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Evaluating the social license to operate of waste-to-energy incineration projects: A case study from the Yangtze River Delta of China

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Abstract

The public has a strong resistance to such potential hazardous facilities as nuclear power plants and waste-to-energy (WTE) incineration due to their potentially negative environment and health effects, which leads to difficulties in siting their location. Exploring the public's cognition and acceptance of such facilities is therefore vital for the sustainable development of the potentially hazardous facilities industry. Based on four typical WTE incineration plants located in four central cities of the Yangtze River Delta, the current study evaluates the social acceptance of potentially hazardous facilities in developed regions of China by a questionnaire survey based on the 'social license to operate' (SLO) framework widely used in energy/mining sectors. The results show that the SLO of WTE incineration plants is relatively low and presents a clear dimension structure that shows differences with the

change of cities. Enriching enterprises' SLO through the accumulation of social capital can help the public accept WTE projects.

Key words:

Waste-to-Energy Incineration Projects; Social License to Operate; Acceptance.

1 Introduction

With the development of urbanization, the generation and disposal of municipal solid waste (MSW) has become one of the major problems faced by countries all over the world, especially in developing countries (Wang, 2018), as continuing with the traditional landfill method not only destroys the soil irreversibly, but also means that cities will eventually become besieged by MSW (Samadder, 2017). Incineration provides one solution as, in terms of current technological development, it is the most advantageous of all treatment methods and has relatively little impact on the environment after the integrated utilization of the economy, technology, and resources (Panepinto, 2018; Li, 2015). In the past decade, the proportion of MSW disposed by incineration has increased significantly, the popularization and development of WTE incineration projects is therefore very important. However, such projects often have a strong NIMBY (not-in-my-backyard) effect, with the public often opposing them due to negative externalities. This has resulted in quite a few large-scale mass incidents around the world, such as group protest of the SHISU WTE incineration plant in Japan and the Renwu WTE incineration project in Taiwan (Kemp, 1990; Hsu, 2006)

As well known for social acceptance being a key to the long-term development of new technologies, according to Imura (2013), its evaluation for WTE incineration power plants can effectively prevent the occurrence of strong public resistance. To help overcome this, most studies of this field use *public acceptance* (PA) to reflect local attitudes (Ren, 2016). Still, although the PA paradigm is widely used in NIMBY facilities, its shortcomings are particularly significant for WTE projects as they involve a continuous and long-term process from construction to operation, so that public acceptance can only reflect the residents' current behaviors and attitudes (Wolsink, 2019). An alternative concept, SLO (social license to operation), can easily remove the restrictions imposed by

PA: in particular, it is dynamic and non-permanent, which is the most remarkable feature that distinguishes it from many other paradigms (Thomson and Boutilier, 2011). Nevertheless, previous SLO-related studies tend to focus on the acceptance of forestry, mining, or nuclear power enterprises, with few applications to waste incineration power plants (Lhtinen, 2016; Prno and Slocombe, 2012).

SLO was originally proposed by Jim Cooney (2017), an employee of the World Bank, at a meeting, who suggested that enterprises need to obtain "social license to operation" (also called social licensing) to improve the reputation of industry. Although the definition of a social license has not been unified at present, most studies generally accept that it is the continuous acceptance and recognition of enterprises by local communities (including stakeholders and non-governmental organizations) in the process of project development and operation (Moffat and Zhang, 2014; Prno and Slocombe, 2014). It is especially intended to meet the expectations of stakeholders more than the legal requirements involved, otherwise the company's image will be damaged, possibly even leading to the cessation of production and huge financial losses (Gunningham et al., 2004). SLO has been widely used in the past two decades in mining, forestry, cotton planting, energy (Edwards et al., 2016; Roth, 2011; Baumber, 2018), and even in finance and education (O'Brien et al., 2015; Haynes, 2018). Therefore, SLO has a relatively complete framework system, which can constitute a new research paradigm for the WTE incineration industry.

The aim of this study is to evaluate the SLO framework in the WTE incineration -industry from drawing lessons from previous SLO studies in other industries. Based on this, projects in the Yangtze River Delta are used as examples under the SLO analysis framework to explore the social license to operate degree of WTE incineration facilities in China. Firstly, a face-to-face questionnaire survey is described of the stakeholders in the communities surrounding WTE incineration projects in four

typical cities in the Yangtze River Delta: Shanghai, Hangzhou, Nanjing, and Ningbo. Then, through exploratory factor analysis, the level of each project is judged under the SLO paradigm. The second aim of this study is to compare the factors and scores of the four projects and to explore the causes involved. The results of this study enrich the scope for measuring the social acceptance of NIMBY infrastructure and provide a new framework for the evaluation of social acceptance. At the same time, they will be helpful in understanding resident attitudes towards WTE projects, forming a benign interaction between the government, enterprises, and the public, being of great significance in encouraging the development of WTE incineration projects in China, helping local governments prevent risks, and forming policy suggestions.

2 Literature review

2.1 Social acceptance of WTE incineration projects

With the rapid development of various infrastructure construction facilities, people have a strong resistance to WTEs as potentially hazardous facilities. Public opposition has seriously affected their planning and construction, making it difficult to select the site of some WTE projects and have even stopped construction (Gohlke, 2007; Dai, 2015). Because of their NIMBY effect, the risks and negative externalities are borne by a few residents near the facility, which makes them angry to be so unfairly treated (Cui, 2020; O'Hare, 1983). Even after years of technical improvement in which the combustion system and flue gas treatment of WTE projects have greatly improved and the emission of air pollutants has significantly reduced, public acceptance has yet to follow suit (Zhao, 2016; Makarichi, 2018). For example, in 1992, the United States' plan to build a WTE-MSW conversion plant was thwarted by the local people because of failure to pay attention to the public's attitude: in the end, the project was relocated, with even the mayor and related members stepping down (Karl,

1996). Similarly, in 2009, residents strongly opposed the construction of the Guangzhou Panyu WTE plant through petition, signatures, and distribution of leaflets (Li et al., 2016).

Many group conflicts caused by WTE projects with NIMBY effect have attracted extensive attention from researchers (Liu, 2019; Chen, 2022). To alleviate this phenomenon and identify corresponding solutions, various methods have been adopted to study the NIMBY effect (Barat, 2022; Ren, 2016). As a research paradigm that reflects the public's cognition of new technologies, PA is playing an increasingly important role in measuring acceptance of WTE incineration projects (Wan, 2015). The SLO is also applicable to the evaluation of industrial acceptance; Gough et al.'s (2018) research shows that social license plays an important role in mining, natural gas, and other industries, but in contrast to PA, the SLO is not static, but always influenced by new information characterized by variability and non-permanence (Thomson and Boutilier, 2011).

2.2 Social license to operate

As for the “continuous acceptance” of the project by the local community, which cannot be easily maintained (Gehman, 2017), in the 1990s, the SLO was first applied to the mining industry, before gradually attracting people's attention when the United States, Australia, Canada, and other countries began its study (Moeremans, 2021). Many companies expanded the interests of local communities by minimizing unexpected impacts and encouraging citizen participation to establish a good reputation as much as possible and prevent the future increase of regulatory restrictions (Jijelava and Vanclay, 2017). Even in industries such as mining, the SLO is no longer confined to local communities. Its further expansion can not only determine whether a single project can obtain the local communities' SLO, but also whether the industry can be widely accepted by the public (Hall et

al., 2014; Lacey and Lamont, 2014). Morrison (2014) believes that all organizations, whether government or non-governmental, should obtain a social license for their projects.

The SLO of enterprises lies in the social acceptance obtained by the consent of local residents and communities to a project. The difference between the two lies in the SLO's intangibility and informality (Smits et al., 2017). As Prno and Slocombe (2012) point out, with the public having more rights to influence the development of government decision-making and the concept of sustainable development, natural capital has become increasingly important, and companies need to acquire, maintain, and improve the SLO. Therefore, although the law does not require companies to implement the SLO, the government is increasingly requiring companies adopt their use (Barreiro and Deymonnaz, 2013). Since the SLO has similar characteristics to a formal regulatory license, it needs a set of processes with clear logic and standardized use conditions (Ford and Williams, 2016). With the acquisition of new information, the views and attitudes of individuals will change at different stages. The SLO has the characteristics of dynamic and sustainable development, which can prevent enterprises from considering people's wishes only at the initial stage of project decision-making and ignoring public opinion after the project is put into production (Thomson and Boutilier, 2011).

In the past, SLO measurement was considered difficult, although Moffat et al. (2014) believed that large-scale public surveys could do this (Parsons and Lacey, 2012); Prno and Slocombe (2014) have used semi-structured interviews to measure the SLO in a qualitative way; and Zhang et al.'s (2015) surveys in Australia, Chile and China have determined the relevant variables involved, such as distributive fairness, procedural fairness, governance confidence and trust. However, there has been no clear consensus to date of the SLO threshold, although various studies have shown that the SLO framework constructed by Thomson and Boutilier (2011) is the most applicable. First, as shown

on the left side of Fig. 1, it defines the SLO as four levels and three boundaries, namely legitimacy, credibility, and trust. The failure to achieve the lowest level of the SLO connection law will make the enterprise withdraw/detain the social license. At this time, the social and political risk is very high, which may increase the enterprise's operation costs, or even shut down or close the project (Franks et al., 2014). The SLO level is inversely proportional to social and political risk. The higher the level, the lower the social and political risk of the project. After experimental modification, the model developed from a pyramid to arrow model, and the four levels were transformed into a continuous whole, which accumulated with the increase in SLO level. This model still contains four factors: economic legitimacy, social and political legitimacy, interactive trust, and institutionalized trust. It not only provides the basis for human social relations, but also includes the concept of cultural capital (Bourdieu & Passeron, 1990; Thomson and Boutilier, 2011).

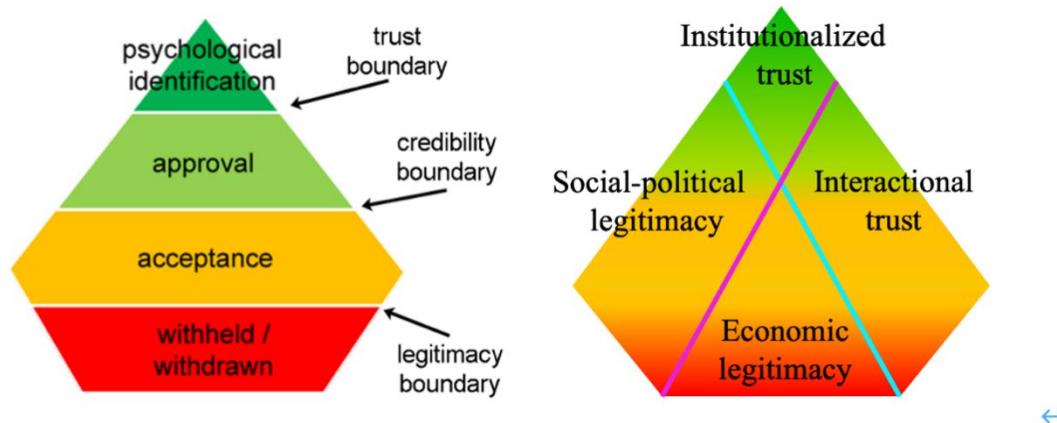


Fig. 1. The SLO model proposed by Thomson & Boutilier (2011)

According to the combination of the previous literature, the SLO has developed a relatively complete theoretical framework and measurement dimension from research and development in mining, forestry, chemical, and other industries. At present, the acceptance analysis of potential hazardous facilities is mostly decentralized and linear, and social license has not been applied. The

SLO has a characteristic of variability, which can compensate for the shortcomings of previous studies. However, while the arrow model with four levels built by [Boutilier and Thomson \(2011\)](#) has been widely used in the mining sector, its applicability in the waste incineration industry still needs further research.

3 Research design

3.1 Overall research framework

The case analysis method is mainly used to explore the social acceptance of WTE incineration projects under the SLO paradigm. Through the process of literature review, questionnaire survey, and data processing, the specific steps are as follows:

Following an extensive literature review, the SLO research paradigm is described in detail. The questionnaire, first used by [Boutilier and Thomson \(2011\)](#) for a Mexico mining project and subsequently to study the SLO in mining, forestry, and other industries, was improved in combination with the special characteristics of WTE facilities to form a measurement scale, conduct the field questionnaire survey, and collect data.

Using the SLO model, the WTE facilities in four central cities of Yangtze River Delta (Hangzhou, Nanjing, Shanghai, and Ningbo) are investigated. The case study is an important method to investigate whether the paradigm is reasonable.

The dimensions under the SLO framework of each project are determined by exploratory factor analysis, and the score of each project calculated, and the SLO measurement results in different circumstances are obtained. The SLO's applicability is explored, and the reasons for the differences in WTE incineration plant project acceptance levels in different regions are analyzed.

3.2 Questionnaire design

The questionnaire is mainly divided into two sections. The first elicits the socio-demographic characteristics of the respondents, including gender, age, education level, and distance from the factory. The second, measures the respondents' attitude towards the project from four dimensions. A series of questions are adapted from [Boutilier and Thomson's \(2011\)](#) questionnaire. There are 15 questions to evaluate the degree of the SLO, which are divided into four dimensions: economic legitimacy, socio-political legitimacy, interactional trust, and institutionalized trust. To improve the accuracy of the SLO measurement of WTE facilities, some adjustments were made to the original problem. Considering regional location and other factors, some stakeholders may not be directly related to the WTE. Therefore, [Boutilier \(2011\)](#) designed two similar questionnaires (A and B), in which questionnaire A was applicable to stakeholders directly related to the project, and questionnaire B was used to investigate those who were not directly related to the project. For the present study, questionnaire A is used for those living within 3 km and questionnaire B for those living beyond 3 km. Except for the demographic data, all items were rated on a 5-point Likert scale from 1 ("extremely disagree") to 5 ("extremely agree").

3.3 Samples and data collection

With the continuing maturation of WTE generation technology, WTE is becoming increasingly preferred to coal-fired power generation, as it has remarkable carbon emission reduction effects and therefore provides an important way towards achieving the goal of carbon neutrality. After an in-depth integration of the industry, China's national Development and Reform Commission proposed the development in the "14th five-year plan" of urban domestic waste classification and treatment facilities to meet a daily national urban domestic waste incineration capacity of approximately

800,000 tons in 2025, accounting for around 65% of the total. The Yangtze River Delta, an economically developed region in China, has experienced an accelerating layout of projects and on an expanding scale. By the end of 2030, a total of 115 WTE incineration plants will be built in the region.

To investigate the attitude of local stakeholders during the project operation stage, four typical waste incineration power plants were selected for measurement and research after consideration of the years of completion and the capacity of plants, namely the Shanghai Tianma, Hangzhou Jiufeng, Nanjing Jiangbei, and Ningbo Mingzhou MSW incineration plants, as Shanghai, Hangzhou, Nanjing, and Ningbo are representative cities in the Yangtze River Delta. The daily treatment capacity of the four waste incineration power plants is more than 2,000 tons. Their geographical locations are relatively similar. There are residents near the plants, and their construction and operation times are less than five years. Most importantly, all projects have experienced strong opposition from local residents, and even mass conflicts over the Jiufeng plant. Therefore, these cases are instructive in the study of social attitudes.

Table 1 Basic information of the four projects

Project name	Capacity (tons/d)	Initial operating time
Shanghai Tianma	2000	2016
Hangzhou Jiufeng	3000	2017
Nanjing Jiangbei	2000	2015
Ningbo Mingzhou	2250	2017

[Ren et al.'s \(2016\)](#) research shows that areas 3 km away from the incineration site have a weak resistance to such projects and are less likely to participate in mass incidents. Meanwhile, we

conducted a pre-survey of four cities in September 2019, and found that residents 3km away were not interested in projects, and even knew little about it. Factors such as population distribution, regional location, and sample size may influence the acceptance of a WTE incineration project. Therefore, for residents within 3 km, their own interests are closely related to the project development, and A questionnaire is used for investigation. Residents who are 3 km away have a relatively small relationship with the project, so the B questionnaire is used in their case.

The survey was conducted in October to November 2019, with stratified random sampling around Shanghai, Nanjing, Hangzhou, and Ningbo. According to the location, population, and distance from the WTE incineration project, each survey area was divided into residential communities or villages. Residents living in communities or villages were randomly selected as respondents. A total of 1,000 questionnaires were sent out to the four places: 250 in each place (including 125 A questionnaires and 125 B questionnaires). 979 were recovered and 717 finally chosen after excluding invalid questionnaires. There are 358 A questionnaires, with 94, 83, 89, and 92 from Hangzhou, Ningbo, Nanjing, and Shanghai, respectively; and 375 B questionnaires, with 88, 83, 91, and 102 from Hangzhou, Ningbo, Nanjing, and Shanghai, respectively – an effective recovery rate of 71.7%. Its high response rate is due to being face-to-face. The respondents were informed that the survey would be completely anonymous and confidential, and no personal information of the respondents would be disclosed, so as to ensure the authenticity of the information received.

Table 2 Socio-demographic characteristics of the respondents (N=358)

Profile	Category	Frequency				
		Overall	Shanghai	Nanjing	Hangzhou	Ningbo
Gender	Male	194(54.19%)	51(55.4%)	51(57.3%)	50(53.2%)	42(50.6%)
	Female	164(45.81%)	41(44.6%)	38(42.7%)	44(46.8%)	41(49.4%)

Profile	Category	Frequency					
		Overall	Shanghai	Nanjing	Hangzhou	Ningbo	
Age	18-25	31(8.66%)	5(5.4%)	9(10.1%)	11(11.7%)	6(7.2%)	
	26-35	58(16.20%)	15(16.3%)	17(19.1%)	19(20.2%)	7(8.4%)	
	36-45	55(15.36%)	15(16.3%)	8(9.0%)	23(24.5%)	9(10.8%)	
	46-60	101(28.21%)	25(27.2%)	23(25.8%)	22(23.4%)	31(37.3%)	
	60+	113(31.56%)	32(34.8%)	32(36.0%)	19(20.2%)	30(36.1%)	
Education level	≤Junior high school	201(56.15%)	49(53.3%)	51(57.3%)	43(45.7%)	58(69.9%)	
	Senior high school	72(20.11%)	20(21.7%)	20(22.5%)	17(18.1%)	15(18.1%)	
	Junior college	50(13.79%)	9(9.8%)	14(15.7%)	20(21.3%)	7(8.4%)	
	Undergraduate	34(9.50%)	14(15.2%)	4(4.5%)	13(13.8%)	3(3.6%)	
	≥Graduate	1(0.28%)	0(0.0%)	0(0.0%)	1(1.1%)	0(0.0%)	
	Distance from the WTE incinerator	≤500 m	5(1.40%)	0(0.0%)	0(0.0%)	5(5.3%)	0(0.0%)
	500-1000 m	42(1.73%)	0(0.0%)	0(0.0%)	20(21.3%)	22(26.5%)	
1000-2000 m	93(25.98%)	30(32.6%)	1(1.1%)	33(35.1%)	29(34.9%)		
2000-3000 m	218(60.89%)	62(67.4%)	88(98.9%)	36(38.3%)	32(38.6%)		

Table 2 shows the demographic characteristics of the respondents, indicating there are 8.38% more males than females, and the proportion over 46 years old is 59.77%. Although the sample data deviate from the total population statistics of various place, the respondents are nevertheless residents within 3 km of WTE incinerators. The research site is in the urban-rural fringe, and young people and some women usually migrate to cities. In terms of education level, only 23.57% have a university degree or above, compared with the seventh national census data, which has 29.07% of the population with a bachelor's degree or above in Hangzhou, Ningbo, Nanjing, and Shanghai. The reason is that the education level of urban-rural fringe and rural areas is lower than in cities.

3.4 Data analysis

The analysis process is mainly divided into three steps. Firstly, through descriptive statistics, the respondents' acceptance of the WTE incineration project is evaluated in the dimensions of economic legitimacy, socio-political legitimacy, institutional trust, and interactive trust. Secondly, an exploratory factor analysis – a widely used method in sociology to find the data's basic structure – is used to determine the dimensions of the SLO data and explore the basic structure of potential harmful facilities. Taking the survey data of the projects in the four cities as a whole, the exploratory factor analysis is carried out for the 15 questions to verify their reliability, with the Kaiser criterion applied to define the significant factors and retain the factors with an eigenvalue greater than 1 (Kaiser, 1960). Finally, the results of each project are compared and analyzed, the characteristics and scale of each project and the reasons for this phenomenon are investigated, and the acceptance level is determined of each WTE incineration project under the SLO framework.

4 Results

4.1 The SLO of WTE incinerations

Through the extensive questionnaire survey, it is found that, generally speaking, under the SLO framework, the public acceptance of WTE facilities is generally low. As Table 3 shows, the analysis indicates there are two factors.

Table 1 Estimated weights for two significant factors

SLO level	Variable	Factor 1	Factor 2
Economic legitimacy	E11		0.557
	E12	0.613	

SLO level	Variable	Factor 1	Factor 2
Socio-political legitimacy	El3	0.592	
	Spl1	0.676	
	Spl2		0.58
	Spl3	0.537	
Interactional trust	Spl4		0.632
	It1	0.682	
	It2	0.592	
Institutional trust	It3		0.631
	InstT1	0.774	
	InstT2		0.643
	InstT3		0.729
	InstT4		0.792
	InstT5		0.831

Factor 1 includes several indicators from the economic legitimacy dimension. In addition, such indicators as Spl1, Spl3, It1, It2, InstT1 are also included in the economic definition terms, which suggests the overall name of this factor to be “economic legitimacy”. The other indicators suggest naming Factor 2 as “social legitimacy”. The Cronbach α coefficient, which estimates the variance shared by the problem, is calculated to assess the internal consistency of the two factors. Research shows that these are considered to be a single structure when the Cronbach α value is greater than 0.7. In this study, the Cronbach α coefficient of “economic legitimacy” and “social legitimacy” is 0.88 and 0.93, respectively. To determine the standard score of the two factors, the average value of the variables mapped to each factor is taken as the measure that factor. Thus, the variables contained in Factor 1 are averaged to create a measure of economic legitimacy and the variables contained in Factor 2 are averaged to create the measure of social legitimacy.

After factor analysis, the attitudes of the respondents under these two measures are determined. The average score of economic legitimacy is 2.15 and that of social legitimacy is 1.82. As Fig. 2 shows, the scatter points are mostly concentrated in the lower left corner and obviously biased to the side of economic legitimacy. Fig. 3 shows the model to which the SLO of WTE incineration projects generally conform, indicating that the SLO is likely to fluctuate in the yellow area. In a better case, it may enter the green (approved) range, but in a worse case, the SLO may also fall into the red area; that is, it will be withdrawn.

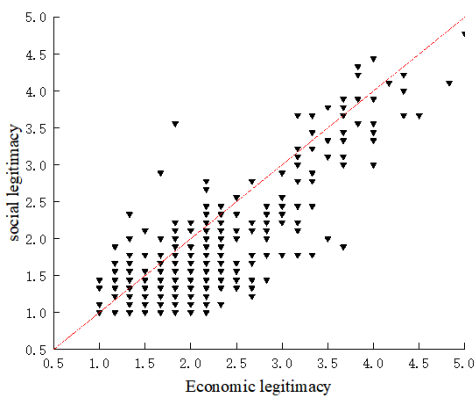


Fig. 2. Scatter plot of individual SLO scores

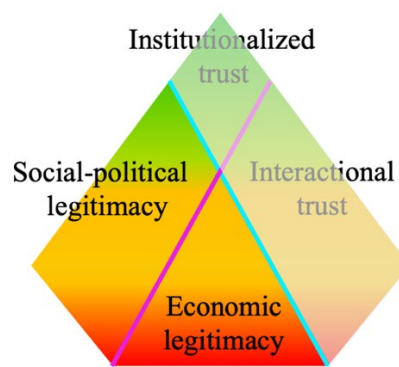


Fig. 3. Levels of social license

4.2 The SLO differences between the four WTE incineration plants

Using the same method, the four WTE projects are analyzed independently. This reveals that, after exploratory factor analysis, there are three factors in Shanghai and Hangzhou and two factors in Ningbo and Nanjing. As Table 4 shows, the Cronbach alpha coefficients of each item all exceed 0.7, indicating that the SLO measurement factors have sufficient internal consistency.

Table 4 Cronbach alpha results of the four projects

Constructs	Cronbach's alpha			
	Shanghai	Hangzhou	Nanjing	Ningbo
Economic legitimacy	0.823	0.738	0.913	0.915
Social legitimacy	0.843	0.911	0.947	0.927
Trust	0.762	0.752		

After rotation, there are three dimensions in Shanghai and Hangzhou: economic legitimacy, socio-political legitimacy, and interactional trust. The levels of each dimension are different. The average Hangzhou scores are 2.22, 1.87, and 1.62 for economic legitimacy, socio-political legitimacy, and interactional trust, respectively; and 1.75, 1.85, and 1.68, respectively for Shanghai. After the rotation of Ningbo and Nanjing, there are only two dimensions of economic legitimacy and social legitimacy – the indicators being 2.26 and 2.09, respectively for Ningbo; and 2.05 and 1.88, respectively for Nanjing.

Table 5 Average scores of each dimension in the four cities

Project	EL	SPL	IT
Shanghai Tianma	1.75	1.85	1.68
Hangzhou Jiufeng	2.22	1.87	1.62
Nanjing Jiangbei	2.05	1.88	\
Ningbo Mingzhou	2.26	2.09	\

All indicators are at a low level, and residents' acceptance of the incinerator project is low. As the right side of Fig. 4 shows, most points in the two-dimensional plan of the Nanjing Jiangbei MSW and Ningbo Mingzhou MSW projects are distributed near the 45-degree line, with many points biased towards the direction of economic legitimacy. For these two projects, the evaluation of economic

legitimacy is generally higher than that of social legitimacy. The three-dimensional scatter diagram of the Jiufeng project also follows this logic. The first SLO level is easier to implement than the second level, and the second level is easier to implement than the third level. In the scatter diagram of Shanghai Tianma MSW project, compared with economic legitimacy, the points in the space are more inclined to the side of social legitimacy.

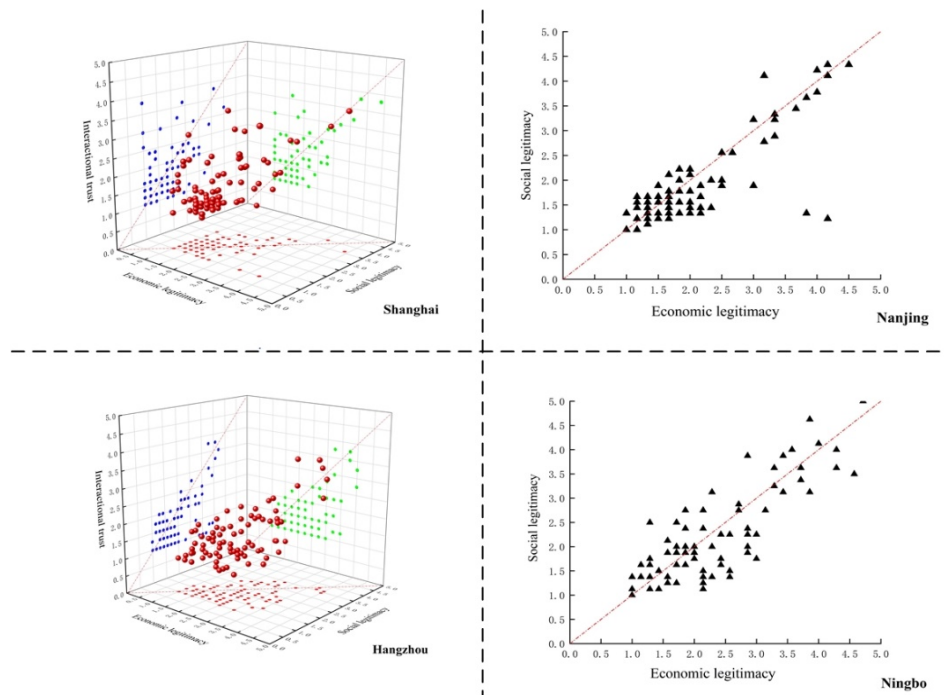


Fig. 4. Scatter plot of individual scores in different dimensions within 3 km in the four cities

5 Discussion

The results of this study show that, overall, the detected dimensions are consistent with the SLO arrow model, while the SLO level of the WTE incinerators, although greatly improved in the past decade, is less than such other industries as mining and forestry. [Lucy et al. \(2018\)](#), for instance, found the average value of trust indicators in mining to be in the middle. Similarly, the [Lucy and Will \(2018\)](#) and [Claire \(2015\)](#) surveys of the evaluation of natural gas industry in Western Australia shows the economic legitimacy dimension and social legitimacy indicators to be significantly higher than the SLO level of the WTE projects. One possible reason is that compared with projects in developed

countries such as Australia, there is a lack of close ties between enterprises and communities in WTE projects, especially after the projects is completed. Another more important reason is that the negative externalities of WTE incinerators are stronger than those industries and its negative image is still rooted in the public's mind – the public has formed an inherent cognitive bias towards it ([Vlachokostas, 2020](#)), the pollutants in the operation of the project may affect safety, health, and other issues – and the residents think they have taken on too many risks and burdens, which exacerbates individual anxiety ([Lahl and Zeschmar-Lahl, 2018](#); [Matheny, 1985](#)). This imbalance of profit and loss leads to the trust problem, which leads to the SLO level for potentially harmful facilities being lower than other industries. Even if communication increases, such projects may still be strongly opposed.

According to the analysis here, China's WTE projects can only reach the second or third SLO level, with the highest level of institutionalized trust being difficult to reach. In terms of the overall situation of the Yangtze River Delta, however, the legitimacy factors have been basically met. All regions have realized economic compensation to relevant stakeholders, provided the social welfare of the whole region, and succeeded in their economic legitimacy and social legitimacy ([Koivurova, 2015](#)). However, the SLO is not stable. In the process of sustainable dynamic development, when the company fails to meet the expectations of residents, the SLO may be withdrawn ([Luke, 2017](#)). There is mutual trust between the Tianma project and Jiufeng project to the extent that they meet the required legitimacy. At the initial stage of a project, there are protests on a certain scale in both places. Therefore, project supporters and government authorities pay special attention to the expectations and opinions of stakeholders and abide by their relevant commitments ([Smits, 2016](#)). As mentioned in previous studies, it is only when the voices of stakeholders (including marginalized groups) are fully

covered and project advocates and stakeholders agree on expectations, that interactive trust can be obtained (Smits et al., 2017). The Jiangbei and Mingzhou factories provided better economic compensation, and their evaluation of legitimacy indicators was even higher than that of Jiufeng and Shanghai, but the project supporters focused more on economic benefits at the expense of building long-term and interactive trust with the local community. In particular, the Nanjing Jiangbei WTE project, due to the small number of local (within 3 km) residents, the company and relevant institutions ignore the deeper values and long-term goal needs of individuals in addition to the economy and well-being (Pan, 2015). The stakeholders seem to have certain recognition of the project in the short term, but the SLO actually has high risks, and fluctuates between cancellation and acceptance (Moffat and Zhang, 2014; Smits et al., 2017).

The results of the SLO's perception of local economic legitimacy and social legitimacy in the Jiangbei, Mingzhou, and Jiufeng factories support the early work of Boutilier and Thomson (2011), in that the value of individual economic legitimacy is higher than that of social legitimacy and the former must be obtained before the latter is given, and it is rare for people to see a non-cumulative model that the scores of higher levels (social legitimacy) exceed those of lower levels (economic legitimacy) in existing research. However, compared with economic legitimacy, the local community evaluates the social legitimacy of the Tianma factory more positively; that is, in this case, economic legitimacy is not a necessary condition for social legitimacy. The possible reason lies in the unique geographical location of the Shanghai Tianma factory, especially the diversity of the geographical location (Billing, 2018). Correspondingly, Shanghai, as a China first tier city, not only has a solid economic foundation, but also has good civic morality and ecological awareness all over the country

(Yang et al., 2016). Therefore, it is reasonable for the Tianma factory located at the junction of Qingpu District and Songjiang District of Shanghai to record a high SLO in terms of social legitimacy.

The continuously developed SLO framework in mining and other industries provides a new idea for research into the social acceptance of potentially harmful facilities. Taking the WTE projects in the present study as an example, this present study accurately investigates citizens in specific regions by quantifying key indicators, with the results showing that the SLO can provide help for WTE projects (Zhang et al., 2015). It is worth noting that enterprises should consider the accumulation of social assets and cultivate their structural, relationship, and cognitive sources to enrich the SLO (Woolcock, 2001). However, not all companies realize that the construction of social capital is actually an investment to improve the possibility of project objectives. At first, there was only a loose connection between the project supporters and the community. For the local community, the company was in a marginalized position. In the process of promoting the project, the connection between the enterprise and the community deepened, and developed into half-marginal members after gaining some trust from the community (Hou, 2019). When the company eventually became the core member of the community where the project is located, the structural source of social assets was established (Harrington, 2001). Based on mutual respect, the community and the company have become mutually beneficial, which is conducive to enhancing the unity of social assets.

Community leaders and company representatives communicate frequently, emphasizing the similarities between the two groups and forming a common identity, which can eliminate the contradictions between groups (Schoemaker, 2005). During the investigation, it was found that, in the early stage of construction, the Ningbo Mingzhou WTE project communicated many times with the residents around the site, and selected regional representatives to visit other completed WTE

projects. The survey results also show that the Mingzhou factory has relatively high scores on the economic and social dimensions. The relationship between the community and the company may only result from short-term profits in the initial stage. Just like the Nanjing Jiangbei project, it is difficult for the project to gain more trust when it fails for a long time to communicate with stakeholders to a promote mutual understanding (Lin, 2001). As far as cognitive sources are concerned, the company tries to use non-technical language. In the process of obtaining the source of the relationship between the company representatives and community leaders, it is clear that communities often do not know the cognitive framework of the company. Therefore, using the same cognitive tools to reach a consensus with the community on future development can help project supporters develop sources of social assets (Chiu, 2007).

The construction of potentially harmful facilities and further maintenance of social licensing needs an improved SLO strategy, and the “three-step process method” is considered to be an effective approach to assess the overall environment of the project (Chaim, 2008). The overall environment of stakeholders is different in different communities. Boutilier (2011) roughly divides them into three categories: the network structure trapped in infighting between factions, the network structure dominated by elites, and the network structure with relatively closed but strong cohesion (Lackey, 2002). Of course, this is the most effective way to improve according to the components of social license. Although the legitimacy of the economy and welfare is a short-term and unstable social license, it is still the most basic and necessary factor in the whole SLO framework (Meehan, 2016). As a long-term dynamic process, social license cannot be simply measured by quarterly performance or key performance indicators. Instead, the SLO is more suited to the five-year performance indicators with a longer time range.

6 Conclusions

Although WTE incineration plants have become an important way for many countries to meet their internal needs, alleviate the pressure of environmental protection, and achieve carbon neutralization, it is still a controversial and high heterogeneous industry. The conceptual framework and SLO measurement method are gradually constructed through research into the emerging negative effects of the mining and natural gas industries. WTE incineration projects and the SLO are organically combined in this study, to examine the conflict cases in the Yangtze River Delta and demonstrate the applicability of the SLO for such projects. Based on an empirical study of four typical WTE incineration plants in the Yangtze River Delta region and the analysis of the acceptance of such facilities by local community residents, the following conclusions are presented:

- 1) For the Yangtze River Delta, the WTE incineration project SLO level is generally low.
- 2) In most cases, the SLO level presents a clear dimensional structure, which allows the differences with the changes of cities to be observed.

The research results provide some valuable implications for the operation of the WTE project. Firstly, due to the strong negative externalities of WTE, the government and enterprises should make joint effort to carry out more positive publicity, raise the awareness of the whole society on WTE projects and improve its image in the eyes of public as much as possible. Secondly, enterprises should maintain continuous communication with stakeholders, build a communication platform with local communities, reach consensus, establish a good corporate reputation, and strive to gradually improve the level of social licensing given by the public. Thirdly, for the first-tier cities with developed economies, economic legitimacy may not be the first demand of stakeholders, and enterprises should establish a decision-making mechanism that are suitable for the local cultural background for different

regions. Finally, for government departments, social licensing may be a potential policy direction, and incorporating SLO into decision-making factors in the approval process will help stakeholders recognize the progress of the project.

This research is a new study of social license of WTE incineration projects, and the results provide support for the applicability of the framework, while the reasons for the differences in WTE incineration plant project acceptance levels in different regions form a foundation for improving the social acceptance of potentially hazardous facilities. In essence, we need to know how to better support more effective relationships between the public, industry, and government on the basis of mutual trust in the social licensing of these projects.

Although the SLO is demonstrated to be applicable for WTE projects, the study is limited in the consideration of the relationship between stakeholders: the alliance of stakeholders in the community can often affect the final level of the community. The research area is limited to the population with direct interaction between local communities and industries, while the SLO has gradually increased from the relationship between a single community and enterprises to the relationship between industry and the general public. In addition, all the projects in this study are located in the most economically and socially developed region in China, and the research results can't represent the whole of China. A nationwide survey will be conducted later. These aspects are therefore in need of further treatment and investigation.

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