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Research Article

An Assessment on the Readiness of the Philippine Domestic Shipping for the Implementation of Sulfur Cap Regulation under MARPOL Annex VI

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ABSTRACT

The study assessed the readiness of the Philippine domestic shipping sector for the implementation of the sulfur cap regulation under MARPOL Annex VI, focusing on Amoroso's dimensions of readiness: cultural refers to awareness and acceptance, structural that refers to the institutional and resources capacity and operational which refers to implementation capability. It examined the regulatory requirements, national policies, stakeholder awareness, capability-building initiatives, implementation and enforcement mechanisms, international and regional best practices, availability of incentives and funding, perceived challenges and measures to support compliance. Mixed methods approach was employed, using a concurrent triangulation design wherein qualitative and quantitative data were collected simultaneously and integrated during analysis to provide a comprehensive assessment of readiness. The findings revealed that the Philippines has a well-defined regulatory framework and a generally adequate level of stakeholder awareness. However, significant gaps remain in technical understanding, financial support mechanisms, and enforcement capacity. Capability-building initiatives are present but require enhancement, particularly through practical and scenario-based training. Although implementation follows a multi-agency approach, inconsistencies in enforcement and limited monitoring resources affect its effectiveness. Furthermore, the absence of dedicated financial incentives places additional burden on shipping companies, especially small and medium-sized operators. The study concludes that the Philippine domestic shipping sector is partially ready for sulfur cap implementation. Strengthening inter-agency coordination, capability-building programs, monitoring infrastructure, and financial support mechanisms is recommended to promote effective and sustainable compliance.

Keywords: *air pollution control, compliance readiness, environmental sustainability, inter-agency coordination, maritime governance, stakeholders awareness, sustainable compliance*

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Introduction

One of the most pressing environmental concerns in the world today is the air pollution. For more than three decades, air pollution was primarily attributed to land-based sources, such as industrial plants and motor vehicles (Campara et al., 2018). However, in recent years, increasing attention has been given to the contribution of marine transport, particularly due to emissions generated from ship engines using fossil-based fuels.

Air pollution poses significant impact to human health and to the environment as a whole. The primary pollutants of concern include nitrogen oxides (NO_x), particulate matter (PM), sulfur oxides (SO_x) and volatile organic compounds (VOCs) have comprehensive effect (EPA, 2022). A major environmental impact is the escalation of global temperature, the melting of the polar ice and the increasing sea level (European Environment Agency, 2023). Additionally, acid rain that causes damage to forest soil, and bodies of water by altering their pH level leading to the loss of biodiversity and the degradation of ecosystem. In the study of Romanello, (Romanello M. et al., 2021) key findings are that, the climate change and air pollution are intertwined with increased heat from global warming effectively worsening air quality. For its impact to human health, exposure to air pollutants can lead to respiratory issues. The World Health Organization (WHO, 2018) highlighted that over 90% of the global population breathes dirty air, leading to around 7 million deaths annually. Without effective air pollution control measures, the long-term consequences for both human health and environmental stability are severe.

In response to these challenges, the United Nations established sustainable development goals in 2015 which comprises of 17 SDG (United Nation, 2015). One of the goals, SDG 13, focuses on reducing greenhouse gas emission, strengthening resiliency to climate-related hazards, and promoting international cooperation on climate action (UN General Assembly, 2015). The United Nations Environment Program (UNEP, 2021) gives emphasis that improving air quality can lead to significant progress on multiple goals including good health, sustainable cities and communities and

climate action. It states that policy interventions such as transitioning to renewable energy, improving public transportation and implementing stricter emissions standards as critical to achieving the target of both health and climate goals.

The International Maritime Organization (IMO, 2014) forecasted an alarming increase in carbon dioxide and nitrogen oxides emissions in the shipping industry. The overall shipping emissions including international, local and the fishing sector in 2012 is 977 million tons, and in 2018 it increases to 1076 million tons (4th IMO GHG study, 2020). These rising trends calls the effort to decarbonize the shipping industry.

To address emissions from ships, the IMO introduces the 1997 Protocol which presents the MARPOL Annex VI. It aims to minimize the pollution at the atmosphere from ships by setting emission limit of SO_x, NO_x, and VOCs. Annex VI set parameter on the volume of SO_x in fuel, NO_x from engines and control VOCs emission from oil tankers. It also requires port to have reception facilities for ship generated wastes. It requires ship to establish measure to enhance energy efficiency. Annex VI also includes special areas with stricter regulation to protect sensitive environments. The Annex VI was updated overtime to address new environmental concerns and technological advancement.

The IMO laid out a strategy to significantly decrease GHG emission from international shipping. The IMO aimed to decrease carbon intensity for at least 40% in 2030 and in 2050, 70% reduction compared to 2008 level (Skuld, 2021).

MARPOL Annex VI was ratified by more than 96 countries, though the compliance varies across the globe. Countries like China, Singapore and Japan have enforced stringent regulations in fuel quality and invested in cleaner technologies such as scrubbers and alternative fuels. As highlighted in Romanello (Romanello, M. et al., 2021), the co-benefits on reducing air pollution by shifting to cleaner energy sources, can mitigate both health risk and the climate change.

The Philippines as an archipelagic country relies heavily on maritime transport for trade and livelihood with waterways serving as vital

transportation routes. The backbone of the Philippine maritime industry is the domestic shipping sector, which includes a wide range of commercial ships and small “bangkas” used by the fishermen. The Philippines, a developing country, bears 90% of the global burden of disease caused by air pollution (UNEP, 2020). For its part, the Philippine Government passed Climate Change Act of 2009 (R.A. No. 9729) which aims to systematically address the increasing threats of climate change on communities and the environment. This law was translated to National Climate Change Action Plan (NCCAP) and one of its priorities is the environmental-friendly industries and services which covers the maritime industry. This prioritizes campaign and development, energy efficiency and conservation, the sustainable environmental-friendly transport, the growth of sustainable and renewable energy, and the climate proofing and restoration of energy system infrastructure. Subsequently, Philippine Energy Plan (PEP 2023-2025) was developed by the Department of Energy (DOE) which outlines the country’s strategic roadmap toward a sustainable and resilient energy future.

The Philippine Government ratified the MARPOL Annex VI in 2019. To comply with this new international regulation, the Maritime Industry Authority (MARINA) released the MC No. Sr-2020-06 on the “Rules and Regulation on the Mandatory Use of 0.50% m/m Sulfur Limit on Fuel Oil for all Philippines-Registered Ships. The circular provides acceptable maximum sulfur content of 0.5% m/m including gas, petrol, distillates, residual and blended fuels except for ships fitted with exhaust gas cleaning system (EGCS). This circular has already been implemented to Philippine vessel plying internationally, while it took effect on January 01, 2025 for the domestic vessels. Over 31,000 registered domestic vessels, including passenger ship, cargo vessels, tankers, tugs, dredger and fishing boats based on MARINA statistical Report (2017-2021) will be covered by the sulfur cap regulation. This circular represents only the initial step towards full compliance with MARPOL Annex VI as it only addresses the sulfur cap. The Philippines has yet to formulate plans for the full compliance of MARPOL Annex VI.

This study focused on the assessment of the readiness of the Philippines domestic shipping sector for the implementation of sulfur cap regulation under MARPOL Annex VI. The result of the study will provide comprehensive information to MARINA as flag administration of the Philippines on the challenges and opportunities associated in the implementation of sulfur cap regulation to domestic shipping sector and its contribution to UN SDG.

Materials and Methods

Research Design

The research design for this study was mixed-method approach using a concurrent triangulation design as it allows in-depth exploration of the complexities surrounding the readiness of the Philippines domestic shipping sector for the implementation of sulfur cap regulation under MARPOL Annex VI.

The research assessed the following variables: regulatory requirements, national policies and regulations, level of awareness among stakeholders, capability-building initiatives, implementation, enforcement and monitoring mechanism, international and regional, best practices, availability of incentives and funding opportunities, perceived challenges and recommended measures to support compliance of the sulfur cap regulation.

The qualitative data were collected through semi-structured interviews with the stakeholders (MARINA, PCG, DOE, MACS, maritime school/center, and ship owners/ operators). Also, the researcher conducted documents review to examine relevant laws, regulations, circulars, advisories technical guidelines and other official documents related to sulfur cap implementation. The structured survey questionnaires were also administered to selected respondents like the marine engineers and financial institution to support and validate the findings from the interviews and document review. The integration of interview, survey, and document review data provided a more comprehensive understanding of the readiness, opportunities and challenges associated with sulfur cap implementation in the Philippine domestic shipping sector.

Respondents of the Study

The study's respondents were consisted of four groups of stakeholders. The first group comprised representatives from regulatory and enforcement agencies like, MARINA, the PCG and the DOE that are responsible for the policy development, enforcement, monitoring and fuel quality regulation. The second group included representatives from the maritime education and training institutions and MARINA accredited classification society that involved in capability-building and knowledge dissemination. The third group consisted on shipowners/operators directly affected by the sulfur cap regulation and responsible for implementing compliance measures within their organizations. And lastly, the fourth group was comprised with sixteen (16) marine engineers that provided insights on operational awareness and five (5) representatives from selected financial institutions as that provided insight on availability of financial support mechanism for compliance as survey respondents.

Respondents of this study are the stakeholders in the Philippine domestic shipping industry, who have a crucial role in ensuring compliance with MARINA Circular No. SR-2020-06 which outlined the sulfur cap regulation under MARPOL Annex VI that effect on January 01, 2025.

Ethical Considerations

Adherence to the highest ethical standard is important to the research to ensure the protection, respect and integrity of all participants.

All participants and selected respondents were fully informed about the purpose, objectives and procedures of the study. The researcher obtained consent to the participants before conducting interviews ensuring confidentiality and anonymity. Participants have the right to withdraw from study at any time without consequence.

The right and privacy of all participants was respected throughout the process. The participants personal information beyond what was necessary for the conduct of the research were not required to disclose. Only the information relevant to the purpose of the study was collected.

Personal identifiers were not disclosed in the research report to protect the identity of the participants. All the responses were presented through generalized descriptions to ensure that individual participants could not be identified.

All information obtained from the interviews, surveys and document reviews was treated with strict confidentiality. The data collected were used solely for academic purposes. Data collected were accessible only to the researcher and authorized academic personnel involved in the study.

As part of the commitment to maintaining originality and academic integrity, Turnitin was utilized to check for plagiarism. The result of the Turnitin test states that there are 20% similarity while AI is undetectable. All findings, interpretations, and conclusion presented in the study were derived from the collected data and supported by relevant literature.

Instrumentation

The study used interview, survey and document review. The structured survey was administered to the selected respondents to provide a robust methodological approach.

Semi-structured interview guide and survey were used as the primary data collection instrument to explore the challenges, practices and readiness of stakeholders of the Philippine domestic shipping sector on the implementation of the sulfur cap regulation. Semi-structured interview format was selected for its flexibility, allowing the researcher to ask prepared questions while encouraging respondents to share details insights shaped by their unique experiences and perspectives. The semi-structured interview and survey was customized to explore the critical areas relevant to the study which includes the readiness, technological solutions, compliance strategies, support mechanism, awareness and knowledge, and business sustainability in the contest of environmental regulations.

Document review was used in addition to the interview to gather historical and contextual information from relevant sources. These include academic literature, legislative text, regulatory circulars, policy reports and industry guidelines. The MARINA Circular No. Sr-2020-06, training materials from maritime

institutions, compliance manual from shipping companies and international reports on sulfur cap compliance are the key documents to be reviewed.

The structured survey questionnaires were administered to the selected respondents to complement the qualitative data. It was distributed to the marine engineers onboard the vessel to assess their level of awareness of sulfur cap regulation. Separate survey questionnaire was administered to the selected five major banks in the Philippines to distinguish the available financial assistance and support mechanism for sulfur cap compliance.

Validation of Instruments

All research instrument used in the study underwent validation prior to data collection to ensure clarity, relevance and appropriateness in addressing the objectives of the research.

All the interview guide used for the participants underwent validation by a maritime expert with extensive experience and knowledge in the maritime industry. The expert reviewed the interview questions to determine their relevance, clarity, and adequacy in gathering information related to the readiness of the Philippine domestic shipping sector for the implementation of the sulfur cap regulation under MARPOL Annex VI. Based on the validation result, minor revisions were recommended to improve the wordings and clarity of selected questions. Nonetheless, the interview guide was found to be appropriate for the study.

The 16-item survey instrument administered to marine engineers assessing their awareness to sulfur cap regulation was subjected to face and content validation by the experts to ensure the clarity, relevance and representativeness of the items. A split-half reliability test was not conducted for six objective type items because they are directly derived from the provisions of the circular and were designed to assess the factual knowledge of its key provisions rather than to measure an underlying construct requiring internal consistency. Moreover, the short length of the six-item test makes split-half reliability estimates less stable and less meaningful, with content validation being more appropriate for establishing the validity of the instrument.

The survey instrument for questionnaire for banks to determine availability of the financial support mechanism for sulfur cap compliance also underwent face validation and checked by one of the maritime experts with a very strong background and knowledge in maritime. Based on the validation result, the instruments were found to be clear, relevant and appropriate for the study.

Generally, the instruments were validated as appropriate for data collection and were considered to be effective in assessing the readiness of the Philippine domestic shipping sector in the implementation of the sulfur cap regulation under MARPOL Annex VI.

Data Gathering Procedure

Data gathering procedure for this study included three key phases: the semi-structured interviews, structured survey and the document review.

For the interview, participants were identified. Selection and identification were based on the respondent direct involvement with domestic vessel of 400GT and above and their roles in ensuring compliance with sulfur cap regulation under MARPOL Annex VI. Formal invitation letters were sent to identified participants explaining the purpose and objectives of the study. Upon obtaining their consent, interviews were scheduled at a time and platform convenient to the participants. Interview were conducted through face-to face meetings. The interviews were audio recorded and supplemented with field notes with participants permission. Recordings were subsequently transcribed verbatim and reviewed to ensure accuracy and completeness.

For the structured survey, the respondents were first identified based on the study criteria. The marine engineers were selected from vessels operated by participating shipowner/operators. On the other hand, the respondents for financial institutions were identified based on their involvement in the financial institutions. Upon obtaining their consent, the survey questionnaire was distributed personally and through email. Respondents were provided with instructions regarding the completion of the questionnaire and were given sufficient time to answer. Follow-ups were conducted to ensure the retrieval of completed

questionnaires. Upon retrieval, the responses were checked for completeness, organized and encoded for analysis.

For the document review, comprehensive review of relevant document specially on the key documents including MARINA circular no. sr-2020-6, MARINA Advisory No. 2024-35, MARINA Technical Guidelines No. 2025-01, DOE Circulars, matrix of companies from MARINA compliance and international sulfur cap compliance reports were conducted in parallel with the interviews. The document review focused on extracting data related to the historical background, regulatory framework, enforcement mechanism and compliance practices in relation to sulfur cap regulation. The information obtained from the document review was systematically organized, categorized by them and stored securely for further analysis.

Data Analysis

The study used both qualitative and quantitative data analysis techniques. The data collected from interviews, surveys and document reviews were analyzed separately and subsequently integrated to provide a comprehensive assessment of the readiness of the Philippine domestic shipping sector for the implementation of the sulfur cap regulation under MARPOL Annex VI.

The obtained quantitative data were from survey questionnaires administered to marine engineers and respondents from selected financial institutions. Descriptive statistics, particularly frequency counts and percentages, were used to summarize and describe the responses of the respondents. For the level of awareness of marine engineers and the availability of the financial support mechanism for sulfur cap compliance, results were presented and interpreted through tables.

The qualitative data analysis was derived from the semi structured interviews and document reviews. The interview recordings were transcribed verbatim and reviewed for accuracy. Data were coded, categorized and group into themes based on recurring patterns, concepts and issues related to regulatory requirements, awareness, capability-building initiatives, implementation and enforcement mechanism, best practices, incentives, challenges

and compliance measures. Relevant information from the document review was used to support, validate and enrich the interview and survey findings through data triangulation. The analyzed qualitative data was presented in table and narrative form to provide an in-depth understanding of the readiness of the Philippine domestic shipping sector for sulfur cap implementation under MARPOL Annex VI.

Limitation of the Study

This research has several limitations. First, the study involved a relatively small but highly specialized sample consisting of nine (9) key informants, sixteen (16) marine engineers, and five (5) representatives from financial institution. Participants and respondents were selected because of their direct involvement in the implementation, enforcement, operational compliance and financing of the sulfur cap regulation. Secondly, the survey of marine engineers was limited to personnel assigned in the bulk carriers and were onboard the vessel on the shipowners who participated in the study. Lastly, the study focused only in the sector directly affected by the regulation which based on MARINA records comprises of 121 domestic vessels operated by 19 shipowners nationwide. Therefore, although the findings may not be generalizable to the entire Philippine domestic shipping industry, they provide an in-depth assessment of the readiness of the affected sector.

Result and Discussion

This chapter discusses in detail the result of the data gathered through document review of the official policy issuance, semi structured interview of the key stakeholders and a supporting survey on shipboard personnel and banks. The Amoroso's Readiness Theory (1992) is the anchor of the study discussion. The findings are presented according to the Statement of the Problem (SOP).

Profile of the Participants and Respondents

A total of nine (9) participants were interviewed. In addition, sixteen (16) marine engineers onboard the vessel operated by the participating shipowners/operators served as survey respondents, along with five (5) bank personnel from selected financial institutions.

The presentation of participants and respondent profile was included to establish credibility and relevance given the regulatory and technical nature of the study. The participants were from Maritime Authority Industry, Philippine Coast Guard, Department of Energy, Classification Society, Maritime Training Center and Ship owner/operators. They were directly involved in policy formulation,

enforcement, fuel regulation, technical verification, training and operational compliance. Most of them are senior experts in maritime industry.

The profile of the participants and respondent shows the diversity and depth of stakeholder's representation that support triangulation and strengthen the trustworthiness of the findings (Table 1).

Table 1. Profile of the Participants

Respondent	Position/Sector	Years in Service	Relevance to MARPOL ANNEX VI
MARINA (1)	Division Chief / Maritime Transport Environment and Energy Development Division	More than 10 years	Policy formulation, enforcement guideline, and SIP Evaluation
PCG (1)	Deputy Chief/ Marine Environmental Protection, CG-9	24 years in service	Policy Formulation
DOE (3)	Division Chief/Oil Industry Standard and Monitoring Division (2) Two Sr. Science Research Specialist	More than 10 years	Fuel Quality and Facility
MARINA Accredited Classification Society (MACS)	Country Manager/ Registro Italiano Navale (RINA)	20 years	Classification and Certification
Maritime Training Center/ School Representative	Quality Assurance and Program Director/ Sr. Adviser for Shipping Business Education/ Philippine Center for Advanced Maritime Simulation and Training, INC (PHILCAMSAT)	More than 10 years	Maritime Safety and Environmental Protection and STCW mandatory training courses and company required training courses
Ship Owner Operator (1)	Vice President	More than 10 years	Ship Management
Ship Owner/ Operator (2)	General Manager	More than 10 years	Ship Management

A total of 16 domestic marine engineers participated in the survey. All of the respondent were onboard in a bulk carrier and occupying positions of fourth engineers to chief engineers during the time of the interview. The age ranges from 30 to 70 years representing both

operational level and management level. There were no respondents from aged 40-49. This age range usually are active in the international trading. The sea service experience ranged as a marine engineer officer is from 1 year to more than 35 years.

Table 2. Profile of the Respondents (Marine Engineers)

Profile Variable	Category	Frequency	Percentage
Age	30-39 years old	6	37.5%
	40-49	0	0%
	50-59 years old	4	25.0%
	60-70 years old	6	37.5%
Years in Service	1-5 years	7	43.8%
	6-15 years	3	18.8%
	16-25 years	1	6.3%
	26-35 years	2	12.5%
	36 years and above	3	18.8%
Rank Onboard	4 th Engineer	3	18.8%
	3 rd Engineer	5	31.3%
	2 nd Engineer	4	25.0%
	Chief Engineer	4	25.0%
Type of Vessel	Bulk Carrier	16	100%

Separate survey questionnaires were administered to the (5) five major banks in the

Philippines. Respondents came from ranks to managerial positions.

Table 3. Profile of the Respondents (Bank Personnel)

No.	Name of the Financial Institution / Bank	Position
1.	BDO	Financial Advisor
2.	Landbank	New Account Officer
3.	BPI	Bank Manager
4.	Chinabank	Bank Manager
5.	Metrobank	New Account Officer

Requirements of the Sulfur Cap Regulation

The requirements of the sulfur cap regulation under MARPOL Annex VI stated in the Regulation 14 which sets limit sulfur content of any fuel oil used on board shall not exceed to 0.50% m/m on and after 01 January 2020. This can be achieved by using fuels with low sulfur content; installation of exhaust gas cleaning system (EGS) or scrubbers; and use of alternative fuels such as LNG.

The regulation applies to ships of 400 gross tonnage and above with certain exceptions under regulation 3 of MARPOL Annex VI. Under Regulation 3 of MARPOL Annex VI, the excepted ships are the ships with diesel electric propulsion, turbine propulsion or hybrid propulsion system. Also ships that emission is necessary for purpose of securing the safety of

ship or saving life at sea. Ships that are damage resulting to emission provide that all reasonable precautions have been taken after the occurrence of the damage or discovery of emission for the purpose of preventing or minimizing the emission.

This only shows that the compliance on the regulatory requirements depends on the several factors such stakeholder's awareness and understanding, adequate financial and technological resources and the actual ability to enforce and implement the regulation.

The baseline condition necessary for organizational readiness was establish in the regulatory requirements. The define policies, technical standards and compliance mechanism that organization must adopt primarily represent structural readiness.

Table 4. Requirements of Sulfur Cap Regulation

Regulatory Basis	Key Requirement	Description/ Implementation
MARPOL Annex VI Regulation 14	Global sulfur limit	Sulfur content of fuel oil used onboard ships shall not exceed 0.50% m/m starting 01 January 2020.

Regulatory Basis	Key Requirement	Description/ Implementation
	Compliance methods	Compliance may be achieved through the use of low sulfur fuel, installation of exhaust gas cleaning system (scrubber) or use of alternative fuels such as LNG.
	Applicability	Applies to 400 gross tonnages above subject to specific exemptions under Regulation 3 of MARPOL Annex VI.
MARPOL Annex VI Regulation 3	Exceptions to regulation	Exceptions apply to ships with diesel-electric propulsion, turbine propulsion or hybrid propulsion systems. Emission are also exempted when necessary for safety of the ship or saving life at sea, or when emissions result for damage to ship, provided reasonable precautions are taken to minimize emissions.

Nevertheless, successful implementation also requires cultural readiness, reflected in stakeholders’ understanding and acceptance of regulation and operational readiness, demonstrated through the capability to implement technical and procedural requirements onboard vessel.

National Policies and Regulations on Sulfur Cap Regulation

In response to the challenges posed by climate change, the Philippines affirms its commitment to environmental protection, sustainable development, and coordinated action within the government and society to ensure resilience and ecological balance. The succeeding policies and regulations demonstrate the Philippine government’s commitment to environmental protection, sustainable maritime transport, and the reduction of air pollution from ships.

Climate Change Act of 2009 (Republic Ac No. 9729)

The Republic Act No. 9729 (Climate Change Act of 2009) and its Revised Implementing Rules and Regulation are the comprehensive national policy and regulatory frameworks that supports the implementation of the sulfur cap regulation in Philippine domestic shipping (Climate Change Commission, 2009). It establishes the national mandate to mitigate climate change and reduce air pollutant from key sectors including transportation and energy. This act provides the legal foundation for aligning

domestic environmental policies with the international conventions such as MARPOL Annex VI (International Maritime Organization (IMO), 2008).

MARINA Circular No. SR. 2020-06

For the maritime sector, MARINA circular No. SR-2020-06 was issued by MARINA to operationalized the sulfur cap regulation (MARINA,2020). It serves as the primary implementing instrument for MARPOL Annex VI to all Philippine registered vessel covering the domestic shipping.

MARINA Advisory No. 2024-35

MARINA Advisory No. 2024-35 further strengthen and clarified the circular as it outlined the detailed requirement, documentation and enforcement measures (MARINA, 2024).

Technical Guidelines No. 2025-01

MARINA also issue the Technical Guidelines No. 2025-01 which details the enforceable procedure (MARINA, 2025). This procedure standardized the method of inspection from fuel sampling, laboratory testing, reporting and enforcement actions.

Department Circular Nos. DCS2025-2-0002 and DC2025-02-0003

On the fuel trader level, Department Circular Nos. DCS2025-02-0002 and DC2025-02-0003 was issued by the Department of Energy. These circulars compliments MARINA circulars on sulfur cap compliance as it enforces the

0.50% sulfur limit for all marine fuel sold in the country (DOE, 2-25a; DOE, 2025b). These also mandate compliance with the PNS ISO 8217:2024 marine fuel standards. Furthermore, these regulate bunker trading practices through documentation, certification, sampling and reporting requirements. And lastly, these empower the DOE to conduct random fuel quality testing to the downstream oil industry and impose penalties in case of non-compliance.

Altogether, these policies demonstrate the wholistic approach of the government on the implementation of sulfur cap regulation. Covering the compliance obligation beyond ship-owners to include fuel suppliers and regulators, therefore, aligning Philippine domestic shipping with MARPOL Annex VI requirement. However, the establishment of policy framework alone does not guarantee consistency of the compliance. To ensure effective compliance gaps between the regulatory

design and actual implementation must be filled in.

The result of the study indicates that the Philippine government demonstrate strong structural readiness as it has established a comprehensive regulatory and institutional framework for sulfur cap implementation. However, structural readiness alone is insufficient as effective compliance still depends on strengthening cultural readiness through stakeholder commitment and operational readiness through consistent enforcement and implementation.

Stakeholders Level of Awareness on the Sulfur Cap Regulation

Based on the interviews and survey, the level of awareness of the sulfur cap regulation was generally high across regulators, enforcement agencies, training institutions and ship-board personnel.

Table 5. Stakeholders Level of Awareness on Sulfur Cap Regulation

Stakeholders	Level of Awareness (1 Lowest-5 Highest)	Evidence from Interview	Interpretation
MARINA	3.5	Awareness level rated 3.5 out of 5. Conducted policy orientation seminars, stakeholders' consultations and information campaigns	This demonstrates strong institutional awareness and active dissemination of regulatory information
PCG	4	Rated 4 out of 5. Personnel attended training, workshop and coordination meeting with MARINA	Personnel show good awareness
Classification Society (RINA)	5	Respondent stated the organization is 100% aware due to its compliance with international classification standards	International classification societies maintain strong awareness due to alignment with global regulatory framework
Maritime Training institutions	5	Sulfur cap regulation integration into MARPOL training courses and specialized training programs	Maritime education institutions demonstrate strong awareness and play a key role in knowledge dissemination
Shipping Company (1)	4	Management and crew were informed through company training and safety meetings	Compliance-oriented companies show proactive awareness and internal communication

Stakeholders	Level of Awareness (1 Lowest-5 Highest)	Evidence from Interview	Interpretation
Shipping Company (2)	3	Respondent acknowledge the awareness of the regulation by express concerns regarding cost and operational impact.	Awareness exists but practical understanding and readiness vary among operators

The result of the interview showed that awareness of the sulfur cap regulation on the key stakeholders such as MARINA, the PCG and the DOE demonstrate high awareness thorough policy implementation, enforcement coordination, and fuel quality regulation. Private institution like classification society and maritime training center also demonstrates high awareness due to alignment with international

standards and training programs related to MARPOL Annex VI. For shipowners and operators that transitioned to low sulfur fuel the level of awareness were generally high. On the other hand, shipowner and operators that has not yet transitioned to low sulfur fuel noted some concerns on the operational cost and compliance adjustment. This indicates a varying level of operational readiness.

Table 6. Level of Awareness of Domestic Marine Engineers on Sulfur Cap Regulation

Awareness Indicator	Response Type	Frequency (n = 16)	Percentage
Awareness of the sulfur cap regulation (MC SR 2020-06)	Yes	15	93%
	No	1	6.25%
Awareness of the Objective of MC SR 2020-06	Correct Answer	16	100%
	Wrong Answer	0	0%
Awareness of the Coverage of the Regulation	Correct Answer	16	100%
	Wrong answer	0	0%
Awareness of the Maximum sulfur content (0.50% m/m)	Correct Answer	16	100%
	Wrong Answer	0	0%
Awareness of Documentary Requirement (BDN)	Correct Answer	16	100%
	Wrong Answer	0	0%
Awareness of Alternative Compliance Measures	Correct Answer	4	25%
	Wrong Answer	12	75%

The table 6 indicates that majority of marine engineers are generally aware of the sulfur cap regulation and its fundamental provisions. Most of the respondents correctly identified documentary evidence, coverage, maximum sulfur content requirements, and required documentary evidence. However, there are gaps observed particularly on the technical aspects of regulations such as on the situation where ships may be exempted from compliance and alternative compliance measures allowed by the administration. This only shows that while the basic regulatory awareness is high, deeper operational understanding of

complex compliance provisions remains limited among shipboard personnel.

The cultural readiness is very evident although, the operational readiness is partial due to the limited understanding of the complex provisions. This is consistent with the findings in India and Vietnam that despite the promotion of knowledge by the Directorate General of Shipping (DGS) and Indian Maritime University the gaps still exist in maritime professional to have a comprehensive understanding of the sulfur cap regulations (Dewan & Godina, 2024).

Stakeholder's Capability-building for Sulfur Cap Regulation

Based on the study, the capability-building initiative related to sulfur cap compliance in Philippine domestic shipping are led by regulators (MARINA), training institutions and shipping companies.

Marine Environmental Protection Development Service was created by MARINA to lead in developing policies and guidelines related to sulfur cap regulation. MARINA have undertaken several capability buildings such as conducting series of familiarization and orientation seminars, public consultations and

policy briefings with stakeholders prior to the implementation of the regulation. Additionally, they conducted readiness assessments and stakeholders' consultations to determine the preparedness of the industry.

The Philippine Coast Guard (PCG) build their capability by sending the personnel to the training workshops and participated in the regulatory forums in preparation of their enforcement role. Additionally, they are also developing the standard operating procedure (SOP) for sulfur cap inspection to ensure uniform enforcement across port nationwide.

Table 7. Stakeholders Capability Building for Sulfur Cap Regulation

Stakeholder Group	Capability building	Purpose of Capability Building
MARINA	Conduct Policy orientation seminars, consultation and readiness assessment	To enhance awareness and understanding for sulfur cap regulation among maritime stakeholders and to prepare the industry for implementation
	Created technical working committee for sulfur oxide policy development	To have guided technical operational manual for uniform implementation of the regulation
Philippine Coast Guard (PCG)	Attended training workshop and online seminars	To strengthen enforcement capability
	Developed the standard operating procedures for enforcement	To ensure uniform inspection procedure across ports.
Department of Energy (DOE)	Developed Philippine National Standards based on ISO 8217	To ensure availability and quality of compliant marine fuel in the domestic shipping
	Conducted information drive with bunker traders and fuel suppliers	
Maritime Training Institution (PHIL-CAMSAT)	Integration of sulfur cap regulation into MARPOL training courses.	To enhance competency of marine engineers and maritime personnel in handling sulfur cap compliance requirements
	Used of simulator-based practical exercises	
Shipping Companies	Conducted internal briefing, onboard training sessions and technical adjustment.	To improve awareness and ensure operational readiness for sulfur cap compliance

While the Department of Energy focused in capability building on the regulation of marine fuel supply, they also developed Philippine National Standard based on ISO 8217 and issued department circulars that establish marine fuel specifications. Additionally, they conducted information drives, and fuel and bunker trader consultation to ensure that compliant fuel is available in the market.

These only shows that the government agencies lead by MARINA are focused on building institutional knowledge, developing enforcements mechanism and ensuring coordination among relevant government agencies. MARINA serves as the lead agency in developing and coordinating capability-building program due to its primary mandate in regulating and implementing sulfur cap requirements in the Philippine maritime sector. MARINA plays a central role in enhancing stakeholders understanding and preparedness for compliance through policy orientation, stakeholders' consultations, readiness assessments and regulatory guidance. Supporting this effort, the PCG focused on strengthening inspection and enforcement competencies whereas, the DOE develops technical expertise related to marine fuel quality regulation and fuel supply compliance

Maritime Education and Training Institutions interviews revealed that they integrate sulfur cap regulation into their MARPOL-related training programs. They include fuel quality management, emission reduction technologies, exhaust gas cleaning system (scrubbers), fuel changeover procedures, and environmental compliance requirements to their maritime training courses. Similarly, training institutions utilize simulation facilities and practical exercise to enhance the competency of Marine Engineers in handling new technologies and compliance procedures. Instructors have to undergo specialized training before teaching the courses to ensure that faculty members possess adequate technical expertise. These capability building initiatives are necessary to improve stakeholders' regulatory awareness and technical capability.

Shipping companies on the other hand prepares their personnel by disseminating information regarding the regulation through onboard safety meetings, internal briefing, and

technical training conducted by equipment suppliers and company management. Some of them have done operational adjustment such as fuel transition procedures and engine modification. These changes are usually recorded in their Safety Management System (SMS) manuals and operational procedures.

The findings showed that capability building efforts of the Philippine domestic sector mainly focus on the awareness and enforcement. These demonstrate improvement in both cultural and operational readiness. The awareness campaigns, stakeholder consultation and training program strengthen stakeholder's acceptance and understanding to the regulation, reflecting cultural readiness. While the procedural development, technical training programs, and simulator exercises improved operational readiness as it enhances the stakeholders' competencies in the implementation sulfur cap requirements. These findings indicate that capability building serves as the bridge between regulatory policies and actual compliance.

Implementation, Enforcement, and Monitoring Mechanism for Sulfur Cap Regulation

Based on the result of interview and document review, multi-agency mechanism is being adopted in the Philippine domestic shipping for implementation, enforcement and monitoring of sulfur cap regulation. MARINA is the primarily lead with the enforcement support from the PCG and the DOE oversight the fuel quality supplied by the bunker trader.

MARINA is responsible for issuing policies, evaluating Ship-Specific Implementation Plans (SIP) and monitoring compliance. The Technical Guidelines No. 2025-01 is the standardized procedure for inspection on sulfur cap regulation. It includes documentary verification, visual inspection of fuel oil systems, fuel sampling, laboratory analysis, and reporting of inspection result. It also includes the adoption of the IMO sulfur testing tolerance limit of 0.53% m/m further ensures consistency and fairness in enforcement. For non-compliance cases, penalties and fines such as issuance of corrective action requirement and issuance of operation restrictions like no -sail condition until compliance is achieved will be imposed.

Consistent with MARINA sulfur cap regulation, PCG plays a very important role in port state type inspection and coastal monitoring. The PCG is responsible to conduct ship inspection to verify the bunker delivery notes (BDN), assist in fuel sampling and verify compliance with the environmental regulation during routine safety and security inspection. During the interview, when the participant was asked how PCG plans to implement MARINA's guidelines for sulfur cap compliance, the participant said "PCG is still in process of coordinating with MARINA for the technical guidelines to formulate the PCG Standard Operating Procedure. Hopefully, the SOP will be finalized before the end of 2025." These findings reflect moderate operation readiness. The absence of finalized SOP indicates gaps for on the consistency of implementation. When asked what are the PCG plan to use for inspection the participant said that: "PCG enforcement is planning to digitalized the inspection since we are a member of IMO and we advocate the automation to minimize corruption and we are planning to acquire equipment for monitoring and surveillance like in Korea. This plan is already included in our strategic roadmap and will be implement on 2030."

PCG 1 Since the acquisition of advance technology and the planned digitalization of inspection point toward future improvements, they do not yet contribute to current readiness. It was also revealed that MARINA and PCG have not yet finalized on how to implement the sulfur cap at the time of the interview when asked what are the PCG planned monitoring mechanism to ensure vessels compliance. The participants answered *"MARINA will coordinate with us and will give us the list of vessels to be inspected as MARINA told us that the it will just be a targeted inspection."* PCG enforcement focus only on the vessels identified by MARINA as covered by the regulation or granted conditional extension.

On the other hand, DOE is responsible for regulating the fuel supply chain level. During the interview, when the participants were asked on how the DOE planned to ensure and monitor the quality of the fuel supplied, The DOE Division Head said: "DOE issued DC 2025-02-0002 and DC 2005-02-0003 as guidelines for compliance of Downstream Oil Industry

(DOI) engaged in the bunkering trading/ sale of marine fuel. There are 100 depots all over the Philippines and we deploy people to do random quality sampling and testing of marine fuel at least once a year. The DOE has enough facilities like (lab testing facilities and equipment) to monitor the DOI. In the guidelines we also make sure that marine fuel bunker traders shall comply with the reportorial requirements under DC no. DC2021-09-0029".

This only means that DOE is well prepared for the implementation, enforcement and monitoring the sulfur cap regulation as they established the regulatory framework, infrastructure and technical capacity to support compliance. Nonetheless, may have challenge in consistency of enforcement as it only limited sampling frequency. Generally, DOE shows adequate readiness in regulating fuel quality.

In summary, the Philippine government uses centralized flag state enforcement model supported by inter-agency coordination in the implementation and enforcement of sulfur cap regulation. This reflects a functioning but capacity-sensitive system, where the effectiveness of compliance is influenced by inter-agency coordination, availability of enforcement tools, and the ability to authenticate compliance documentation. The finding shows the need to enhance the operational support, digitalized inspection, standardized the enforcement procedures and the need to investment in technology to strengthen the sulfur cap compliance in domestic shipping sector.

The findings indicate that the implementation and enforcement mechanism indicate strong structural readiness, as clear institutional responsibilities have been assigned to MARINA, the Philippine Coast Guard and the Department of Energy. Nevertheless, the operational readiness remains moderate as enforcement procedures was still incomplete, inspection technology was still limited and verification heavily depends on documentary. These findings suggest to that operational capabilities must be further strengthened to achieve effective and consistent implementation.

Best Practices in the Implementation of Sulfur Cap Regulation at the International and Regional Levels

Based on the document review, the best practices of international and regional level in implementing the sulfur cap regulation under MARPOL Annex VI generally involve early policy adoption, coordinated enforcement systems, effective monitoring of marine fuel supply chains, and sustained capability-building programs.

In the international level like Australia and Norway best practices noted in the documents review with Australian Maritime Safety Authority (AMSA 2020) implementation of IMO 2020 Sulfur Cap and European Maritime Safety Agency (EMSA, 2019) in sulfur emission control areas and compliance monitoring.

Australia is one of the countries who demonstrate strong best practices in implementing sulfur cap regulation under MARPOL Annex VI. The AMSA enforces the sulfur limit through national legislation the Marine Order 97: Marine Pollution Prevention-Air Pollution (AMSA, 2020). This regulation clearly defines compliance requirements, inspection procedures and enforcement mechanism for ships operating in Australian waters. Additionally, the national inspection program where port state control officers verify sulfur content through documentation checks, fuel sampling and laboratory analysis - was implemented and enforced. The standardized inspection procedures, fuel sampling protocol and laboratory system may be adopted by the Philippines to improve the consistency and reliability of compliance monitoring.

Australia established clear framework and institutional responsibilities. They also developed inspection and monitoring programs. Moreover, their awareness industry campaign contributes to the knowledge and acceptance of environmental regulation among shipping companies.

In Norway, their best practices are linked to the participation in the North Sea and Baltic Sea Sulfur Emission Control Areas (SEACAs). In these areas the ship must use fuel with sulfur content not exceeding 0.10% which is even stricter than the global sulfur cap (European Maritime Safety Agency (EMSA), 2019). Additionally, Norwegian authorities implemented advanced monitoring programs including remote emissions monitoring systems that measure vessel emissions while ships are

sailing through controlled areas. They also enforced strict port state control inspections by checking bunker delivery notes, fuel samples and emissions records. Moreover, Norway established a green shipping incentives program which provides financial incentives for ship-owners that adopt cleaner fuel technologies or install emission reduction system such as scrubbers or alternative fuel.

Overall, Norway demonstrates operational readiness through advanced monitoring technologies and strict inspection. The established comprehensive environmental regulatory framework reflects Norway's structural readiness while the cultural readiness was strengthened through the established incentives and sustainability initiatives encouraging industry participation in environmental compliance. The Norway's green shipping incentives may serve as a model of the Philippines for developing financial assistance programs, tax incentives or other support mechanism for domestic shipping operators affected by sulfur cap compliance requirements.

In the regional level, best practices are based on the documents in the Ministry of Transport of China (2018). Emission Control Areas Implementation Plan and Maritime and Port Authority of Singapore (MPA 2020) Guidelines for IMO 2020 Sulfur Cap Implementation.

China's best practices include the establishment of Domestic Emission Control Areas (ECAS) in major ports regions. The regulation was implemented gradually that was started in Yangtze River Delta, Pearl River Delta and Bohai Sea (Ministry of Transport of China, 2018). This allows the shipping industry to slowly adapt the use of low-sulfur fuel. Additionally, they also established the risk-based inspection programs which the port authorities prioritize inspection for vessel that are more likely to violate emission regulation. Moreover, the use of fuel sampling and laboratory testing was implemented to ensure that fuel used onboard ships meets the required sulfur content limits. Furthermore, they established inter-agency coordination mechanism that are composed of maritime safety administrations, environmental agencies and port authorities. These agencies were assigned to monitor vessel emission and enforce environmental compliance within

emission control areas. The risk-based inspection approach of China may assist MARINA and the PCG in prioritizing inspection of vessel with the higher likelihood of non-compliance, thereby maximizing limited enforcement resources.

In summary, China demonstrates structural readiness and cultural readiness by establishing the phased implementation of the regulation allowing the stakeholders time to transition to new regulatory requirements. The operational readiness reflects on the established risk-based inspection and fuel testing system.

Singapore has implemented several programs to support sulfur cap compliance. One of the best practices that the country had is the implementation of the bunker licensing system, where marine fuel suppliers must comply with strict fuel quality standards (Maritime and Port Authority (MPA), 2020). The bunker delivery notes (BDN) and supported by laboratory analysis were required to the fuel suppliers to ensure traceability of marine fuel quality. Moreover, the country conducted industry engagement programs such as workshops, seminars and regulatory guidance for shipping companies and bunker suppliers. This is to ensure that maritime stakeholders understand compliance requirements before enforcement actions were implemented. The Philippines may also adopt the Singapore's fuel quality monitoring, bunker supplier regulations and continuous stakeholder engagement program to enhance fuel traceability, industry awareness and compliance verification.

Overall, Singapore demonstrates operational readiness through systematic inspection and fuel quality monitoring. The regulatory framework governing bunker suppliers and maritime operators reflected structural readiness and the awareness programs show cultural readiness.

Compared with international and regional practices, the Philippines has a clear and well defined fundamental regulatory framework. The Philippines also adopted a multi-agency approach similar to Australia, China and Singapore. The country also established procedures, fuel quality standards and documentary requirement aligned with MARPOL Annex VI. Nevertheless, the Philippines still has limited

monitoring technologies, laboratory support and enforcement infrastructure unlike Australia and Norway. Also, the Philippines relies heavily on documentary verification and targeted inspection rather than having a systematic fuel monitoring and risk-based inspection system like in Singapore and China. Additionally, the Philippines has no dedicated incentive or funding program to support the sulfur cap regulation compliance compared to countries like Norway and Singapore.

Overall, the international and regional experiences demonstrate that successful implementation for sulfur cap regulation requires not only a string regulatory framework but also effective enforcement system, reliable monitoring mechanism, sustained capability building programs and adequate financial support. It means that successful implementation requires the balance development of all three-readiness dimension. Countries like Australia, Norway, China and Singapore have achieved structural, cultural and operational readiness. Compared to these countries, the Philippines has established the fundamental legal and institutional framework for sulfur cap compliance, which demonstrate strong structural readiness but still requires improvement in operational capacity and sustained stakeholders engagement to attain full organizational readiness.

Incentives and Funding for Sulfur Cap Regulation

During the interview with MARINA representative, the participant confirmed that there were no established subsidy programs to assist the ship operators for the compliance of sulfur cap regulation. When asked whether MARINA has developed incentives or funding programs to support compliance efforts among domestic shipping she answered "No". This only shows that the regulatory implementation is treated as a regulatory obligation rather than an incentive-based environmental policy. Although, they released the Memorandum Circular No. DS-2026-02 Temporary Regulatory Relief and Support Measure to Domestic Shipping Operations During the State of National Energy Emergency (MARINA, 2026). This reduces the fees for the application and renewal of all domestic shipping trading

certificates. However, this is not exclusively to support the green shipping. In the transitory provision of MARINA Advisory 2024-35 stated that the "Administration may extend the compliance deadline based on the Ship Implementation Plan timelines as verified by MARINA, but not to exceed five (5) years." As the result most shipping companies asked for extension for compliance until 2030.

In the same way, the DOE representative when asked about the programs established to encourage suppliers or distributors to support compliance. They responded that there were "none as of the moment and the suppliers are mandated to comply with DC 2025-02-002". DOE also emphasized that its role focuses on regulating the marine fuel supply and ensuring the availability of compliant fuel.

Additionally, when a representative from shipowner/operator asked if there are additional government programs or support

example financial support and incentives that have helped their company to comply in the regulation the answered is "none". The other shipowner respondent suggested that "the government should implement tax holidays to encourage shipowner to comply with the regulation or other programs like in the land that if one uses a hybrid or e-car the user is exempted to coding". These responses suggests that the respondents experienced financial burden particularly, on the transition from the use of high sulfur fuel oil to compliant fuel.

Moreover, the surveys from the government banks revealed that no dedicated financial programs currently exist to support sulfur cap compliance. Existing financing mechanism are generally limited to vessel acquisition or large capital investment. The survey results highlighted that the shipping companies must rely on internal funding and operational adjustment to comply with the regulation.

Table 8. Incentives and Funding Available for Sulfur Cap Regulation

Financial Institution / Bank	Offer Environmental Financing	Financial Assistance for Shipping	Existing / Planner Program for green shipping	Challenges Identified for providing financial assistance to green shipping	Suggested Financial Mechanism for green shipping
BDO	No	N/A	None	Lack of incentives	Tax incentives
Landbank	No	N/A	None	Limited demand	Subsidies tax
BPI	No	N/A	None	Lack of incentive	Loan guarantees
Chinabank	No	N/A	None	Limited Knowledge	Tax incentives
Metrobank	No	N/A	None	Limited knowledge	Green bonds, Government support, Subsidies

In summary, the findings show that the implementation of sulfur cap regulation in the Philippine domestic shipping was regulatory driven, with limited economic facilitation compared to internal practice where, financial incentives or green shipping programs were used to encourage compliance to sulfur cap regulation. This gap will greatly affect particularly the small and medium-sized domestic shipping operators, which often have limited capital resources to absorb the increased in operational cost associate with compliance to the sulfur cap regulation. Moreover, financial assistance program or incentive mechanism will support the long-term compliance readiness of the Philippine domestic shipping for sulfur cap regulation.

The findings indicate that the absence of dedicated financial assistance programs

represent a significant weakness in structural readiness. Similarly, operational readiness is also affected, as shipping companies face financial barriers that limit their ability to sustain compliance. Strengthening financial policies and incentive program would enhance both structural and operational readiness across the domestic shipping industry.

Challenges on the Implementation of Sulfur Cap Regulation

The Philippine domestic shipping faces multiple and interrelated challenges in complying with the sulfur cap regulation as reveal in the interviews with MARINA, PCG, shipowners/operators and maritime training institution. The challenges include the gaps of knowledge in maritime personnel, increased operational cost, limited financial and

technical capacity and enforcement and monitoring issues.

Gaps in Knowledge of Maritime Personnel

The study revealed that gap in knowledge still exist in the maritime personnel. Based on the survey, most shipboard personnel are generally aware of the basic requirements-there remains limited understanding of the more complex regulatory provision. This limitation affects the consistency and reliability of compliance practices across vessels.

High Cost of Compliant Fuel

The biggest challenges cited by the shipowners/operators were the increase in cost associated to the use of compliant fuel. The shipowner respondent explained that 40% of the operational cost is intended for the fuel. Higher price of compliant fuel will significantly affect the operation expense and may increase the freight rates and decrease profitability. Respondent stated that “sea freight cost will increase and the cost will be passed to the client”.

Likewise, MARINA respondent said that most of the shipowners asked for extension of compliance, explaining that extensions and resistance often linked to financial considerations rather than environmental objectives.

The findings suggests that cost implications of the transition to compliant fuel remain the major barrier for the domestic shipping industry.

Limited Financial and Technical Capacity

Limited financial and technical capacity were other challenges cited in the interview. A shipowner respondents said that “although transition to low-sulfur fuel required a minimal operational adjustment like tank cleaning, replacement of engine component and coordination with the engine maker, the struggle is to sustain long-term compliance due to financial constraints and technical requirements”. This was also validated with the data gathered by MARINA on the ship specific implementation plan that out of 121 vessels that submitted the SIP, 75 vessels asked for extension to use the low sulfur fuel oil (LSFO) due to high cost of LSFO compared to high sulfur fuel oil (HSFO).

Most of the operators often plans for the transition to low- sulfur rather than

installation of Exhaust Gas System or scrubber and using marine diesel or other alternative fuel due to the much higher capital requirement and technical capability than the use of low sulfur fuel oil. Having no available government financial support programs further compounds these challenges, as companies must rely on their own internal resources to comply with the regulation.

Challenges in Inspection and Enforcement

Challenges were identified by the regulatory authorities on ensuring the consistent enforcement of sulfur cap requirements across the country. The need to standardized the inspection procedures and the improvement of monitoring tools was highlighted by the PCG. The PCG respondent answered when asked about the challenges they faced in the enforcement of sulfur cap regulation she explained “I guess the challenges that we are going to face is the uniformity of enforcement but we are doing are best that we will have a uniform and clear enforcement implementation.” Moreover, the PCG explained that the enforcement currently relies heavily on documentary verification and target inspection due to the high cost of fuel analysis.

Challenges Encountered on the Implementation of Sulfur Cap Regulation

Overall, challenges noted on the Philippines domestic shipping sector are primarily driven by regulatory knowledge gap, financial constraints, technical capacity limitation and enforcement complexities. Regulatory framework was in placed but the effectiveness of compliance largely depends on the availability of resources, industry preparedness and institutional coordination among regulatory agencies.

The findings demonstrate a similar pattern seen in developing maritime sectors that the regulatory frameworks are established but implementation capacity and economic resources may limit full compliance with environmental regulations.

These findings indicate that knowledge gaps among maritime personnel demonstrate weakness in cultural readiness and limited financial resources, technical capabilities and government support highlighted the

deficiencies in structural readiness. Similarly, limited inspection technologies, enforcement issues and inconsistent monitoring demonstrate gaps in operational readiness. Overall, these findings suggest that the Philippine domestic shipping industry must improve across all three readiness dimension.

Recommendation for Effective Implementation of Sulfur Cap Regulation

Several respondents provided recommendations during the interviews regarding on how to improve the readiness of the Philippine domestic shipping sector for sulfur cap regulation compliance.

The MARINA respondent highlighted the need for continuing capacity-building activities and intensified awareness programs to ensure that stakeholders understand the environmental impact of sulfur oxide emission and the importance of regulatory compliance. Likewise, the maritime training institution respondent suggested that MARINA should “issue a clear, consolidated guidance for training center and conduct of train-the-trainer-workshops” to guarantee that the maritime education institution can deliver the training related to sulfur cap compliance effectively.

On the enforcement side, the representative from PCG suggested on the acquisition of specialized monitoring equipment so as not to rely solely on the document verification. As the respondent said “having the proper equipment would allow us to definitively confirm compliance and address discrepancies”.

On the shipping company side, one of the respondents recommended that MARINA should increase the number of their personnel to strengthened the regulatory monitoring and ensure uniformity of implementation across operators. The other respondent suggested that the government should develop financial assistance programs such as tax incentives or tax holiday to encourage shipowners to comply with the regulation.

Overall, the recommendations from the respondents directly address the three-readiness dimension. The awareness campaigns, continuous education and stakeholders engagement strengthen cultural readiness. The policy enhancement, developing financial assistance and institutional support will improve

the structural readiness. Lastly, the standardized enforcement procedure, technical training and investment in inspection technology will reinforce operational readiness. In total, these recommendations provide a comprehensive strategy for enhancing the readiness of the Philippine domestic shipping industry for the implementation of sulfur cap regulation.

Conclusion

The study found that requirement of MARPOL Annex VI for sulfur cap regulation established a clear and comprehensive global standard on marine fuel oil sulfur content including exceptions and alternative ways to comply. These requirements provide the technical basis for reducing sulfur oxide emissions from ships and guide compliance measures for the maritime operators. However, these does not guarantee compliance. The compliance relayed heavily on the resources adequacy, system reliability and stakeholders’ technical capacity.

The national policies and regulations issued by the MARINA and DOE provides the legal and institutional framework supporting sulfur cap compliance in domestic shipping sector. The issued regulations collectively operationalized the implementation of sulfur cap regulation and establish procedures for monitoring and enforcement. Nevertheless, the study also found that the policies alone were not sufficient to assure effective implementation. The success of the implementation depends on the capacity of the stakeholders, the availability of resources, consistency of enforcement and effective inter-agency coordination.

The level of awareness was generally high among the stakeholders. They are aware of the sulfur cap regulation and recognize the importance of reducing sulfur emission. However, there were gaps identified on the familiarity of the detailed technical provision and compliance procedures among operators and shipboard personnel. The study found that the stakeholders indicate cultural readiness as they generally recognized the regulation and its basis requirements. Nevertheless, the study also found that awareness remains surface-level than operationally comprehensive which

will affect the operational readiness for sulfur cap compliance.

The capability-building initiatives on sulfur cap compliance undertaken by the regulators, maritime training institutions and shipping companies were through training programs, policy briefing, stakeholders' consultation and onboard awareness programs. These efforts indicate a developing operational readiness as it supports the acquisition of knowledge and skills necessary for compliance. But then again, these efforts still need to be strengthened and expanded to ensure consistent and effective implementation across the sector.

Multi-agency approach involving MARINA, PCG and DOE were carried out for the implementation, enforcement and monitoring of sulfur cap regulation. They performed complementary roles in policy implementation, ship inspection and regulation of marine fuel quality. The study found that MARINA demonstrate structural readiness at the policy level, DOE shows operational readiness in fuel supply regulation while PCG's standard operating procedures and its equipment were still on the pipeline for 2030 it demonstrates limited operational readiness. This show imbalance between structural and operational readiness. The imbalance will greatly affect the consistency and effectiveness of the enforcement across the sector.

The identified best practices in the international and regional experiences showed that effective sulfur cap implementation was supported by clear and comprehensive regulatory framework, coordinated enforcement system, monitoring technologies and industry engagement programs. These were the factors on how to have a successful and consistent implementation of the regulation. Comparison indicates that Philippines demonstrates progress in establishing regulatory and institutional frameworks. However, the Philippines remains constrained by limited financial support, technological resources and enforcement capacity. These findings suggest the need to strengthen the operational support systems, enhanced the monitoring capability and additional sustainable compliance assistance programs to align Philippine domestic shipping with the international best practices in sulfur cap implementation.

The findings identified no specific incentives or funding programs currently exist in the Philippines to support domestic shipping companies in complying sulfur cap regulations. As a result, shipping companies heavily relied compliance on the internal resource and operational adjustment. The study found that the absence of financial assistance demonstrates a significant gap in structural readiness. This will greatly the ability of shipping companies to comply with the regulation that can lead to uneven compliance capacity across the sector.

Several challenges were identified in complying with the sulfur cap regulation, including limited knowledge, increased fuel cost, limited financial and technical capacity and operational adjustment required for fuel transition. Additionally, authorities also encountered challenges related to inspection procedures and verification of compliance documentation. This indicates gaps in financial, technical and enforcement capacity that will result to uneven compliance across the sector.

Numerous measures that may assist domestic shipping companies were recommended by the respondents in complying with sulfur cap regulations. Recommendation like strengthening training and awareness programs, improving inspections and monitoring capabilities, enhancing inter-agency coordination and exploring financial support mechanism such as incentives or assistance programs were identified. Therefore, effective implementation requires a balances development of cultural, structural and operational readiness. These ensures that stakeholders are not only aware of regulation but are also equipped with the necessary resources and capability to comply.

Therefore, it is concluded that the Philippine domestic shipping sector demonstrated cultural readiness as validated in the awareness and acceptance of sulfur cap regulation among stakeholders. The operational readiness found to be in uneven due to variation in training capacity, enforcement capability and inter-agency coordination. While the structural readiness remains limited on financial support, technological assistance and incentive programs. The findings showed an imbalance among readiness dimension where

established regulatory framework surpasses the available structural and operation capacities required. These implied that additional structural and operational support mechanism are necessary to ensure consistent and sustainable compliance across the Philippine domestic shipping sector.

Overall, the study found that there was an imbalance across the readiness dimension, where policy and awareness were more advanced than the actual capacity to implement and sustain compliance. While Philippine domestic shipping sector was ready in terms of regulation and awareness, However, it was not yet fully ready in terms of resources and implementation capacity. Therefore, the study concluded that Philippines domestic shipping was partially ready for the implementation of the sulfur cap regulation under MARPOL Annex VI.

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