

Environmental aspects of the public examination of the construction of an Incineration complex

Margarita Kuzmina^{1*}, *Vadim Timshin*¹, *Valentina Kashintseva*², and *Kymbat Kunanbayeva*³

¹ Vyatka State University, Moskovskaya str., 36, Kirov, 610000, Russia

² Moscow State University of Civil Engineering, Yaroslavskoye Shosse, 26, 129337 Moscow, Russia

³ E-Finance Center JSC The Republic of Kazakhstan, 010000, Nur-Sultan, 18 Dostyk Street, Kazakhstan

Abstract. The article examines the case of preparation for public expertise on a project for the construction of a waste incineration complex. Public expertise is a legal requirement and often leads to the cancellation of a project for which preparation resources have already been spent. The authors conducted a field study, which assists to develop a methodology for forming a favourable public opinion regarding the designed complex, as well as compose recommendations for the implementation of the program. An important element of the study is to identify the main concerns of the population regarding the project, as well as to identify the target audience, its channels for consuming information and the features of the implementation of information through these channels. The study will significantly reduce the risks of a ban on the project, as well as the resistance of the local population.

1 Introduction

Waste disposal by incineration remains a pressing problem in the modern world. Every year the amount of waste increases, and the problem of its disposal becomes more acute. One of the most effective ways to dispose of waste is incineration.

Incineration helps to quickly and efficiently destroy organic waste such as food, paper, fabrics and other materials that cannot be recycled. In addition, incineration reduces the amount of waste in landfills and reduces environmental pollution. Analysis of the efficiency of incineration of waste textile materials was studied by A. Bartl [1-2], household waste by A. Selinger and V. Schmidt [3], assessment of urban environment by E. Ganebnykh, T. Burtseva, V. Reutov and others [4-10].

However, waste disposal by incineration has its drawbacks. First, combustion produces toxic substances such as dioxins and furans, which can be harmful to human health and the

* Corresponding author: doptaganka@yandex.ru

environment. Secondly, combustion requires a lot of energy and can release large amounts of carbon dioxide into the atmosphere. Issues of safe combustion and use of the energy obtained from this process are studied in the works of J. Yan and Ch.A. Salman [11], and an analysis of the impact of solid waste incineration plants on human health in the works of M.F. Reis [12].

In order for waste disposal through incineration to be safe and effective, certain rules and regulations must be followed. For example, it is necessary to use special filters to capture toxic substances and reduce carbon dioxide emissions through the use of more efficient technologies.

In addition, waste disposal must be organized in such a way as to minimize the negative impact on the environment. To do this, it is necessary to use environmentally friendly technologies and recycle waste for reuse.

Despite the rapid development of new technologies aimed at the gentlest disposal of waste, the reputational component of this process leaves a clearly negative attitude among the population. This fact significantly complicates the construction of appropriate waste incineration complexes, since public examination of such projects today is legally mandatory (Article 22 of Federal Law No. 212-FZ of July 21, 2014 “On the Fundamentals of Public Control in the Russian Federation”).

Issues of safe and efficient waste disposal became acute in European countries much earlier than in Russia. In this regard, research and the formation of corresponding public opinion abroad have been quite well studied, for example in the works of P.W. Tait et al. [13], J.L. Domingo et al. [14], P. Khamaneechan et al. [15], Y. Huang et al. [16] and others.

Thus, even at the design stage it is necessary to create a favorable image and reduce the resistance of the population regarding the launch of a waste incineration complex in a populated area.

Statistics show that the number of environmental organizations in Russia is constantly growing. According to a report by the World Wildlife Fund (WWF), there are already more than 500 environmental organizations in Russia that are engaged in various activities in the field of nature conservation and biodiversity.

One of the main reasons for the growth in the number of environmental organizations is people’s awareness of the need to take care of nature. However, another important factor in intensifying public opinion regarding environmental activities is the growing awareness of the population’s influence both on legislative activity and on the direct activities of their region.

The state also plays an important role in supporting environmental organizations. Various programs and projects have been created in Russia aimed at supporting environmental initiatives and developing the environmental consciousness of the population:

- The “Ecology of Russia” program includes measures to protect the environment, develop environmental culture and educate the population;
- The “Preservation of Russia's Biological Diversity” program is aimed at preserving and restoring the country’s biodiversity, measures are being taken to preserve rare and endangered species of animals and plants, as well as to protect natural areas;
- The “Clean Water” program is aimed at improving the quality of drinking water and protecting water resources from pollution, measures are being taken to treat wastewater, improve the system for treating industrial emissions and develop new technologies for water purification;
- The “Energy Efficiency” program is aimed at increasing the energy efficiency of the country’s economy; measures are being taken to modernize energy equipment, introduce energy-saving technologies and develop new energy sources.

All these programs are aimed at developing the environmental consciousness of the population, instilling responsibility for the environment and establishing order in the field of environmental management and ecology.

A number of eco-educational initiatives aimed at developing the environmental consciousness of children Znanie [15-16] deserve special attention.

In this regard, the growing importance of public opinion and the methods of its formation are extremely significant.

2 Methods and Materials

To understand the fears and pains of the population regarding the planned construction of a waste incineration complex, a field study was conducted. For this purpose, a questionnaire consisting of 54 questions was compiled. The questionnaire consisted of the following sections:

- Population concerns related to health hazards;
- Public concerns related to unpleasant odors;
- Population concerns related to violations of order and aesthetics;
- Public concerns related to the appearance of insects and pests;
- Other public concerns;
- Associations and strong opinions about the waste incineration process;
- Sources of knowledge about the waste incineration process and similar complexes.

To understand the mechanism for forming a stable opinion about the waste incineration complex, the survey also examined the main associations and strong opinions of respondents about it. The collection of this information was carried out in the format of association words using the snowball method: the first respondent was asked to offer his own association words (an open question), the second respondent was asked, if he agreed, to join the previous associations or offer his own, and then each subsequent respondent could agree with individual associations previous ones and/or offer your own. This method was chosen to minimize the use of synonymous words and variations in word formation.

According to the formula for calculating representativeness (a standard online calculator with a 5% error was used), 256 people were interviewed in proportion to the composition of the population, excluding children (Table 1).

Table 1. Composition of respondents

| Gender | Age | | | | | |
|--------|-------|-------|-------|-------|-------|---------|
| | 14-18 | 19-25 | 26-35 | 36-45 | 46-55 | over 55 |
| Male | 5 | 4 | 11 | 37 | 39 | 23 |
| Female | 7 | 5 | 13 | 41 | 43 | 28 |

Then the obtained data was processed in SPSS:

- Correlations have been identified;
- Cluster analysis was carried out.

A partially similar methodology was used in the work of E. Ganebnykh and Yu. Igoshina [6-7], who studied the channels of perception of the environmental situation by young people.

As a result of the analysis, a list of the most relevant factors shaping the population's opinion on the construction of a waste incineration complex was obtained.

Additionally, the sources of information from which the local population draws knowledge were analyzed. Thus, a list of factors was obtained, information about which needs to be covered in popular information sources in order to form a favorable opinion of the population before designing the work.

To understand the effectiveness of the work carried out, a repeated survey of the population is necessary. It was not carried out as part of the current study, as the design procedure was frozen during the COVID-19 pandemic.

A significant limitation of the study is the nature of the case, that is, the obtained static data cannot be replicated to similar cases. However, the methodology developed during the study can be used.

3 Results

The results of the study showed that the main concerns of the population are related to harm to health and the expectation of an unpleasant odor from the waste incineration complex (Table 2).

Table 2. General survey results (main concerns)

| Gender | Main concerns | | | | |
|---------------|---------------------------------|-----------------------------------|------------------------------------|--|--------------------------|
| | Fears related to health hazards | Fears related to unpleasant odors | Violations of order and aesthetics | Fears related to the appearance of insects and pests | Other fears and concerns |
| Male, total | 51 | 44 | 13 | 7 | 4 |
| ages 14-18 | 1 | 3 | 0 | 0 | 1 |
| ages 19-25 | 1 | 2 | 1 | 0 | 0 |
| ages 26-35 | 5 | 4 | 1 | 1 | 0 |
| ages 36-45 | 18 | 13 | 3 | 2 | 1 |
| ages 46-55 | 18 | 15 | 3 | 2 | 1 |
| ages over 55 | 8 | 7 | 5 | 2 | 1 |
| Female, total | 67 | 34 | 18 | 16 | 2 |
| ages 14-18 | 3 | 1 | 2 | 1 | 0 |
| ages 19-25 | 3 | 0 | 1 | 1 | 0 |
| ages 26-35 | 4 | 2 | 3 | 3 | 1 |
| ages 36-45 | 24 | 6 | 7 | 3 | 1 |
| ages 46-55 | 21 | 16 | 1 | 5 | 0 |
| ages over 55 | 12 | 9 | 3 | 4 | 0 |

It is interesting that women are more concerned than men about the possible harm to health that the construction of a waste incineration complex can bring. In general, this problem is leading among the female population, and with age it becomes even more aggravated. Male respondents also show a similar trend regarding rising health concerns. However, contrary to expectations, men were much more sensitive to the expectation of an unpleasant odor than women, and at a young age this fear is even more significant than all others. Female respondents, in contrast, pay more attention to aesthetics and the possible appearance of pests than men.

To understand the presence of relationships between the analyzed data, data analysis was carried out using a correlation search (Table 3).

Table 3. Correlation matrix

| | | Male | | | | | | Female | | | | | | |
|--------|--------|--------|-------|-------|-------|-------|--------|--------|-------|-------|-------|-------|--------|--|
| | | 14-18 | 19-25 | 26-35 | 36-45 | 46-55 | over 5 | 14-18 | 19-25 | 26-35 | 36-45 | 46-55 | over 5 | |
| Male | 14-18 | 1,000 | | | | | | | | | | | | |
| | 19-25 | 0,732 | 1,000 | | | | | | | | | | | |
| | 26-35 | 0,565 | 0,717 | 1,000 | | | | | | | | | | |
| | 36-45 | 0,561 | 0,681 | 0,991 | 1,000 | | | | | | | | | |
| | 46-55 | 0,634 | 0,736 | 0,992 | 0,995 | 1,000 | | | | | | | | |
| | over 5 | 0,469 | 0,843 | 0,923 | 0,910 | 0,913 | 1,000 | | | | | | | |
| Female | 14-18 | -0,179 | 0,367 | 0,668 | 0,666 | 0,611 | 0,777 | 1,000 | | | | | | |
| | 19-25 | -0,333 | 0,000 | 0,565 | 0,588 | 0,508 | 0,535 | 0,895 | 1,000 | | | | | |
| | 26-35 | -0,358 | 0,157 | 0,546 | 0,511 | 0,453 | 0,590 | 0,923 | 0,895 | 1,000 | | | | |
| | 36-45 | 0,045 | 0,333 | 0,804 | 0,840 | 0,782 | 0,783 | 0,901 | 0,915 | 0,777 | 1,000 | | | |
| | 46-55 | 0,565 | 0,623 | 0,987 | 0,978 | 0,978 | 0,848 | 0,602 | 0,565 | 0,518 | 0,783 | 1,000 | | |
| | over 5 | 0,465 | 0,656 | 0,989 | 0,969 | 0,963 | 0,904 | 0,718 | 0,634 | 0,645 | 0,823 | 0,982 | 1,000 | |

Regression analysis identified 4 groups of large correlation dependencies, but to understand their mutual homogeneity, an additional cluster analysis was carried out.

Data clustering made it possible to identify 3 main relatively homogeneous groups of respondents (Figure 1).



Fig.1. Data clustering

The first cluster consisted of young men (from 14 to 25 years old), their opinion is almost identical: they are concerned about possible unpleasant odors from the operation of the complex. Otherwise, they pay little attention to other side effects.

The second cluster is more extensive and includes the remaining male respondents, as well as women over 46 years of age. The main concern of this cluster is the possible health hazards for residents. This category of respondents is much more numerous - more than 70% of all respondents and residents of the locality, respectively, since the sampling structure repeated the structure of the population. This fact dictates the need to identify this cluster as a key one, since focusing on it will allow reaching a critically important part of the population.

The third cluster is women under 45 years old. Their opinion is generally very heterogeneous, but among the main concerns are the violation of order and aesthetics, as well as the appearance of insects and pests.

In total, the entire set of respondents made it possible to rank the main concerns of the population, highlighting concerns related to harm to health and those associated with unpleasant odors in the first two places (Figure 2).

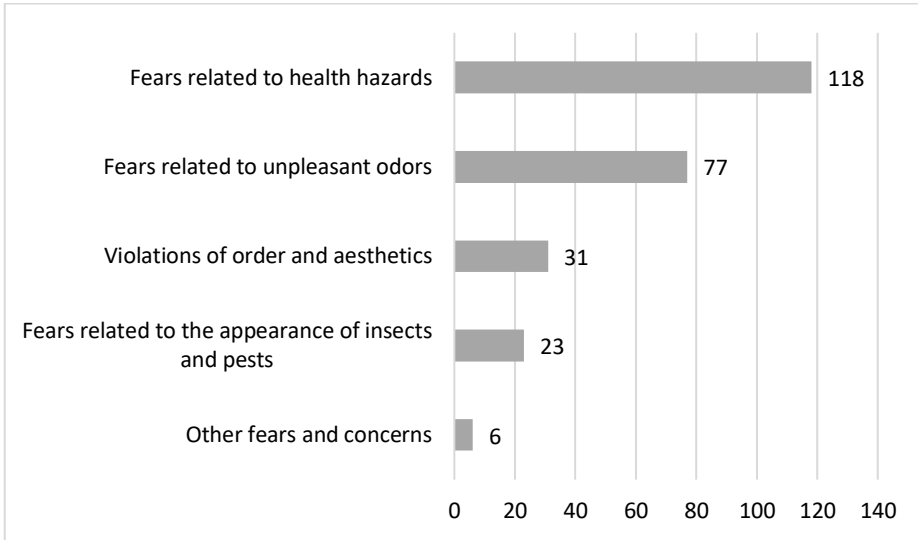


Fig.2. General concerns of the population about the waste incineration complex

The associative series consisted of more than 50 words, the most popular of which were:

- Garbage – 52%;
- Dirt – 49%;
- Stink – 46%;
- Clutter – 34%;
- Ecology (in a negative sense – deterioration of the environmental situation) – 29%;
- Violations – 14%;
- Inspections – 8%.

Sources of knowledge about the topic under discussion were collected in a similar way to an associative series, and then ranked:

- Internet: social networks and media (VK, OK, YouTube) – 83%;
- Internet: news feeds, pop-up banners – 47%;
- TV – 46%;
- Printed press (the local newspaper duplicates information on its Internet page) – 24%;
- “Word of mouth” - 19%;
- Internet: specialized publics – 8%;
- Internet: official websites of government agencies, legal reference systems – 2%.

Remarkable that the leading source by a significant margin, social networks and media, is not used for conscious information search. Most often, the information gleaned from these sources is randomly obtained as a result of surfing or recommended by an AI system. If respondents have a conscious need to obtain relevant information, most often they turn to specialized public pages or official websites of government agencies, as well as legal reference systems. Taking into account the fact that these sources were indicated by only 8 and 2 percent of respondents, respectively, it can be said that respondents receive most of the information unconsciously. From this we can conclude that it is possible to form the opinion of the population even before the need for public examination of the project for the construction of a waste incineration complex arises. And the most optimal resources for this are social networks and media.

4 Discussion

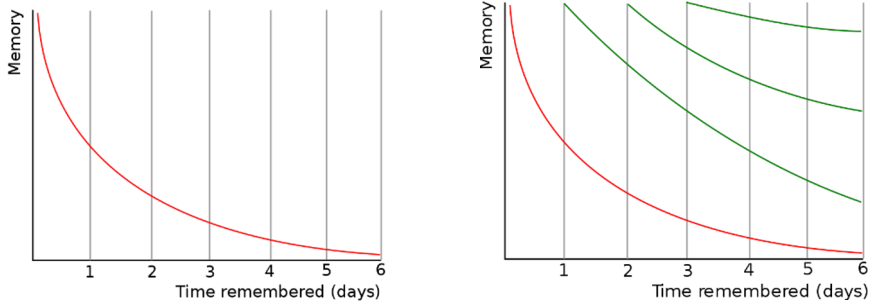
The dynamically growing capabilities of recommendation systems based on artificial intelligence technologies, as well as the settings of targeted displays of information on social networks and media, provide enormous opportunities for both neutral information about the problems of overcrowded landfills and the need to find alternative ways of waste disposal, and for the formation of a favorable opinion among residents. This will serve as a good basis for the moment when public examination can become a serious obstacle to the construction of a waste incineration complex.

History shows many examples when developed projects that had financial support and objective need, confirmed by local regional or municipal authorities, and were already at the stage of initial implementation, did not pass public examination and were not implemented or required serious reworking or relocation of the location. For example, the Lipetsk District Eco-Technopark project received a negative public assessment in May 2023. The local population supported a different approach to solving the garbage problem - separate collection and minimization of waste generation, as well as the placement of MSW management facilities in other places that, in their opinion, were more suitable due to hydrogeological conditions. Similarly, the implementation of the project for the construction of a waste processing plant with high-temperature processing of solid household waste in the city of Troitsk, Moscow region, was stopped. The City Duma, taking into account public opinion and the submitted conclusion of the public environmental assessment, canceled the construction permit.

It is proposed to use the VK social network platform to promote educational information about the problem and possible ways to solve it. To set up targeted inclusion in the target audience's recommendation feeds must be used:

- Hashtags;
- Geolocation markers;
- Influencers;
- Advertising.

Marketers identify two global mechanisms for remembering advertising information. Explicit memory, which refers to information we are aware of (the facts and events we can consciously access), and implicit memory, which refers to information we're not consciously aware of (it's stored in our brain and can affect behavior, but we can't recall it) [2]. Unconscious associations create a more stable opinion, but they require long-term exposure, which is extremely difficult to achieve in planning conditions. At the same time, short-term memory decomposes memories catastrophically quickly. Fundamental research shows that the very next day, half of the subjects completely forget information accidentally received the day before, if it was not received by them consciously and systematized [5].



A representation of the forgetting curve showing retained information halving after each day

Forgetting Curve with Spaced Repetition

Fig.3. Forgetting curve

The Ebbinghaus forgetting curve (Figure 3) shows that to maintain the required level of awareness, a reminder is needed every 3 days, otherwise previous efforts are reduced to the level of critical forgetting [17].

5 Conclusion

To summarize, when planning the placement of a waste incineration complex, it is necessary to include a preliminary period for the formation of appropriate public opinion. In the case studied by the authors, the target audience is men over 26 years old and women 46 and older. The main concerns of the target audience were the expectation of harm to public health from the project. The main channels of communication for the target audience are social networks and media, in which, in addition to contextual information, it is also necessary to attract influencers from among trusted individuals. Repetition of information should be at least once every three days. A significant limitation of the study is the nature of the case, that is, the obtained static data cannot be replicated to similar cases. However, the methodology developed during the study can be used.

References

1. Bartl, A. (2011) Textile Waste. A Handbook of Management (ed. T.M. Letcher, D.A. Vallero), chapter 12, pp.167-179. <https://doi.org/10.1016/B978-0-12-381475-3.10012-9>
2. Brandt, D. (2017) Understanding Memory in Advertising. Nielsen Journal of Measurement, February 2017. URL: <https://www.nielsen.com/insights/2017/understanding-memory-in-advertising/>
3. Selinger, A., Schmidt, V. (1997) The Abb Dry Ash Concept: Inrec. Studies in Environmental Science, vol.71, pp.79-84. [https://doi.org/10.1016/S0166-1116\(97\)80192-6](https://doi.org/10.1016/S0166-1116(97)80192-6)

4. Burtseva, T., Ganebnykh, E., Mironova, N., Feoktistova, O. (2019) Quality assessment of urban environment, E3S Web Conf., 110, 01077. <https://doi.org/10.1051/e3sconf/201911001077>
5. Ganebnykh, E., Burtseva, T., Petuhova, A., Mottaeva, A. (2019) Regional environmental safety assessment, E3S Web Conf., 91, 08035. <https://doi.org/10.1051/e3sconf/20199108035>
6. Ganebnykh, E., Igoshina, Yu., Pryadko, I. (2023) Channels for Perception of Ecological Situation by Youth, XV International Scientific Conference "INTERAGROMASH 2022". INTERAGROMASH 2022. Lecture Notes in Networks and Systems, Springer, vol 575, p.107-115. https://doi.org/10.1007/978-3-031-21219-2_10
7. V. Reutov, V.Varzin et al., Smart city development in the context of sustainable development and environmental solutions, E3S Web of Conferences 402, 09020 (2023) <https://doi.org/10.1051/e3sconf/202340209020>
8. O. Epkhiev et al., Factors of the "green" construction development from the point of view of different stakeholder, E3S Web of Conferences 402, 07031 (2023) <https://doi.org/10.1051/e3sconf/202340207031>
9. E. Petrova et al., Strategic diagnostics of the organization's development in modern conditions, E3S Web of Conferences 402, 08043 (2023) <https://doi.org/10.1051/e3sconf/202340208043>
10. N. Nikonova The role of green marketing in regional Sustainability E3S Web of Conferences 402, 08042 (2023) <https://doi.org/10.1051/e3sconf/202340208042>
11. Yan, J., Salman Ch.A. (2023) Waste-to-Energy (WtE): Current technologies and their future potential. Waste Biorefineries: Advanced Design Concepts for Integrated Waste-to-Energy Processes, pp.25-61. <https://doi.org/10.1016/B978-0-323-91761-2.00005-2>
12. Reis, M.F. (2011) Solid Waste Incineration: Health Impact. Encyclopedia of Environmental Health, pp. 162-217. <https://doi.org/10.1016/B978-0-444-52272-6.00489-X>
13. Tait, R.W. et al. (2019) The Health Impacts of Waste Incineration: a systematic review. Public Health, vol. 44(1), pp.40-48. <https://doi.org/10.1111/1753-6405.12939>
14. Domingo, J.L. (2020) Adverse health effects for populations living near waste incinerators with special attention to hazardous waste incinerators. A review of the scientific literature. Environmental Research, vol. 187, 109631. <https://doi.org/10.1016/j.envres.2020.109631>
15. Khammaneechan, P. et al. (2011) Community concerns about a healthcare-waste incinerator. Journal of Risk Research, vol. 14(7), pp. 847-858. <https://doi.org/10.1080/13669877.2011.571779>
16. Huang, Y. et al. (2022) Perceptual differences in the factors of local acceptance of waste incineration plant. Frontiers in Psychology, vol. 13, pp. 1-14. <https://doi.org/10.3389/fpsyg.2022.1067886>
17. Ebbinghaus, H. (1915) Memory: A Contribution to Experimental Psychology. New York: Columbia University.