



A Study on the Odor Management of Traditional Markets in the Old and New Towns

Yeon-Kyo KOO¹, Ji-Min YOUN², Jae-Yeon JO³, Woo-Taeg KWON⁴

1. First Author Researcher, Department of Environmental Health & Safety, Eulji University, Korea, Email: jkyk9999@naver.com
2. Second Author Researcher, Department of Environmental Health & Safety, Eulji University, Korea, Email: yy9373@naver.com
3. Third Author Researcher, Department of Environmental Health & Safety, Eulji University, Korea, Email: jayeontree@naver.com
4. Corresponding Author Professor, Department of Environmental Health & Safety, Eulji University, Korea, Email: awtkw@eulji.ac.kr

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Abstract

Purpose: Odor generated in traditional markets causes discomfort, hindering the pleasant life of residents, and complaints of odors are steadily increasing every year. Odor is defined as a smell that stimulates a person's sense of smell by stimulating hydrogen sulfide, mercaptans, amines, and other irritating gaseous substances. **Research design, data and methodology:** It is not easy to grasp and manage the current status of the odor analysis of living odors such as traditional markets. Seongnam City has an advanced new town of Bundang and Pangyo, while old cities such as Sujeong-gu are relatively underdeveloped. **Results:** As a result, the gap between the old city center and the new city center widens, so it is urgent to develop a balanced development. Based on this, the market of Seongnam-si is divided into the old city center and the new city center, and the odor complaint in the traditional market is analyzed to find a solution. A survey was conducted to understand the current status of odor management in the Seongnam-si market and the odor felt by users. Moran Market, Seongnam Jungang Market, and Kumho Market and Dolphin Market, located in the new city center, were selected as targets. The items of the survey consisted of the frequency and cause of the odor, the current status of market management, matters that need improvement, and efforts to resolve the odor. **Conclusions:** Therefore, this study aims to help citizens feel better about odor environment in places where odor standards are exceeded or complaints occur frequently, and to help local governments and market merchants establish more efficient and useful development plans.

Keywords : Odor, Traditional markets, Old city, New city, Solution

JEL Classification Codes : E44, F31, F37, G15

1. Introduction

1.1. Background and Purpose of the Study

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Odor generated in traditional markets causes discomfort, hindering the pleasant lives of residents, and complaints of odors are steadily increasing every year.

Odor defines hydrogen sulfide, mercaptans, amines, and other irritating gaseous substances as odors that stimulate a person's sense of smell and cause discomfort and disgust, and is considered one of the reasons for hindering pleasant urban life (Odor Prevention Act, 2021). It is not easy to grasp and manage the current status of odors analysis on living odors such as traditional markets.

In the case of living odors, there is no legal obligation to install odor prevention facilities in household odor emission sources such as markets, restaurants, and dry cleaners, so owners avoid investing to improve facilities even if they cause inconvenience to citizens (Institute of Health and Environment, 2014).

In Korea, odors have been managed as part of the management of air emission facilities under the Air Environment Conservation Act. However, as odor-related complaints rapidly increased and the existing management system alone was limited to reflecting the odor characteristics, the odor-related matters of the Air Environment Conservation Act 2004 were independent and supplemented to enact the odor prevention law. The main purpose of the Odor Prevention Act is to designate areas with severe odors as "odor management areas" and manage complex odors and emission of designated odor substances from discharge facilities in the area within the allowable standards. However, as discussed earlier, the improvement of serious non-regulated emission facilities is still insufficient, and no fundamental solution has been made. In addition, management of workplaces other than odor management areas is virtually not well carried out. Many of the odor complaints companies are located individually outside the odor management area and often adversely affect the surroundings. These companies are often excluded from technology or funding. In this case, it is possible to recommend improvement with the authority of the mayor and the head of the county, and if it does not improve, additional measures can be taken, but there is a limit to strict management because the penalty provisions are not clear.

Seongnam City has an advanced new town of Bundang and Pangyo, while old town such as Sujeong-gu is relatively underdeveloped. As a result, the gap between the old city center and the new city center widens, so it is urgent to develop a balanced development. Based on this, the market of Seongnam-si was divided into the old city center and the new city center, and the study was conducted based on the current status of complaints about the market odor located in Seongnam-si over the past five years. In the case of Moran Market located in the old city center, where the largest number of complaints occurred, complaints were filed about

the smell of oil alleys and the release of dog meat carcasses and blood, and the smell of paint inside the market was also received as the main complaint. In the case of the new city center, it was confirmed that complaints such as odors in exhaust communication of underground restaurants and odors in underground stores were continuously received in elephant shopping centers. Focusing on these complaints, I would like to present the difference in the odor concentration between the market that conducted the modernization project and the market that did not, the current status of complaints, and the problems and solutions.

Bundang-gu, Seongnam-si, is taking the lead in creating a hygienic traditional market through "Creating a Clean Food Restaurant," a project to improve hygiene facilities at five traditional markets and 13 food handling businesses in the district. This project provides customized consulting for each restaurant through consultants specializing in facility improvement for food handling businesses in traditional markets and supports aging facility renovation costs and sanitary equipment according to the consulting results. Dolphin Market and Kumho Happy Market were adopted for this project and received 80% of the cost of renovating facilities such as ceilings, floors, and kitchen ventilation facilities, and improved hygiene management awareness by providing food hygiene education to operators and workers. As a result of the survey of participating businesses, it was found that hygiene was very improved and satisfaction was high, and the project will continue to be promoted to revitalize the traditional market by securing hygiene and safe food for food handling businesses in the traditional market (Seongnam City Hall, 2021).

Based on the current status of odor complaints in traditional markets in Seongnam over the past five years, a survey was conducted on market merchants and users of Moran Folk Market located in the old city center, Seongnam Jungang Market, and Kumho Happy Market and Dolphin Market located in the new city center.

Therefore, this study aims to help local governments and market merchants establish more efficient and useful development plans by reviewing ways to improve the odor environment in places where odor standards are exceeded or complaints occur frequently.

2. Research Methods

2.1. Survey

Survey conducted an offline survey of citizens and market merchants by visiting the Peony Folk 5-day Market located in the old city center, Geumho Happiness Market located in the new city center, and Dolphin Market. Participants can describe whether they feel odors, causes of

odors, complaints related to odors, places where odors occur, satisfaction with odors management, changes in odors frequency compared to the past, reasons why odors have not improved, needs to be improved, and efforts to resolve odors.

2.2. Odor Measurement

2.2.1. Selection of Measurement Area

This study compared the old city center and the new city center of Seongnam, focusing on the elephant market where odor complaints occurred in 2019, and the old city center and the new city center where odor complaints occurred in 2022, and measured odor substances in the old city center, Seongnam Central Market, and Geumho Happiness Market and Dolphin Market. The concentration of odor substances was measured and analyzed by dividing into four points based on the total travel distance for each market.



Figure 1: Kumho Happy Market



Figure 2: Seongnam Central Market

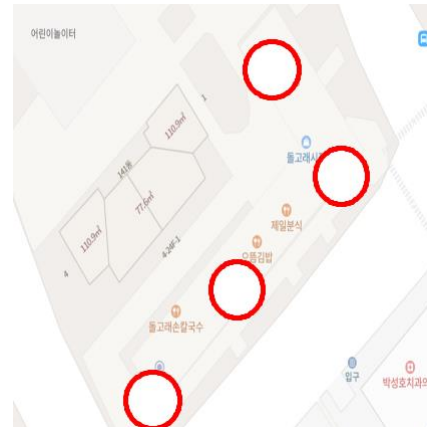


Figure 3: Dolphin Market



Figure 4: Moran Folk Market

2.2.2. Selection of Measuring Substances

The concentration of hydrogen sulfide (H₂S) and total volatile organic compounds (TVOC), which are most likely to occur in traditional markets, was measured among 22 designated odor substances regulated by environmental law.

2.2.3. Measurement Process

AOMS-1000's target fluid is Air (Odor). The sampling method is a forced suction method, and a type measurement, dilution multiple, and composite odor graph are displayed. The sensor array module has four basic types and can accommodate up to eight types. The proper temperature of use is -20°C ~ -65°C. Sample collection is not supported. Communication is optional and weighs about 5 kg. The screen size is a 10° touch-operated (Tablet PC). The appearance is 365(W)1×51(H)×296(D)mm, ABS. The AOMS-1000 used in this study is a portable odor measurement device that measures and analyzes complex odors through individual concentrations and dilution drainage of four typical odor-causing substances in various sites. The collector is composed of Teflon, a material that does not deteriorate by adsorption, transmission, and

interaction, and samples were analyzed by collecting odorous substances widely dispersed at low concentrations by forced inhalation.

The measurement device was used to measure the complex odor, TVOC, and hydrogen sulfide concentration by branch after dividing it into 4 points for accuracy in the Peony Folk 5-day Market, Seongnam Jungang Market, Kumho Happy Market, and Dolphin Market located in Seongnam City. Seongnam Jungang Market was measured for 20 minutes at 5-minute intervals from 13:25 and 20 minutes at 5-minute intervals from 19:45. The peony folk 5-day market was measured for 20 minutes at intervals of 5 minutes from 14:10 and 20 minutes at intervals of 5 minutes from 19:00. In Kumho Happy Market, it was measured for 20 minutes at 5-minute intervals from 15:58 and 20 minutes at 5-minute intervals from 17:25. In the dolphin market, it was measured for 20 minutes at intervals of 5 minutes from 15:15 and 20 minutes at intervals of 5 minutes from 18:00.

3. Research Results

3.1. Survey Results

Based on the current status of odor complaints in Seongnam-si over the past five years, the market for civil complaints was preferentially selected, and the odor felt by residents was analyzed through a survey of citizens' odor consciousness in the selected target market. The total number of participants in the survey is 100 market merchants and visitors. The questionnaire was surveyed with multiple responses.

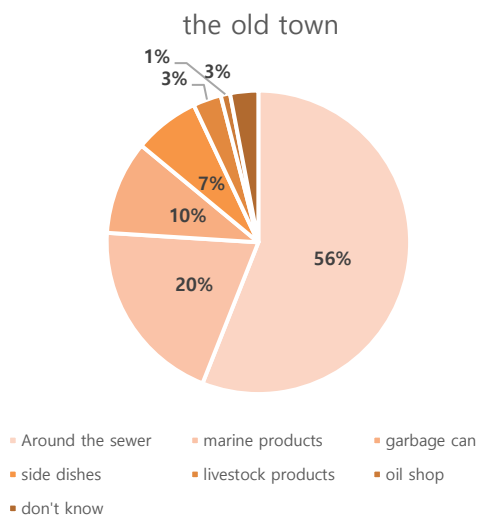


Figure 5: The cause of the stench of the old town

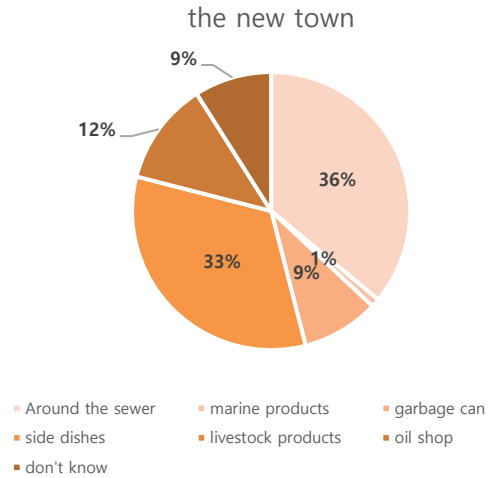


Figure 6: The cause of the stench in the new town

When asked, "What do you think is the cause of the odor you felt?" both old and new cities (56%) and (36%) were the highest around the sewer, while side dishes were 33% in the new city, the second highest after the sewer.

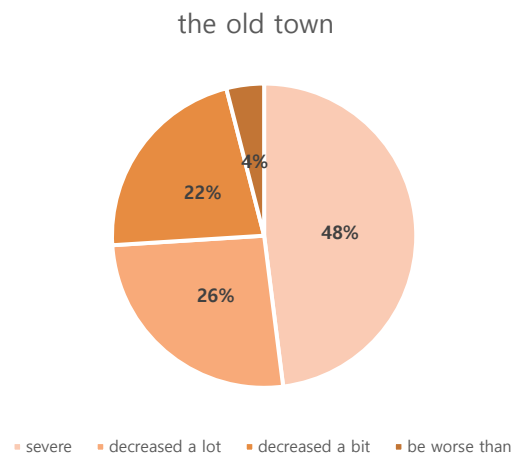


Figure 7: The Odor Generation and Frequency of Old Town

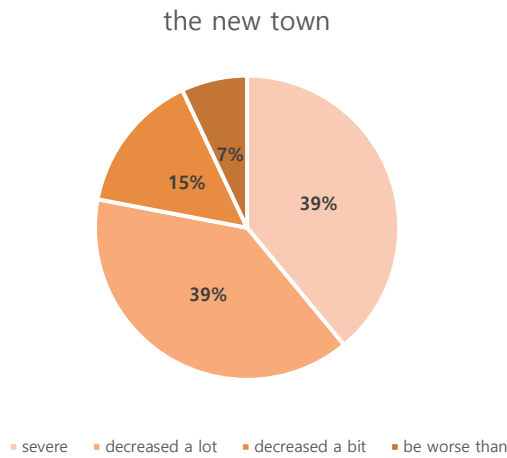


Figure 8: The Odor Generation and Frequency of New Town

When asked, "Do you think there is a change in the incidence and frequency of odors compared to the past?" the old city was the highest (48%) and the new town was the same (39%) and the number of new towns was the same (39%).

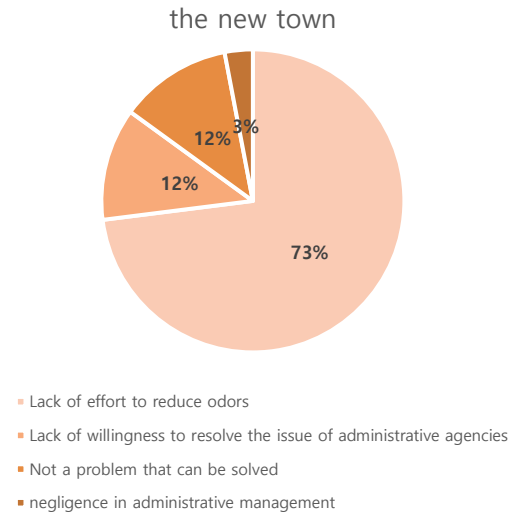


Figure 10: The reason why the new town market's odor has not improved

When asked, "What do you think is the reason why the odor problem cannot be solved if it has not been improved?" both old and new cities showed the highest lack of efforts to reduce odors (55%) and (73%).

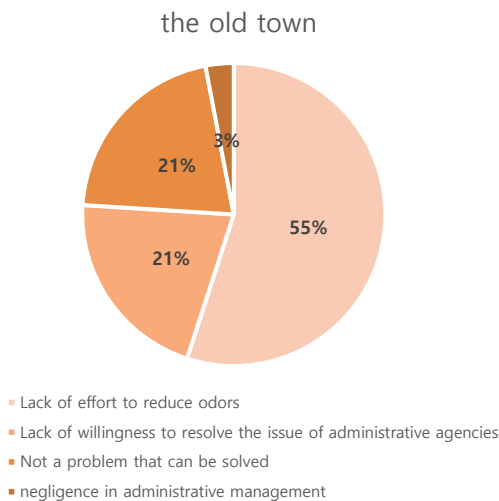


Figure 9: The reason why the old town market's odor has not improved

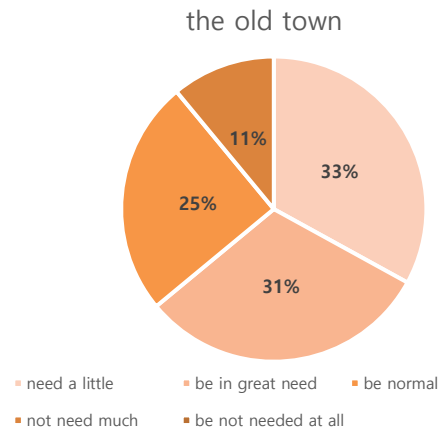


Figure 11: Necessity of Market Odor Management in Old Town

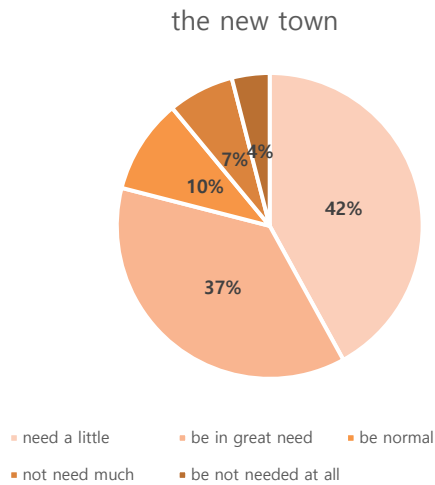


Figure 12: Necessity of Market Odor Management in New Town

When asked, "How much do you feel the need to regulate market odor management?" both old and new cities were somewhat needed (33%) and (42%).

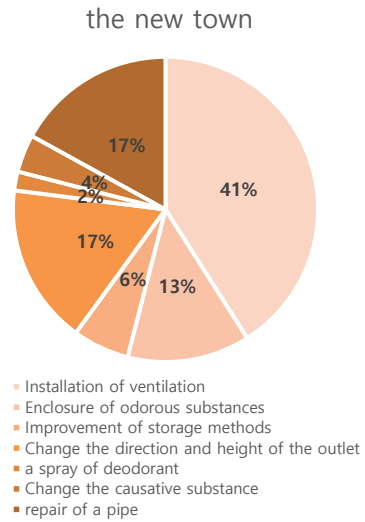


Figure 14: Areas requiring improvement as odor prevention facilities in the new town

When asked, "What do you think should be improved the most with odor prevention facilities?" the old city center was the highest with ventilation (48%) and the new city center was also the highest with ventilation (41%).

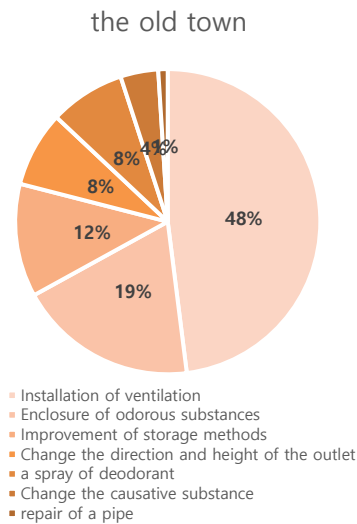


Figure 13: Areas requiring improvement as odor prevention facilities in the old town

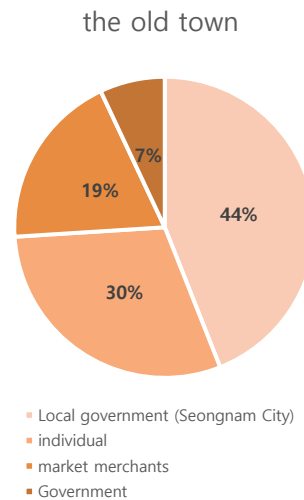


Figure 15: Efforts necessary to improve the odor of the old town

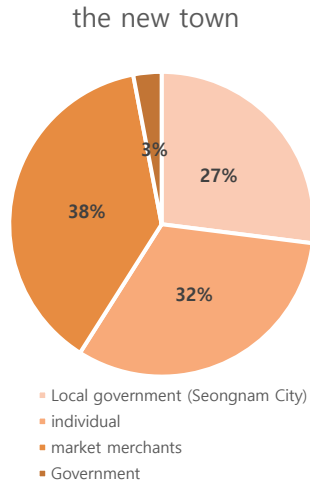


Figure 16: Efforts necessary to improve the odor of the new town

When asked, "What do you think the biggest effort is needed to improve the odor?" the old city center was the highest with local governments (44%) and the new city center with market merchants (38%).

3.2. Measurement Results

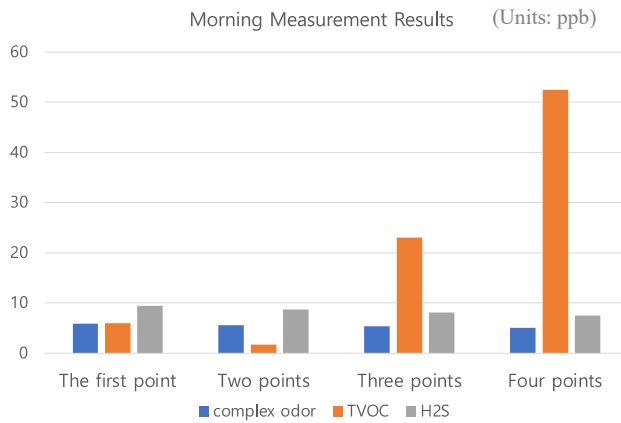


Figure 17: Morning Measurement Results of Seongnam Central Market

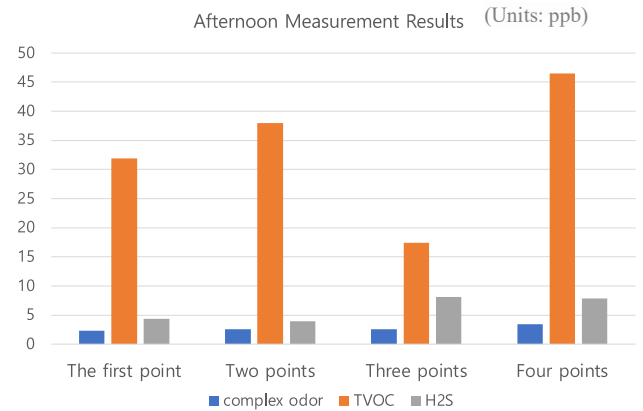


Figure 18: Afternoon Measurement Results of Seongnam Central Market

The substance detected at the highest concentration during morning measurements is TVOC, and the next highest concentration is hydrogen sulfide. The TVOC was detected as a maximum value (113.73 ppb) at the fourth point and a minimum value (3.61 ppb) at the third point. Hydrogen sulfide was detected at a maximum value (11.91 ppb) at the fourth point and a minimum value (6.56 ppb) at the fourth point. Each average concentration was detected as 20.273 ppb of TVOC and 8.449 ppb of hydrogen sulfide. The substance detected at the highest concentration during afternoon measurements is TVOC, and the next highest concentration is hydrogen sulfide. The TVOC was detected as a maximum value (58.49 ppb) at the second point and a minimum value (3.07 ppb) at the fourth point. Hydrogen sulfide was detected at the maximum value (6.38 ppb) at the first point and at the minimum value (0.95 ppb) at the first point. The average concentration of each was 33.4465 ppb of TVOC and 6.06175 ppb of hydrogen sulfide.

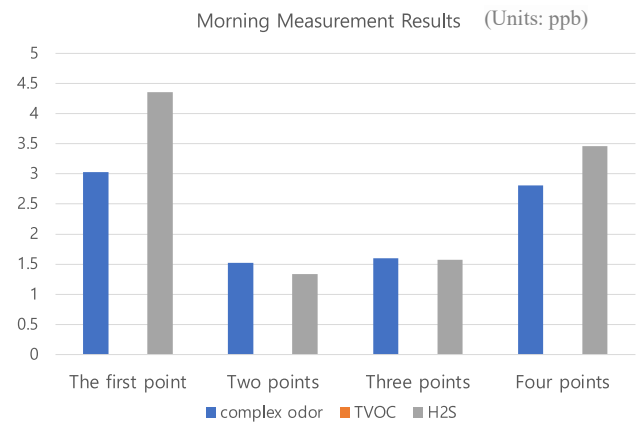


Figure 19: Morning Measurements of Moran Folk Market

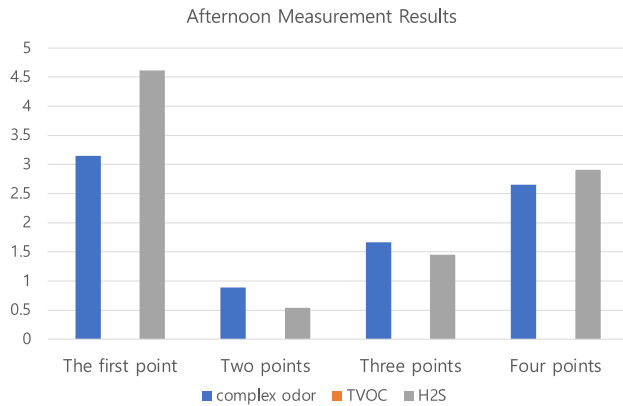


Figure 20: Afternoon Measurement Results of Moran Folk Market

Hydrogen sulfide is the highest concentration detected during morning measurements. Hydrogen sulfide was detected at a maximum value of 10.22 ppb at the first point and a minimum value of 0.23 ppb at the second point. The average concentration of hydrogen sulfide was detected at 2.68075 ppb. The substance detected at the highest concentration during the afternoon measurement was hydrogen sulfide, which was detected as the maximum value (19.25 ppb) at the first point and the minimum value (0.24 ppb) at the second point. The average concentration of hydrogen sulfide was detected at 2.3775 ppb.

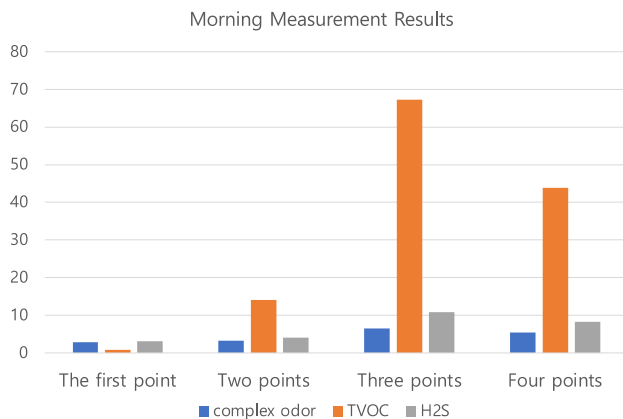


Figure 21: Morning Measurement Results of Dolphin Market

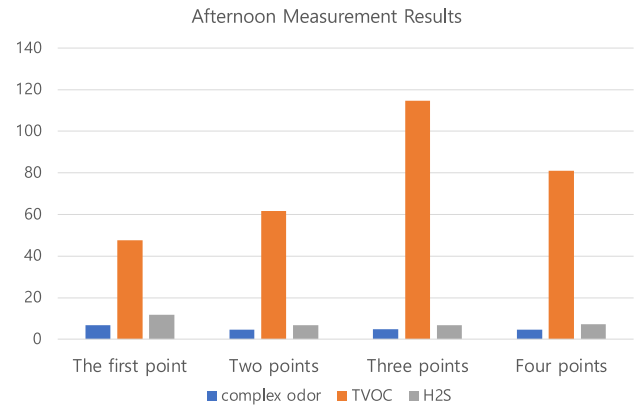


Figure 22: Afternoon Measurement Results of Dolphin Market

The substance detected at the highest concentration during morning measurements is TVOC, and the next substance detected at the highest concentration is hydrogen sulfide. The TVOC was detected as a maximum value (95.12 ppb) at the fourth point and a minimum value (8.67 ppb) at the second point. Hydrogen sulfide was detected at a maximum value (12.35 ppb) at the fourth point and a minimum value (1.34 ppb) at the third point. The average concentration of each was 31.491 ppb of TVOC and 6.570 ppb of hydrogen sulfide. The substance detected at the highest concentration during afternoon measurements is TVOC, and the next substance detected at the highest concentration is hydrogen sulfide. The TVOC was detected as a maximum value (164.40 ppb) at the third point and a minimum value (22.29 ppb) at the first point. Hydrogen sulfide was detected at the first point at maximum (22.33 ppb) and at the fourth point at minimum (4.92 ppb). The average concentration of each was 76.235 ppb of TVOC and 8.161 ppb of hydrogen sulfide.

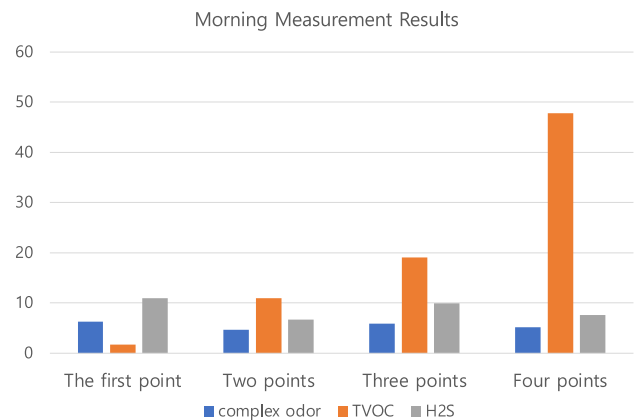


Figure 23: Morning Measurement Results of Kumho Happy Market

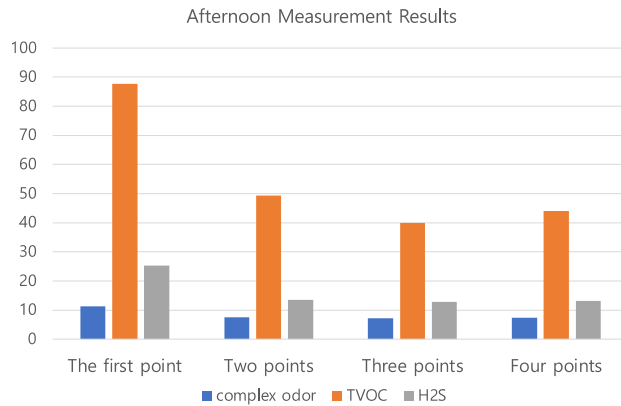


Figure 24: Afternoon Measurement Results of Kumho Happy Market

The substance detected at the highest concentration during morning measurements is TVOC, and the next substance detected at the highest concentration is hydrogen sulfide. The TVOC was detected as a maximum value (140.30 ppb) at the fourth point and a minimum value (0.72 ppb) at the first point. Hydrogen sulfide was detected at a maximum value (31.00 ppb) at the first point and a minimum value (5.80 ppb) at the third point. The average concentration of each was 19.8955 ppb of TVOC and 8.7988 ppb of hydrogen sulfide.

The substance detected at the highest concentration during afternoon measurements is TVOC, and the next substance detected at the highest concentration is hydrogen sulfide. The TVOC was detected as a maximum value (126.87 ppb) at the first point and a minimum value (33.01 ppb) at the fourth point. Hydrogen sulfide was detected at maximum (32.00 ppb) at the first point and at minimum (12.09 ppb) at the second point. Each average concentration was detected as 55.204 ppb of TVOC and 16.217 ppb of hydrogen sulfide.

4. Consideration

4.1. Survey

In the survey conducted in this study, there is a response question, "Have you ever felt an unpleasant smell (odor) around the market?" "Yes" was the highest at 38% and 35%, respectively.

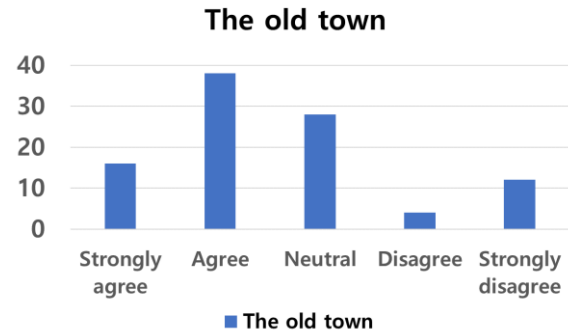


Figure 25: A sense of odor in the old city center

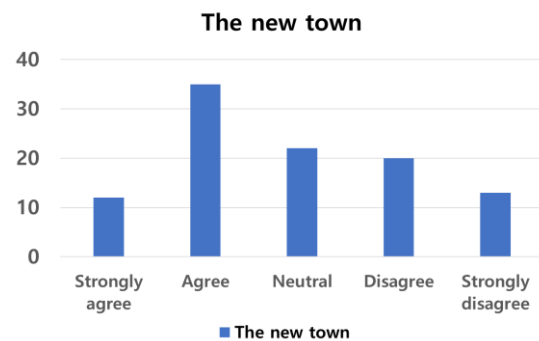


Figure 26: A sense of smell in the new town center

In a survey conducted by Seongnam-si, the investigators were divided into residents, merchants, managers, office workers, and students, with less than once a week, two to three times a week, one to two times a day, and three or more times a day.

In this study, if the survey questions were added and subdivided, it would be possible to accurately grasp the correlation and perception of odor in the market, the frequency of odor occurrence, and the time of odor occurrence.

In comparison, it is said that the Seoul Metropolitan Government will introduce the "Seoul-type sewage odor target management system" from February 2022. This is to set a target grade for improving sewage odor in each region, strengthen the management of odor sources such as septic tanks, and to achieve the goal, as well as to customize the latest odor reduction technology to suit local characteristics. Of the five grades under the Ministry of Environment's management guidelines, it is announced that it will manage the entire Seoul Metropolitan Government to catch the smell of sewage in 29 places, and a total of more than 7 billion won is estimated to be spent on these areas. As one of the new technologies applied to this project, it is said to introduce an adsorption and decomposition type odor reduction facility that adsorbs and removes odor gases at room temperature using complex adsorbents. As shown in a

survey of four markets in Seongnam City, both the new city (56%) and the old city (36%) said they felt the most odor around the sewer. Through this, Seongnam-si also needs to derive causes and solutions for sewage odor.

4.2. Measurement Results

In this study, a total of four places were selected: Folk 5-day Market, Seongnam Jungang Market, Kumho Happy Market, and Dolphin Market, which do not know the odor measurement points, and the concentration of odor substances was investigated. Seongnam Jungang Market, Kumho Happy Market, and Dolphin Market are located indoors, but the peony folk 5-day market is located outdoors.

In the odor survey using field olfactory measurement, temperature, humidity, air pressure, wind direction, and wind speed were measured using a weather measuring device to find out the weather conditions of the survey area correlated with odor detection. When the atmosphere is unstable, the odor substance mainly moves in the vertical direction and when the atmosphere is stable, it is known that the odor concentration near the surface is the largest when it is stable. It appears that the weaker the wind speed, the higher the odor detection rate. The Peony Folk 5-day market was expected to have a high odor concentration due to a number of complaints related to the odor, but the odor concentration was actually detected as 2.68075 ppb of hydrogen sulfide in the morning and 2.3775 ppb of hydrogen sulfide. In this study, it is judged that a higher reliable conclusion would have been drawn if the four measurement sites had the same environment.

5. Results and Discussions

Table 1: Allowable emission standard

Sortation	Emission acceptance criteria(ppm)	
	An industrial area	Other regions
Ammonia	Less than 2	Less than 1
Methyl mercaptan	Less than 0.004	Less than 0.002
Hydrogen sulfide	Less than 0.06	Less than 0.02

The figure above is about allowable emission standard. The average concentration of hydrogen sulfide measured in this study was 0.0072 ppm in Seongnam Jungang Market, 0.0025 ppm in peony folk 5-day market, 0.012 ppm in Kumho Happy Market, and 0.0074 ppm in Dolphin Market, which did not exceed the environment-designated emission standard.

However, hydrogen sulfide is easily detected even at very low concentrations and is highly corrosive, so it is

known to have a harmful effect on the human body due to damage to facilities and toxicity when exposed for a long time. As a characteristic of odor, the minimum detection concentration at which humans can detect odor varies depending on the odor substance. Because the concentration of the compound is large, the odor does not feel strong, and the measurement of the odor concentration by the device or the amount of the substance within a certain volume, it is necessary to convert the analysis result of the compound into the odor intensity (Park & Kwon, 2014).

Table 2: Relationship between Odor Strength and Concentration of 8 Odorful Substances

Material Name	Odor intensity							
	1	2	2.5	3	3.5	4	5	
Ammonia	0.1	0.6	1	2	5	10	40	
Methyl mercaptan	0.0001	0.0007	0.002	0.004	0.01	0.03	0.2	
Hydrogen sulfide	0.0005	0.0006	0.02	0.06	0.2	0.7	9	
Methyl sulfide	0.0001	0.002	0.01	0.05	0.2	0.8	20	
Methyl disulfide	0.0003	0.003	0.009	0.03	0.1	0.3	3	
Trimethylamine	0.0001	0.001	0.005	0.02	0.07	0.2	3	
Acetaldehyde	0.002	0.01	0.05	0.1	0.5	1	10	
Styrene	0.03	0.2	0.4	0.8	2	4	20	

Table 3: Step 6 Indication of Odor Strength

Strength	State
0	Odorless
1	Minimum detection value
2	Minimum recognition value
3	An easy smell
4	A strong smell
5	An unbearable strong smell

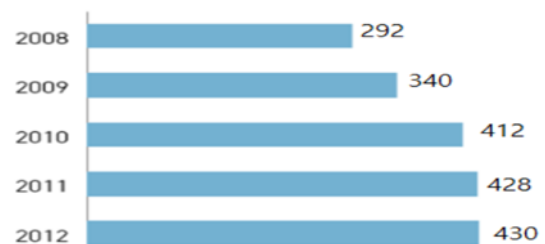


Figure 27: Current status of complaints about odors in daily life by year

Table 2 is about relationship between odor strength and concentration of 8 odor substances. Table 3 is about step 6 Indication of odor strength. Stage 0 is odorless and stage 5 is an unbearable strong smell. Table 4 is about current status of complaints about odors in daily life by year. When converting the average concentration of hydrogen sulfide measured in Fig. 2 and Fig. 3, it is judged that there is no physical damage due to odor because it does not reach stage 5, which is about two steps, but based on Fig. 4, it is not right

to determine the degree of damage based on the basis of figures.

As odor complaints continue to increase, the Ministry of Environment and each local government have carried out odor-reduction pilot projects for sewage facilities that generate odors, and are carrying out national R&D projects to develop odor-reduction technologies suitable for domestic odor-reduction conditions.

In this study, since the market was selected based on the current status of odor complaints, it is necessary to respond based on the method of handling odor complaints. In managing odor pollutants, complaints may not necessarily be included in facilities subject to regulation under laws and regulations, and complaints may occur even if they meet the regulatory standards of laws and regulations. For the preceding reasons, odor complaints may not reach a solution simply by regulations based on laws, and various measures are needed, such as persuading business operators, technical guidance, and in some cases providing a forum for discussions between civil petitioners and business operators. In addition, on-site investigation of civil petitioners is conducted, and continuous management and supervision of the progress of work is required (MOE, 2012).

According to a survey of Seongnam Mayor, "Do you feel the need to regulate market odor management?" both old and new cities answered "somewhat necessary," so the odor in the market cannot be completely reduced regardless of the concentration of the research results, and management should be continued. In addition, when asked, "Which part of the odor prevention facility do you think should be improved the most?" both cities showed the highest number of ventilation installations at more than 40%. Even if the ventilation hole is installed, if there is no steady management and accurate management system, the management of odor will not be properly carried out.

This study aims to present a solution to this, focusing on the main contents of odor complaints. First of all, the main contents of the elephant market odor complaint are the odor of stores located underground and the odor of exhaust communication. In the case of the dolphin market, natural ventilation cannot be properly performed unless ventilation is through ventilation because it is located underground in the building, and in the case of the dolphin market, odor management is more difficult because ventilation is not properly cleaned. The introduction of projects to reduce odors such as replacing dust collectors, improving ventilation facilities, exhaust ducts and adsorbing facilities, photochemical oxidative odors that automatically inhale gas from the vents, clean specific vents, and remove odors at room temperature. I think cleaning ventilation is a fundamental element of odor management, and systematic cleaning management measures should be established and a system should be prepared so that merchants can practice

them. Next, the peony folk 5-day market and Seongnam Jungang Market were complained of the smell of chemicals such as oil and paint. The solution to this problem can reduce odor by a relatively simple method, such as blocking the source of odor, storing raw materials that generate odor, or sealing waste containers such as waste and wastewater.

In addition, in the case of Seongnam Jungang Market, there are many street lamps around it, and the odor emitted from sewage pipes is inhaled and removed using streetlights installed on the road. If a discharge fan is installed at the top of the streetlight and forced to discharge it, the rainwater gutter in the sewer can reduce odors by preventing the odor from being discharged to the outside through the rainwater gutter (Seoul researcher, 2013). In the case of Moran Market, even if the odor is easily generated because it is located outdoors, it is common that the odor does not occur after the market is closed. However, in the case of marine products areas, even if the market is closed, contaminants remaining on the floor may not flow to the outlet, causing water to accumulate and odor to remain. Therefore, it is considered that other regulations such as spraying deodorants after the market operation is completed by designating a zone.

As a result of this study, all markets except Kumho Market had ventilation and sewers. In particular, Seongnam Jungang Market, a public market in Seongnam, also had vents at each store. However, while installing these facilities is important, management such as periodic cleaning and checking operation is also very important. Except for the outdoor market Peony Folk 5-day Market, both Dolphin Market and Kumho Market have difficulty in regular cleaning and management because there are no proper regulations on vent cleaning, so management and regulation can also be seen as a fundamental solution to the odor problem.

The technologies for reducing odors for each sewage facility currently being commercialized and applied in the domestic sewage odor management guidebook are divided into source countermeasures, emission source countermeasures, and emission source countermeasures. Among the source measures, the air supply device is applied to the drainage tank of the septic tank sewage treatment facility building, which is a method of injecting air into the discharge tank of the septic tank and sewage treatment facility. By installing an inverter in the manhole of the sewer pipe, sediment generation is prevented through the smooth flow of sewage. In the case of a stepped manhole among the emission source measures, a pipe shall be installed outside the manhole or a manhole with an attached pipe shall be applied to prevent the odor from spreading due to falling sewage. The emission source measure is a spray odor reduction facility that removes odors emitted from the soil and manholes by using the properties of hydrogen sulfide dissolving in water.

Not only Korea but also overseas have carried out projects to reduce odors, and Japan legally prohibits the installation of septic tanks in sewage treatment areas, and the existing septic tanks were used to induce direct input into sewage pipes and close them. In the case of the United States, the 'Sewer Odor Control Master Plan' has been established to systematically manage odors. It is believed that the introduction of the above-mentioned projects to reduce odors in the Seongnam market surveyed in this study will reduce odors damage to local residents and merchants.

6. Conclusion

Based on these studies, it is possible to reduce odors and create a better market environment through the introduction of odor management projects in traditional markets and systematic odor management.

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