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Raising Public Awareness of Air Pollution and How to Mitigate The Health Risk

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Abstract

Rapid economic growth has an impact on increasing the use of motorized vehicles in the city of Yogyakarta, resulting in the level of carbon monoxide (CO) concentration. Although the level of CO concentration in Yogyakarta City is still below the threshold (3-11 ppm), this level is the highest when compared to the level of CO concentration in the other three districts. Tegalrejo is one of the sub-districts in Yogyakarta City with the highest level of CO concentration. The Community Partnership Program (PKM) aims to increase public awareness of Tegalrejo District about the negative impacts of air pollution and how to overcome them. PKM activities are based on the results of mapping air pollution in the city of Yogyakarta using the Kringing technique. Activities to increase public awareness about health risks due to air pollution are still rare in Yogyakarta as well as knowledge dissemination about mitigating air pollution risks. PKM activities are donating air pollution monitoring tools, conducting counseling, and planting air pollution-reducing plants. The result of this community partnership is that the counseling activities can increase public understanding of the negative impacts of air pollution. Public awareness to reduce the negative impact of air pollution increased to 46% after attending the counseling compared to 18% before the counseling. Measurements were carried out using a questionnaire with 55 respondents. The mitigations carried out by the community include planting plants to reduce air pollution, routinely servicing motorized vehicles, and reducing the use of motorized vehicles.

Kata kunci: polusi udara, kesadaran masyarakat, mitigasi, kemitraan komunitas, resiko kesehatan

Abstrak

Pertumbuhan ekonomi yang cepat berdampak pada meningkatnya penggunaan kendaraan bermotor di Kota Yogyakarta sehingga berakibat pada level konsentrasi karbon monoksida (CO). Walaupun level konsentrasi CO di Kota Yogyakarta masih berada di bawah ambang batas (3-11 ppm) namun level tersebut paling tinggi jika dibandingkan dengan level konsentrai CO di tiga kabupaten lainnya.

Tegalrejo adalah salah satu kecamatan di Kota Yogyakarta dengan level konsentrasi CO paling tinggi. Hal ini disebabkan oleh minimnya area terbuka hijau dan dominannya kegiatan masyarakat menggunakan kendaraan bermotor. Program Kemitraan Masyarakat (PKM) ini bertujuan untuk meningkatkan kesadaran masyarakat Kecamatan Tegalrejo tentang dampak negatif pencemaran udara dan cara menanggulanginya. Kegiatan PKM didasarkan pada hasil pemetaan pencemaran udara di Kota Yogyakarta menggunakan teknik Kringing. Kegiatan peningkatkan kesadaran masyarakat tentang risiko kesehatan akibat pencemaran udara masih jarang di Yogyakarta demikian pula penyuluhan pengetahuan tentang mitigasi risiko pencemaran udara. Kegiatan PKM adalah menghibahkan alat pemantauan pencemaran udara, melakukan penyuluhan, dan penanaman tanaman pengurang pencemaran udara. Hasil dari kemitraan masyarakat ini adalah dengan adanya penyuluhan dapat meningkatkan pemahaman masyarakat tentang dampak negatif pencemaran udara. Kesadaran masyarakat untuk mengurangi dampak negatif pencemaran udara meningkat menjadi 46% setelah mengikuti penyuluhan dibandingkan dengan 18% sebelum penyuluhan. Pengukuran dilakukan menggunakan kuesioner dengan 55 orang responden. Adapun mitigasi yang dilakukan masyarakat antara lain penanaman tanaman pengurang polusi udara, rutin servis kendaraan bermotor, dan pengurangan penggunaan kendaraan bermotor.

1. INTRODUCTION

In addition to being an increasingly significant problem, air pollution is a major concern in numerous fields, such as the atmosphere, health, economy, and politics. In the literature, there are many definitions of air pollution (Devinny, Deshusses & Webster, 1998; Güney, 2004; Flagan & Seinfeld, 2013; Özey, 2009). Air pollution, in general, can be defined as the increase in the rate of harmful gases and particles in the atmosphere, combining these definitions (Özey, 2009). The rise of air polution harms living standards. For example, in 2012, millions of people lost their lives due to air pollution-related causes, according to the World Health Organization (WHO) in 2018. It can also be said that while air pollution harms human health and other living organisms (Oanh *et. al*., 2006), it also harms historical objects, technical devices, and buildings (Hyslop, 2009; Paulos, Honicky & Goodman, 2007; Ridker & Henrick, 1967). In addition, as it creates economic and legal problems for countries (Selden & Song, 1994; Best & Collins, 1982; Rothbard, 1982), air pollution emergency steps must be taken.

Economic activities that run fast require urban transportation facilities. Economic growth, which is marked by an increase in per capita income, will increase the people's purchasing power of motorized vehicles as a means of transportation. Various types of transportation, especially motorized vehicles, crowd urban streets as the center of economic activity (central business district). This phenomenon also occurs in the province of Yogyakarta Special Region where there are many trade and education centers that support the regional economy. In Yogyakarta City, the CO concentration of carbon monoxide is still below the quality standard threshold, however, when compared to the three previous districts, the CO concentration is still higher. The CO concentration in Yogyakarta City ranges from 3-11 ppm. This higher CO concentration may be due to the higher number of vehicles in Yogyakarta City than in the other three districts, namely Bantul, Kulon Progo, and Gunung Kidul (Basuki & Saptutyningsih, 2012). The result of air pollution by carbon monoxide (CO) is an increase in people with ARI (Acute Respiratory Infection). For this purpose,

to reduce air pollution and bring its negative effects, various studies are conducted to assess the current situation and determine the possible steps to be taken (e.g., Kyoto Protocol, 1997; Paris Agreement, 2015). Improving the educational level and raising environmental awareness are essential for reducing air pollution (Selden & Song 1994). There is still low public awareness of maintaining air quality due to the lack of knowledge about the negative impacts of air pollution on health and a lack of understanding of ways to mitigate the risk of air pollution. Therefore, this Community Partnership Program (PKM) activity aims to increase public awareness about the negative impacts of air pollution and how to mitigate it.

Based on the results of monitoring the concentration of carbon monoxide gas (CO) pollutants in four districts and the city of Yogyakarta, using the Kriging technique it was found that the areas with the highest CO concentrations were in the city of Yogyakarta including the districts of Jetis, Gondomanan, Tegalrejo, Kraton, Mantrijeron, some Ngampilan, Gedongtengen, and Mergangsan (Basuki & Saptutyningsih, 2012). Many centers of economic activity and other public facilities demand a means of transportation that produces motor vehicle exhaust emissions, where CO gas is one of the products of motor vehicle exhaust. In addition, the combustion products produced by industries can also cause high CO concentrations in the region. The high exhaust gas from motorized vehicles and combustion products which are not matched by the presence of green open space (RTH, Ruang Terbuka Hijau) causes the CO concentration in Yogyakarta to be relatively high. This can be shown in Figure 1, wherein in the city of Yogyakarta, green open spaces are rarely found.

Based on the results of air pollution mapping, the area that has the highest CO concentration is in the city of Yogyakarta, one of which is Tegalrejo. The road conditions in Tegalrejo, especially RW 07, are dominated by asphalt roads, as well as small roads that have been installed with paving blocks to support the activities of residents, most of whom have private motorized vehicles. One household even owns more than one motor vehicle. Based on observations, RW 07 Tegalrejo have regularly meetings every month. This meeting can be used as an outreach for residents about the importance of mitigating the negative impact of air pollution on health. The absence of air pollution monitoring tools so that people can realize the importance of reducing air pollution. Likewise, based on observations, there are still rare plants that can reduce air pollution, which can also be used as ornamental plants in every household or the garden.

Some of the problems experienced by the community based on our observations are: 1) Most of the RW 07 community has a private motorized vehicle with a densely-built environment without

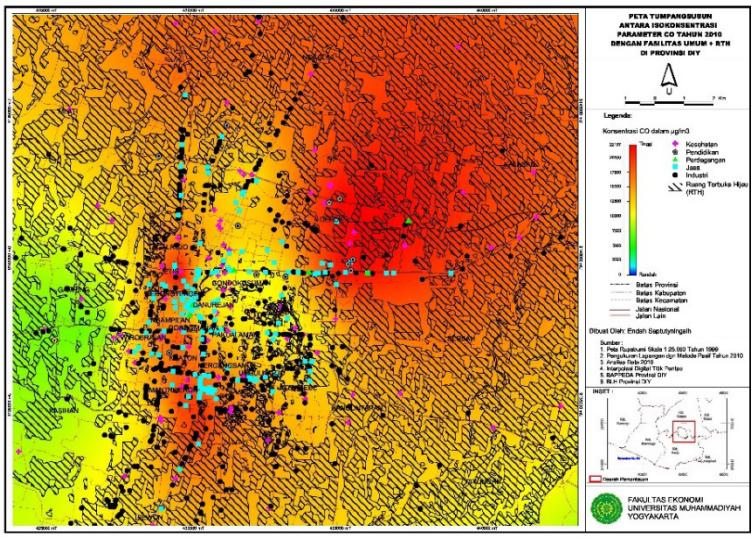

Figure 1. Overlay Map between Isoconcentration of CO Parameters with Public Facilities and Green Open Space in Areas with the Highest CO Concentration in DIY province

any air pollution monitoring device that can encourage people to be aware of reducing air pollution; 2) Lack of public awareness of the impact of air pollution, especially from motorized vehicles and the importance of mitigating the negative impacts of air pollution; 3) Lack of public awareness of motorized vehicle owners to perform routine servicing to clean motor vehicle exhausts; 4) There has been no effort to mitigate the negative impact of air pollution in RW 07 Tegalrejo, Yogyakarta.

This Community Partnership Program (PKM) is aimed at detecting the content of air pollution and increasing public awareness to mitigate the negative impact of air pollution on public health. This community partnership program will socialize the importance of mitigating the impact of air pollution by conducting counseling and planting plants to reduce pollutant emissions in the air as well as donating pollutant detectors to carry out routine measurements of carbon monoxide pollution in the RW 7 area regularly.

2. METHODS

The high level of economic activity demands transportation facilities. Economic growth, which is marked by an increase in per capita income, will increase the people's purchasing power of motorized vehicles as a means of transportation. The use of motorized vehicles harms public health and reduces environmental comfort. Based on the results of research by Agus & Saptutyningsih (2012), it is concluded that Tegalrejo is one of the areas that has a high level of carbon monoxide (CO) pollution. Mitigation of the negative impact of air pollution on public health needs to be done based on local wisdom to support government programs in improving public health and environmental management in a good and sustainable manner.

Based on observations and mapping results of air pollution, density of buildings and high levels of carbon monoxide (CO) pollution and a lack of public awareness to mitigate the negative impacts of air pollution, PKM proposed several programs to the community of RW 07, Tegalrejo sub-district, Yogyakarta City. The pilot group for this program is the residents of RW 07 which consists of RT 25, 26, 27, 28, 32 and 46.

Figure 2. Gas Analyzer Tool

Use of An Air Pollution Monitoring Device (Gas Analyzer)

To monitor the level of carbon monoxide (CO) pollution in RW 07, Tegalrejo, a gas analyzer will be installed. This is so that residents know how high the CO level is in the area where they live.

Counseling

To increase public awareness, especially the community of RW 07 Tegalrejo, Yogyakarta about the negative impacts of air pollution, the Community Partnership Program provides counseling to mitigate the negative impacts of air pollution on health. In addition, by reducing air pollution, energy consumption, especially motor vehicle fuel, can be saved. Energy efficiency can directly improve people's welfare. Counseling is carried out to RT administrators online using videos uploaded on Youtube. The distribution of counseling content to the residents is carried out by each RT administrators through the Youtube link. The total number of residents who became respondents was 55 people.

Planting Sansevieria

To support the series of activities of the Community Partnership Program, one of the efforts to mitigate air pollution in RW 07, Tegalrejo, is to promote the planting of Sansevieria plants to reduce air pollution, especially carbon monoxide (CO) gas. As the results of research by Adawiyah *et. al* (2013), which found that Sansevieria plants were one of the plants that could reduce air pollution. RW 07 people will get the plant and it is hoped that it can be bred in their respective homes as well as in gardens in the RW 07 area of Tegalrejo, Yogyakarta. With the mass planting of this plant,

it is hoped that the level of air pollution in RW 07 Tegalrejo can be reduced, and indirectly can improve public health so that people's welfare increases.

3. RESULTS AND DISCUSSION

Handover of Air Pollution Monitoring Equipment

In order to increase public awareness of the importance of mitigating the negative impact of air pollution on health and fuel savings, the Community Partnership Program implementation team has donated 5 units of gas analyzers which will be distributed to 5 RTs under the auspices of RW 7, Tegalrejo. The handover of goods grants was represented by the Chairperson of RW 7 of Tegalrejo, Yogyakarta on Monday, July 27, 2020 at the residence of the Chairman of RW 7, Tegalrejo. The use of this gas analyzer is to determine the level of air pollution, especially carbon monoxide (CO) gas, which is one of the pollutants generated from motorized vehicle exhaust gases in the RW 07 Tegalrejo and its surroundings. and mitigate the impact of air pollution in the region.

Submission of Air Pollution Reducing Plants

The handover of the sansiviera plant was carried out to the RW Chairman on Sunday, July 26, 2020. The planting of this plant is intended to reduce air pollution produced by motorized vehicles in the area of RW 7, Tegalrejo, Yogyakarta.

Figure 3. Handover of Gas Analyzer Goods Grants with the Head of RW 7 Tegalrejo, Yogyakarta City

Figure 4. Handover of Air Pollution Reduction Plant Grants

In addition, a questionnaire has been prepared which will be distributed to community members of RW 07 Tegalrejo Yogyakarta regarding the importance of mitigating the risk of air pollution due to motorized vehicles and energy efficiency. This questionnaire consists of two types, namely those distributed before online counseling and after online counseling. This questionnaire is distributed through the online WhatsApp media using the following googleform link:

http://bit.ly/Sebelum-Penyuluhan-Dampak-Polusi

http://bit.ly/Setelah-Penyuluhan-Dampak-Polusi

In addition to preparing a questionnaire in the form of a google form, due to the COVID-19 pandemic conditions that did not allow large groups of people, the PKM implementer made a video information about the impact of air pollution and mitigation methods which would be distributed to residents of RW 07, Tegalrejo to be followed as a substitute for face-to-face counseling. The counseling video is uploaded on social media, namely Youtube with the following link:

https://www.youtube.com/watch?v=u6NM0vgpgAk

Online Counseling

After filling out the questionnaire before counseling, the PKM Implementation Team top up credit for residents' mobile phone who had filled out the questionnaire as a substitute for consumption because counseling was carried out

online via Youtube. The credit is used by residents to open and follow counseling via Youtube and then fill out a google questionnaire form after counseling. Offline counseling was given to RT administrators, which numbered approximately 12 people and online via youtube media which was witnessed by RW 7 residents individually by giving questionnaires via googleform before and after counseling which could be accessed by these residents.

RT administrators in the RW 07 area of Tegalrejo distributed the youtube link that was given by the PKM implementation team to the respective RT residents with the link:

https://www.youtube.com/watch?v=u6NM0vgpgAk

Many views have watched an outreach video about the impact of air pollution and how to mitigate it. The video is uploaded on Youtube publicly so that not only the residents of RW 07 Tegalrejo will get insight into the impact of air pollution and ways of mitigating it, but also the wider community can benefit from this counseling.

Filling out the Questionnaire Before and After Counseling

After all the materials and questionnaires were prepared, the PKM Implementing Team sent a questionnaire before counseling in the form of a google form to whatsapp each RT head in the RW 07 area of Tegalrejo. RT 25, 26, 27, 28, 32 and 46 administrators then distributed a google link questionnaire form before counseling to their residents to their respective RT groups with the link http://bit.ly/Sebelum-Penyuluhan-Dampak-Polusi

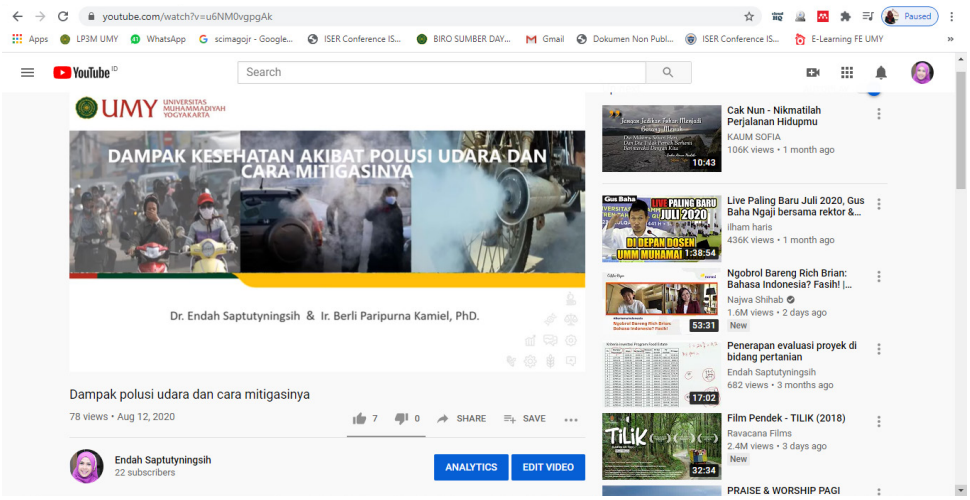

Figure 5 Counseling Videos Uploaded on Youtube

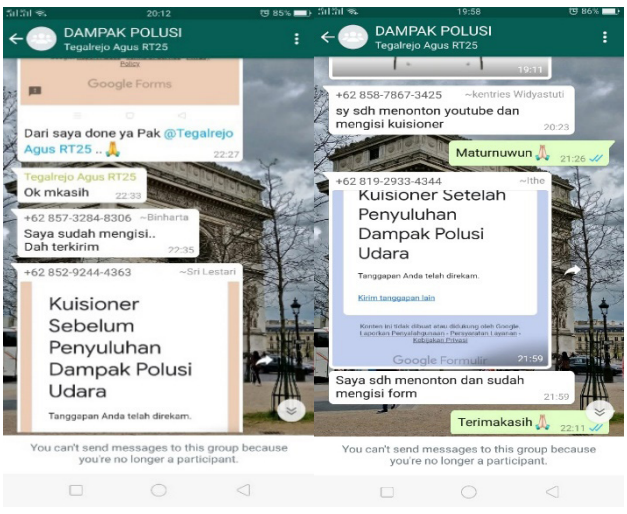

Figure 6 The Questionnaire Before and After Outreach that Had Been Filled in by the Residents.

After residents take part in the online counseling, the PKM Implementation Team sends a google link to the questionnaire form after counseling to each RT head in the RW 07 area so that it is distributed to residents who have already received credit through their respective RT groups with the link: http://bit.ly/Setelah-Penyuluhan-Dampak-Polusi

Fifty-five residents in RW 07, Tegalrejo, have filled out the questionnaire before the counseling that has been distributed on the WhatsApp group of each RT. As for the results of the questionnaire will be explained further.

Based on age, 42% of the participants were 41-50 years old, while the remaining 22% were 31-40 years old, 51-60 years old and the rest less than 20 years and over 60 years old.

The participants based on sex consisted of 67.3% male and 32.7% female.

Based on marital status, participants were dominated by those who were married, namely as much as 81.8%, while the remaining 10.9% were unmarried and 7.3% were widows/ widowers.

Table 1. Composition of Participants by Age

Age	Percentage
<= 20 years old	2
21-30 years old	5
31-40 years old	22
41-50 years old	42
51-60 years old	25
>= 60 years old	4

Table 2. Composition of Participants by Sex

Sex	Percentage
Male	32.7
Female	67.3

Table 3. Composition of Participants by Marital Status

Marital status	Percentage
Unmarried	10.9
Married	81.8
Widower	7.3

Table 4. Composition of Participants by Education Level

Education level	Percentage
Elementary school	5
Junior high school	4
Senior high school	64
Vocational	6
Graduated	20
Post graduate	1

According to the level of education, as many as 56.4% of the participants had a high school education/ equivalent, 20% graduated 20%, while the rest had an elementary, junior high, D3 and other education.

According to knowledge about the impact of air pollution on health, with counseling, there was an increase in the number of participants who knew and had mitigated the negative impacts of air pollution, from 18.25 to 45.9% of all participants. The number of participants who only heard but did not know in detail the impact decreased from 32.7% to 24.3% of the participants. Thus, the existence of counseling can increase participants' knowledge about the negative impacts of air pollution and the importance of mitigating these impacts.

Based on knowledge about Upper Respiratory Infection, after attending counseling, participants found out about ISPs increased from 85.5% to 97.3% of participants. This shows that the existence of counseling can increase knowledge about the health effects of air pollution in the form of upper respiratory infections.

With counseling, the number of participants who did not know about gas analyzers decreased from 70.9% to 21.6%. As many as 45.6% of participants already knew that there had been much improvement than before there was counseling. This shows an increase in the participants' knowledge of air pollution monitoring tools, namely gas analyzers, which are useful for monitoring air quality conditions in the surrounding environment.

Table 5. The Composition of Participants based on Knowledge of the Impact of Air Pollution on Health

Knowledge	Percentage	
	Before counseling	After counseling
Not know	9.1	5.5
Only hear but didn't know	32.7	24.3
Know but didn't mitigate the impact	40	24.3
Know and mitigate the impact	18.2	45.9

Table 6. The Composition of Participants Based on Knowledge of Upper Respiratory Infection

Knowledge	Percentage	
	Before counseling	After counseling
Not Know	14.5	2.7
Know	85.5	97.3

Table 7. The Composition of the Participants Was Based on an Understanding of the Benefits of the Sansevieria Plant

Knowledge	Percentage	
	Before counseling	After counseling
Not know	29.1	8.1
Only hear but didn't know	38.2	10.8
Know but didn't plant it	16.4	56.8
Know and have already plant it	16.4	24.3

According to the knowledge about air pollution reducing plants, after the extension there was a significant increase in participants' understanding of the types of plants that can reduce air pollution from 40% to 67.6%. This illustrates an increase in public understanding of one way of mitigating air pollution by planting air pollution-reducing plants by knowing these types of plants.

Table 8 The Composition of Participants Was Based on Knowledge of Air Pollution Reducing Plants

Knowledge	Percentage	
	Before counseling	After counseling
Bougenville	16.4	8.1
Puring	9.1	2.7
Pucuk merah	21.8	0
True all	40	67.6
False all	12.7	21.6

Table 9 The Composition of Participants Was Based on the Benefits of Routine Vehicle Checks to Reduce Air Pollution

Benefit	Percentage	
	Before counseling	After counseling
Yes	85.5	97.3
No	14.5	2.7

The hope of the participants after attending the counseling on the health impacts of air pollution, after the counseling, there was an increase in the number of participants who would mitigate the negative effects of air pollution, both planting air pollution reducing plants and servicing motor vehicles from 40% to 70.3%. Thus, extension can increase public awareness about the importance of mitigating the negative impacts of air pollution.

With counseling, in general all mitigation measures for the negative impacts of air pollution have increased both by planting air pollution reducing plants, carrying out routine motorized service services, reducing motor vehicle use, installing filter devices in the exhaust and choosing vehicles less than 10 years old. This shows that counseling can increase public awareness about the importance of mitigating the negative impacts of air pollution.

Counseling on How to Use A Gas Analyzer

Counseling on how to use a monitoring device (gas analyzer) to RT administrators to find out the level of air pollution in the RW 07 area of Tegalrejo and its surroundings and monitoring by each RT regularly.


Figure 7. Counseling on using of a gas analyzer to RT administrators in the RW07, Tegalrejo

Based on the results of the meeting, the air pollution monitoring device, namely the gas analyzer, will be used in each RT in the RW 07 area of Tegalrejo. The plan is to conduct monthly monitoring to monitor air pollution conditions around the residence, especially carbon monoxide gas. In addition, planting air pollution reducing plants can also help reduce pollutant levels in the area of RW07, Tegalrejo, Yogyakarta.

4. CONCLUSION

Based on the PKM activity plan, all the planned activities have been carried out well. However, due to the COVID-19 pandemic condition, the method of implementation is different from the plan. The activities are carried out online instead of offline to avoid the spread of the virus. The activities include monitoring air pollution using a gas analyzer, counseling, and planting sansevieria. The results of the questionnaire before and after online counseling shows that in general, there is an increase in public knowledge regarding the negative impacts of pollution and ways of mitigating it, both by planting reducing plants and by reducing motor vehicle use and servicing motorized vehicles which at the same time may increase energy or fuel-efficiency. The main objective of the activities is reached satisfactory where the public awareness is increase about the negative impacts of air pollution, about the importance of clean air quality and ways to mitigate the negative impacts of air pollution. They also agree about the importance of energy efficiency to maintain clean air quality to improve public health.

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