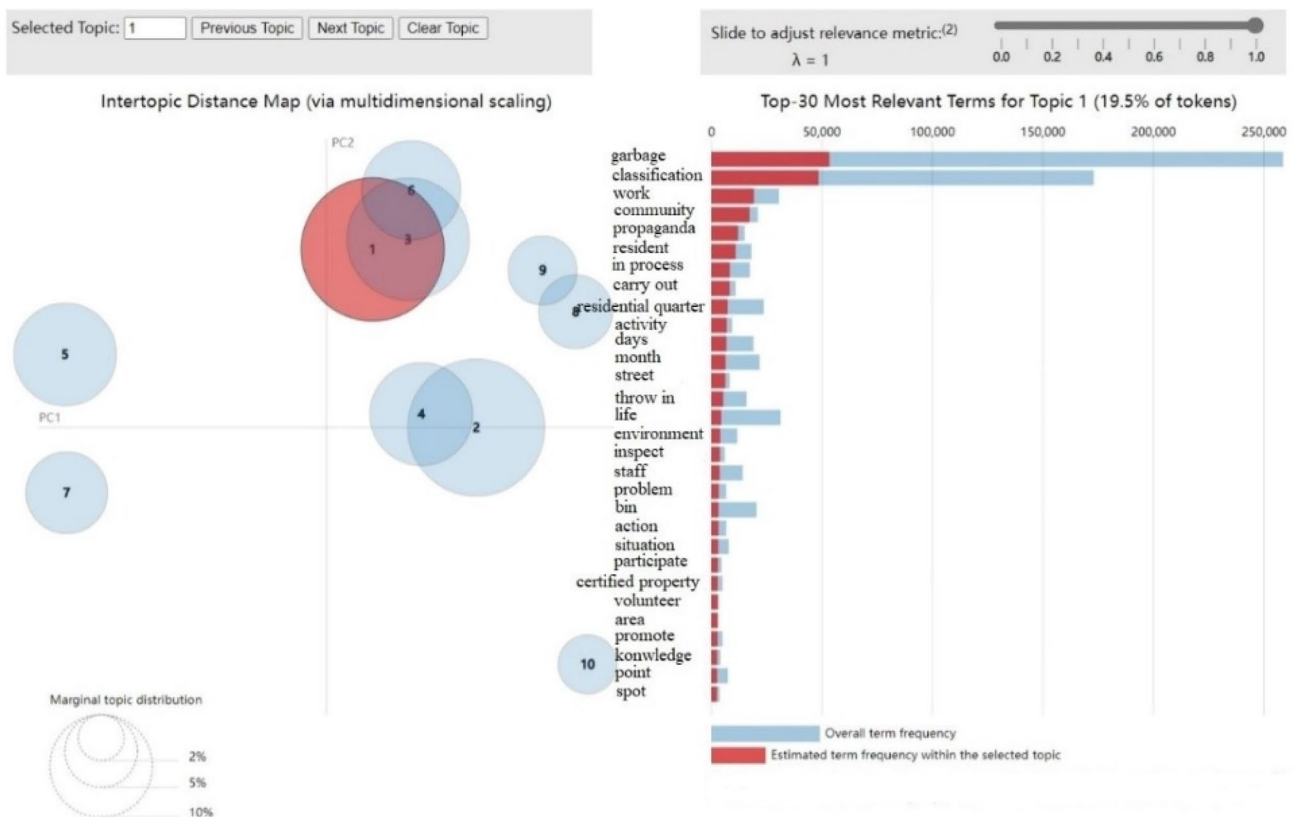


Fig. 5 Topic 1 of topic models (negative sentiment) in 2020

The red bar chart shows the total frequency of a keyword in the selected topic. The circle on the left of the figure represents the topic of the text, and the distance between the circles represents the distance between the topics. Due to a large number of themes, each theme will not be displayed one by one in this paper. This article selects the first theme in 2020 as an example for analysis.

Positive sentiment foci

Table 2 shows the feature words of the Weibo text data of garbage classification positive orientation in 2020. From the results both displayed and non-displayed, we can summarize the main reasons for the positive sentimental orientation of garbage classification are: (1) The public's own environmental responsibility. With the deepening and popularization of environmental protection propaganda in the whole society, public awareness of environmental protection is enhanced. More and more people are willing to participate in garbage classification to achieve the goal of sustainable development. (2) Some effective incentives, the most obvious of which is the redemption of green account points, have promoted the public's willingness to garbage classification. (3) The volunteer successfully achieve the demonstration effect, and enhanced the public's willingness to classify garbage. Besides, entertainment stars also call on a multitude of their fans to devote to garbage classification. Figure 6 displays the feature words in a visual form as an example.

Conclusions and policy implication

Residents are direct participants in garbage classification and increasing their willingness to classify can improve the effect of garbage classification. To grasp the public's sentimental orientation provide a basis for government work. It is crucial to effectively adjust rules to grasp the reasons that promote and hinder residents' garbage classification in time. Based on the garbage classification comment text data released by residents on the Weibo platform from 2015 to 2020, this paper analyzes the most concerned issues of the public in the garbage classification process. The main conclusions can be summarized as:

- (1) Although garbage classification has been promoted with great efforts in recent years, the proportion of residents holding negative sentiment towards garbage classification as high as 55%. The public's positive sentiments are mainly caused by the public's responsibility and the incentive measures adopted by the government. The main reasons for negative sentiments are imperfect infrastructure and unreasonable garbage sorting arrangements.
- (2) The obstacles to the classification of residents' garbage are mainly the unsustainable measures taken by the government. For example, the distribution of degradable garbage bags is irregular. Garbage classification work floating in slogan at present, lack of long time momentum. Among the garbage classification work, kitchen garbage classification encountered the most

Table 2 Topics of positive attitude in 2020

Topic	Feature words
1	garbage, classification, community, work, activity, propaganda, carry out, resident, civilization, street, life, day, participate, in process, environment, service, month, knowledge, residential quarter, action, positive, organize, staff, creat, city, volunteer, party member, in, jurisdiction
2	Work, environment, construction, development, city, year, management, promote, new, ecology, government, countryside, life, dispose, improve, social, problem, enterprise, service, facility, project, conference, administration, in, economic, drive, comprehensive, village, mass, achieve
3	garbage, classification, say, one, do, little, inside, eat, barrel, today, life, in, most, know, time, frequent, only, again, after, true, see, now, year, Weibo video, two, month, friends, below, throw
4	garbage, classification, activity, knowledge, environmental protection, little, practice, day, student, college, education, month, in, children, propaganda, university, year, theme, in process, carry out, life, social, environment, primarily school, community, awareness, participate, school, 2020
5	garbage, classification, life, Beijing, month, management, city, work, enformance, rule, throw in, town, day, community, promote, new age, street, Shenzhen, dispose, Nanjing, formal, year, new, the whole city, release, reduce, kitchen waste, resident
6	garbage, classification, civilization, environment, protection, life, start, together, earth, green, ecology, beautiful, environmental protection, do, Xiaozhan, action, frequent, complete, public benefit, house, Xi'an, nature, Weibo video, city, China, resource, one, save
7	COVID-19, Ouhao, prevention and control, health, sanitation, work, staff, mask, complete, school, management, month, garbage, medical, pneumonia, prevention, safe, sterilize, day, in process, epidemic prevention, measure, classification, patriotic, reinforce, life, environment, student, practicable

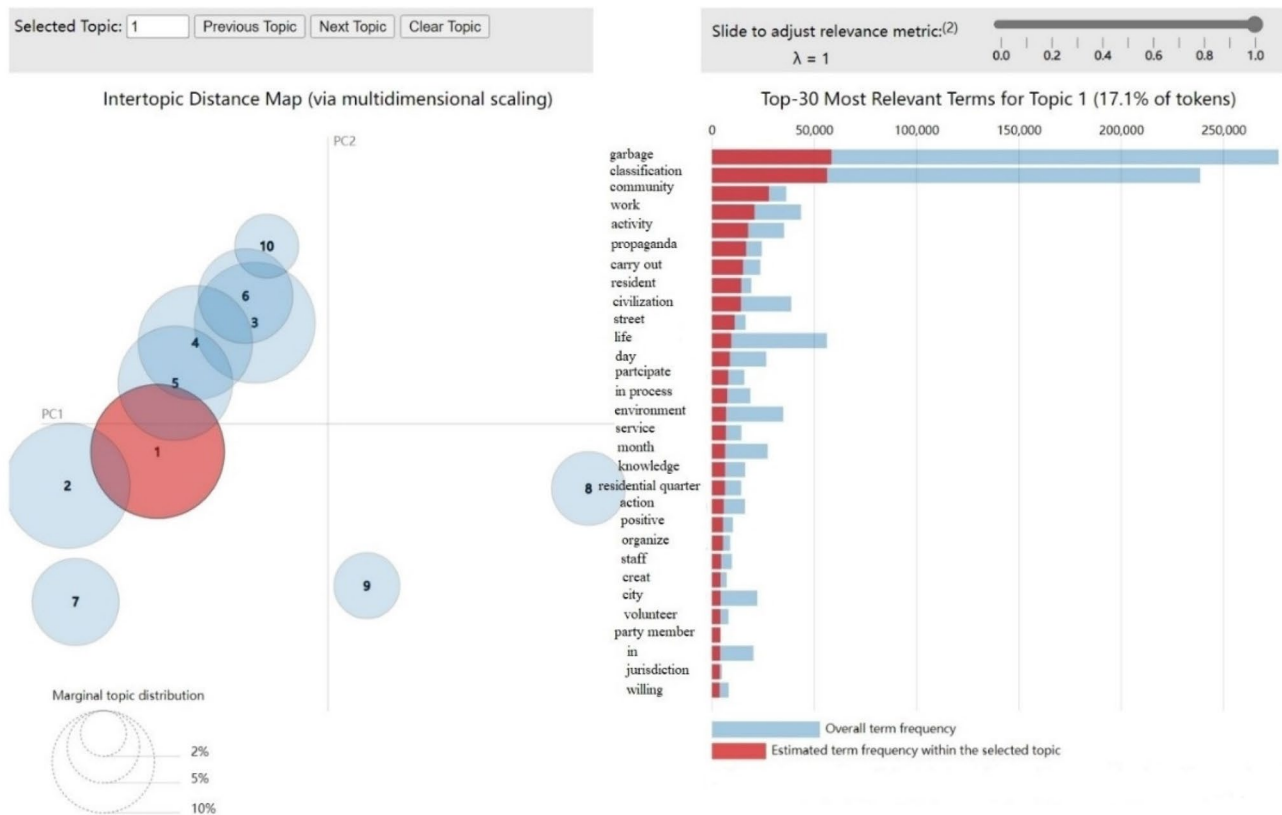


Fig. 6 Topic 1 of topic models (positive sentiment) in 2020

problems, followed by the classification of batteries, plastics, clothes, metal and glass.

- (3) The process of garbage classification in various regions shows a great discrepancy. The governments of the pilot cities Beijing, Shanghai, Guangzhou, and Hangzhou have adopted the most garbage classification measures and has the greatest responses. The different garbage classification policies in various places are also an important reason for residents' disgust.

Based on the research results, this paper puts forward the following suggestions:

- (1) According to the results, opposition to incentive or punishment measures is an important source of public negative emotions about garbage classification. To win public support for the incentive or punishment measures, fundamental understanding of the residents' response to the incentive or punishment measures is essential. For example, before adopting the incentive or punishment measures, use the questionnaire survey to investigate the residents' habits and thinking characteristics to enhance the wide public support for the policy.

- (2) Attaches great importance to the cultural, psychological and cognitive factors of individual actors at the micro and macro level of social action system of consideration. The system of urban environmental protection policy should not only pay attention to the policy enforcement but also attaches great importance to the process of informal institution building, such as taking garbage classification into school education, and continue to carry out publicity activities.
- (3) Based on the result that the public is not satisfied with the infrastructure construction, the garbage collection devices need well-planned, such as properly plan the location of garbage cans, time to collect garbage. Only by making the garbage classification process convenient and user-friendly, can the residents will more willing to participate in the garbage classification work.

There are still research limitations to our research. As the users of Sina Weibo are generally young. So, the data used in this paper is less effective for the investigation of the garbage willingness of the older.

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