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Legal and Technical Aspects of Submarine Cables Installation in Supporting Marine Spatial Planning in Indonesia

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ABSTRACT

The spatial planning of marine areas in Indonesia faces significant challenges in integrating various activities within coastal and marine zones, particularly with the installation of subsea cables. These cables are crucial for developing telecommunications infrastructure, supporting 97% of global telecommunication traffic. However, submarine cable installation projects in Indonesia encounter obstacles such as incomplete regulations, overlapping spatial use, and potential damage from both human and natural activities. This study examines two critical aspects, legal and technical, and their implications for marine spatial planning in Indonesia. From a legal perspective, the study examines regulations governing submarine cable installation. At the same time, the technical aspect addresses considerations for submarine cable deployment, route selection, route surveys, cable laying, and maintenance in accordance with established standards. Additionally, the study evaluates the implementation of the Coastal and Small Islands Spatial Planning in North Sumatra Province, where several subsea cable routes intersect with conservation zones and fishing areas.

The research emphasizes the importance of collaboration among government agencies, stakeholders, and industry players to optimize the use of limited marine space while safeguarding marine ecosystems and national interests. The findings aim to inform policy improvements related to marine spatial planning and subsea infrastructure management in Indonesia.

1. Introduction.

Indonesia has a vast maritime territory with abundant marine resources that need to be managed optimally and sustainably. This management aims to establish Indonesia as the world's maritime axis, as outlined in Presidential Regulation No. 16 of 2017 on Indonesia's Maritime Policy.

Indonesia's strategic location between two continents and oceans and its vast marine biodiversity position it as a global maritime crossroads (Limbong, 2015; Buntoro, 2012). To harness its maritime potential, Indonesia aims to manage its marine resources through sustainable practices, ensuring equitable and optimal use, as outlined in Presidential Regulation No. 16 of 2017. Marine spatial planning is crucial in allocating space for marine resource utilization and preventing conflicts.

Indonesia has made significant strides in utilizing its maritime potential, mainly through installing submarine cables, which enhance inter-island connectivity and support the telecommunications industry. Submarine cables transmit 97% of global internet traffic, making them the backbone of international communication (Burnett et al., 2014). By 2024, Indonesia had installed 217 submarine cable segments, spanning 115,104 km, with 55,069 km in the Exclusive Economic Zone (EEZ) (Coordinating Ministry for Maritime and Investment Affairs, 2023).

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These cables have reduced spatial limitations and costs, fostering equitable access to information. However, the legal and regulatory framework for submarine cable installations remains fragmented, leading to conflicts with marine spatial planning and potential threats to aquatic ecosystems (Djunarsjah et al., 2021).

To address these issues, the government introduced regulations like the Ministerial Decrees (Kepmen KP) No. 14 of 2021 and No. 42 of 2022, focusing on routing and placing submarine cables and underwater installations. Despite these regulations, further legal and technical studies are required for effective implementation. The installation process must balance environmental protection, economic concerns, and international legal rights, such as those outlined in the United Nations Convention on the Law of the Sea (UNCLOS) 1982.

Managing marine space, including submarine cables, is essential to achieving the United Nations Sustainable Development Goal (SDG) 14, which aims to conserve and sustainably use ocean resources. Indonesia's Coastal and Small Island Zoning Plan (CSIZP) is critical for ensuring sustainable marine area use while protecting ecosystems.

This research examines and analyzes regulations related to submarine cables in Indonesia, in connection with international legal instruments and existing regulations, both legislative and implementing regulations. It focuses on legal and technical aspects, with the aim of providing recommendations to improve marine space management and ensure environmental sustainability. By addressing these gaps, the study aims to enhance alignment between submarine cable installations and marine spatial planning, contributing to both sustainable development and environmental conservation, in line with SDGs 14.

2. Research Methodology.

This study aims to explore and analyze two critical aspects related to submarine cable installations in Indonesia: legal and technical aspects and their impact on marine spatial planning. From a legal perspective, the study will examine the regulations governing submarine cable installations, including existing policies and potential legal gaps that could cause issues in the field. Additionally, it will highlight the discrepancies between existing regulations and the actual conditions on the ground, especially concerning the limited use of marine space. From a technical perspective, the study will map and implement submarine cable routes in line with conservation area zone in Indonesia and CSIZP in North Sumatra Province to assess the compatibility of marine spatial planning with submarine cable routes.

3. Results and Discussion.

3.1. Legal Aspects Analysis.

Based on existing regulations, the legal aspects consider several laws, government regulations, ministerial regulations, ministerial decrees, and references to international regulations.

Table 1: Research Data.

No.	Data	Source
1.	Indonesia Submarine Cables Route	Ministerial Decree of Marine Affairs and Fisheries (Kepmen KP) No. 14 of 2021
2.	Existing Submarine Cable Routes in Indonesia	The Naval Hydro-Oceanography Center Indonesia
3.	The Conservation Area Zone of Indonesia Map	
4.	CSIZP Map of North Sumatera Province	Ministry of Marine Affairs and Fisheries
5.	Legal	UNCLOS 1982 Constitution (code: UU) Government Regulations (code: PP) Ministerial Regulation (code: Permen) Ministerial Decree (code : Kepmen)
6.	Technical	• Manual on Hydrography Publication C-13 2005 • Standars for Hydrographic Surveys 2022 6th Edition (IHO S-44) • Recommendation No. 9 International Cable Protection Committee (ICPC) Minimum Technical Requirements for a Desktop Study • Recommendation No. 18 ICPC Minimum Technical Requirements for the Acquisition and Reporting of Submarine Cable Route Sourvey
7.	Secondary data related to Submarine Cables	Interview with the government authorities (Coordinating Ministry for Maritime Affairs and Fisheries)

Source: Authors.

3.1.1. Submarine Cables Installation Regulations Based on UNCLOS 1982.

1. Territorial Sea.
   Coastal states have full sovereignty over their territorial waters and the authority to regulate activities within these waters, including installing, maintaining, and repairing submarine cables. According to Article 58(3) of the UNCLOS 1982, all states must comply with the regulations set by the coastal state within its territorial waters.
   The coastal state can restrict the right of innocent passage of foreign ships operating in its territorial waters, especially if their activities involve the installation or maintaining submarine cables, as outlined in Article 21 of UNCLOS 1982. While foreign ships are granted the right of innocent passage for transit through territorial waters, this right does not extend to activities that affect vital infrastructure, such as the laying of submarine cables. Coastal states, like Indonesia, have full sovereignty to regulate and oversee these activities to protect national interests and safeguard their maritime security.

2. Archipelagic Waters.

An archipelagic state has sovereignty over the waters enclosed by the baselines of its archipelago, known as archipelagic waters. The archipelagic state has the right to regulate ships engaged in non-interfering navigation in its waters, including those involved in the installation, repair, and maintenance of submarine cables (UNCLOS 1982, Article 21 (1) (c)). However, the archipelagic state must respect submarine cables installed by other states that pass through its waters and allow maintenance and replacement of those cables, provided proper notification of the cable's location and repair plans is given (UNCLOS 1982, Article 58 (1)).

3. Exclusive Economic Zone (EEZ).
   An exclusive Economic Zone (EEZ) is a maritime area a country can claim up to 200 nautical miles from its territorial sea baseline. Within the EEZ, the coastal state has sovereign rights to explore, exploit, conserve, and manage natural resources, both living and non-living, including resources on the seabed and subsoil, as well as to conduct other economic activities like energy production from water, currents, and wind (UNCLOS 1982, Article 56 (1) (a)).
   All states can engage in lawful international activities within the EEZ, including laying submarine cables (UNCLOS 1982, Article 58 (1)). Although foreign states have the right to install submarine cables in the coastal state's EEZ, they must respect existing cables and avoid interfering with the coastal state's ongoing resource exploration or exploitation.
   Overall, while the coastal state has extensive jurisdiction within the EEZ, the rights of other states to conduct activities like laying submarine cables are still respected, with the obligation to coordinate and prevent damage to existing infrastructure while balancing resource exploitation with lawful international maritime use.

4. Continental Shelf.
   Continental Shelf refers to the seabed and subsoil extending beyond the territorial sea, following the natural extension of a coastal state's land territory up to the continental margin's outer edge (UNCLOS 1982, Article 76). The coastal state has sovereign rights to explore and exploit natural resources on the continental shelf, including minerals and other non-living resources (UNCLOS 1982, Article 77 (1)).
   While the coastal state has sovereign rights over the exploration and exploitation of resources on the continental shelf, these rights must not interfere with navigation or the rights of other states (UNCLOS 1982, Article 78 (2)). The coastal state is required to allow the installation and maintenance of submarine cables by other states and ensure that repairs can be conducted without hindrance (UNCLOS 1982, Article 79 (2) and (3)).
   States conducting surveys, laying, repairing, and maintaining cables on the continental shelf must respect existing cables and ensure that repairs can be carried out (UNCLOS 1982, Article 79 (5)). They must also consider the coastal state's rights to explore and exploit natural resources and the preservation of the marine environment in the region (UNCLOS 1982, Article 56).

3.1.2. Submarine Cables Installation Regulations Based on National Law.

This section provides an analysis of the regulations related to the installation of submarine cables under Indonesia's national law:

Regulations governing submarine cable installations in Indonesia face several key challenges, particularly regarding interagency coordination, clarity of technical guidelines, and legal enforcement. Many existing regulations focus on specific aspects, such as maritime safety, telecommunications, or environmental protection, without a comprehensive approach to managing submarine cable installations. The lack of coordination between agencies often hampers the licensing process and causes regulatory overlaps. Furthermore, the existing technical guidelines are still limited, making it difficult to ensure submarine cable installations are carried out to optimal standards. Another challenge lies in implementing and enforcing regulations, which require capacity building and better resource allocation.

3.2. Technical Aspects Analysis.

3.2.1. Technical Stages of Submarine Cable Installation.

The deployment of submarine cable installations is a complex process that requires careful planning and surveying to ensure the success and sustainability of the project. Below are the stages of submarine cable installation deployment by the recommendations of the International Cable Protection Committee (ICPC) and the standards of the International Hydrographic Organization (IHO) S-44:

1. Cable Route Selection.
   The initial planning and selection of the route are crucial elements in ensuring the security of the route and the overall system's total ownership costs. This stage should be part of the feasibility study and the conceptual design phase in the planning process. During the route development phase, the design team needs to identify, assess, and evaluate risks and hazards the cable system may encounter during its design phase. This allows the system planners to design a route that avoids hazardous areas or, if avoidance is not possible, estimate the cost of risk mitigation and preventive engineering measures. The initial planning usually includes:
   - Preliminary review of available maps, bathymetric data, and literature on landing sites and cable routes between landing locations.
   - Identifying political constraints on the cable route, such as crossing international boundaries and territorial waters.
   - Consider maritime jurisdiction issues, including surveying, installation, and maintenance licensing requirements.

Table 2: Regulations on National Law.

Regulation	Evaluation	Gap Identification
UU No. 5 of 1983 on Indonesia's EEZ	- Establishes Indonesia's rights in the EEZ, including the right to install and maintain submarine cables. - Provides the legal framework for managing natural resources in the EEZ.	- This law does not detail specific procedures for installing submarine cables. - There are no technical guidelines or standards must be met by companies or proponents installing cables.
UU No. 32 of 2014 on Marine Affairs	- Regulates various aspects of marine affairs, including protecting the marine environment and managing natural resources. - Provides a legal framework for marine activities, including installing submarine cables.	- Doesn't specify particular licensing procedures for submarine cables. - There is a lack of coordination among Ministries / Agencies in managing and overseeing submarine cable installations.
PP No. 6 of 2020 on Structures and Installations in the Sea	- Regulates permits and technical standards for construction and installation at sea, including submarine cables. - Provides a framework for supervision and law enforcement.	- Implementation and enforcement of this regulation remain a challenge - There is a lack of detailed technical guidelines for various submarine cable installations.
Minister of Transportation Regulation No. 129 of 2016 on Shipping Routes at Sea and Structures and Installations in Waters	- Regulates shipping routes and installation location in waters to ensure navigation safety. - Provides permitting procedures for installations in shipping routes.	- Focuses more on navigation safety than submarine cable installation technical aspects. - Lack of coordination with other ministries / agencies responsible for technical and environmental aspects of submarine cable installations.
Minister of Maritime Affairs and Fisheries Decree No. 51 DII of 2023 on the National Team for Managing the Laying of Submarine Pipelines and / or Cables	- Establishes a National Team to manage the laying of submarine pipelines and cables. - Provides a coordination mechanism between ministries / agencies.	- Lack of detailed technical guidelines for submarine cable installation. - There is a need for an agreement on the scope of the National Team's work, whether all laying activities must go through the National Team or if certain activities can be exempted.
Kepmen KP No. 14 of 2021 on Submarine Pipelines and / or Cable Routes	- Establishes routes for the installation of submarine pipelines and / or cables.	- Implementation and enforcement of this regulation remain a challenge. - There is a need for technical regulations regarding the allowable deviation between the permitted plan and the actual laying. - A need for an agreement on international cables crossing trough Indonesia - Need for regulation on the width of the corridor - Separate landing points for communication, power, and pipelines are needed. - Need for an agreement on the efficient distance between cables by the marine area.
Kepmen KP No. 42 of 2022 on the Mechanism for Organizing the Establishment and / or Placement of Structures and Installations at Sea	- Regulates the licensing mechanism and technical requirements for establishing and placing structures and installations at sea. - Provides a more comprehensive legal framework for sea-based installations.	- Implementation and enforcement of this regulation remain a challenge. - There is a need for detailed Standard Operating Procedures (SOPs) for each stage of the business process, including output standards. - According to the time calculation flow, from proposal submission to the marine survey process takes only 40 working days, and from discussions to installation, the process requires only 51 working days. - The time for site visits, integrated presentations, marine surveys, data submission, and technical discussions depends on the initiator. - An evaluation of activities already carried out and not repeated in the licensing process at other Ministries is needed to reduce the licensing time.

Source: Authors.

- Selection of routes closest to existing platforms and risers.
- Determination of seabed conditions to identify potential obstacles to the submarine cable route and installation, such as rocks, coral reefs, seismic activity, steep seabed slopes, and sediment flows.
- Analysis of human activities in the surrounding sea that could pose obstacles, such as fishing, mining, or other industrial activities.

2. Desktop Study
A Desktop Study (DTS) is a crucial prerequisite for a detailed submarine cable route survey. When conducted properly, the DTS and marine route surveys help identify the safest and most technically feasible routes for the submarine cable system's engineering, construction, installation, and subsequent maintenance. The Desktop Study is governed by the ICPC No 09 Minimum Technical Requirements for a Desktop Study and ICPC No 18 Minimum Technical Requirements for the Acquisition and Reporting of Submarine Cable Route Survey. Essential minimum requirements covered in these recommendations include:
   - Executive Summary: An introduction, overview of cable engineering, and risk analysis.
   - Field Visit Summary: Information on the chosen location for the Beach Manhole (BMH).
   - Route Description: Cable crossing tables, maritime boundaries, and restricted areas.
   - Geology: Tectonic setup, seabed morphology and lithology, volcanic activity (including underwater volcanoes), seismic activity, tsunami risk, surface faults, sediment transport, waves, beach and seabed stability near shore, and offshore geology.
   - Climatology: Seasonal variations in climate and weather, climatological checks (temperature, rainfall, wind), proximity to flood-prone areas.
   - Oceanography: Sea conditions, currents, underwater temperature, wind and waves, and tides.
   - Commercial Operations, Hazards, and Restricted Areas: Anchorage areas, military training zones, etc.

   This comprehensive study prepares for the detailed survey and ensures the route's suitability and safety.
3. Cable Route Survey.
A submarine cable route survey determines the cable path that will maximize the cable's durability while keeping the system and component costs within acceptable limits. The selected route determines the cable length and design (factors that the cable manufacturer must understand) and establishes the methods for cable installation. This survey also generates reference records supporting the cable's future maintenance and repair. The recommended scope of the survey includes:

Beach Landing Survey.
The Beach Landing Survey is conducted on the area from the proposed or existing BMH to the low water line. The survey corridor ranges from 500 m to 250 m in width, starting from a depth of 250 m towards the land, from the BMH to the low water line at the time of the survey, depending on the landing location conditions. Conventional land survey techniques can be used along with beach probes to measure sediment thickness at the beach.

Driver Survey.
The Diver Survey covers the area from the beach landing survey boundary to the land survey boundary, typically at a water depth of 3 m. It involves a single pass along the route, with coverage up to 10 m wide, depending on the seabed conditions. The survey utilizes satellite-based or land-based positioning systems, video and photo cameras, sediment thickness probes, and, if necessary, acoustic methods to detect cables.

Coastal Survey.
The Coastal Survey extends from the diver survey boundary to a depth of 15 m or 20 m, with a corridor width of 500 m. The survey utilizes satellite-based positioning systems, along with navigation recording systems for the survey. The equipment used includes Singlebeam Echosounders, Multibeam Echosounders, Sidescan Sonar (minimum 100 kHz), Sub-bottom Profilers, Magnetometers, Grab Samplers, and Sound Velocity Measuring Equipment.

Shallow Water Survey.
The Shallow Water Survey covers depths from 15 m or 20 m to the end of cable burial, with a corridor width ranging from 5 meters to 1.000 m, depending on the regulations. The survey employs satellite-based positioning systems and navigation recording systems. Additionally, an Underwater Positioning System is used, along with Singlebeam Echosounders, Multibeam Echosounders, Sidescan Sonar (minimum 100 kHz), Sub-bottom Profilers, Magnetometers, Grab Samplers, Gravity Corers (with 3-meter core barrels), Core Penetration Tests (CPT) for Burial Assessment Surveys (to measure soil strength), and Sound Velocity Measuring Equipment.

Deep Water Survey.
The Deep Water Survey extends beyond the cable burial depth (End of Burial) and covers up to three times the water depth, with a maximum corridor width of 10 kilometers (km). It utilizes satellite-based positioning systems and navigation recording systems. The survey also employs Multibeam Echosounders and Sound Velocity Measuring Equipment.

Branch Unit Survey.
The Branch Unit Survey is conducted in shallower areas than the cable burial depth (End of Burial), covering a

range of 3 to 6 times the water depth (minimum 2 km). In areas deeper than the cable burial depth (End of Burial), the survey corridor extends 3 to 6 times the water depth, with a minimum of 10 km. A Multibeam Echosounder is used for Water Depth (WD) when the depth exceeds the Effective Operational Depth (EOB). If the water depth is less than the adequate operational depth, a combination of Multibeam Echosounder, Sidescan Sonar, and Sub-bottom Profiler is required to gather complete data about the seabed.

4. Route Clearance.

Route Clearance (RC) is conducted to clear the cable route of obstacles such as out-of-service (OOS) cables identified during the cable route survey, as these cables can pose a risk to both the installation equipment and the new cable itself. RC is only performed in areas where cable burial is deemed necessary. The Desktop Study and Sea Route Survey will determine the locations of OOS cables that may need removal from the proposed route. The OOS cable sections are typically removed to clear a 500-meter corridor on both sides of the route's centerline, leaving the cable ends on the seabed.

5. Pre-Lay Grapnel Run.

The Pre-Lay Grapnel Run (PLGR) is performed along the planned cable burial route before plowing begins to clear obstacles that could damage the plow, such as rocks, fishing gear, and debris. One or more grapnels are dragged along the seabed, with the vessel moving at a speed ensuring the grapnel maintains contact with the seabed at a depth of 40-80 cm. The grapnel is connected to a towing line with a 30 m chain. The grapnel's design helps clear the route by hooking linear obstacles. It is periodically lifted onto the vessel's deck for inspection and disposal of collected debris at the port.

6. Cable Deployment.

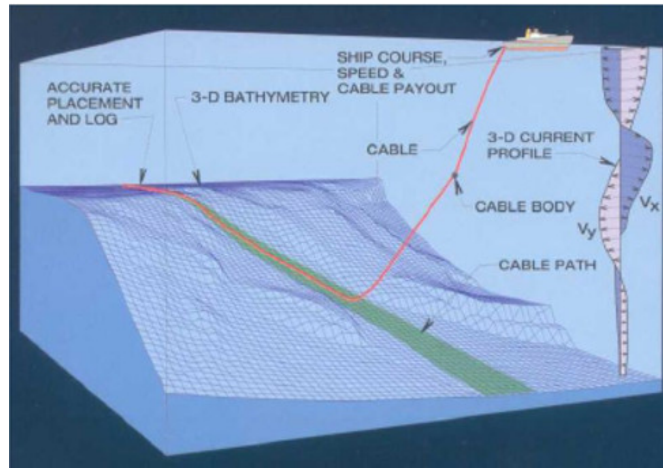
Cable Laying (Surface Laying)

At depths greater than 1.000 m, the cable will be laid on the seabed surface.

Cable Laying (Cable Burial).

Plough cable burial is carried out in depths of less than 1.000 m where the seabed conditions allow. The weight of the cable plough is around 12 tons in water, and it is deployed from the rear of the vessel and pulled behind the ship, burying the cable into the seabed, usually to a depth of 1 m as it moves along the route. Plough burial can reach a maximum depth of 2 m, depending on the type of seabed.

Figure 1: Surface laying.



Source: ICPC, 2002.

Figure 2: Sea plough cable.

Source: ICPC, 2002.

A plough is suitable for muddy substrates, while sandy sediments require a plough equipped with water jets to create a trench for cable placement. The plough will not be used in areas with steep slopes, obstructing sides, or on routes crossing active cables. In specific challenging environments, where the seabed is soft and high-intensity shipping activity poses increased threats to the cable, deeper burial requirements may be specified. For example, cables must be buried 10 m below the seabed in Singapore's port limits. Such deep burial can be achieved with specialized jetting equipment and rock cutters.

7. Repairs and Maintenance.

Cables can be restored due to damage, component failure, cable aging, or the need to clear congested routes. Cable repair involves locating the cable, retrieving it with a grapnel, and lifting it to the surface. Cable repair is a complex process considering various factors, such as the speed and angle of repair, cable tension, water depth, and currents. Around 70% of all cable damage caused by external aggression originates from fishing and shipping activities in waters less than 200 m deep (Kordahi and

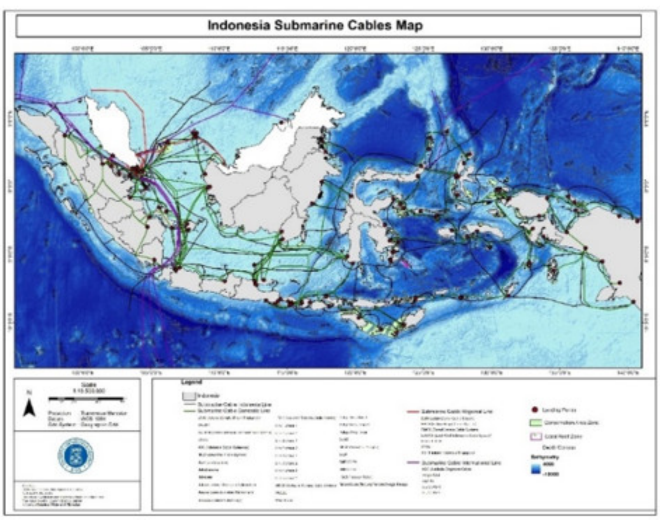
Shapiro, 2004).

For buried cables, the repair procedure is carried out by dragging a grapnel along the cable route, cutting the cable, and retrieving both ends. A new section can be inserted or "spliced" on the repair vessel to replace the damaged cable. The repaired section of the cable is then re-laid on the seabed at a perpendicular angle to the original route to minimize slack from the joint (Drew and Hopper, 1996). The repair is then reburied using an ROV equipped with jets (Mole et al., 1997).

3.2.2. Analysis of Submarine Cable Conditions in Indonesia.

The establishment of the legal framework for submarine cable and pipeline routes in the Minister of Marine Affairs and Fisheries Decree No. 14 of 2021, which designates 217 national submarine cable routes, 43 submarine pipeline routes, 4 landing stations, and 209 BMH points. Below is the map of the submarine cable conditions in Indonesia (Figure.3):

Figure 3: Indonesia submarine cables map.



Source: Authors.

The data for the Indonesia submarine cables map is compiled based on the latest data from 2024 to provide an accurate overview of the development of submarine telecommunications infrastructure in Indonesia. Currently, approximately 58 submarine cables are deployed in Indonesia, consisting of 40 domestic/national submarine cables, 8 regional submarine cables, and 10 international submarine cables. This data is sourced from information published by The Naval Hydro-Oceanography Center Indonesia.

Based on interviews with the Coordinating Ministry for Maritime Affairs and Investment authorities, the issues related to submarine cable installation in Indonesia are complex and require collaborative handling. Through this inventory, practical policy recommendations can be formulated to address these issues and support the development of high-quality and sustainable submarine telecommunications infrastructure.

Table 3: Inventory of Submarine Cables Conditions in Indonesia.

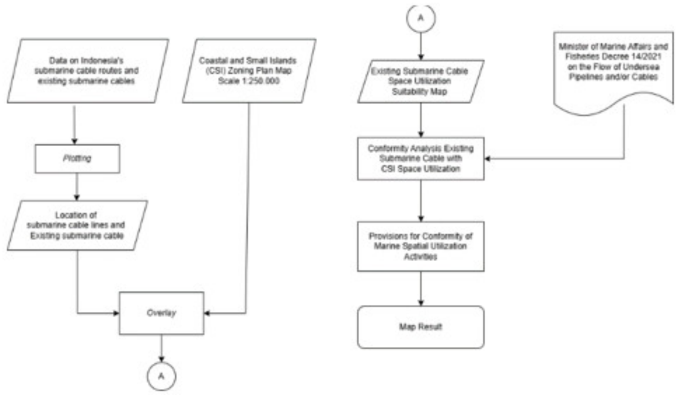
Issue	Current Regulatory	Follow Up
The distance between cables in ICPC's recommendation condition is not efficiently applied	- PP No. 27/2021 Article 31 on Maritime Administration, which regulates Safety and Security Zones - ICPC Recommendation No. 2, Issue date July 31, 2023, states that in cases where cable separation is less than the recommended ICPC standard, all related parties, including owners of existing submarine cable routes that are nearby, must be aware of and understand this condition, especially the risks involved during cable repair processes.	For depths below 100 m, it is recommended to maintain a minimum distance of 250 m between cables.
The need for separation of Landing Points for communication cables, power cables, and pipelines	PP No. 27/2021 on Maritime Administration, which regulates Safety and Security Zones	Landing Point locations can be determined based on regencies or cities.
The regulation on corridor width will be limited to a specific width or given the flexibility to adjust to field conditions under certain conditions.	Routing Information Protocol for Communication Networks, Electrical Networks, and Energy Networks.	Regulations regarding the corridor width should allow flexibility to adjust to field conditions, considering that if there are existing cables, adding new cables should be accommodated by adjusting to the field conditions.
There is a need for further detailing of the Standard Operating Procedures (SOPs) at each stage of the business process for the Mechanism for the Establishment and/or Placement of Buildings and Installations at Sea.	Kepmen KP No. 42 of 2022 on the Mechanism for the Establishment and/or Placement of Buildings and Installations at Sea.	Kepmen KP No. 42 of 2022 needs to be supplemented with timeframes for the completion of each SOP or licensing process to provide certainty regarding timelines to the proponents.

Source: Authors.

3.2.2.1 Mapping Methodology.

In implementing planning and managing submarine cable infrastructure, mapping is a crucial step. This approach is essential to ensure that cables are laid along optimal routes, safe from natural disturbances and human activities, and in compliance with national and international regulations concerning the use of marine space. Below are the general steps involved in the mapping process, presented in the following flow diagram (Figure. 4):

Figure 4: Mapping flowchart.



Source: Authors.

Suitability of Submarine Cable Routes under Kepmen KP No. 14 of 2021 with Conservation Areas Zone.

The development of submarine cable is vital for improving Indonesia's digital connectivity and economic growth. However, it must align with global sustainability goals, particularly SDG 14: "Life Below Water," which focuses on conserving marine resources and protecting sensitive ecosystems, including conservation areas.

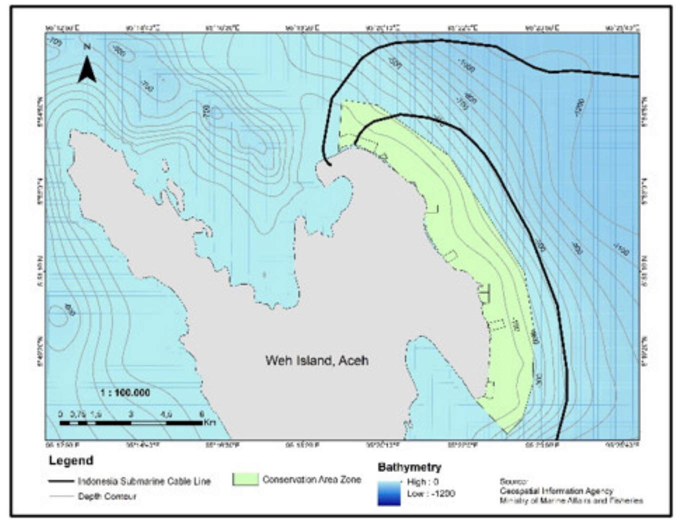
Kepmen KP No. 14 of 2021 provides a regulatory framework to ensure submarine cable routes avoid conflicts with key areas, including marine conservation zones under Regulation of the Minister of Marine Affairs and Fisheries No. 31/Permen-KP/2020 on The Management of Conservation Areas. Analyzing the alignment of submarine cable routes with these zones helps ensure minimal disruption to underwater ecosystems, supporting both connectivity and environmental sustainability.

Figure 5: Research area.

Source: Authors.

1. North of Weh Island, Sabang, Aceh Province
Weh Island, located off the eastern coast of Sabang City, Aceh Province, has a designated marine conservation area regulated under the Decree of the Minister of Maritime Affairs and Fisheries No. 57/KEPMEN-KP/2013. As one of the strategic areas for underwater communication and telecommunications infrastructure, the waters around Weh Island are often considered a potential route for installing submarine cables.

Figure 6: Compatibility of submarine cable North of Weh Island with conservation area zone.

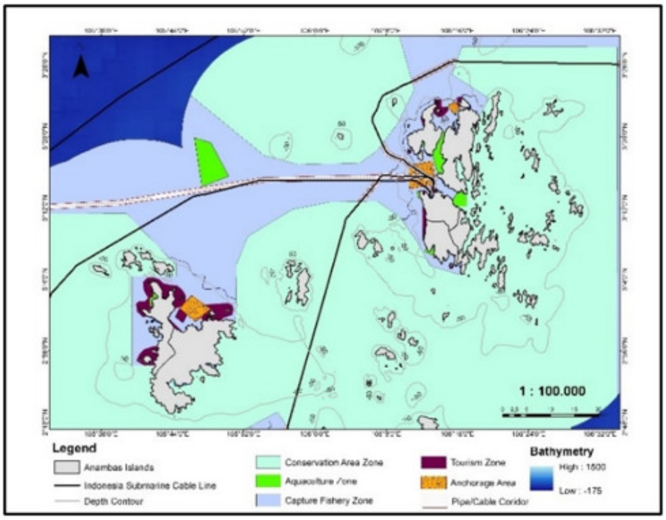


Source: Authors.

However, the overlay results indicate an overlap between the submarine cable route at depths of 0–300 meters, which has been established, and the marine conservation zone around Weh Island. This condition presents a potential risk to the preservation of the marine ecosystem. Simplification of the route and adjustment of alternative paths are required to avoid the conservation area and minimize environmental impact. This approach not only supports the protection of marine ecosystems but also ensures the technical efficiency and operational sustainability of the submarine telecommunications network.

2. West Anambas Islands, Riau Islands Province
One of the marine conservation areas in the Riau Islands is the Anambas Islands and Surrounding Seas Marine Tourism Park, established through the Minister of Maritime Affairs and Fisheries Decree Number 37/KEPMEN-KP/2014. This area boasts high biodiversity and includes ecosystems such as coral reefs, seagrass meadows, and other critical habitats.
The overlay map results indicate that the submarine cable routes established under Ministerial Decree No. 14/2021 still overlaps with conservation areas in the Anambas Islands Marine Tourism Park, including core zones and limited-use areas. Some cable routes also pass through anchorages, which are strategic zones for shipping and logistics activities. This overlap could lead to maritime spatial conflicts, disrupt the ecological functions of the conservation areas, and increase the risk of cable damage due to vessel activities. Strategic actions are needed, including route simplification, adjustment of cable paths,

Figure 7: Compatibility of submarine cable West Anambas Island with conservation area zone.

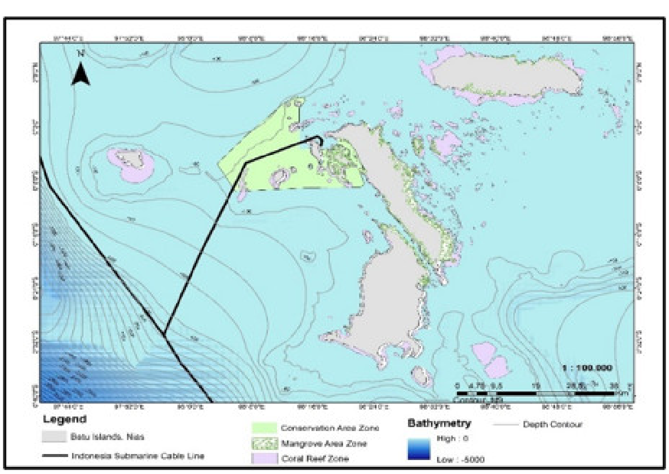


Source: Authors.

and mitigation measures that consider both ecological and operational aspects.

3. Hibao Telo Islands, Nias, North Sumatera Province. Based on the overlay map analysis, the submarine cable routes designed under Ministerial Decree No. 14/2021 still intersects with conservation areas around Hibao Telo Island, Nias, which are regulated by Ministerial Decree No. 86 / KEPMEN-KP / 2020. The intersecting submarine cable routes is located at depths of less than 100 m. This situation presents challenges in ensuring integrated management between the protection of conservation areas and the need for the submarine cable routes. Therefore, route simplification and efforts to avoid conservation areas are required to prevent spatial conflicts and support harmonious management.

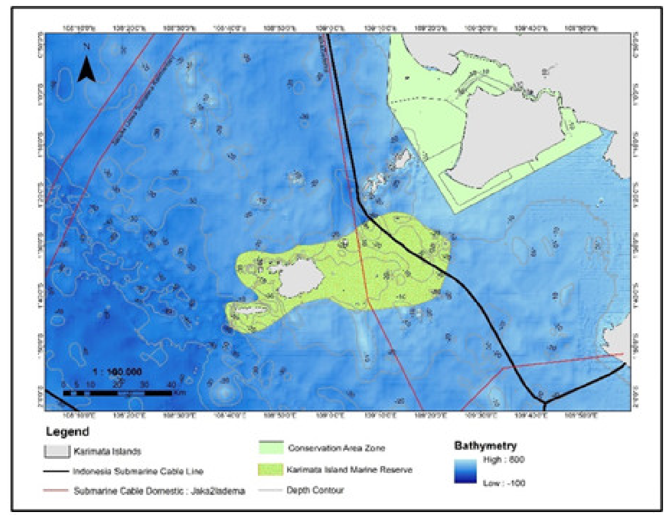
Figure 8: Compatibility of submarine cable Hibao Telo Island with conservation area zone.



Source: Authors.

4. East of Karimata Island, West Kalimantan Province. The existence of conservation areas, such as the Karimata Islands Marine Nature Reserve established by the Minister of Forestry Decree No. 381/Kpts-II/1985 on December 27, 1985, is a priority for protection to preserve biodiversity and marine ecosystems.

Figure 9: Compatibility of submarine cable East Karimata Island with conservation area zone.

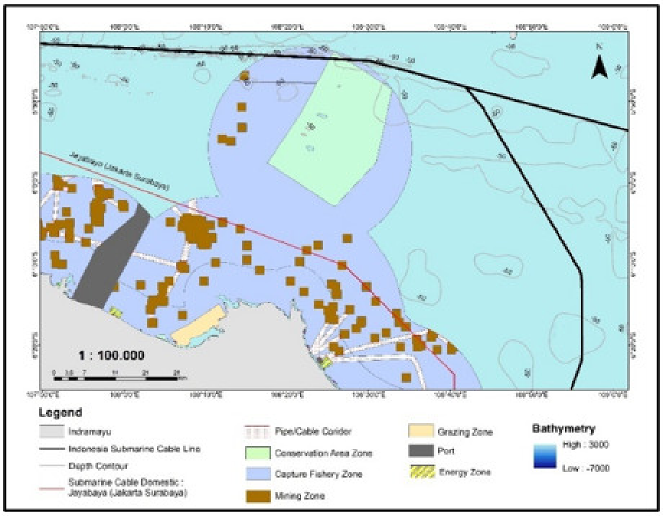


Source: Authors.

However, the cable route in the Minister of Marine Affairs and Fisheries Decree No. 14/2021 still overlaps with the marine nature reserve area at depths of 10 – 40 m. Additionally, in the same area, there is existing underwater cable infrastructure, namely the Java-Lombok-Denpasar-Makassar (JALA2LADEMA) submarine cable network, which spans 1,800 km and connects five islands in Indonesia-Kalimantan, Sulawesi, Java, Bali, and Lombok and has been operational since 2010. This situation indicates a potential spatial conflict that needs to be addressed immediately to prevent ecosystem damage and operational disruptions to the underwater infrastructure.

5. Northern Waters of Indramayu, West Java Province. The submarine cable routes based on Minister of Marine Affairs and Fisheries Decree No. 14/2021 overlaps with the Marine Conservation Area of Indramayu Regency, established through the Regent's Decree No. 556/Kep.528 Diskanla/2004. This area is crucial for protecting marine biodiversity and supporting the sustainability of the capture fisheries sector.
In addition, the submarine cable routes also intersects with the capture fisheries zone. According to the spatial utilization regulations for the capture fisheries zone, the installation of submarine cable is categorized as an allowed activity, provided it does not interfere with fishing activities or the sustainability of fishery resources. Furthermore, the existing submarine cable, the Jakarta-Surabaya (Jayabaya) cable, which has been operational since 2018, overlaps with the mining zone. Strategic

Figure 10: Compatibility of submarine cable Northern Waters of Indramayu with conservation area zone.

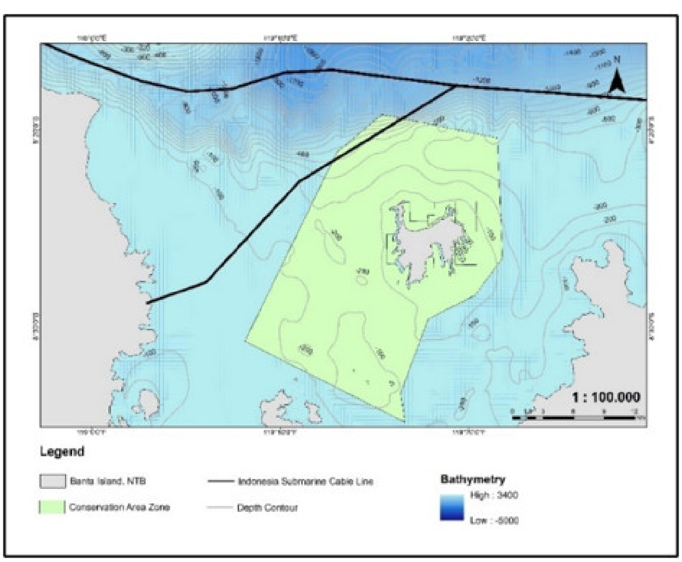


Source: Authors.

steps are needed, such as harmonizing marine spatial planning through route adjustments, mitigating conflicts of interest, and implementing more integrated zonal management.

6. Northen Banta Island, West Nusa Tenggara Province. One of the strategically important conservation areas is the Gili Banta Marine Conservation Area and its surrounding waters, which were established through the Minister of Maritime Affairs and Fisheries Decree No. 21/KEPMEN-KP/2020 in 2020.

Figure 11: Compatibility of submarine cable Northern Banta Island with conservation area zone.



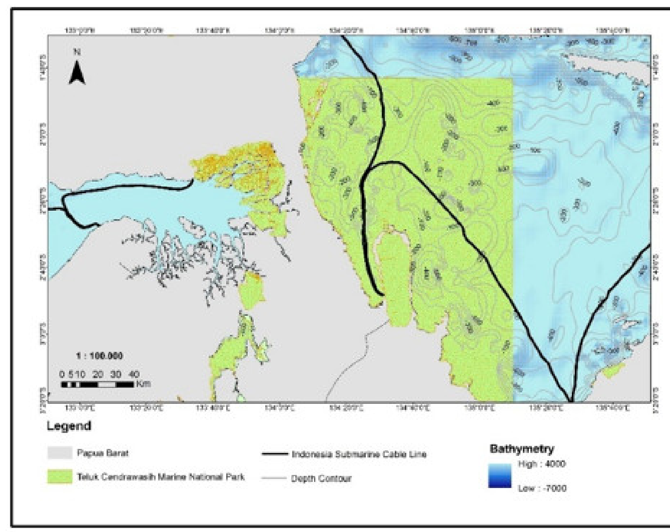
Source: Authors.

However, the designation of the submarine cable route under Ministerial Decree No. 14/2021 is found to still overlap with the conservation area.

7. Cendrawasih Bay.

One of the priority protection areas is the Cenderawasih Bay Marine National Park, designated through the Minister of Forestry Decree No. 8009/Kpts-II/2002 on August 29, 2002. This area is a marine ecosystem rich in biodiversity, including coral reefs, seagrass beds, and important habitats for various marine species.

Figure 12: Compatibility of submarine cable Cendrawasih Bay with conservation area zone.



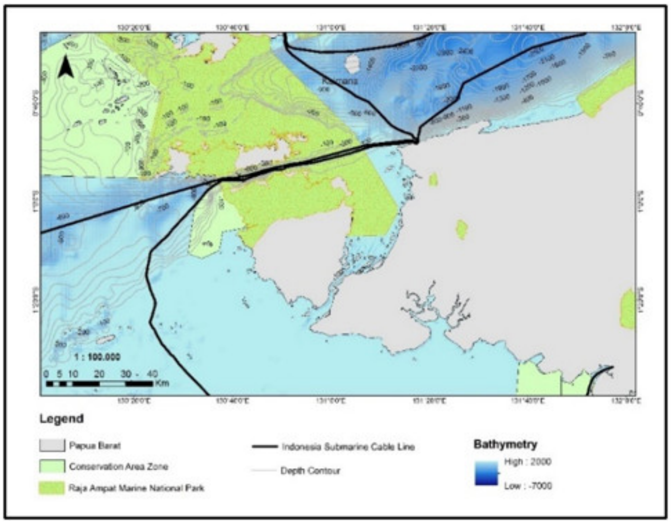
Source: Authors.

However, the designation of the sea space utilization route for the SKKL in the Minister of Maritime Affairs and Fisheries Decree No. 14/2021 is found to overlap with the Cenderawasih Bay Marine National Park area, as shown in the overlay map above. This overlap presents a strategic issue that requires attention, given that the area holds a high protection status designed to preserve the marine ecosystem.

8. Raja Ampat National Marine Park, West Papua Province.

As an archipelagic country, Indonesia faces significant challenges in managing its maritime space optimally while maintaining a balance between conservation and development. One area of particular concern is the Raja Ampat Archipelago Marine National Park, designated by the Minister of Maritime Affairs and Fisheries Decree No. 13 of 2021. This area is known as one of the world's highest marine biodiversity hotspots, with coral reef ecosystems, seagrass beds, and mangroves that serve as critical habitats for various marine species.

Figure 13: Compatibility of submarine cable Raja Ampat National Marine Park with conservation area zone.



Source: Authors.

However, the overlay results show that the submarine cable route, as regulated in the Ministerial Decree No. 14/2021, still overlaps with the conservation area. The cable passes through the Raja Ampat National Park at depths ranging from 100 to 500 m. This situation raises concerns about the potential negative impacts on the ecosystem functions in Raja Ampat, including habitat destruction due to cable installation and potential disturbances to marine life. This poses a challenge for the protection of conservation areas that have already been designated as national and global priorities.

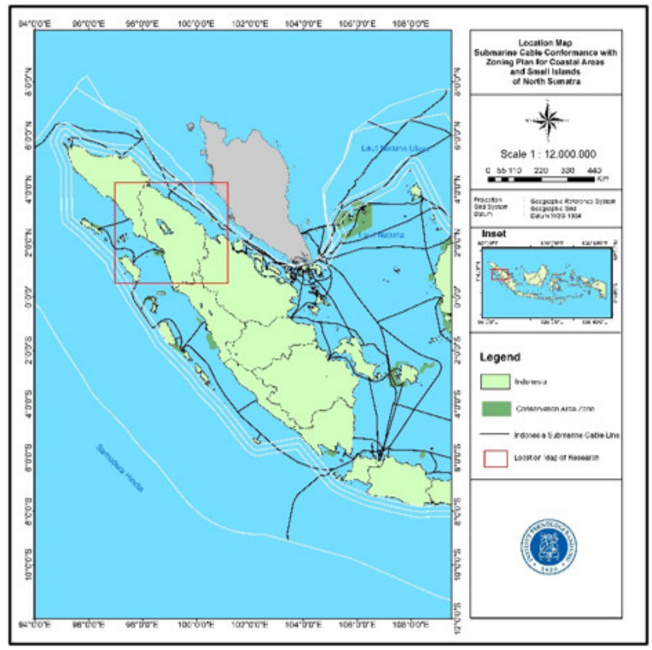
Suitability of Existing Submarine Cable Routes with the Coastal and Small Island Zoning Plan (CSIZP) of North Sumatera Province.

Underwater telecommunications infrastructure supports global digital connectivity and accelerates economic growth, especially in coastal areas and small islands. Several existing submarine cables, such as Aceh, Sibolga, Batam, Larantuka (ASBL), SEAMEWE 3, and SEAMEWE 5 cable owned by Telkom Indonesia, make significant contributions to information flow between countries and islands.

The SEA-ME-WE-3 cable connects Indonesia with other countries, passing through Ancol, Jakarta, and Medan in North Sumatra. This cable spans 39,000 km and crosses countries such as Brunei, Belgium, China, and the UK. Meanwhile, the SEA-ME-WE 5 cable, installed in 2016, connects Medan to 15 countries, with a total length of 20,000 km and a capacity of 24 terabits per second using 100G technology. Additionally, the ASBL underwater cable connects several regions in North Sumatra, with a total length of 770 km, linking Sabang, Aceh, Sibolga, Nias, Larantuka, Atambua, Batam, and Tanjung Balai Karimun.

However, it is essential to assess further the compatibility of these submarine cable routes with the CSIZP of North Sumatra Province, as regulated in Regional Regulation No. 4 of 2019, to ensure proper integration with the coastal and small island spatial planning. The following research areas are shown in Figure. 14:

Figure 14: Research Area.



Source: Authors.

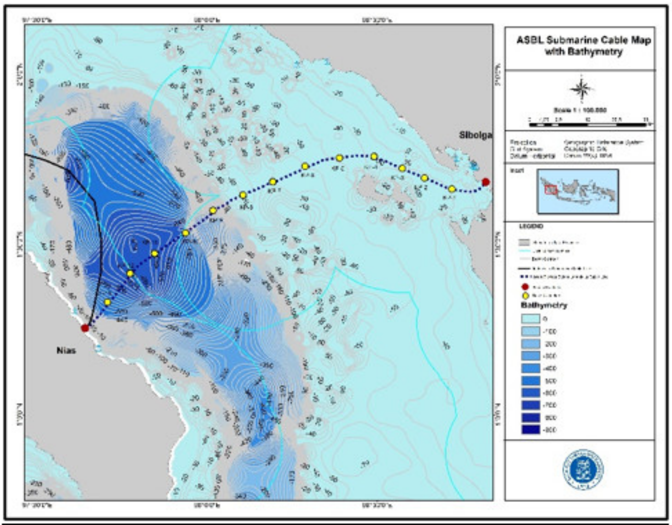
- Bathymetry Condition.

  ASBL Submarine Cable.

The ASBL submarine cable route, which connects Nias Island with the city of Sibolga, has a cable length of 156 km. The bathymetric map within the corridor is a contour map with a maximum depth of 665 m and a minimum depth of 0 m. The reference depth is based on the Mean Sea Level (MSL) derived from tidal observations at the Sibolga and Gunungsitoli stations owned by BIG. The landing point in Sibolga is the starting point for measuring the length of the route along the corridor.

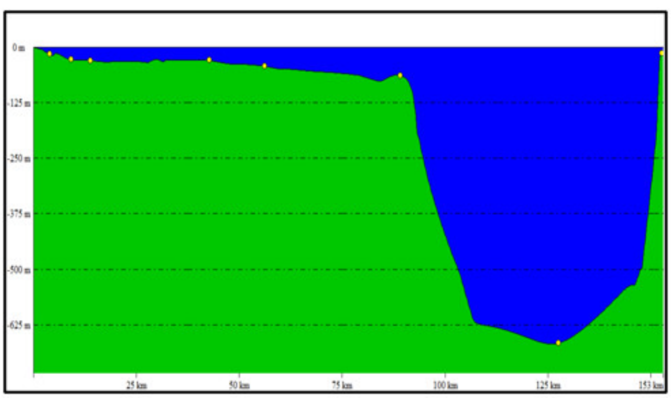
- Kilometer Pangkal (KP) / Base Kilometer 0 or Landing Point is located in Sibolga, with a distance from KP 0 to KP 1 of approximately 12 km and a depth ranging from 0 to 20 m.
- Distance 0 - 88 km (KP 0 - KP 8): In this segment, the average slope of the seabed is 0.2° or 0.34%, indicating a relatively flat seabed. This low slope allows for cable placement with minimal risk of physical disturbances or damage due to drastic depth changes.
- Distance 88 - 107 km (KP 8 - KP 11): In this segment, the seabed slope increases significantly to 1.86°

Figure 15: ASBL Bathymetry.



Source: Authors.

Figure 16: Path Profiler ASBL.



Source: Authors.

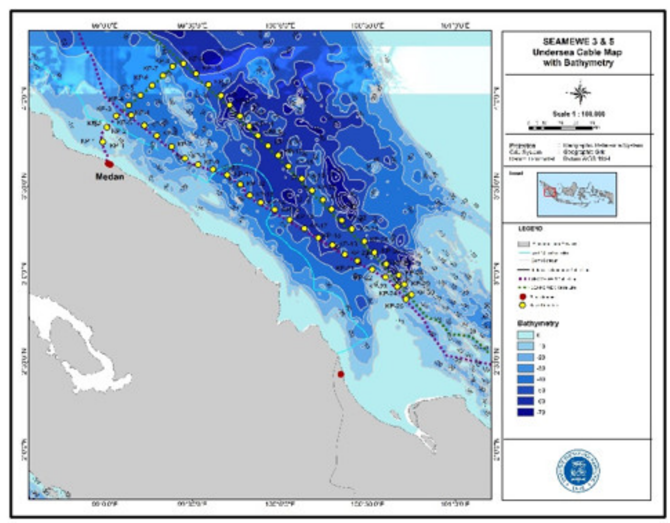
or 3.25%, with depths fluctuating between 74 m and 625 m. The steeper slope indicates the presence of more rugged geological features, which may increase the challenges in cable installation and raise the risk of mechanical damage to the installed cable.

- Distance 123 - 125 km (KP 12): In this segment, the seabed slope decreases to 0.16° or 0.279%, with a depth reaching 669 m. The lower slope and greater depth indicate a relatively stable seabed, though the increased depth could cause cable laying and maintenance difficulties.
- Distance 125 - 145 km (KP 12 – KP 14): In this segment, the depth decreases from 669 m to 532 m.
- Distance 145 - 156 km: In the final segment, the seabed depth increases significantly from 532 m to 10 m, with a slope of 4.99° or 8.73%. This is a sharp change, indicating the presence of very steep underwater structures or hilly contours. The steep slope presents a significant challenge for cable installation and requires extra attention to ensure that the cable is not damaged due to the rapid changes in depth.

SEAMEWE 3 and 5 Submarine Cable.

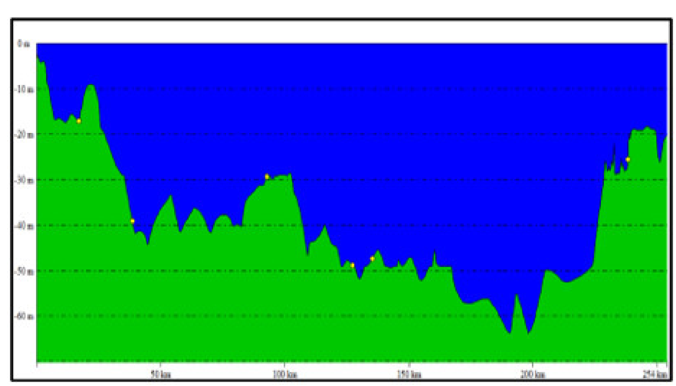
The Landing Point location of the SEAMEWE 3 cable route is in Medan, North Sumatra, and Ancol, Jakarta. The length of the SEAMEWE 3 subsea cable passing through Medan, North Sumatra, is 253 km. The bathymetric map within the corridor is a contour map with a maximum depth of 65 m and a minimum depth of 0 m. The depth reference is based on the Mean Sea Level (MSL) derived from tidal observations at the Belawan station in North Sumatra, owned by BIG. The landing point in Medan is the starting point for calculating the total length of the cable route.

Figure 17: SEAMEWE 3 & 5 Bathymetry.



Source: Authors.

Figure 18: Path Profiler SEAMEWE 3.



Source: Authors.

- Kilometer Pangkal (KP) / Base Kilometer 0 or Landing Point is located in Medan, with a distance from

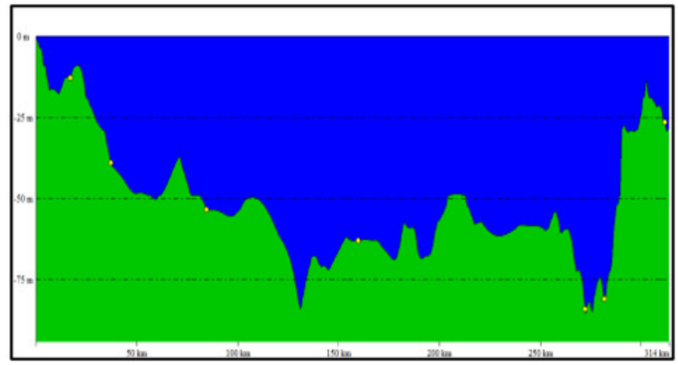
KP 0 to KP 1 of approximately 10 km and a depth ranging from 0 to 17 m.

- Between 10 km to 35 km (KP 1 to KP 3), the average depth is 20 m with a seabed slope of 0.27° or 0.47%.
- The seabed slope is relatively low along most of the route (from KP 0 to KP 20), with values ranging from 0.1° to 0.28° or equivalent to 0.17% to 0.48%. This indicates that most of the cable route corridor has a relatively flat seabed, which allows for stable subsea cable installation.
- There are no significant changes between 35 km to 95 km (KP 3 to KP 9), with an average depth of 40 m and a seabed slope of 0.1° or 0.17%.
- Between 95 km to 200 km (KP 9 to KP 20), the average depth is 50 m with an average seabed slope of 0.1° or 0.17%.
- Between 200 km to 210 km (KP 20 to KP 21), the depth increases to 20 m with a seabed slope of 0.28° or 0.48%.
- Between 210 km to 220 km (KP 21 to KP 22), the depth becomes 25 m with an increased seabed slope of 0.93° or 1.62%. This indicates a more steep seabed topography in this segment, which may require special attention during the cable installation process to ensure the safety and stability of the cable route.
- Between 220 km to 253 km (KP 22 to KP 25), the average depth is 30 m with a stable seabed slope of 0.1° (0.17%), indicating a flatter seabed condition.
- The SEA-ME-WE 3 subsea cable route along Medan, North Sumatra, shows that most of the corridor has a relatively stable seabed with a low slope, making it ideal for subsea cable installation.

The SEA-ME-WE 5 cable route has a landing point in Medan, North Sumatra, with a total cable length of 303 km. The bathymetric map within this corridor is a contour map with a maximum depth of 65 m and a minimum depth of 0 m. The depth reference is Mean Sea Level (MSL), based on tidal observations at the Belawan station, North Sumatra, owned by BIG. The Landing Point in Medan is the starting point for measuring the cable route length throughout the corridor.

- Kilometer Pangkal (KP) / Base Kilometer 0 or Landing Point is located in Medan, with a distance from KP 0 to KP 1 of approximately 10 km and a depth ranging from 0 to 17 m.
- From 10 km to 35 km (KP 1 to KP 3), the average depth is 20 m with a seabed slope of 0.27° or 0.47%. This indicates a relatively flat seabed at the beginning of the cable route, suitable for stable cable installation.

Figure 19: Path Profiler SEAMEWE 5.



Source: Authors.

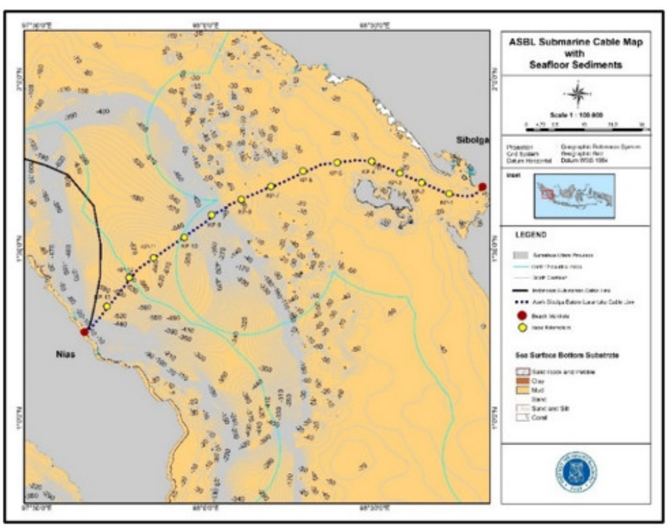
- From 35 km to 110 km (KP 4 to KP 11), the average depth is 50 m with an average seabed slope of 0.06° or 0.1%. This segment has a stable depth and a shallow slope, which supports cable installation with minimal risk of disruption.
- From 110 km to 125 km (KP 11 to KP 12), the average depth is 60 m with a slope of 0.13° (0.23%). This segment has a slight increase in depth and slope, but the changes are still within reasonable limits and do not pose significant technical challenges.
- From 125 to 130 km (KP 12 to KP 13), the average depth is 70 m with a seabed slope of 0.15° or 0.27%.
- From 130 km to 250 km (KP 13 to KP 25), the average depth is around 63 meters, with a slope of 0.08° to 0.12% (0.14% to 0.21%). This segment remains relatively stable in depth and slope, ensuring favorable seabed conditions for cable installation without drastic changes.
- From 250 km to 303 km (KP 25 to KP 30), the average depth is 75 m, with a slope of 0.17° (0.29%). The final segment shows slightly deeper depths and a steeper slope compared to the previous segments, but it remains within limits that can be handled by cable installation technology.
- Although some depth and slope changes need attention, most cable corridors can be installed stably. Segments with deeper depths or slightly steeper slopes require special consideration during cable installation planning. Overall, the seabed conditions along the SEA-ME-WE 5 route support cable installation with minimal operational disruption risks.
- According to the North Sumatra Provincial Regulation No. 4/2019 on RZWP3K for 2019-2039, the burial of underwater cables is mandated: from the shoreline to offshore waters with depths less than 10 m, cables must be buried 2 m below the natural seabed; in waters from 10 to 15 m, cables should be buried 1 m; in waters between 15 and 28 m, cables must be buried 0.5 m, and in deeper waters (over 28

m), cables may lie on the seabed, but must remain stable in position.

- Seabed Sediment Conditions.

The condition of seabed sediments is a critical factor in the planning and installation of underwater cables, which connects various coastal areas. Seabed sediments can impact the stability of cable installation, operational continuity, and the potential for cable damage due to the movement or deposition of seabed materials. The side scan sonar results, which provide seabed imagery along the underwater cable route corridors of ASBL and SEAMEWE 3 and 5, align with the bathymetric survey route. The interpretation of sediment types along the cable route corridors is shown in Figures 20 and 21 below:

Figure 20: Seabed sediment ASBL.



Source: Authors.

The seabed conditions along the ASBL cable route from Sibolga to Nias Island are generally mud. Qualitative interpretation based on seabed imagery indicates that mud sediments appear darker than sand. This is consistent with Khomsin et al. (2020), who stated that side scan sonar imagery with lower backscatter appears darker. The analysis of seabed sediment types can be assessed using a scoring system with values ranging from 1 to 5, as outlined in Pratomo et al. (2020). Below is the table categorizing sediment types:

Table 4: Seafloor Sediment Type Score.

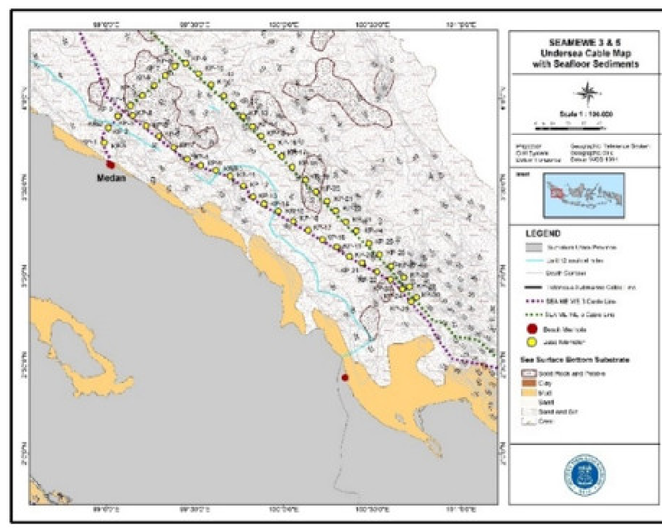
Sediment Type	Score
Clay	5
Mud	4
Sand	3
Gravel	2
Large Rocks	1

Source: Pratomo et al. (2020).

Based on the sediment type categories, it is recommended to place the submarine cable in areas with higher sediment hardness levels to support cables laid directly on the seafloor, preventing them from shifting and protecting them from anchor strikes, particularly for cables buried below the seafloor (Pratomo et al., 2020).

According to this scoring system, mud has a score of 4, indicating a medium hardness. With a dominant mud layer, cables placed directly on the seafloor are likely to shift, mainly if influenced by ocean currents or nearby vessel activity. Mud is also prone to erosion by waves, which could destabilize the cable and lift it from its original position. Therefore, it is crucial to consider cable installation technologies to ensure long-term stability and maintenance, such as burying the cable or using unique protective coverings.

Figure 21: Seabed sediment SEAMEWE 3 & 5.



Source: Authors.

The seabed conditions along the SEAMEWE 3 and 5 cable routes generally consist of muddy sand. The dominant sediment types from KP 4 to KP 8 are hard rock and gravel, with depths ranging from 20 to 50 m and no steep slopes. Table 4 categorizes muddy sand with scores of 3 to 4, indicating medium hardness. Muddy sand can provide sufficient stability for cables installed directly on the seafloor; however, there is a risk of the wires shifting or eroding by currents or waves, particularly in areas affected by vigorous maritime activity. While muddy sand offers moderate stability, cables in such sediment types require additional protection, such as cable burial or protective covers, to reduce the potential for cable displacement.

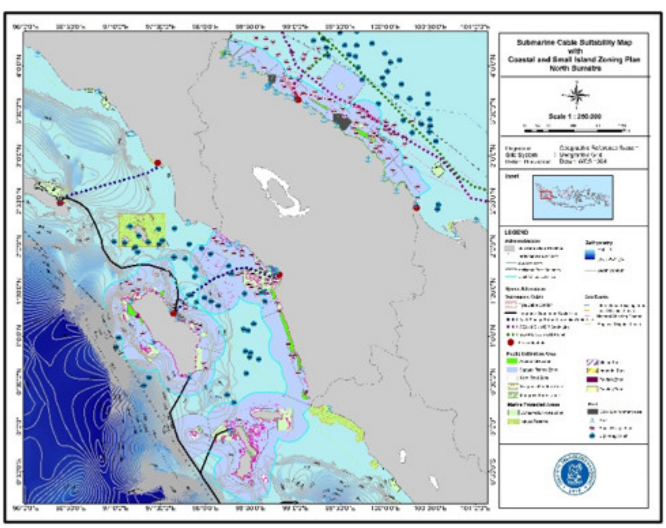
In the KP 4 to KP 8 segment, the dominant sediments are hard rock and gravel, which score lower (gravel with a score of 2 and large stones with a score of 1). In areas with hard rock, cable burial becomes challenging. However, techniques such as jetting, where high-pressure water is used to create a seafloor trench can safely bury the cables (Lekkerkerk et al., 2006). In some cases, cables may be laid on the seafloor surface if burial is not feasible, with careful consideration given to cable stability to prevent disruption from currents or human activities.

Alignment of ASBL, SEAMEWE 3 and 5 with CSIZP North Sumatera.

By the Regional Regulation of North Sumatra No. 4 of 2019 concerning the CSIZP of North Sumatra for 2019–2039, the alignment of submarine cable with CSIZP is crucial. This is because the installation of submarine cables must consider both environmental aspects and spatial planning as outlined in the CSIZP. This includes an environmental impact analysis of cable installation activities and the designation of specific zones to protect marine ecosystems and prevent damage to aquatic life habitats.

The alignment of ASBL submarine cable with the CSIZP in North Sumatra is particularly significant because the ASBL submarine cable is a telecommunication infrastructure project to improve connectivity in western Indonesia. Based on the map overlaid with CSIZP North Sumatra (Figure. 22), the cable route towards the landing point in Sibolga crosses the Coastal and Small Islands Conservation Area Zone of South Nias and its surrounding waters in North Sumatra, as shown in Figure 22 below:

Figure 22: CSIZP North Sumatera with submarine cable existing.



Source: Authors.

By the Minister of Maritime Affairs and Fisheries Regulation No. 31/PERMEN-KP/2020 on the Management of Conservation Areas, installing infrastructure in conservation areas must comply with licensing requirements by applicable laws. It is only allowed in areas where live coral cover is less than 50% and does not obstruct the migration routes of protected fish species or those that are the focus of conservation efforts. Additionally, the installation must maintain the economic activities of local communities within the conservation area. Collaboration with the conservation area managers is mandatory to avoid negative impacts on the function and objectives of the conservation area.

According to the results of the map overlay with the CSIZP, the ASBL, and the SEAMEWE 3 and 5 cable routes cross fishing zones. As regulated in the Regional Regulation of North Sumatra Province No. 4 of 2019 concerning the CSIZP for North Sumatra Province for the period 2019–2039, the activities allowed along the submarine cable routes include small boat transportation, such as the sander boat and other types of fishing boats, pelagic fish fishing, and marine tourism activities. Activities prohibited include mining, anchoring, demersal fishing using moving or towed equipment, installation of fish shelters and fishery aids (e.g., fish aggregating devices), waste disposal, and dumping areas. According to data from the Ministry of Maritime Affairs and Fisheries, the type of fishing carried out in this area is pelagic fish fishing. Therefore, there are no significant issues with the ASBL and SEAMEWE 3 and 5 cables routes crossing the fishing zones.

Conclusions.

The study shows that although several regulations are related to submarine cable installation in Indonesia, there needs to be comprehensive and detailed guidelines regarding licensing procedures, technical standards, and consistent law enforcement mechanisms. Existing regulations are generally broad and must address technical details or operational standards. There is a need to harmonize international regulations, such as UNCLOS 1982, which grants countries the right to lay submarine cables. However, the lack of a precise enforcement mechanism at the national level necessitates harmonization with national regulations to protect sovereignty and marine ecosystems.

The submarine cable routes published and regulated under Minister of Marine Affairs and Fisheries Decree No. 14 of 2021 still overlap with conservation zones. Existing submarine cables installed before the issuance under Minister of Marine Affairs and Fisheries Decree No. 14 of 2021 in North Sumatra still overlap with conservation zones and fishing zones, which must be coordinated while considering the existing requirements and conditions.

Based on the study's conclusion, several key recommendations need to be implemented to improve regulations related to submarine cable installation in Indonesia:

1. More comprehensive and detailed guidelines regarding licensing procedures, technical standards, and consistent law enforcement mechanisms should be developed. This will ensure clear guidance for all relevant stakeholders.
2. The submarine cable routes published and regulated under Minister of Marine Affairs and Fisheries Decree No. 14 of 2021 should be adjusted to avoid overlap with conservation and fishing zones, as some cable routes still conflict with these zones. It is also recommended that the Ministerial Decree be elevated to a Government Regulation to ensure stronger legal enforcement and greater clarity in its implementation.
3. Clear procedures for decommissioning unused submarine cables should be introduced to prevent environmental damage from no longer using wires. Another recommendation is a unified data management system that

tracks information on cable locations, issued permits, and hydrographic data, facilitating planning and monitoring.

By implementing these recommendations, Indonesia can ensure more efficient, environmentally friendly, and well - coordinated management of submarine cables.

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