Research on the Evaluation Index of Air Pollution Control Audit Based on PSR Model

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Abstract. Since the reform and opening up, China's economy has achieved high-speed growth. However, due to the extensive economic growth mode and the limited level of technical conditions, air pollution has become a serious problem, endangering the natural environment and human health. In order to speed up the improvement of ambient air quality, Chinese government continues to carry out air pollution control actions. This paper analyzes the current situation of air pollution control in China, and constructs an evaluation index system of air pollution control audit based on PSR model in combination with the characteristics of air resources.

1. Introduction
As the largest carbon emitter in the world, the task of air pollution control in China is arduous. In order to promote the leading cadres to fulfill their responsibilities of natural resource management and ecological environment protection, China issued the “Pilot Program for Accountability Audit of Natural Resource of Leading Cadres” in 2015, which clarified that land resources, water resources, forest resources, air pollution control and other fields are the key areas involved in the audit. In 2017, China issued the “Regulations on Accountability Audit of Natural Resource of Leading Cadres (for Trial Implementation)”, and the accountability audit of natural resource entered the stage of comprehensive promotion.

At present, the accountability audit of air pollution control in China can not meet the needs of air pollution control situation. There are many problems, such as the audit scope is small, the audit content is not comprehensive, the audit method is not advanced, and the audit effect is not outstanding [1]. Therefore, it is necessary to discuss the theory and status of the accountability audit of air pollution control, and to build a quantifiable audit evaluation index, so as to promote the implementation of the accountability audit of air pollution control.

2. Theoretical analysis on the accountability audit of air pollution control

2.1. The connotation of the accountability audit of air pollution control
The air pollution control is a key area of accountability audit of natural resource. The accountability audit of air pollution control refers to the comprehensive audit of the development, utilization, pollution control of the air resources performed by the main leading cadres during their term of office [2].
2.2. The objective of the accountability audit of air pollution control
The objective of accountability audit of air pollution control is to objectively evaluate the responsibility of the audited leading cadres for air pollution control by auditing the performance of air resource management and ecological environment protection during their term of office, define the responsibility for the found problems, put forward audit suggestions and urge relevant departments to rectify and improve the level of air pollution control.

2.3. The content of the accountability audit of air pollution control
In accordance with the requirements of the “Regulations on the Accountability Audit of Natural Resource of Leading Cadres (for Trial Implementation)”, the contents of the accountability audit of air pollution control should include the implementation of air pollution control policies, the leading cadres' compliance with the laws and regulations on the air pollution control, major decision-making of air pollution control, the completion of specific indicators specified in relevant documents of air pollution control, implementation of the responsibility of air pollution supervision, the management of air pollution control funds and project construction and operation.

3. Current situation of the accountability audit of air pollution control

3.1. Implementation of the accountability audit of air pollution control
According to the relevant audit news published on the website of the National Audit Office, audit institutions have used mapping remote sensing, automatic monitoring, multi-dimensional analysis and other technical methods to carry out the accountability audit of natural resource in recent years. However, at present, the accountability audit of natural resource mainly focuses on water resources, land resources, forestry resources, marine resources and so on. The accountability audit of air pollution control carried out by auditors is relatively few. The accountability audit of air pollution control mainly focuses on the completion of relevant air pollution control indicators, the management of special funds for air pollution control, the elimination of coal-fired boilers, the completion of clean heating transformation tasks, etc.

3.2. Effect analysis of the accountability audit of air pollution control
Huang Rongbing et al. (2019) used the DID model to investigate the role of the accountability audit of natural resource in the control of air pollution. Through the comparison between the pilot cities and non-pilot cities, it was found that the accountability audit of natural resource promoted the emission reduction of PM$_{10}$ and PM$_{2.5}$ in the pilot areas, reduced the emission peak of SO$_2$ and other pollutants, but did not bring the overall improvement of air quality [3].

In order to analyze the control of air pollution in China, this paper makes statistics on the air quality of 338 cities at prefecture level and above from 2016 to 2018 according to the bulletin of China's ecological environment [4]. From the statistical analysis of the average concentration of the main air pollutants in Table 1, it can be seen that the average concentration of the main air pollutants PM$_{2.5}$, PM$_{10}$, SO$_2$ and CO decreased year by year, but the decreasing range is very small. The average concentration of O$_3$ increased year by year, and the average concentration of NO$_2$ remained at about 30 μg/m$^3$.

| Index | Unit   | 2016 | 2017 | 2018 |
|-------|--------|------|------|------|
| PM$_{2.5}$ | μg/m$^3$ | 47   | 43   | 39   |
| PM$_{10}$  | μg/m$^3$ | 82   | 75   | 71   |
| O$_3$     | μg/m$^3$ | 138  | 149  | 151  |
| SO$_2$    | μg/m$^3$ | 22   | 18   | 14   |
| NO$_2$    | μg/m$^3$ | 30   | 31   | 29   |
| CO        | mg/m$^3$ | 1.9  | 1.7  | 1.5  |

Table 1. Average concentration of main air pollutants in 2016-2018.
It can be seen from Table 2 that from 2016 to 2018, the standard-reaching rate of ambient air quality showed an increasing trend year by year, and the proportion of days with AQI ≤100 basically remained at about 78%.

| Index                                         | 2016      | 2017      | 2018      |
|-----------------------------------------------|-----------|-----------|-----------|
| Standard-reaching rate of ambient air quality | 24.9%     | 29.3%     | 35.8%     |
| Proportion of days with AQI ≤100              | 78.8%     | 78.0%     | 79.3%     |

It can be seen that since the implementation of the accountability audit of air pollution control, the air pollution control situation in China has been improved, but the improvement effect is not obvious. Air pollution is still an important problem in the current period. To some extent, this shows that the effectiveness of the current accountability audit of air pollution control is not outstanding. The positive effect of accountability audit of air pollution control on air pollution reduction and air quality improvement is limited.

4. Evaluation index construction of the accountability audit of air pollution control based on PSR model

David J. Rapport and Tony Friend first proposed PSR model in 1979. The PSR model was subsequently developed and applied by the UNEP and OECD [5]. The PSR model includes pressure index, state index and response index. Pressure index refers to the impact and damage of human economic and social activities on natural resources and ecological environment, such as the pollution of air caused by the emission of SO$_2$ and nitrogen oxides. State index refers to the state of natural resources and ecological environment in a specific time period or point, such as the state of air quality. Response index refers to the preventive, remedial and recovery measures taken by human beings to deal with environmental problems, such as the establishment of pollutant emission standards in order to control air pollution.

On the one hand, the policy on air pollution control are the basis for the accountability audit of air pollution control of the leading cadres, and also the basic standard for the evaluation of the leading cadres in fulfilling the responsibility of air pollution control. Therefore, this paper refers to the latest policies on air pollution control when setting the relevant indicators. On the other hand, according to the basic principle of PSR model, following the principles of objectivity and operability, combined with the characteristics of air resources, this paper constructs the evaluation index of the accountability audit of air pollution control.

4.1. Pressure index construction

In areas with large population density, there will be more discharge of domestic garbage and harmful gases. Economic development can also lead to the increase of air pollutant emissions. Mining, manufacturing, construction and other secondary industries can produce a lot of air pollutants. SO$_2$, nitrogen oxide and dust are the main air pollutants. Therefore, this paper selects population density, per capita GDP, GDP proportion of secondary industry, SO$_2$ emissions, nitrogen oxide emissions and dust emissions as pressure indicators to evaluate the situation of leading cadres in reducing the pressure of air pollution control. The VOCs emissions, industrial exhaust emissions, the number of motor vehicles and coal energy consumption affects the total amount of air pollutants emissions and the composition of different pollutants. Auditors can judge how the leading cadres reduce the pressure of air pollution control according to the measured values of the indicators and the changes in different time periods. The larger the value of these indicators is, the worse the effect of leading cadres in reducing the pressure of air pollution control is. Table 3 shows the construction of pressure index for the accountability audit of air pollution control.
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Table 3. Pressure index for the accountability audit of air pollution control.

| Index type | Index level | Unit |
|------------|-------------|------|
| Pressure index | Population density | (person / km$^2$) |
|              | Per capita GDP | yuan |
|              | GDP proportion of secondary industry | % |
|              | SO$_2$ emissions | ton |
|              | Nitrogen oxide emissions | ton |
|              | Dust emissions | ton |
|              | VOCs emissions | ton |
|              | Industrial exhaust emissions | m$^3$ |
|              | Number of motor vehicles | |
|              | Coal energy consumption | ton |

4.2. State index construction

In carrying out the accountability audit of air pollution control, the audit institutions should focus on the inspection of the treatment of air pollutants. The state index can be expressed by the proportion of days with AQI ≤100, the annual average concentration of some air pollutants and acid rain frequency. The conventional air pollutants include PM$_{2.5}$, PM$_{10}$, SO$_2$, NO$_2$, O$_3$ and CO. In addition, according to the “List of Toxic and Harmful Air Pollutants (2018)”, the annual average concentrations of six volatile organic compounds and five heavy metals in the list are selected as state index. Table 4 shows the construction of state index for the accountability audit of air pollution control.

Table 4. State index for the accountability audit of air pollution control.

| Index type | Index level | Unit |
|------------|-------------|------|
| State index | Proportion of days with AQI ≤100 | % |
|            | Annual average concentration of PM$_{2.5}$, PM$_{10}$, SO$_2$, NO$_2$, O$_3$ | $\mu g/m^3$ |
|            | Annual average concentration of CO | mg/m$^3$ |
|            | Annual average concentration of CH$_3$Cl, HCHO, CHCl$_3$, C$_2$HCl$_3$, C$_2$Cl$_4$, CH$_3$CHO | mg/m$^3$ |
|            | Annual average concentration of cadmium and its compounds, chromium and its compounds, mercury and its compounds, lead and its compounds, arsenic and its compounds | mg/m$^3$ |
|            | Acid rain frequency | % |

Auditors can judge the effect of leading cadres in the control of air pollution according to the measured values of the above indicators. The improvement of the proportion of days with AQI ≤100 can reflect the efforts of leading cadres in the control of air pollution. The higher the concentration of conventional air pollutants and toxic and harmful air pollutants is, the more serious the degree of air pollution is. By checking the concentration change of air pollutants, auditors can evaluate whether the leading cadres have made a strong contribution to the control of air pollution. Acid rain belongs to air pollution. The reduction of acid rain frequency can show the effect of leading cadres in acid rain treatment.

4.3. Response index construction

In recent years, Chinese government has issued a series of policies to control air pollution and clearly pointed out that the local people's governments are responsible for the implementation of specific policies. Audit institutions need to audit the completion of the specific indicators in the relevant policies for leading cadres to carry out the accountability audit of air pollution control. According to the
main measures taken by leading cadres to carry out air pollution control, this paper selects relevant indicators, mainly including the allocation of air pollution control funds and project, total coal consumption control, vehicle exhaust emission control, dust control, industrial structure adjustment, transportation structure adjustment, straw burning control, agricultural ammonia emission control and enforcement of air pollution cases. According to the measured values of specific indicators, auditors can judge the leading cadres' management of air pollution control funds and the implementation of air pollution control policies. Table 5 shows the construction of response index for the accountability audit of air pollution control.

| Table 5. Response index for the accountability audit of air pollution control. |
|-----------------|-----------------|-----------------|
|Control methods | Index level      | Unit            |
|-----------------|-----------------|-----------------|
|Fund allocation and project | Investment in air pollution control | yuan |
|Number of key air pollution control projects |
|Total coal consumption control | Number of coal-fired boiler demolition | m³ |
|Gas for "coal to gas" project |
|Vehicle exhaust emission control | Number of buses per 10000 people | % |
|Proportion of new energy vehicles |
|Emission qualification rate of diesel vehicle | % |
|Qualified rate of diesel and vehicle urea | % |
|Number of vehicles with high emission eliminated |
|Dust control | Road mechanized cleaning rate | % |
|Green coverage area | hectare |
|Industrial structure adjustment | Relocation progress of heavily polluted enterprises | % |
|Closure schedule of eliminated projects | % |
|Transportation structure adjustment | Proportion of enterprise railway transportation | % |
|Straw burning control | Comprehensive utilization rate of straw | % |
|Agricultural ammonia emission control | Fertilizer utilization rate | % |
|Comprehensive utilization rate of livestock manure | % |
|Enforcement of air pollution cases | Number of air pollution administrative penalty cases |

When carrying out the accountability audit of air pollution control, audit institutions can refer to the above evaluation index system, select indicators in combination with the energy structure, industrial structure, characteristics of air pollution sources in different regions, and use AHP and PCA to evaluate, so as to realize the quantitative evaluation of the accountability audit of air pollution control of leading cadres. For example, the primary pollutant in Nanjing and Xiamen is nitrogen dioxide. When carrying out the accountability audit of air pollution control in these cities, auditors should take the concentration of nitrogen dioxide as a state index.

5. Conclusion
By analyzing the current situation of air pollution control in China, it is found that the emission concentration of PM$_{2.5}$, PM$_{10}$, SO$_2$, NO$_2$, O$_3$ and CO has not been effectively reduced, the air quality standard rate is still low, and the effect of air pollution control is not outstanding. Based on the PSR model, this paper constructs the pressure index, status index and response index of the air pollution control audit based on the latest policy documents, in order to evaluate the reduction of air pollution control pressure, the treatment of air pollutants and the implementation of air pollution control policies.
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