Subjectivity Analysis of Underground Incinerators: Focus on Academic and Industry Experts

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Abstract: Recently, incinerators have been shifted to underground complexes because of concerns regarding environmental pollution and declining land prices. In Korea, an underground waste incinerator has been built for the first time, with additional construction being expected in the near future. Therefore, a perception survey was conducted to acquire responses from South Korean experts regarding the impact of underground complex incinerators. The Q-methodology was used in the survey to examine various viewpoints. Academicians showed concerns regarding environmental effects of ground incinerators, and environmental and economic effects of underground complex incinerators; conversely, industrialists were concerned about civil complaints and administrative processing, indicating that the academicians were more concerned about scientific issues, whereas the industrialists were more concerned about democratic issues. Furthermore, both groups expressed concerns regarding land value and civil complaints of ground incinerators, safety issues and resultant social distrust of underground incinerators. The findings suggest that, to address the safety issues involving underground incinerator construction, governance by local experts is required for a holistic evaluation of environmental issues and economic feasibility of underground incinerators. To establish a link between science and democracy, measures for transparently sharing information are necessary.

Keywords: underground incinerator; ground incinerator; science and democracy; information sharing transparency; Q-methodology

1. Introduction

Incinerator construction can have significant negative effects, such as environmental pollution and low land values [1,2]. Therefore, such constructions are still opposed by many local communities. However, incinerators are necessary waste treatment and disposal facilities. Accordingly, to increase the acceptability of incinerators by local communities, sewage treatment plants [3,4] have been built underground using new technologies. Meanwhile, parks, shops, and convenience facilities have been constructed above the incinerators for residents; additionally, measures to increase the incinerator efficiency by linking food waste and sewage treatment have been suggested [5]. The Hanam Union Park in Korea is the world’s first underground sewage and waste treatment facility, which also supplies heating and cooling utilities. In addition, the Ministry of Land, Infrastructure, and Transport of Korea has proposed the construction of additional underground complex incinerators.

Underground incinerators are highly practical facilities for local community stakeholders to participate in installing and operating because any change in incinerator operation can exert immediate and long-term effects on local communities [6]. Despite multiple studies on stakeholder engagement [7,8], process [9,10], policy reflection [11], and post-monitoring [12] regarding the installation of ground incinerators, studies on community interest in underground and complex incinerators are limited.
Underground incinerators differ from the existing ground incinerators, serving as waste treatment facilities underground and facilitating the creation of green spaces and convenience facilities aboveground for residents. Therefore, analyzing and comparing interest in underground and ground incinerators is necessary. Previous studies have assessed the interest in ground incinerators and resident participation processes; however, similar studies on underground incinerators are lacking. Therefore, it is necessary to discuss how the interest in underground incinerators differs from that in ground incinerators and assess alternatives that can be implemented. Furthermore, estimating the relationship among high acceptability by communities, more green spaces, and convenience facilities on the ground, as well as other potential issues, is essential.

Before the construction of underground incinerators, concerns regarding their effects on local communities and alternatives should be identified. This process can reduce misperceptions and conflicts by providing appropriate information to local communities [13]. Therefore, in this study, we conducted a survey to examine the perceptions of experts regarding underground incinerators via an objective evaluation of the incinerators. Perceptions of various experts from academia with prior knowledge of incinerator operation, along with industrialists, environmental scientists, and engineers, were considered. Furthermore, we determined the types of approach needed to increase community acceptance of underground incinerators.

The Ministry of Land, Infrastructure, and Transport has commissioned projects to shift incinerators into underground complex facilities. Various pretests are being conducted to study the potential impact of these constructions on the environment and land value. Based on the results of such pretests, the Ministry is delivering the relevant results to local government organizations that will undertake the projects and is attempting to conduct the relevant compensation projects through negotiations. In this study, South Korean incinerator experts were surveyed to acquire their perceptions on the difference between the existing and underground incinerators' impact on the local community. Local government, legislators, and the public can only express their preferences and decisions when they are provided with accurate and consistent information from experts. Therefore, discussions among experts regarding the impacts of underground incinerators are necessary. The Q-methodology used in the survey ensured that the viewpoints of the minority as well as the majority population could be studied. Through this methodology, expert perceptions of the effects of underground incinerators on local communities were obtained. Furthermore, we attempted to outline suggestions to provide consistent information to local residents and the general public in the future.

2. Materials and Methods

We employed the Q-methodology to estimate the perceptions of experts (academicians, industrialists, environmental ecologists, and engineers) on underground incinerators. This methodology can be used to analyze the subjectivity of individuals. It has the advantage of comparing different perceptions of stakeholders and identifying both majority and minority perceptions [14]. The Q methodology derives statements from a literature review and interview as qualitative approaches, and then goes through the process of deriving quantitative results using a structured questionnaire called Q sorting. It has the advantage of being able to examine the research subject in depth qualitatively and objectify the results quantitatively [15]. In addition, Q-methodology is effective for studies with a small sample size, such as a group of experts, because it can quantitatively analyze statements rather than people and thus can be conducted with only one person [16]. We also used Q-methodology to present alternatives by considering the minority and majority perceptions of experts regarding the construction of underground incinerators.

To confirm the difference in interest between existing ground and underground incinerators, a perception survey was conducted using Q-methodology for the most critical issues for the two incinerator types. This methodology enabled Q sorting twice for each type (Figure 1).
2.1. Statement Setting

In this study, the relevant issues were established as Q statements based on the process of Q-methodology, and a Q sorting survey was distributed to experts for analysis. The statement setting was constructed purely by referencing the literature, as it was difficult to interview stakeholders of underground complex incinerators.

Literature on the environmental, social, economic sustainability [17,18] and safety aspects [19] of underground complex incinerators was examined. Incinerators are potentially detrimental to the environment and human health because they pollute the nearby environment [6,11]. In particular, odors from toxic gas and leachates are problematic, since they may cause secondary problems to the local ecology, as well as landscape and health complications for the local residents [20,21]. Nonetheless, convenience centers can be constructed aboveground to increase the land-use efficiency of underground incinerators. By converting exhaust gas into energy through thermochemical and biological processes, shifting incinerators to complex facilities may increase resource circulation efficiency and energy intensity [22,23]. Therefore, statements regarding gas odor, aquatic environment, ecology, landscape, convenience centers, land use, energy consumption, and energy generation were included in the survey.

From a social perspective, the residents and local governments may oppose the construction of underground incinerators because of concerns regarding environmental damage. The views of the residents are expressed through public hearings or civil complaints [8]. Local government can complicate administrative procedures which hinders the establishment of incinerators. After the installation of incinerators, residents independently monitor the environment [12]. Therefore, regarding the social aspect, the administrative process, resident participation, civil complaints, and monitoring uncertainty factors were included as statements in the survey.

From an economic perspective, local incinerators incur waste treatment and maintenance costs, and underground complex incinerators require additional costs for employing experts [5]. The surrounding land prices are likely to be affected, and disputes concerning compensation may occur [24]. Therefore, from the economic perspective, treatment, maintenance, employment costs, land price, and compensation were included as statements in the survey.

Furthermore, this study examined the safety issues of underground incinerators [25]. Incinerators can threaten human life and health, and underground incinerators as complex facilities require additional safety inspections [26]. Therefore, regarding the safety aspect, statements on accidents and transportation were included in the survey [27]. For operational stability, a management system is required for emergency measures and maintenance, firefighting, and evacuation [28]. To ensure facility safety, it is necessary to take measures against accidents such as gas leakages, fires, and explosions [29]. Moreover,
transportation safety precautions prevent accidents that may occur during commuting [30]. Statements concerning the environmental, social, economic, and safety aspects were included in the survey to identify the experts' perceptions on the difference between existing and underground complex incinerators (Table 1).

Table 1. Selected Q statements included in the perception survey.

| Item | Statement |
|------|-----------|
| 1    | Harmful gases and odors There are large negative effects of harmful gases and odors. |
| 2    | Aquatic environment There are substantial negative effects on the surrounding aquatic environment (e.g., leachate and groundwater). |
| 3    | Ecosystem There are large negative effects on the surrounding natural ecosystem |
| 4    | Landscape and aesthetics There are large negative effects on the landscape (chimney) and aesthetics (appearance). |
| 5    | Convenience facilities There is a low possibility of developing convenience facilities (e.g., parks, amusement parks, and complex centers). |
| 6    | Land use The efficiency of land use is low. |
| 7    | Energy production The efficiency of resource circulation is low. |
| 8    | Energy consumption There is high energy consumption (e.g., concentrated uses, and distributed arrangement). |
| 9    | Insecurity of residents There is high insecurity and distrust in the facility operation. |
| 10   | Resident participation The burden of sharing information and communicating with residents is high. |
| 11   | Civil complaints of residents The potential for civil complaints of residents is high. |
| 12   | Administrative procedures The burden of licenses and permits for business operators/local governments is high. |
| 13   | Monitoring There is a need for post-monitoring (environment and safety). |
| 14   | Treatment costs Local waste disposal costs are high. |
| 15   | Maintenance costs The maintenance cost of the facility is high. |
| 16   | Employment costs The costs of hiring professionals related to facility operation are high. |
| 17   | Land value There are substantial negative effects on the surrounding land value and the local economy. |
| 18   | Compensation The scope of damage compensation is wide. |
| 19   | Operational stability There is an issue of facility operational stability (e.g., failure and maintenance). |
| 20   | Facility safety There is an issue of industrial accident risk (e.g., collapse, and fire). |
| 21   | Transportation safety There are high transportation safety risks due to construction and transport vehicles. |

2.2. Expert Identification and Q Sorting

Fifteen experts on incinerator construction in South Korea from academia (policy experts) and industry (technical experts) were identified. These were waste-related scholars, managers of business entities, environmental ecologists, and related facility experts (see Table 2).

Table 2. Distribution of the P sample (participating stakeholders).

| Division | Academia (Policy Experts) | Industry (Technical Experts) |
|----------|---------------------------|-----------------------------|
|          | Researchers | Professors | Business Entities | Government Officers |
| Number of participants | 8          | 3          | 3                 | 1                    |

According to the experts, Q sorting was performed for two assumptions (i.e., ground and underground incinerators). For each case, the statements with high agreement (concerns) were assigned a point of +4 and the statements with high disagreement (low impact) were assigned a point of −4 to create a Q sheet. The participants were encouraged to participate in Q sorting using Q software (Figure 2).
Finally, Q factor analysis was performed on the two Q sorting surveys using SPSS 22.0. To interpret the factor analysis results, we referred to the subjective responses of the participants corresponding to each factor.

3. Results
3.1. Factor Analysis

Q factor analysis led to the extraction of two factors with an eigenvalue of 1 or higher (Table 3). Factor 1 comprised of academicians, including researchers, professors, and government officers, whereas Factor 2 comprised of managers of business entities (industries). Accordingly, Factor 1 was named Academia and Factor 2 was named Industry (Table 4).

![Figure 2. Q sorting.](image-url)

Table 3. Explained total variance for each factor.

| Component   | Total | % of Variance | Cumulative % | Initial Eigenvalue | Total | % of Variance | Cumulative % | Extracted Sum of Squares Loading | Total | % of Variance | Cumulative % | Rotation Sum-of-Squares Loading | Total | % of Variance | Cumulative % |
|-------------|-------|---------------|--------------|-------------------|-------|---------------|--------------|----------------------------------|-------|---------------|--------------|----------------------------------|-------|---------------|--------------|
| 1           | 6.167 | 41.115        |              | 41.115            | 6.167 | 41.115        |              | 4.874                            | 32.493|               |              | 32.493                          |
| 2           | 1.623 | 10.822        |              | 51.937            | 1.623 | 10.822        |              | 2.917                            | 19.444|               |              | 51.937                          |

Extraction method: Principal component analysis.

Table 4. Component matrix.

| Division                  | Components | 1 (Academia) | 2 (Industry) |
|---------------------------|-----------|--------------|--------------|
| Researcher-energy         |           | 0.803        | 0.394        |
| Professor-landscape       |           | 0.790        | −0.111       |
| Researcher-conservation   |           | 0.790        | −0.151       |
| Researcher-odor           |           | 0.775        | −0.147       |
| Researcher-ecology        |           | 0.763        | 0.140        |
| Government officer        |           | 0.728        | −0.353       |
| Researcher-safety         |           | 0.661        | −0.291       |
| Researcher-public participation | | 0.660       | 0.133       |
| Professor-urban planning  |           | 0.648        | −0.372       |
| Professor-soil            |           | 0.546        | 0.150        |
| Researcher-housing        |           | 0.544        | −0.274       |
| Researcher-ecology        |           | 0.464        | 0.295        |
| Industry-engineering     |           | 0.286        | 0.745        |
| Industry-engineering     |           | 0.428        | 0.534        |

Extraction method: Principal component analysis.
3.2. Factor 1 (Academia)

Factor 1 (Academia) considered that ground incinerators had a large negative effect on the environment due to the release of harmful gases and odors, and triggered social burdens, such as civil complaints, licenses, and permits (Table 5). A researcher belonging to this factor stated the following while expressing environmental and social concerns about ground incinerators:

“The creation of new waste facilities will face more opposition from residents than that in the past, and as a result, administrative and compensation costs will increase. It will cause more damages, such as exposure to harmful gases and odors, negative landscapes, and lower land values, to the socially vulnerable.”

Conversely, we assessed that underground incinerators carried economic burdens, such as maintenance and employment costs, as well as the social burden of post-monitoring. One professor belonging to this factor stated the following, highlighting the increased efforts needed for maintenance:

“The (underground complex incinerator) plan seemed to have the least (environmental and social problems on the ground due to underground incinerators) problems, but it requires a higher level of technology as high-use facilities are located in one space, resulting in higher installation and maintenance costs.”

Table 5. Main statements of Factor 1 (Academia).

| No. | Area                      | Ground Incinerator Statements                                      | Factor Score | No. | Area                      | Underground Incinerator Statements                           | Factor Score |
|-----|---------------------------|-------------------------------------------------------------------|--------------|-----|---------------------------|----------------------------------------------------------------|--------------|
| 1   | Environment-Harmful gases and odors | There are substantial negative effects of harmful gases and odors. The potential for civil complaints of residents is high. | 4 (Very Strongly Agree) | 15  | Economy-Maintenance costs | The maintenance cost of the facility is high. | 4 (Very Strongly Agree) |
| 11  | Society-Civil complaints of resident | The burden of licenses and permits for business operators/local governments is high. | 3 (Strongly Agree) | 16  | Economy-Employment costs  | The cost of hiring professionals related to facility operation is high. | 3 (Strongly Agree) |
| 12  | Society-Administrative procedures | There are substantial negative effects of harmful gases and odors. The potential for civil complaints of residents is high. | 3 (Strongly Agree) | 13  | Society-Monitoring | There is a great need for post-monitoring (environment and safety) functions. | 3 (Strongly Agree) |

3.3. Factor 2 (Industry)

Factor 2 (Industry) was concerned about possible civil complaints about ground and underground incinerators, highlighting the need for monitoring of incinerators and addressing social aspects (Table 6). There were concerns regarding the economic aspect of land value after ground incinerator construction and the social aspect of distrust for underground incinerators. An industry employee stated:

“As for ground incinerators, we can find all problems on the ground and underground. In fact, there are odors generated from the transfer of food waste by waste transport vehicles (e.g., nighttime movement),”

emphasizing the negative social effects associated with environmental problems of ground incinerators. Furthermore, regarding underground incinerators, the employee stated:

“Underground construction of incinerators has the least effect on land use and residents, but the biggest problems are the stability of underground facilities, and the distrust in the facility operation.”

thus emphasizing the significant negative effects on society (e.g., social distrust), rather than environmental problems.
Table 6. Main statements of Factor 2 (Industry).

| No. | Area                                | Ground Incinerator Statements                                                                 | Factor Score | No. | Area                                | Underground Incinerator Statements                            | Factor Score |
|-----|-------------------------------------|---------------------------------------------------------------------------------------------|--------------|-----|-------------------------------------|----------------------------------------------------------------|--------------|
| 11  | Society-Civil complaints from residents  | The potential for civil complaints of residents is high. There are substantial negative effects on the surrounding land value and the local economy. | 4 (Very Strongly Agree) | 11  | Society-Civil complaints of residents | The potential for civil complaints of residents is high. | 4 (Very Strongly Agree) |
| 17  | Economy-Land value                  | There is a great need for post-monitoring (environment and safety) functions.              | 3 (Strongly Agree) | 13  | Society-Monitoring                  | There is an urgent need for post-monitoring (environment and safety) functions. | 3 (Strongly Agree) |
| 13  | Society-Monitoring                  | There is high insecurity and distrust in the facility operation.                            | 3 (Strongly Agree) | 9   | Society-Insecurity of residents     | There is high insecurity and distrust in the facility operation. | 3 (Strongly Agree) |

3.4. Statements with Large Differences

After confirming the distinguishing statements (Tables 7 and 8), which showed a gap in the perception between the two factors, ground incinerators showed a large variance in environmental aspects. Researchers expressed concerns about environmental effects (e.g., harmful gases and odors, and the aquatic environment), whereas practitioners did not. Regarding underground incinerators, researchers were concerned about the environmental effects (e.g., the aquatic environment), whereas practitioners expressed concerns about the social effects (e.g., civil complaints and information sharing). This indicated that it is necessary to accurately investigate the environmental effects and contributors of social effects in order to prepare suitable alternatives.

Table 7. Distinguishing statements regarding ground incinerators.

| No. | Area                        | Statements Regarding Ground Incinerators                                                                 | Factor 1                     | Factor 2                     | Variance |
|-----|-----------------------------|---------------------------------------------------------------------------------------------------------|------------------------------|------------------------------|----------|
| 1   | Environment-Harmful gases and odors | There are substantial negative effects of harmful gases and odors. There are substantial negative effects on the surrounding aquatic environment (e.g., leachate, and groundwater). | 4 (Very Strongly Agree)     | −2 (Disagree)                | 18       |
| 2   | Environment-Aquatic environment | There are substantial negative effects on the surrounding aquatic environment (e.g., leachate, and groundwater). | 2 (Agree)                   | −4 (Very Strongly Disagree)  | 18       |

Table 8. Distinguishing statements on underground incinerators.

| No. | Area                        | Statements Regarding Underground Incinerators                                                                 | Factor 1                     | Factor 2                     | Variance |
|-----|-----------------------------|-------------------------------------------------------------------------------------------------------------|------------------------------|------------------------------|----------|
| 11  | Society-Civil complaints of residents | The potential for civil complaints of the residents is high. There are substantial negative effects on the surrounding aquatic environment (e.g., leachate and groundwater). | −3 (Strongly Disagree)     | 4 (Very Strongly Agree)     | 24.5     |
| 2   | Environment-Aquatic environment | The burden of sharing information and communicating with residents is high.                                | 2 (Agree)                   | −3 (Strongly Disagree)      | 12.5     |
| 10  | Society-Resident participation | There is a great need for post-monitoring (environment and safety) functions.                            | −2 (Disagree)               | 2 (Agree)                   | 8        |

3.5. Common Statements

Common statements between the two factors included concerns about the negative effects of ground incinerators on the economic aspect (i.e., land value) and social aspect (i.e., civil complaints) (Table 9). One researcher stated:

“Because it is still built on the ground, civil complaints of residents, adverse effects on the local economy, and the resultant difficulties in licenses and permits are expected.”
Table 9. Consensus statements regarding ground incinerators.

| No. | Area                  | Statement                                                                 | Factor 1                  | Factor 2                  | Mean | Variance |
|-----|-----------------------|---------------------------------------------------------------------------|---------------------------|----------------------------|------|----------|
| 17  | Economy-Land value    | There are substantial negative effects on the surrounding land value and the local economy. | 1 (More or Less Agree)    | 3 (Strongly Agree)         | 2    | 2        |
| 11  | Society-Civil complaints of residents | The potential for civil complaints of residents is high. | 3 (Strongly Agree)        | 4 (Very Strongly Agree)    | 3.5  | 0.5      |

Regarding underground incinerators, both factors indicated higher insecurity and distrust regarding post-monitoring, safety, and operation (Table 10). A researcher belonging to Factor 1 stated:

“As a large-scale facility is designed underground, the safety and stability risks and maintenance costs are expected to be high. Accordingly, post-monitoring is essential.”

An industry employee also stated:

“Because it is built underground, it is assumed that there will be a substantial problem in terms of stable facility operation, due to the complexity of the facility, rather than on the ground.”

Table 10. Consensus statements on underground incinerators.

| No. | Area                  | Statement                                                                 | Factor 1                  | Factor 2                  | Mean | Variance |
|-----|-----------------------|---------------------------------------------------------------------------|---------------------------|----------------------------|------|----------|
| 13  | Society-Monitoring    | There is a great need for post-monitoring (environment and safety) functions. | 3 (Strongly Agree)        | 3 (Strongly Agree)         | 3    | 0        |
| 19  | Safety-Operational safety | There is an issue of facility operational stability (e.g., failure, maintenance, etc.). | 1 (More or Less Agree)    | 2 (Agree)                 | 1.5  | 0.5      |
| 9   | Society-Insecurity of residents | There is high insecurity and distrust in the facility operation. | 1 (More or Less Agree)    | 3 (Strongly Agree)         | 2    | 2        |

4. Discussion

As waste management involves public goods and relates to public health and environmental protection issues, problems should be defined and resolved through governance [24], which encompasses a wide range of actors such as local residents, local government, environmental groups, and business entities [31]. To this end, accurate and fair information should be provided to all. As there are few cases of complex underground waste management, more objective and detailed information and scenarios should be shared. It is thus necessary to present the organized perceptions of experts. Therefore, we attempted to obtain the perception of academicians and industrialists using the Q-methodology.

Our findings indicated that the academics (Factor 1) were concerned about the environmental effects (e.g., harmful gas and odors, aquatic environment) of ground incinerators, but expressed concerns about both environmental and economic aspects (e.g., maintenance and employment) of underground incinerators (Figure 3). Accordingly, the industrialists (Factor 2) were mainly concerned with social aspects that were consistent with the environmental and economic aspects, as civil complaints and administrative processing exist regarding both environmental and economic issues. Thus, the results indicate that both factors had common concerns. Industrialists believed that the environmental and economic concerns expressed by academicians can be resolved through technological measures [5]. Academicians were more concerned about the scientific aspects of incinerators, such as the environment and the economy, whereas industrialists were more concerned about democratic realms, such as civil complaints and administrative processing. In principle, academia takes an interest in the impacts on the surrounding environment; however, civil complaints and complicated administrative processes may be of greater concern for industry. Information regarding underground complex incinerator construction belongs to the scientific realm; however, the decision-making is a democratic process [32]. There is
a risk of wrong decisions being taken when the information provided is not scientific [10]. Additionally, unsound decisions can cause several undesirable consequences despite the provision of accurate information [1]. Therefore, incinerator construction requires the combination of scientific information provision and a democratic process. Thus, accurate investigation and evaluation of environmental damage and safety [6,12], sharing of information through a credible institution [7,11], and participation of experts and scientists, via local governance, in the process [9,33] are required to narrow the perception gaps between these two factors.

Figure 3. Perceptions of ground and underground incinerators. (Line thickness is expressed as the sum of positive values).
Regarding the common points recognized by the two factors, both emphasized economic (land value) and social (civil complaints) issues regarding ground incinerators and post-monitoring issues due to distrust in the safety of underground incinerators. Therefore, while recognizing such issues and considering local conditions, selecting the best alternative is necessary (Table 11). We confirmed that underground complex incinerators can cause distrust due to safety issues. A long-term [10] and strengthened post-monitoring process should be followed for easy community acceptance [12]. These results showed that the difference in perception between ground incinerators and underground complex incinerators concerned safety issues [27], and that monitoring should be strengthened to resolve the resultant distrust issue. Furthermore, both incinerators should be constructed based on accurate investigation, evaluation, and information sharing. Overall, we confirmed that safety and anxiety issues were associated more with underground complex incinerators than with ground incinerators; experts also indicated that it was necessary to objectively inform effect relationships via more accurate information about the aquatic environment, maintenance costs, and civil complaints.

Table 11. Academician and industrialist perceptions of ground and underground incinerators.

| Category              | Differences                                      | Similarities                                      |
|-----------------------|--------------------------------------------------|--------------------------------------------------|
|                       | Academia                                         | Industry                                         |
| Ground incinerator    | Environmental (toxic gas and odor and water      | Concerns over economic (land price) and social   |
|                       | environment) concerns                           | (civil complaints) aspects                        |
| Underground incinerator| Environmental (water environment) and economic   | Concerns over stability and social aspects        |
|                       | (maintenance, employment) concerns              | (distrust, monitoring)                           |

Using the Q-methodology in this study, we attempted to confirm the issues of perception among stakeholders qualitatively, and show differences among experts quantitively. Experts identified the parts to be clarified to maintain consistency in the provision of information to the general public in order to build local governance [7]. Furthermore, the results showed that the management of underground incinerators requires information sharing regarding the environment, safe technologies, and economy while resolving issues such as civil complaints and administrative processing through concise steps [33]. The results were difficult to generalize because of limitations with the Q methodology used in this study. Only 15 Korean experts were targeted, and more researchers should be involved to obtain professional perceptions to a greater extent. Nevertheless, considering that the crucial part of governance is validated information to reduce the discrepancies between the experts regarding the incinerators, objective information on the identified common perceptions should be provided to the public by confirming the differences in perception among experts. There should be a foundation to conduct a more sophisticated investigation of unresolved areas. Another limitation is that the participation of legislators from the local government and the National Assembly was restricted because a specific site has not been selected. Future research must address how different stakeholders (experts, local governments, legislators, and environmental organizations) view specific sites for underground incinerators and find alternatives by consolidating different opinions.

5. Conclusions

Accurate investigation and assessment of underground complex incinerators are necessary because their potential impacts on a region differ from those of existing ground incinerators. In this study, the Q-methodology was used to study, compare, and analyze various expert perceptions on the impact of ground and underground incinerators. Consequently, a contrast in perception between academia and industry was observed. The academics were concerned with environmental pollution from ground incinerators and
safety and environmental issues from underground incinerators. However, the industrialists were concerned with civil complaints and administrative processing. This indicated that the academicians were more concerned about the scientific realms of incinerators, whereas the industrialists expressed more concerns about the democratic realms.

As science and democracy are two essential entities in incinerator construction, a plan to link these two is essential. Therefore, through governance with the participation of local scientists, experts, and local communities, accurate investigation and assessment of environmental and safety issues must be provided. When shared properly, the results may help reduce the gap in perception between academia and industry, which could help to improve the consistency of information delivered to local governments, relevant policymakers, and the public, which may reduce civil complaints and administrative issues. Meanwhile, this implies that issues such as civil complaints and administrative processing can be resolved with accurate investigation and evaluation of environmental and safety issues via governance involving local scientists, experts, and local communities, and sharing of information. In addition, considering that both groups showed consensus on the effects of ground incinerators on land value and civil complaints, and the effects of underground incinerators on safety, distrust, and the need for post-monitoring, local governments should consider these aspects when selecting the incinerator type.

This study confirmed that there were differences in perceptions among experts regarding incinerators, which require an accurate impact assessment. Considering that environmental effects and safety issues should be identified accurately, the resultant information should be transparently shared and subsequently, a process that can determine the types and locations of incinerators should be created. Although this study only focused on cases in South Korea, this methodology can also be applied to other countries. In the future, we expect increased studies that focus on detailed processes, including environmental and safety investigations, information sharing, and public discussions of facilities such as incinerators.

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