A Study on Management Standards and Assessment Model for the Atmospheric Environment of Ports

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1. Purpose

▸ The purpose of this study is to develop the Standards of Management Activities for Port Atmospheric Environment (draf t)[5] and its optimal assessment model, which corresponds with the reality of Korean ports, and to explore and find policy measures to introduce and utilize them.

- These efforts will allow domestic ports to achieve sustainable management of atmospheric environment, while providing main agents of implementation such as port authorities and local governments with policy and technological basis for effectively implementing and assessing relevant regulations.

5) It presents classification system and major methodologies of management activities of port atmospheric environment in accordance with concepts, types and attributes.

〈Table 1〉 Purpose of this study

Purpose	Expected effects
• Developing the Standards of Management Activities for Port Atmospheric Environment (draft) and its optimal assessment model, which corresponds with the reality of Korean ports • Seeking policy measures for introducing and utilizing management standards (draft) and assessment model	• Preparing policy and technological methodologies to identify health and environmental impacts resulting from ports' activities and preemptively manage them and organize necessary works, organizations and operational systems → Promoting the sustainable operation of port environment which goes beyond the demand of complying with domestic and foreign laws and regulations → Enhancing eco-friendly technological and operational capacity of national port authorities / local governments

Source: Prepared by the author

2. Methodology and Feature

1) Methodology

▸ Major methods used in this study include a review of domestic and foreign relevant literature, focus group interview (FGI) with experts in individual field and experts' survey and analysis. These methods intend to summarize the types and concepts of management activities of atmospheric environment in ports, while organizing the present status and trends at home and abroad.

▸ The classification system and content of the 'Standards of Management Activities of the Atmospheric Environment at Ports' were confirmed after reflecting the opinion of experts in each

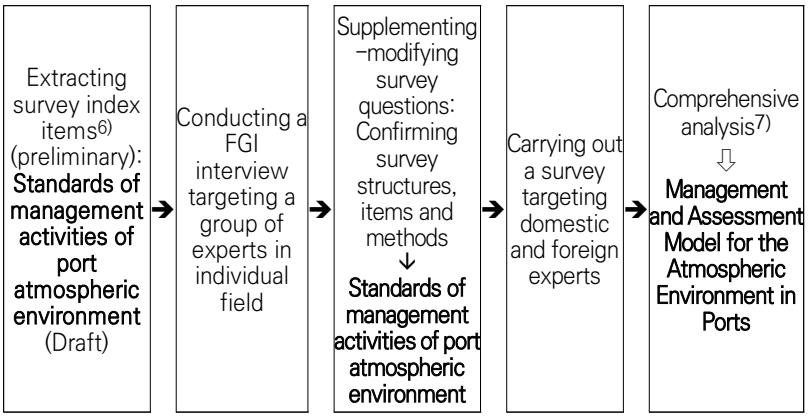
filed on the draft investigated and produced by researchers. In addition, an analysis model was designed to extract the optimal assessment model.

- This study also utilized a comparative analysis of domestic and foreign policy cases and laws surrounding management guidelines and assessment systems regarding atmospheric environment in ports as well as an analysis of domestic and foreign pending issues. These efforts resulted in a draft of limitations in operating the managerial systems of atmospheric environment in Korean ports as well as types and concepts of management activities of atmospheric environment in ports.

  → Based on aforementioned analyses, the study extracted index items (standards of management activities, criteria of classification by types and items) and content were drawn after modification and confirmation based on in-depth interview with domestic and foreign experts as well as working level groups and consultation meetings etc.). Following this process, the hierarchy of higher and lower attributes (areas and types) was established.

- After that, a survey was conducted targeting domestic and foreign experts selected based on their expertise in individual sector relevant to port atmospheric environment. Summarizing the results of the survey, the study extracted and analyzed relative importance for each type and activity of atmospheric environment management at ports. Based on this result, it presented the 'Management and Assessment Model for Atmospheric Environment in Korean Ports'.

〈Picture 1〉 Process of Experts' survey – Analysis



Source: Prepared by the author

2) Feature

- This study was designed and carried out as a joint study with Korea's major port authorities (BPA and IPA), a direct consumer of the study's results and China (China Waterborne Transport Research Institute) whose geographical environment is similar to Korea.
- The scope of expert groups was not limited to Korea but rather extended to experts in China and Europe in the field of port operation and atmospheric environment. With this effort, the experts' survey was able to comprehensively reflect external perspectives and opinions, not limited to domestic viewpoints.

6) ② assessing the priority and weight per each attribute/activity of management activities of atmospheric environment in Korean ports.
7) ① Utilizing the Fuzzy analysis, it prepared assessment criteria and standard framework for management activities of atmospheric environment in Korean ports,

3. Results

1) Summary

▸ Comparative analysis of domestic and foreign regulations surrounding port atmospheric environment

- In order to realize the genuine purpose of atmospheric environment management in ports, this study selected items for 'management activities of port atmospheric environment' required by main agents of implementation and then classify them based on specific standards and attributes.

  → After that, it compared and analyzed the contents of current domestic and foreign regulations in the form of reviewing whether specific item is included and reflected or not, while focusing on major activity items. And then it identified a gap in the requirements or levels to achieve the sustainability of port atmospheric environment.

▸ Limitations of atmospheric environment management system in domestic ports

- **(Misleading purposes and methodologies of port atmospheric environment management policy)** The 'Special Act on the Improvement of Air Quality in Port and Other Areas' (hereinafter as 'Special Act on Air Quality in Ports'), subordinate laws, a comprehensive plan, major policies that have been implemented and R&D projects have been focusing on strategic goals for the so-called mid-point such as emission reduction or reduction technology development than the ultimate goals

- **(Lack of the basic background data for the development and application of a policy)** Production and acquisition of accurate data was insufficient which represents the present status of emissions from domestic ports and ships, the distribution of pollution concentrations and their resulting health impact on local communities.
- **(Lack of rationale for the role of supervision and management)** There is a lack of legal and institutional grounds for the actual implementation of major policies stipulated in the 'Special Act on Air Quality in Ports' and regulations. This includes clear regulations in regards to work boundaries and jurisdictions among government ministries and departments and between local governments and port authorities.
- **(Lack of consistent standards and standardized methodologies per management activity)** Providing consistent standards and methodologies are urgently necessary to enable main agents such as local governments and port authorities to implement policy and technological measures required by recently enacted Special Acts etc.
- **(Sluggish development and introduction of new and alternative technologies)** Efforts for conducting R&D for reducing 'emission and pollution dispersion from ports' as well as further developing a new technological paradigm have been insignificant which can maximize the cost efficiency.

〈Table 3〉 Necessity for Management Standards and Assessment Model of Port Atmospheric Environment

Limitations of atmospheric environment management system in domestic ports		Improvement through introduction and utilization of management standards and assessment model of port atmospheric environment
Misleading purposes and methodologies of port atmospheric environment management policy		• Strategic approach considering distinctive social, economic, and geographical features of individual ports or specific regions(selection/introduction–implementation–assessment) • Establishing management and operational strategies for port atmospheric environment
Lack of the basic background data for the development and application of a policy	➔ Development and application of the management standards and assessment model of port atmospheric environment	• Writing and assessing an emission inventory by investigating emission sources of air pollutants in ports and calculating the amount of emissions. • Building a network for measuring pollution inside and outside of ports • Pushing forward analysis and forecasting the movement, dispersion and impact to local communities of emission
Lack of rationale for implementation roles, Lack of consistent standards and standardized methodologies		• (National level) Preparing and announcing requirements and guidelines (methodologies) of major management activities • (National level) Providing laws and systems as a clear basis for supervision, management, regulations and incentives • Establishing working system dedicated to the management of port atmospheric environment

Sluggish development and introduction of new and alternative technologies	• Developing and localizing highly efficient new technologies in the form of appropriate technology • Developing and introducing a program to support leading alternative technologies • Building new technology for analysis, forecasting and automatic control in the form of smart connectedness as well as it platform

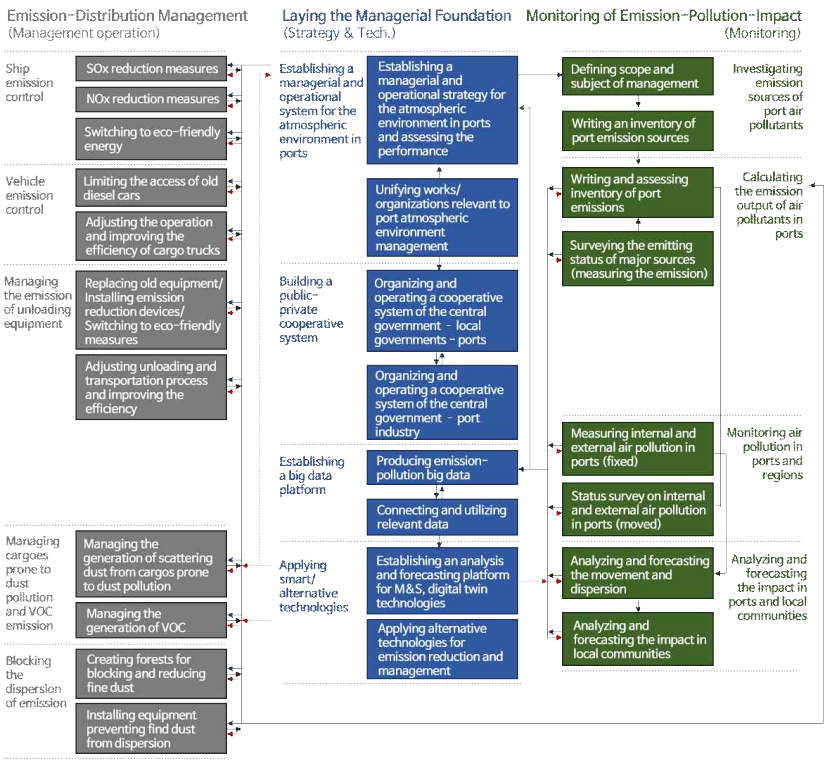
Source: Prepared by the author

▸ Standards of Management Activities for Port Atmospheric Environment

- The total of 27 specific activities required for achieving the genuine purpose of port atmospheric environment policies are classified into 13 activity items and then subdivided into 6 groups of lower attributes as follows; ① establishing a managerial and operational system of port atmospheric environment, ② applying smart and alternative technologies, ③ investigating emission sources of air pollutants in ports and estimating the amount of emission ④ monitoring, analyzing and forecasting air pollution-impact in ports and regions, ⑤ managing combustible emissions, and ⑥ managing the occurrence and leakage of non-combustibles.

- Lastly, the highest items in the concept of large classification include the following 3 areas including: ①building a managerial basis at the port and regional level, ② monitoring the process of 'Emission-Pollution-Impact' in ports and ③ managing emission sources at ports.

〈Picture 2〉 Structural concept of management standards (draft)



Source: Prepared by the author

- Activities for 'laying the managerial foundation at the level of ports and local governments' are classified into two; one for preparing the ground for policy implementation which is followed by ① setting up a strategy and rearranging implementation systems. The other activity is for 'building the foundation for applying new technologies' which intends to develop and apply ② smart technologies based on big data, wired and wireless networks (IoT) and artificial intelligence (AI) as well as leading alternative technologies capable of innovating existing paradigms.

〈Table 4〉 Structure of Management Standards: Laying the Managerial Foundation at the level of Ports and Local Governments

Attribute	Activity	Activity (detailed)	Concept
Establishing a managerial and operational systems for the atmospheric environment in ports	Establishing a managerial and operational systems for the atmospheric environment in ports	Establishing a managerial and operational strategy for the atmospheric environment in ports and assessing the performance	Establishing a managerial and operational systems and drawing requirements for correction and supplement through assessment
		Unifying works/organizations relevant to ports' atmospheric environmental management	Organizing and unifying a dedicated department to improve the efficiency of works relevant to port atmospheric environment
	Building a public-private cooperative system	Organizing and operating a cooperative system of the central government-local governments-ports	Establishing a common goal at the regional and ports level and formulating cooperation measures as well as a cooperative system for joint response
		Organizing and operating a cooperative system of the central government-port industry	Discussing relevant issues together with the government and the private sector, formulating and operating communication/discussion channels for adjusting interest
Applying smart/ alternative technologies	Establishing a big data platform	Producing emission-pollution big data	Constructing big data of basic information by switching the basic data cycle of 'reporting-collection' into 'real-time' collection

Attribute	Activity	Activity (detailed)	Concept
		Connecting and utilizing relevant data	Building a continued sharing and connecting system through consultation with other departments and organizations
	Applying smart/ alternative technologies	Establishing an analysis and forecasting platform for M&S, digital twin technologies	Building and operating intelligence- based platform for analysis and forecasting driven by policy demands with phased-in application of M&S and digital twin technologies etc.
		Applying alternative technologies for emission reduction and management	Developing, adopting and operating leading technologies, in other words, 'highly cost-effective' alternative reduction technologies

Source: Prepared by the author

- Monitoring of emission-pollution-impact of ports' consists of processes for establishing strategies for the area of 'laying the managerial foundation at the level of ports/local governments' as well as securing and producing basic data for technological development and application. This process can be classified into the following two; ① 'writing an emission inventory including investigating sources of air pollutants and ② 'identifying and analyzing the movement and dispersion of pollution concentrations in the air and its resulting impact to local communities.'

〈Table 5〉 Structure of Management Standards: Monitoring 'Emission-Pollution-Impact'

Attribute	Activity	Activity (detailed)	Concept
Investigating sources of air pollutants in ports and calculating the emission output	Investigating sources of air pollutants in ports	Defining scope and target for management	Designating geographical and task-wise scope of management activities of port atmospheric environment and confirming the subject of survey accordingly
		Writing an emission inventory	Collecting and summarizing the operational status, data information and activity data per emission sources in individual ports through investigating emission sources
	Calculating the emission output of air pollutants in ports	Writing and assessing an emission inventory	Estimating the emission output of individual ports per sources, air pollutants and periods and make an assessment
		Surveying the emitting status of major sources (measuring the emission)	Measuring individual emission sources to verify and supplement the accuracy of the estimation results
Monitoring / analyzing and forecasting the air pollution-impact in regions and ports	Monitoring air pollution in ports and regions	Measuring internal and external air pollution in ports (fixed)	Measuring and collecting pollution concentrations of a particular air pollutants through fixed measurement network
		Status survey on internal and external air pollution in ports (moving)	Carry out the measurement through movement (vehicles etc.)
	Analyzing and forecasting the impact in ports and local communities	Analyzing and forecasting the movement and dispersion	Identifying the mechanism and movement pattern from the 2nd order response of emitted pollutants in the air and then analyzing and forecasting

Attribute	Activity	Activity (detailed)	Concept
			movement and dispersion patterns in accordance with changing conditions of emission and pollution
		Analyzing and forecasting the impact in ports and regional communities	Forecasting the degree of danger in accordance with changing individual conditions and environment by measuring and analyzing the level of health damage having impact on local communities

Source: Prepared by the author

- 'Management of emission sources in ports' is the processes of actually performing direct activities for reducing and preventing the emission for the purpose of improvement air quality in accordance with the strategy already established. The process can be classified into the following two which includes; ① activities for reducing and preventing air pollutants generated and emitted during the combustion process for operating main sources of emission in ports such as ships, cargo trucks and unloading equipment etc. and ② activities for reducing the leakage or preventing VOCs as well as scattering dust which can be generated during unloading and distribution process, and activities for blocking and reducing the movement and dispersion of pollutants already emitted in the air.

〈Table 6〉 Structure of Management Standards: Management of Emission Sources in Ports

Attribute	Activity	Activity (detailed)	Concept
Managing combustible emissions	Ship emission control	SOx reduction measures	Applying methodologies for reducing and preventing SOx emissions
		NOx reduction measures	Applying methodologies for reducing and preventing NOx emissions
		Switching to eco-friendly energy	Switching or supporting to clean energy such as LNG and LPG powered drive methods and drive methods for selectively combining gasoline, diesel, LPG and natural gas with electric power
	Vehicle emission control	Limiting the access of old diesel cars	Limiting the access of sub-standard old cargo trucks into ports by replacing old cars with new cars to meet emission standards, or installing emission reduction devices in accordance with the law
		Adjusting the operation and improving the efficiency of cargo trucks	Improving the efficiency of movement and transportation within ports by adjusting the operation and allocation of cargo trucks and resultantly boosting energy efficiency to reduce emissions
	Managing the emission of unloading equipment	Replacing old equipment/ Installing emission reduction devices/ Switching to eco-friendly measures	Replacing or upgrading old unloading equipment with new ones / In the case that the replacement is not available, installing emission reduction devices to meet emission standards or supporting the switch into eco-friendly drive methods

Attribute	Activity	Activity (detailed)	Concept
		Adjusting unloading and transportation process and improving the efficiency	Improving the efficiency of energy or jobs within cargo handling areas by rearranging the order or allocation of unloading and transportation process
Managing the generation / leakage of non-combustibles	Managing cargoes prone to dust pollution and VOC emission	Managing the generation of scattering dust from cargos prone to dust pollution	Applying methodologies for reducing and preventing the generation and dispersion of scattering dust during the process of unloading, transporting and storing cargos prone to dust pollution
		Managing the generation of VOC	Applying methodologies for preventing the emission of VOC (Volatile Organic Compound)
	Blocking the dispersion of emission	Creating forests for blocking and reducing fine dust	Creating forests for blocking and reducing the movement and distribution of air pollutants already emitted into the air
		Installing equipment preventing find dust from dispersion	Installing outdoor air purifiers for blocking and reducing the movement and dispersion of air pollutants already emitted into the air

Source: Prepared by the author

▸ Assessment Model for the Management of Port Atmospheric Environment

- Based on the classification system of 'Management Standards of Port Atmospheric Environment', this study presents an 'Assessment Model for the Management of Port Atmospheric Environment' with which includes assessment criteria per items

for assessing the capacity and outcome of management activities of port atmospheric environment (draft) [8] as well as weights (relative importance) as major contents.

〈Table 7〉 Relative weights (priority) between specific activities

Area	Attribute (priority/total)	Activity (priority/total)	Specific activity (priority/total)	Weight
① Laying the managerial foundation at the level of ports and regions	①-1. Establishing a managerial and operational systems for the atmospheric environment in ports (2/6)	①-1-1. Establishing a managerial and operational systems for the atmospheric environment in ports (1/13)	Establishing a managerial and operational strategy for the atmospheric environment in ports and assessing the performance (1/27)	0.0497
			Unifying works/organizations relevant to ports' atmospheric environmental management (3/27)	0.0448
		①-1-2. Building a public-private cooperative system (5/13)	Organizing and operating a cooperative system of the central government - local governments - ports (8/27)	0.0428
			Organizing and operating a cooperative system of the central government - local governments - ports (9/27)	0.0428

8) See pp.241~258 of this study for more information.

Area	Attribute (priority/total)	Activity (priority/total)	Specific activity (priority/total)	Weight
	①-2. Applying smart/ alternative technologies (5/6)	①-2-1. Establishing a big data platform (3/13)	Producing emission-pollution big data (4/27)	0.0445
			Connecting and utilizing relevant data (10/27)	0.0425
		①-2-2. Applying smart/ alternative technologies (13/13)	Establishing an analysis and forecasting platform for M&S, digital twin technologies (22/27)	0.0297
			Applying alternative technologies for emission reduction and management (24/27)	0.0276
② Monitoring the emission - pollution - impact in ports	②-1. Investigating sources of air pollutants in ports and calculating the emission output (3/6)	②-1-1. Investigating sources of air pollutants in ports (4/13)	Defining scope and target for management (5/27)	0.0433
			Writing an emission inventory (6/27)	0.0432
		②-1-2. Calculating the emission output of air pollutants in ports (2/13)	Writing and assessing an emission inventory (2/27)	0.0492
			Surveying the emitting status of major sources (measuring the emission) (11/27)	0.0425
	②-2. Monitoring / analyzing and forecasting the air pollution -	②-2-1. Monitoring air pollution in ports and regions (6/13)	Measuring internal and external air pollution in ports (fixed) (7/27)	0.0432

Area	Attribute (priority/total)	Activity (priority/total)	Specific activity (priority/total)	Weight
	impact in regions and ports (6/6)		Status survey on internal and external air pollution in ports (moving) (19/27)	0.0337
		②-2-2. Analyzing and forecasting the impact in ports and local communities (10/13)	Analyzing and forecasting the movement and dispersion (20/27)	0.0332
			Analyzing and forecasting the impact in ports and regional communities (18/27)	0.0338
③ Managing the sources of emission in ports	③-1. Managing combustible emissions (1/6)	③-1-1. Ship emission control (8/13)	SOx reduction measures (23/27)	0.0286
			NOx reduction measures (25/27)	0.0266
			Switching to eco-friendly energy (27/27)	0.0199
		③-1-2. Vehicle emission control (11/13)	Limiting the access of old diesel cars (17/27)	0.0342
			Adjusting the operation and improving the efficiency of cargo trucks (21/27)	0.0308
		③-1-3. Managing the emission of unloading equipment (12/13)	Replacing old equipment/ Installing emission reduction devices/ Switching to eco-friendly measures (14/27)	0.0380

Area	Attribute (priority/total)	Activity (priority/total)	Specific activity (priority/total)	Weight
			Adjusting unloading and transportation process and improving the efficiency (26/27)	0.0260
	③-2. Managing the generation / leakage of non-combustibles (4/6)	③-2-1. Managing cargoes prone to dust pollution and VOC emission (7/13)	Managing the generation of scattering dust from cargos prone to dust pollution (15/27)	0.0374
			Managing the generation of VOC (12/27)	0.0391
		③-2-2. Blocking the dispersion of emission (9/13)	Creating forests for blocking and reducing fine dust (16/27)	0.0343
			Installing equipment preventing find dust from dispersion (13/27)	0.0384

Source: Prepared by the author

▸ Introduction and utilization of an Assessment Model for the Management of Port Atmospheric Environment

- The followings are the ways to overcome the limitations of the existing system and further achieving the genuine purpose of the atmospheric environment management at ports through the introduction and utilization of the port atmospheric environment management standards (draft) and assessment model.
- Establishing a virtuous circle via the assessment and reflection of implementation performance

〈Table 8〉 Introduction and Utilization of Evaluation Model: Assessing and Reflecting Implementation Performance

Limitations of Existing Domestic Port Atmospheric Environment Management		Improvement Plan via Introduction/Utilization
Area	Description	
Misleading the purpose of port atmospheric environment management policy and methodologies	• Focusing more on the strategic goals for the so-called mid-point such as emission reduction or reduction technology development than the ultimate goals. • Accepting the domestic and overseas regulative items and levels successively or totaling and aggregating the existing major measures for emission reduction by individual emission sources.	• Strategic approaches in consideration of social, economic, geographical environment inherent to individual ports or relevant regions (selection/introduction-implementation-assessment) • Establishing managerial and operational strategies for the port atmospheric environment → Reflecting them in the establishment of the (national) comprehensive plan and (local government) detailed policy

Source: Prepared by the author

- Calculating and connecting accurate basic data.

〈Table 9〉 Introduction and Utilization of Assessment Model: Calculating and Connecting Basic Data

Limitations of Existing Domestic Port Atmospheric Environment Management		Improvement Plan via Introduction and Utilization
Area	Description	
Lack of basic background data for the development and application of a policy	• Lack of the accurate data of the current status on emissions from domestic ports and ships, the distribution of pollution concentrations and the resultant health impact on the local communities.	• Developing and assessing an emission inventory by investigating the sources of air pollutants at ports and calculating emissions. • Establishing an air pollution monitoring network in and out of ports.

Limitations of Existing Domestic Port Atmospheric Environment Management		Improvement Plan via Introduction and Utilization
Area	Description	
	• The official announcement of the statistics on the national air pollutant emissions has been delayed for three years.	• Pushing ahead with the analysis and forecasting on the movement and dispersion of emitted materials and their impact on local communities. → Reflecting them in the establishment of the (national) comprehensive plan and (local government) detailed policy

Source: Prepared by the author

- Preparing the standards for a joint management with the central government, ports and local governments

〈Table 10〉 Introduction and Utilization of Assessment Model: Preparing the Management Standards

Limitations of Existing Domestic Port Atmospheric Environment Management		Improvement Plan via Introduction and Utilization
Area	Description	
Lack of the rationale for the implementation roles, the consistent standards and standardized methodologies	• Lack of consistent standards and methodologies for major implementation agencies such as local governments and port authorities to implement policy and technical measures. • Lack of legal ground such as work and jurisdiction boundaries and among government ministries and departments and between local governments and port authorities	• Preparing and announcing requirements for (national) major management activities and guidelines (methodologies) • Preparing the legal system with the clear rationale for the (national) supervision, regulation and incentives • Establishing a work system dedicating to the port atmospheric environment management. → Reflecting them in the establishment of the (national)

Limitations of Existing Domestic Port Atmospheric Environment Management		Improvement Plan via Introduction and Utilization
Area	Description	
		comprehensive plan and (local government) detailed policy.

Source: Prepared by the author

- Establishing a joint response system for the improvement of atmospheric environment in port areas

〈Table 11〉 Introduction and Utilization of Assessment Model: Establishing a Joint Response System

Limitations of Existing Domestic Port Atmospheric Environment Management		Improvement Plan via Introduction and Utilization
Area	Description	
Lack of public-private cooperation and joint response plans	• Lack of legal ground for creating a cooperation and joint response system among government ministries and departments, local governments, port authorities and related organizations and the port industry • Establishing the public-private joint response system is necessary to implement policies surrounding the port atmospheric environment	• Formulating and operating a cooperation system of the central government-local governments-ports as well as that of the central government-the port industry → Reflecting them in the establishment of the (national) comprehensive plan and (local government) detailed policy

Source: Prepared by the author

- Working on a pacesetting development and introduction of new and alternative technologies for reducing and controlling emissions from ports

〈Table 12〉 Introduction and Utilization of Assessment Model: Developing and introducing new and alternative technologies

Limitations of Existing Domestic Port Atmospheric Environment Management		Improvement Plan via Introduction and Utilization
Area	Description	
Sluggish development and introduction of new and alternative technologies	• Recommending the extensive implementation of international standards or introducing technologies and products already operating at major ports, rather than developing technologies of the new paradigm or applying new technologies on a trial basis. • Existing legislations lack provisions regarding the development and utilization of technologies to reduce emissions from ports	• Developing and localizing highly cost efficient new technologies in the form of appropriate technology • Developing and introducing a pacesetting 'alternative technology support program' • To analyze/forecast the Smart Connected concept and establish the new automatic control technology and platform. • Building new technology for analysis, forecasting and automatic control in the form of smart connectedness as well as it platform

Source: Prepared by the author

2) Policy suggestions and relevant activities

▸ Preparing a 'guideline on the establishment of the strategy to improve air quality in ports and regions' at the national level

〈Table 13〉 Short- and Mid-term Major Tasks (2020~2022)

Implementation task	Main agent
Developing the 'Management Standards for the Port Atmospheric Environment' and its assessment model → Working on reflecting it to and amending the 'Special Act on the Improvement of Air Quality in Port and Other Areas'	Marine Environment Policy Division, etc. of the Ministry of Oceans and Fisheries

Implementation task	Main agent
→ Applying it to domestic ports on a trial basis and work on the international standardization	
Creating an organization or agency dedicating to works surrounding the port atmospheric environment management + Forming a presidential/prime ministerial organization dedicating to the port atmospheric environment + Coordinating and adjusting interests among government ministries and departments	The Office for Government Policy Coordination, all government ministries and departments
Establishing a 'guideline for managerial and operational strategies of the port atmospheric environment' + Guidelines (methodologies) by management activities and reference demand survey, etc. + Reflecting the results of implementation assessment into the comprehensive plan	Marine Environment Policy Division, etc. of the Ministry of Oceans and Fisheries ※ Consultation and cooperation is required with related departments such as the Maritime Industry and Technology Division and Port Technology and Safety Division, etc.
Establishing the 'Port Atmospheric Environment Management and Operation Strategy' by ports. → Establishing and announcing (update) the strategy and disclosing its results on an annual basis	Jointly pushing ahead with local governments and port authorities
Building a joint response system for improving the atmospheric environment with local governments and port authorities → Working on reflecting it to and amending the 'Special Act on the Improvement of Air Quality in Port and Other Areas'	Jointly working with the Regional Oceans and Fisheries Offices, River Basin Environmental Offices, local governments, port authorities, etc.
Building and operating a public-private cooperation and consultation program for the improvement of air quality at ports and port cities → Working on reflecting it to and amending the 'Special Act on the Improvement of Air Quality in Port and Other Areas'	Jointly working with the Marine Environment Policy Division, etc. of the Ministry of Oceans and Fisheries (national level) and local governments, port authorities, etc. (by individual ports and regions)

Implementation task	Main agent
Working on the launch of a regional cooperative organization for port and shipping areas with air pollution, including Northeast Asia/+ASEAN, etc. ※ Joint response to international current issues, knowledge and experience sharing etc. → Working on reflecting it to and amending the 'Special Act on the Improvement of Air Quality in Port and Other Areas'	Ministry of Oceans and Fisheries

Source: Prepared by the author

▸ Producing the basic data for improving the port atmospheric environment and preparing a plan for connecting them

〈Table 14〉 Short- and Mid-term Major Tasks (2020~2022)

Implementation task	Main agent
Preparing a plan for connecting and sharing data among related ministries and departments as well as organizations for calculating the basic data to monitor air pollution at ports → Mandating government ministries and departments for connecting and sharing the data and reflecting it to and amending the 'Special Act on the Improvement of Air Quality in Port and Other Areas'	Marine Environment Policy Division, Maritime Industry and technology Division, etc. of the Ministry of Oceans and Fisheries ※ Consultation/cooperation is required with related ministries and departments and their affiliated organizations such as the Ministry of Oceans and Fisheries, Ministry of Land, Infrastructure, and Transport, Ministry of Health and Welfare, etc.
Developing a guideline on the preparation for emission sources classification system from ports, an emission calculation system and an emission inventory → Announcing the guidelines, etc. and reflecting it to and amending the 'Special Act on the Improvement of Air Quality in Port and Other Areas'	Environment Policy Division, etc. of the Ministry of Oceans and Fisheries ※ Consultation and cooperation is required with related ministries and departments such as the Maritime Industry and technology Division, Port

Implementation task	Main agent
	Technology and Safety Division, etc. by emission sources ※ Consultation and cooperation is required with related ministries and departments such as the Ministry of Environment (National Institute of Environmental Research, National Center for Fine Dust Information)
Surveying the emission sources by ports and preparing an emission inventory → Establishing and assessing (update) a strategy and disclosing its results on an annual basis + Reflecting the results into the comprehensive plan	Jointly working with local governments and port authorities Environment Policy Division, etc. of the Ministry of Oceans and Fisheries
Developing the guideline and standards on the measurement of air pollution at ports and the identification of its movement and diffusion as well as its resulting impact → Announcing the guidelines, etc. and reflecting it to and amending the 'Special Act on the Improvement of Air Quality in Port and Other Areas'	Environment Policy Division, etc. of the Ministry of Oceans and Fisheries ※ Consultation and cooperation is required with related ministries and departments such as the Ministry of Environment (National Institute of Environmental Research, National Center for Fine Dust Information)
Building and operating a (fixed/moving) monitoring network for measuring air pollution within the land and sea areas of ports	
Incorporating the emission calculation system by emission source and air pollutants at ports into the statistics on air pollutant emissions	Ministry of Environment (National Institute of Environmental Research, National Center for Fine Dust Information).
Improving the problem of delay taking place from calculation – announcement of air pollutant emissions from ships and ports	

Source: Prepared by the author

▸ Launching a leading technology program for reducing air pollution at ports

〈Table 15〉 Short- and Mid-term Major Tasks (2020~2022)

Implementation task	Main agent
Preparing a plan of securing finances in order to develop and support leading technologies for reducing air pollution at ports → Reflecting it to and amending the 'Special Act on the Improvement of Air Quality in Port and Other Areas'	Environment Policy Division, etc. of the Ministry of Oceans and Fisheries
Introducing and operating a leading technology program for reducing and controlling air pollution at ports + The classification system for port air pollution reduction technologies and the demand survey, setting the priorities of technology development and introduction, etc. → Reflecting it to and amending the 'Special Act on the Improvement of Air Quality in Port and Other Areas'	Environment Policy Division, Port Management Division, Port Technology and Safety Division, etc. of the Ministry of Oceans and Fisheries

Source: Prepared by the author

3) Expected benefits including policy contribution

▸ Following the concept and type of management activities of the port atmospheric environment, this study presented the standards and an optimal assessment model. In the situation where there has yet to be a comprehensive review on the overall atmospheric environment management activities at domestic ports and the methodologies by the activities accordingly, this study will provide the guideline and standard for the nation or major implementation organizations to establish and implement their strategies and plans.

- Major agents of implementation such as local governments and port authorities can draw the demand of change and complementation for their own current operating strategies and related projects. In addition, they will identify their relative positions as well as weaknesses and strengths in relation to other ports and regions by applying the capacity and performance assessment model according to the consistent evaluation criteria. These processes will allow them to draw improvement plans and readjust their existing goals and strategies.

▸ This study provides a policy and technical foundation for achieving the sustainable management of atmospheric environment in domestic ports. At the same time, this study enables major implementation organizations such as port authorities and local governments to effectively implement and evaluate related Special Acts.

- The study identifies health and environmental impacts resulting from port-related activities, which allows the preparation of policy and technical methodologies to preemptively prevent and control such impacts. In addition, it will contribute to the establishment of work-related, organizational and operating systems thereof, enhancing and improving the operational capacity of sustainable ports beyond the demand of complying with domestic and international legislations and regulations.

▸ By reflecting the items and criteria of the management standards and its assessment models, this study seeks the integrity of related special acts on the improvement of air quality in local

communities and the nation such as the 'Special Act on the Improvement of Air Quality in Port and Other Areas'.

- The government is able to accurately identify the demand such as specific methodologies and guidelines required to implement related legislations and plans, including special acts, develop and announce them, while further improving and complementing weaknesses of the current legal system.