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Surveillance of Shark Species Utilization at the Cilacap Ocean Fishing Port (Indonesia) using a Systems Approach

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ABSTRACT

The utilization of shark species in Indonesia still encounters legal violations, thus necessitating an effective surveillance system. This study aims to identify the issues within the surveillance system regarding the utilization of shark species at the Cilacap Ocean Fishing Port (PPS Cilacap). The study uses a system approach, limited to the system analysis stage. The results showed that there are still problems in the shark species utilization monitoring system at PPS Cilacap. These problems result in violations that continue to occur, especially concerning the legal regime of Regional Fisheries Management Organizations (RFMOs). The problems identified in the conclusions of this study cover several aspects. Regarding regulations and institutions, the mandate holders lack synergy, law enforcement remains weak, and support from management institutions for surveillance agencies is insufficient. Regarding surveillance procedures and budget, the existing standard operating procedures (SOPs) do not represent surveillance needs in accordance with legal regulations on shark management, and the available budget is inadequate. Regarding facilities and infrastructure, surveillance facilities for shark species have not been utilized at PPS Cilacap, and unreported fishing still occurs. Regarding human resources, the number of fisheries inspectors does not meet actual needs, while vessel captains and owners' knowledge and legal awareness remain limited. To address these issues, the recommended strategies include the maintenance and development of port facilities at PPS Cilacap, the integration of information systems among institutions, the dissemination of shark governance, the recruitment, education, and training of fisheries inspectors, the revision of SOPs, and comprehensive law enforcement.

Keywords: *PPS Cilacap; shark; surveillance system*

INTRODUCTION

Sharks are a fishery resource that is vulnerable to the pressures of excessive fishing activities. The status of shark resources in Indonesia, according to the Red List of the International Union for Conservation of Nature (IUCN), indicates that one species is classified as critically endangered, five species are classified as endangered, 23 species are classified as vulnerable, and 35 species are classified as near threatened. Meanwhile, the Convention on International Trade in Endangered Species

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of Wild Fauna and Flora (CITES) has listed 43 species under Appendix II. The IUCN Red List and CITES Appendix must be considered in the management of fisheries (Sentosa and Hedianto 2016). Shark fisheries management is necessary due to the ecological role of sharks in the ecosystem as apex predators within the food web, thereby contributing to the maintenance of ecosystem balance (Fitriyani 2019).

The legal basis for the management of shark species utilization in Indonesia is outlined in the Regulation of the Minister of Marine Affairs and Fisheries (MMAF) of the Republic of Indonesia Number 61/PERMEN-KP/2018, Regulation of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number 58/PERMEN-KP/2020, and Regulation of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number 10 of 2021. According to Mardhatillah *et al*. (2023) the implementation of shark fisheries management in Indonesia must be supported by monitoring, controlling, and surveillance programs. The oversight of shark fisheries should be a concern for the government (Nurbani *et al.* 2021). Furthermore, fisheries oversight is a preventive measure against illegal, unreported, and unregulated (IUU) fishing (Suharto *et al.* 2017).

According to the Cilacap Ocean Fishing Port (PPS Cilacap 2023) 18 species of sharks were landed in 2022. The development of shark production at PPS Cilacap from 2018 to 2022 has shown a declining production trend of 7.5%. Production decreased from 586.10 tons in 2018 to 320.98 tons in 2022. Sharks, as tuna bycatch from the operation of longline and gillnet fishing gear in Cilacap, contributed 4.7% to the total national catch (Fahmi and Dharmadi 2015; Muslim *et al*. 2019). Raharjo *et al*. (2024) state that the utilization status of the shark species *Alopias pelagius* and *Alopias superciliosus* at PPS Cilacap has experienced overfishing over the past ten years.

The utilization of shark species at PPS Cilacap indicates the presence of legal violations. These violations are caused by complex issues, including a lack of synergy among stakeholders, insufficient knowledge among fishery operators, poor dissemination of regulations regarding shark species utilization, profit motives, inadequate numbers and capacity of fisheries inspectors, and a lack of integration of data and information with fisheries oversight.

Legal violations in the utilization of fish species will adversely affect the achievement of sustainable and responsible shark management objectives. Other impacts include an increased potential for violations that complicate enforcement actions, the invalidity of calculations regarding the level of utilization and the Non-Tax State Revenue (PNBP) from sharks, and suboptimal governance of shark fisheries based on the principles of legality, traceability, and sustainability.

The complex issues mentioned above can be addressed through the analysis of the surveillance system for the utilization of shark species using a systems approach. The systems approach is a method employed to tackle complex problems that are dynamic and fraught with uncertainty. The stages of the systems approach in this study are limited to system analysis only.

This study aims to identify the issues within the surveillance system for the utilization of shark species at the PPS Cilacap using a systems approach. The resulting system analysis is expected to provide recommendations for improving the surveillance system for the utilization of shark species at PPS Cilacap.

METHODS

This research was conducted from September to December 2024. Data collection in the field was carried out at the Marine and Fisheries Resource Surveillance Station Cilacap (PSDKP Cilacap), PPS Cilacap, and the Coastal and Marine Resource Management Center Serang (Loka PSPL Serang).

The study employed a systems approach, focusing on the system analysis stage. System analysis includes the stages of needs analysis, problem formulation, and system identification (Nurani *et al*. 2019; Anwar *et al*. 2019; Asaf *et al*. 2021). The stages undertaken are as follows:

1. The needs analysis is determined based on the requirements of the stakeholders involved in the surveillance system for the utilization of shark species at PPS Cilacap.
2. Problem formulation involves defining the issues precisely to identify alternative solutions. Problem formulation is the result of a comprehensive understanding of the gaps between the needs of the system stakeholders and the existing conditions of the system.

3. System identification provides a comprehensive overview that illustrates the relationships between the identified needs and the problems faced. System identification is represented in causal loop diagrams and input-output diagrams.

Needs analysis and problem formulation were obtained through field observations and interviews with stakeholders involved in the system, along with a study of documents. For this purpose, data collection was conducted through field surveys. Primary data were gathered through field observations, interviews, and morphometric measurements of sharks. The selection of respondent samples was based on accidental and purposive sampling approaches. The accidental sampling technique was used to select the sample of fishing vessels observed and the corresponding respondents, namely the vessel captains and owners, who were interviewed. The sample of fishing vessels observed consisted of those that landed sharks. Observations on board the fishing vessels involved examining the fishing gear, identifying the species of sharks that landed, and conducting morphometric measurements of the sharks. Meanwhile, the purposive sampling technique was used to select other respondent samples, including fisheries inspectors, officers from PPS Cilacap, officers from Loka PSPL Serang, shark traders, and holders of the Fish Species Utilization Permit (SIPJI). Officers from PPS Cilacap comprised the fisheries harbor master, data collection personnel, and operational port staff. Officers from Loka PSPL Serang included shark and ray enumerators and members of the working team responsible for the protection and sustainable use of marine conservation areas and biodiversity. The respondents from the institutions were selected based on the criterion of having at least three years of work experience at PPS Cilacap in accordance with their duties and functions. The criteria for shark trader respondents refer to specialized fish traders who exclusively trade in shark products and conduct their transactions at PPS Cilacap. The criteria for SIPJI holder respondents refer to individuals or entities holding a Fish Species Utilization Permit (SIPJI) and sourcing shark raw materials directly from PPS Cilacap. A total of 51 fishing vessels were observed. The population of the sample observed consists of vessels that landed shark fish, and according to 2023, there were 469 vessels. According to Arikunto (2018), if the population of fishing vessels exceeds 100 units, the sample can be taken at 10–15% of the total population. In this study, the respondents represented the sampled vessels, comprising 51 captains and 23 vessel owners. Additional interviews were conducted with five fisheries inspectors, three PPS Cilacap officers, two Loka PSPL Serang officers, three shark traders, and three holders of the Fish Species Utilization Permit (SIPJI). Secondary data included an overview of the research location and supporting data on violations, legal regulations, institutional aspects, human resources, budgets, infrastructure, and Standard Operating Procedures (SOPs) obtained from the Head of the Surveillance station (PSDKP) Cilacap, PPS Cilacap, and the Loka PSPL Serang.

Data analysis

Realization of the shark catch quota

The identification of violations related to exceeding the realization of the catch quota is calculated using the following formula:

$$R_j = \frac{\sum_{i=1}^{n} P_{ij}}{(Q_j x c_j)} \; x \; 100\% \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; (1)$$

With:

R_j = Quota realization for shark species j (%)
Q_j = Quota of shark species j (individuals)
n = Number of vessels cooperating with the SIPJI holder
P_{ij} = Landed catch of shark species j from cooperating vessel i during the period (kg)
c_j = Conversion constant for shark species j (50 kg/head in 2023; 40 kg/head in 2024)

Budget effectiveness and efficiency

The evaluation of the budget is conducted through the calculation of effectiveness and efficiency using the following formulas:

$$Effectivity = \frac{\text{Realization of the direct expenditure budget}}{\text{Target of the direct expenditure budget}} \; X \; 100 \; \% \ldots\ldots\ldots\ldots (2)$$

$$Efficiency = \frac{\text{Realization of the direct expenditure budget}}{\text{Realization of the expenditure budget}} \; x \; 100 \; \% \ldots\ldots\ldots\ldots (3)$$

Human Resource Requirements

The analysis of human resource requirements is conducted following the

Regulation of the Head of the National Civil Service Agency of the Republic of Indonesia Number 10 of 2021, utilizing the following formulas:

$$Employee\ requirements = \frac{Total\ result\ x\ completion\ time}{effective\ time} \quad \ldots\ldots\ldots (4)$$

With:

1) Total Output: The aggregate quantity of work produced within one year.
2) Completion Time: The duration required to finalize each unit of work (hours).

Effective Time: The total number of hours available within a year, quantified as 1,250.

RESULTS

Research the location conditions

1. The port facility of PPS Cilacap

According to Pujiastuti *et al*. (2018), to support the operational and functional efficacy of the port effectively and optimally, the fishing port facilities must include essential, functional, and ancillary facilities. While such facilities are available at PPS Cilacap, operational challenges persist, including sedimentation in the entrance channel and the harbor basin. The capacity of the dock is limited to accommodating 200 vessels, whereas the existing fleet comprises 756 vessels, with the unloading dock distributed across three locations. The anchorage area, divided into three zones covering 15.5 hectares, is insufficient to accommodate the vessels. The condition of these facilities contributes to the occurrence of misreported (unreported) data regarding fish catch statistics at PPS Cilacap. Misreported fishing increases uncertainty in fish stock assessments and resource management (Svorken *et al.* 2023).

2. Utilization of shark species

a. Shark catching units and production

The shark-catching units at PPS Cilacap comprise vessels employing handline, longline, and gillnet fishing methods. In handline fisheries, sharks are considered a non-target species; however, in longline fisheries, they are classified as both target and non-target species. Sharks are specifically targeted in longline operations due to the inclusion of specialized equipment known as kleweran or shark line, which is particularly effective in capturing sharks in the Indian Ocean (Kurniawan *et al.* 2016). This assertion is further supported by Triyono *et al*. (2020), who indicate that sharks are a primary target in drift longline and bottom longline fishing in various regions of Indonesia.

From 2019 to 2023, a total of 18 shark species were landed at PPS Cilacap. The dominant shark species recorded include the thresher shark (*Alopias superciliosus*), pelagic thresher (*Alopias pelagicus),* blue shark (*Prionace glauca*), silky shark (*Carcharhinus falciformis*), and shortfin mako (*Isurus oxyrinchus*). The average production of sharks from 2019 to 2023 amounted to 219.45 tons. Species diversity and average shark production provide an overview of utilization activities that are the subject of surveillance.

b. Shark trade

The trade of sharks from PPS Cilacap is conducted through various methods aimed at both domestic and international markets (Figure 1). The shark products traded include meat, fins, bones, and skin (Wardono *et al.* 2022). According to Prasetyo *et al*. (2021), the shark trade in Indonesia is concentrated in two cities, namely Surabaya and Jakarta, while export destinations encompass Japan, Singapore, Hong Kong, and China. The illegal shark trade occurs through various modus operandi, including finning at sea, failing to report shark catch production data, mixing protected species with non-protected species, and flag of convenience practices. As indicated by Prasetyo *et al*. (2021), the illegal shark trade in Indonesia can be inferred from inconsistencies in global trade statistics, which reveal several gaps: 1. A discrepancy in volume between landings and exports; 2. A gap in information regarding landing locations and primary suppliers at the domestic level; 3. A disparity in volume between exports and imports as reported by trading partners.

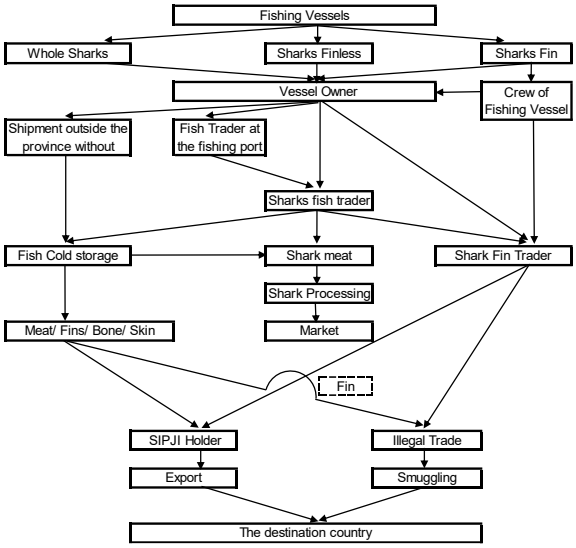

Figure 1 Shark trade from the Cilacap Ocean Fishing Port (Indonesia) is conducted through various channels targeting both domestic and international markets

c. Shark processing

Shark processing in Cilacap Regency encompasses the production of dried fins, bones, salted meat, oil, grilled meat, teeth, and entrails. These processing methods catalyze the increasing demand for shark products (Yulianto *et al.* 2018). However, shark processing in the Cilacap Regency faces several challenges, including many processors lacking a SIPJI. Additionally, SIPJI holders encounter difficulties sourcing raw shark materials from PPS Cilacap, and the species of sharks utilized as raw materials are classified under Appendix II and do not have an established quota for extraction.

3. Surveillance of the utilization of shark species

The surveillance of shark species utilization is an activity aimed at ensuring compliance with the regulations governing fisheries, particularly concerning the exploitation of species designated for protection and the regulation of their capture and distribution. Surveillance is an integral component of the Monitoring, Controlling, and Surveillance (MCS) system (Darwinto et al. 2016), which is a key element in combating Illegal, Unreported, and Unregulated (IUU) fishing. IUU fishing has significant repercussions, including loss of revenue, environmental degradation, economic losses, and depletion of fish stocks (Zulbainarni et al. 2024; Leonardo and Deeb 2022).

The authority for fisheries surveillance at PPS Cilacap resides with the fisheries inspectors of the Surveillance station (PSDKP) Cilacap. This is consistent with the statement by Aji et al. (2016) that one of the locations of fisheries monitoring is the fishing port. Although fisheries inspectors have conducted surveillance of shark species utilization, it has proven ineffective at PPS Cilacap. This ineffectiveness is attributed to a surveillance strategy that is limited to risk-based licensing oversight, a lack of integration of shark management data and information with the Surveillance station (PSDKP) Cilacap, and suboptimal implementation of fisheries vessel surveillance following standard operating procedures.

Existing conditions of the surveillance system for shark species utilization

The systems approach is a problem-solving process undertaken by individuals that examines the relationships and interactions relevant to the studied issues (Nurani *et al.* 2019). The systems approach begins with a description of the existing conditions, which encompasses the following aspects:

1. Aspects of violation

A violation is an act that does not comply with the prohibitions and obligations established by state authorities through legislation (Simamora *et al.* 2024). Violations related to the utilization of shark species represent acts of non-compliance with the regulatory provisions governing shark management as stipulated in Minister of Marine Affairs and Fisheries Regulation Number 61 of 2018 and Number 58 of 2020. Table 1 Number and percentage of violations in shark species utilization identified from observations of 51 fishing vessels landing sharks at PPS Cilacap (Indonesia), based on the CITES and RFMO legal regimes.

Table 1 Number and percentage of violations in shark species utilization identified from observations of 51 fishing vessels landing sharks at PPS Cilacap (Indonesia), based on the CITES and RFMO legal regimes.

No	Legal regime/ type of violation	Total (Unit)	%
1.	Protected/ CITES appendix		
	a. Capture of protected fish	-	-
	b. Ownership of SIPJI/ KTP SIPJI	1	1.96
	c. Catch permit	1	1.96
	d. Exceeding the catch quota	-	-
	e. Shark species do not have a quota	1	1.96
	f. The length of the shark is below the recommended size.	-	-
	g. Landing sharks that are not whole	-	-
2.	Utilization of RFMO areas		
	a. Catch a juvenile shark	20	39.2
	b. Landing sharks that are not whole	38	74.5
	c. Transferring, storing, landing, and selling *A. supercilious* and *A. pelagicus, C. falciformis,* and *C. longimanus*	43	84.31

The research findings indicate that violations concerning the utilization of shark species have occurred at PPS Cilacap (Table 1). These violations were observed in 51 fishing vessels that landed sharks at PPS Cilacap, comprising 46 handline vessels, four longline vessels, and one gillnet vessel. The most prevalent violation involved the transfer, storage, landing, and sale of prohibited shark species committed by 43 vessels (84.31%). The second most common violation was the landing of sharks in an unwhole condition, meaning that the head and fins were separated from the body, carried out by 38 vessels (74.51%). The third most frequent violation involved the capture of juvenile sharks by 20 vessels (39.22%), identified based on total length measurements smaller than the minimum size for adult sharks as defined in the literature. Juveniles are young fish that resemble adult fish but have not yet reached sexual maturity (Budiarto *et al.* 2015).

Violations of the CITES Appendix legal regime were noted in only one vessel (1.96%). Violations of the legal regime of the Regional Fisheries Management Organization (RFMO) competencies were predominant, consistent with the findings of Fahmi and Dharmadi (2015), which indicate shark fishing areas between 8º-13º S latitude and 106º-111,3º E longitude and Krisnafi *et al*. (2024) which indicates that the distribution of shark fishing areas based on PPS Cilacap lies between 8º-15º S latitude and 100º-111º E longitude. Krisnafi *et al*. (2024) also stated that the dominant shark species in the Indian Ocean waters include the pelagic thresher (*Alopias superciliosus*) and silky shark (*Carcharhinus falciformis*). Furthermore, studies by Arrum *et al*. (2016) and Prihatiningsih *et al*. (2019) reported that shark catches in the Indian Ocean were dominated by the pelagic thresher (*A. pelagicus*) and the bigeye thresher *(A. superciliosus*). These facts indicate that the shark fishing areas are located within the Exclusive Economic Zone of Indonesia (EEZI) WPP 573 and/or the high seas of the Indian Ocean, which fall under the area competence of RFMOs. Furthermore, the pelagic thresher (*A. superciliosus*), the bigeye thresher *(A. Superciliosus*), and the silky shark (*C. falciformis*) are classified as prohibited species sharks at the area competence of RSMOs. The fishing area serves as the primary basis for establishing the applicable legal regime.

The identification of violations concerning the excess realization of quotas is conducted solely against Company A, the SIPJI owner, specifically for one type of shark. This is because only Company A possesses three partner vessels based at PPS Cilacap, and only the species of lanjaman shark (*Carcharhinus falciformis*) was landed by these three partner vessels in 2023 and 2024. Company A holds a quota for capturing lanjaman sharks (*Carcharhinus falciformis*) exclusively during the second and third phases of 2023, amounting to 66 and 61 individuals, respectively, and in 2024, only during the first phase, which is set at 100 individuals. The calculations for the realization in the second and third phases of 2023 yielded results of 34.66% and 0%, while the first phase of 2024 recorded a mere 0.70%. These calculations indicate that Company A did not

exceed its quota, as the realization was below 100%. However, based on production data from the first phase of 2023 and the second phase of 2024, which amounted to 1,742 kg and 7 kg, respectively, it is evident that Company A violated the regulations by not possessing a valid catch quota.

Interviews conducted with the captains and owners of the vessels revealed that the violations in the utilization of shark species stem from several factors. Firstly, there is a financial motive, as capturing sharks is perceived to augment the crew's income. Secondly, both the captains and vessel owners lack knowledge regarding the management of shark species. Thirdly, most captains and vessel owners have not participated in the socialization efforts concerning shark management. Fourthly, the supervision and enforcement of regulations regarding the utilization of shark species at PPS Cilacap have not been effectively implemented. Lastly, the company's management has not directed adherence to the stipulations governing shark management.

The identification of violations concerning shark utilization faces several challenges. First, legal terms are subject to multiple interpretations, such as "juvenile." Second, there has yet to be a determination regarding the length category for juvenile sharks. Third, a legal vacuum exists concerning the regulations for species listed in the CITES appendix that are captured within the area of RFMO's competence but not prohibited.

2. Aspects of legislation

The analysis of legislation can be viewed from the aspects of legal substance, legal structure, and legal culture (Wiarti 2023). The results of the analysis indicate that the enforcement of laws regarding the utilization of shark species is weak (Table 2).

3. Aspect of institutional

The analysis of institutions can be conducted by focusing on human resources, technological resources, and management (Pratiwi and Salomo 2020). The institution responsible for the surveillance of shark species at PPS Cilacap is solely the government agency specifically tasked with oversight, namely the Surveillance station (PSDKP) Cilacap. In addition, the institutions that support this oversight include PPS Cilacap and Loka PSPL Serang. This aligns with one of the principles of the rule of law in Indonesia, which emphasizes the administration of government based on applicable legislation (Siallagan 2016). Evaluation of organizational resources supporting shark monitoring at the Surveillance station (PSDKP) Cilacap, including human resources, technological infrastructure, and management systems, is detailed in Table 3.

Table 2 The qualitative evaluation of the components of the legal system (substance, structure, and culture) governing the use of sharks in the PPS Cilacap (Indonesia), based on interviews with experts and legal analysis

Criteria	Evaluation
Legal substance	Shark management regulations have established governance for shark utilization. However, specific provisions, such as the prohibition on capturing juvenile and pregnant sharks, lack specific technical criteria. Furthermore, not all obligations and prohibitions related to shark utilization are accompanied by legal sanctions. For example, violations concerning harvest quotas and the possession of the Identification Card for the Permit to Utilize Fish Species (KTP SIPJI), thereby weakening the overall effectiveness of legal enforcement.
Legal structure	Institutions involved in surveillance activities clearly understand their respective duties and functions; however, inter-agency synergy in achieving the objectives of shark species utilization monitoring remains suboptimal. The existing legal framework is comprehensive, encompassing laws, government regulations, presidential decrees, and ministerial regulations. Law enforcement personnel are in place and supported by the necessary infrastructure, technical guidelines, and standard operating procedures (SOPs) to carry out their mandates.
Legal culture	The human resources of fisheries inspectors exhibit a disciplined work culture and high integrity. However, the effectiveness of surveillance remains limited due to insufficient support from management institutions, which restrict data and information sharing on the grounds of confidentiality, indicating underlying issues of inter-agency trust.

Table 3 An assessment of the organization's resources (human resources, technology, and management) at the Surveillance station (PSDKP) Cilacap, based on the results of the agency's internal audit and interviews.

Dimension	Evaluation
Human resources	Fisheries inspectors at the PSDKP Station in Cilacap have clearly understood their duties, functions, and procedures related to supervising fish species utilization. They are also actively involved in addressing organizational challenges and obstacles. However, in practice, the number and competency of inspectors remain insufficient to meet the ideal requirements, partly due to the additional administrative tasks at the office, which reduce their time and focus on field supervision.
Technological resources	The PSDKP Station in Cilacap has utilized various technologies, including the E-SLO information system, VMS, VTC tracking systems, and maritime and aerial patrols. However, the current information systems are not fully integrated with those of other shark management institutions, such as PIPP and E-SAJI, thereby hindering the efficiency and effectiveness of coordinated surveillance efforts.
Management	Activity planning, implementation, and procedures at the PSDKP Station in Cilacap have been developed by legal provisions and are aligned with the organization's objectives, with regular evaluations conducted through internal audits. The Head of the Station demonstrates a clear understanding of the organization's vision and mission, is capable of mobilizing human resources, and maintains effective collaboration with relevant agencies in supervising and enforcing marine and fisheries regulations. However, the effectiveness of surveillance performance related to shark species utilization and the follow-up of violations remains limited, primarily due to insufficient support from management institutions, particularly regarding data and information.

4. Aspect of infrastructures

The analysis of infrastructure is conducted through a qualitative assessment of the facilities and equipment used for surveillance of the utilization of fish species, as outlined in the Director General of Surveillance for Marine and Fisheries Resources Decree Number 7 of 2022, which is owned by the Surveillance station (PSDKP) Cilacap. The analysis results indicate that the three fishery surveillance vessels are in good condition. The land transportation modes include eight four-wheeled vehicles, of which three are in severe disrepair, one three-wheeled vehicle in good condition, and thirty-six two-wheeled vehicles, with five also in severe disrepair. Identification books and surveillance reports are available in soft file format. Two GPS units are in good condition. Communication devices, specifically Icom HT radios, number twelve, are in good condition. Documentation equipment includes one camera, which is also in good condition. Measurement tools consist of one measuring tape, which is in good condition. Based on the results of the analysis, it is evident that the existing infrastructure supports the surveillance of the utilization of shark species. The better the available infrastructure and facilities, the more they are expected to support the performance of surveillance activities (Krisnafi *et al.* 2017)

5. Aspects of the budget

The budget evaluation is conducted by analyzing effectiveness and efficiency (Putra and Dhiniharitsa, 2020). The results of the effectiveness and efficiency analysis of the budget at Surveillance station (PSDKP) Cilacap, as presented in Table 4 below, indicate that the budget utilization at Surveillance station (PSDKP) Cilacap from 2019 to 2023 is categorized as effective and efficient, with the year 2021 being classified as very efficient. This behavior in budget utilization serves as a strong foundation for the implementation of program activities. The budget allocated for the surveillance of protected fish in 2019 amounted to IDR 60,000,000, which decreased to only IDR 6,722,000 in 2023. This budget demonstrates a disparity when compared to the number of surveillance objects, which includes 28 companies, and there is no specific budget allocated for oversight at PPS Cilacap.

Table 4 Analysis of the efficiency and effectiveness of the budget for direct expenditures related to shark monitoring at the Surveillance station (PSDKP) Cilacap (2019–2023), based on PSDKP financial reports

Year	The realization of the direct expenditure budget (Rp.)	The target of the direct expenditure budget (Rp.)	Realization of budget (Rp.)	Effectivity		Efficiency	
				%	Category	%	Category
2019	17,816,162,507	18,115,947,000	24,386,811,244	98.35	Effective	73.06	Efficient
2020	15,935,354,000	15,935,354,000	23,698,832,622	98.93	Effective	66.52	Efficient
2021	11,346,056,822	11,419,734,000	9,882,038,041	99.35	Effective	57.07	Very Efficient
2022	16,307,611,000	16,307,611,000	25,680,786,429	99.77	Effective	63.36	Efficient
2023	19,838,605,443	19,949,452,000	30,173,503,113	99.44	Effective	65.75	Efficient

6. Aspects of standard operating procedure (SOP)

The Standard Operating Procedures (SOP) for the surveillance of shark species utilization at fishing ports are outlined in the SOP on the Supervision of Unloading and Weighing of Fish Catches from Fishing Vessels. This SOP primarily analyses the catch results concerning the presence of protected fish, CITES appendices, and look-alike species, which, therefore, fails to adequately represent the legislative framework for shark management. This has resulted in a gap between the expected performance of the SOP and the actual performance, particularly regarding violations in the utilization of shark species. Consequently, the following follow-up actions are necessary:

a. Revision of the SOP, which includes:

1) Involvement of Loka PSPL Serang;
2) More detailed analysis related to licensing, catch quotas (quantity, species, and size), the condition of sharks, categorization of juveniles or pregnant individuals, and prohibited species;
3) Data integration.

b. Enhanced oversight by leadership regarding the implementation of the SOP;

c. Procurement and improvement of infrastructure to anticipate unreported activities.

7. Aspects of human resources

The duties of fishery oversight at PPS Cilacap encompass the issuance of Standard Operating Licenses (SLO), the issuance of unloading recommendations, and the supervision of unloading and weighing fish. The output of fishery oversight in 2024 recorded the issuance of SLOs for central permit vessels totaling 1,436, with three vessels deemed unfit, and the issuance of SLOs for provincial permit vessels totaling 2,294, with two vessels also deemed unfit. Unloading recommendations were provided for 1,328 vessels. Supervision and unloading of central permit vessels accounted for 1,446, while provincial permit vessels totaled 2,320. The completion time for central permit vessels' SLOs was 1.5 hours, with unloading recommendations taking 2.5 hours and supervision of unloading and weighing taking 1.42 hours. In contrast, the completion time for provincial permit vessels was 0.08 hours faster. Based on the calculations, the requirement for fishery inspectors is 12 individuals daily (rounded from 11.10); however, the number currently on duty is only 4, resulting in a shortfall of 8 individuals. This aligns with the findings of Sembada *et al.* (2024), which indicates that the challenges of fishery oversight at fishing ports stem from the workload of fishery supervisors being disproportionate to the available human resources. Furthermore, the number of fishery inspectors with specialized competencies in the surveillance of the utilization of shark species is limited to only 8 individuals.

Analysis of the system

1. Needs analysis

Nurani *et al*. (2019) describe the needs analysis as derived from the requirements of system stakeholders, including both individuals and institutions associated with the system. In Table 5, various stakeholders involved in the shark utilization system in PPS Cilacap (Indonesia) are categorized, each with their own specific roles and requirements.

2. Problem formulation

The gaps that can be analyzed between the needs of stakeholders and the existing conditions can be categorized into five aspects or subsystems: (a) Regulatory and

Institutional Aspects, (b) Surveillance Procedures and Budget, (c) Human Resources, and (d) Facilities and Infrastructure. The issues related to the oversight of shark species utilization at PPS Cilacap are presented in Table 6.

3. System identification

The identification of the surveillance system for shark species utilization at PPS Cilacap is illustrated through a causal loop diagram and an input-output diagram. The causal loop diagram (Figure 2) depicts the interrelationships among the components within the system, thereby revealing the mechanisms of system performance in meeting the needs of the stakeholders. The input-output diagram (Figure 3) represents the inputs, outputs, and controls associated with the surveillance of shark species utilization at PPS Cilacap.

According to Figure 2, the utilization of shark resources to prevent over-exploitation requires effective surveillance. The implementation of regulations necessitates surveillance, which includes shark catch results, fish trader/ SIPJI permit holders, and the market. This aligns with Gunawan *et al*. (2021), who state that surveillance is an integral part of fisheries resource management aimed at ensuring compliance with regulations and licensing requirements. Fisheries surveillance serves to prevent violations and fisheries-related crimes (Syah *et al.* 2021). Such violations in the fisheries sector result in environmental degradation and are often carried out irresponsibly (Rizky *et al.* 2017).

According to Figure 3, the desired outputs include human resources development, improvement of infrastructure and facilities, enhancement of SOPs and budget performance, improvement of legal performance and institutional synergy, improvements of business actors' compliance, and sustainability of sharks. Undesired outputs include violations in the utilization of shark resources, disruption of the shark ecosystem balance, and disturbances in the shark and tuna fishing business. The existing conditions indicate that violations in shark utilization continue to occur, which can be categorized as IUU fishing. The impact of IUU Fishing includes the degradation of fishery sustainability and the environment, loss of state revenue leads to economic losses and undermines national sovereignty (Ali 2021; Amiruddin *et al*. 2022; Ishak and Fatimah 2019; Supit *et al*. 2016). Minimal protection for sharks may result in trade sanctions from Regional Fisheries Management Organizations (RFMO) (Hardiningsih *et al.* 2018).

Table 5 Matrix of stakeholder roles, responsibilities, and requirements within the shark management system at PPS Cilacap (Indonesia), synthesized from stakeholder mapping and field observations.

No	Stakeholder	Needs
1.	Loka PSPL Serang	- Increase in compliance of fishery business actors and Non-Tax State Revenue (PNBP) - Sustainability and continuity of the Shark resource
2.	PPS Cilacap	- Improvement of facilities and shark production at PPS Cilacap - Increase in compliance of fishery business actors and Non-Tax State Revenue (PNBP) - Sustainability and continuity of the shark resource
3.	Fisheries supervisors	- Data and information on shark landings and morphometrics - Legislation, technical guidelines, supervision SOPs, and an increase in budget, infrastructure, and human resources - Sustainability and continuity of the Shark resource
4.	Fisherman	- Increase in the productivity of shark catch.
5.	Fishing vessel owner	- Mastery of sustainable fishing technology - Increase in knowledge related to shark management. - Guarantee of business sustainability and improvement of welfare
6.	SIPJI owner	- Increase in productivity of catches and profits - Ease of ship licensing and utilization of sharks
7.	Fish trader	- Increase in knowledge related to shark management. - Guarantee of business sustainability

Table 6 The identification of systemic issues within the shark utilization monitoring system at the PPS Cilacap (Indonesia) from various perspectives—namely institutional, procedural, and resource-related—based on a gap analysis and consultations with stakeholders.

No	Aspect	Problem
1.	Regulation and institutional	- Surveillance institutions lack synergy, and law enforcement is weak. - Lack of support from management institutions in the form of data and information to surveillance agencies.
2.	Surveillance and budget procedure	- The existing SOPs do not reflect the surveillance needs as required by shark fisheries management regulations. - There is no specific budget for surveillance at PPS Cilacap.
3.	Human resources	- The number and capacity of fisheries inspectors are insufficient. - Knowledge and legal awareness among vessel captains and owners remain limited.
4.	Infrastructures	- Infrastructure has not been utilized to monitor the utilization of fish species at fishing ports. - Unreported production of fish catches still occurs.

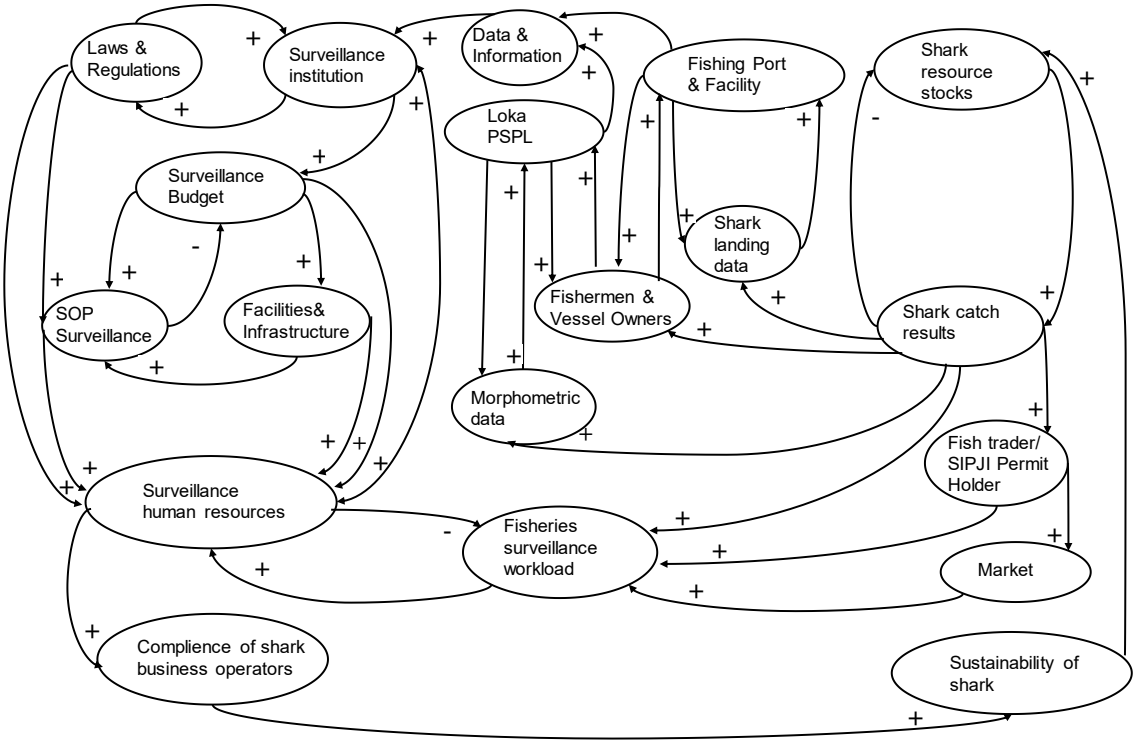

Figure 2 Causal Loop Diagram (CLD) illustrating the dynamic feedback mechanisms in a shark utilization monitoring system, developed through systems thinking analysis

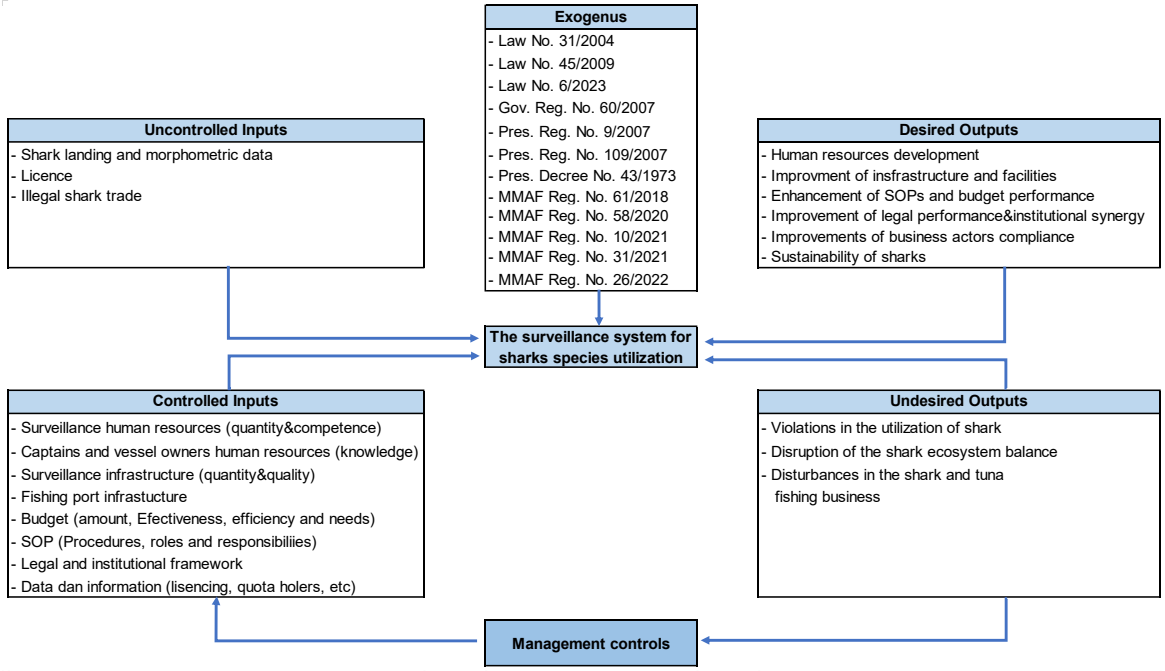

Figure 3 The Input-Output Diagram illustrating the transformation process and monitoring results at the PPS Cilacap (Indonesia), adapted from a systems approach framework.

DISCUSSION

Violations in the utilization of shark species at PPS Cilacap are driven by systemic constraints across multiple surveillance dimensions. From a regulatory and institutional perspective, the Surveillance station (PSDKP) Cilacap, PPS Cilacap, and Loka PSPL Serang exhibit limited synergy, reflecting institutional fragmentation in which each institution tends to operate strictly within its own mandate and functions without integration. As a result, the requirements of surveillance systems, particularly regarding landing and morphometric data, are not optimally fulfilled. In terms of procedures and budgeting, the prevailing Standard Operating Procedures (SOPs) do not fully reflect existing legal provisions, as they fail to cover all obligations and prohibitions in shark fisheries management. This creates regulatory loopholes that undermine the certainty of surveillance. The situation is further exacerbated by the absence of a dedicated budget for surveillance activities at PPS Cilacap, causing implementation to rely more heavily on individual, agent-based functions of fisheries inspectors rather than on structured institutional mechanisms. From the human resources (HR) perspective, the limited number and competencies of fisheries inspectors, coupled with the low level of legal knowledge and awareness among vessel captains and owners, present significant barriers. HR serves as a critical component driving surveillance functions, making these limitations particularly detrimental. Regarding infrastructure, although surveillance facilities are relatively adequate, their utilization remains suboptimal, while the condition of port facilities still provides opportunities for unreported fishing practices.

The interrelationships among system elements in shark management surveillance are illustrated in Figure 2. Effective surveillance of shark utilization at PPS Cilacap requires institutional support, particularly from PPS Cilacap and Loka PSPL Serang. PPS Cilacap, as the authority responsible for port management, provides the infrastructure needed to support fishing operations and data collection. In contrast, Loka PSPL Serang performs morphometric data enumeration of sharks landed at PPS Cilacap. Within a systems framework, shark catch volume has a negative causal relationship with natural shark stocks; higher catch levels lead to declining shark populations in their natural habitats. Therefore, surveillance of landings, trade, and distribution of shark catches represents a critical systemic intervention to ensure population sustainability. However, the current system exhibits disconnections among subsystems, resulting in reduced surveillance effectiveness and limited compliance among stakeholders, which ultimately diminishes the sustainability of shark stocks. According to Sulaiman and Triharyuni (2021), strategies for achieving

sustainable shark fisheries management include regulatory formulation, database strengthening, institutional reinforcement, and capacity building for both fishers and fisheries authorities.

The current shark utilization surveillance system at PPS Cilacap demonstrates that violations continue to occur as system outputs (see Figure 3). These violations represent undesirable outcomes, underscoring the need for system improvements through an integrated surveillance framework involving the Surveillance station (PSDKP) Cilacap, PPS Cilacap, and Loka PSPL Serang. Such improvements require systemic management controls, including: (1) enhancing the capacity of port facilities, particularly berthing pools and docks, to support ideal data collection; (2) integrating data and information through institutional information systems encompassing shark fishing units, fishing locations, fishing and utilization licenses, landing data, catch quotas, shark conditions (juvenile, gravid, or protected species), and distribution; (3) improving stakeholder legal knowledge and awareness through outreach activities; (4) increasing the number and competencies of fisheries inspectors through recruitment, education, and training; (5) revising SOPs to align with prevailing legal frameworks; and (6) ensuring comprehensive law enforcement. These findings are consistent with those of Suharto *et al*. (2017), who emphasized that key factors in optimizing fisheries surveillance include the availability of infrastructure, budgetary support, inspector competency, and the dissemination of regulations and legislation.

CONCLUSION

The issues within the surveillance system for shark species utilization at PPS Cilacap encompass various aspects. One significant problem is the lack of synergy among surveillance institutions, which hinders collaborative efforts. Additionally, there is weak law enforcement, resulting in insufficient adherence to existing regulations, which undermines the effectiveness of surveillance activities. The managing institutions also fail to provide the necessary data and information to the surveillance agencies, further complicating the situation. Moreover, the current Standard Operating Procedures (SOPs) do not adequately reflect the surveillance needs as stipulated by legal regulations, and there is no specific budget allocated for surveillance activities at PPS Cilacap. The number and competence of fisheries inspectors are insufficient to meet the demands of effective surveillance, and legal knowledge and awareness among captains and vessel owners are lacking. In addition, the available infrastructure has not been optimally utilized for the surveillance of shark species utilization, and unreported fishing continues to occur.

RECOMMENDATION

The implementation of an integrated surveillance system for shark species utilization involving the Surveillance station (PSDKP) Cilacap, PPS Cilacap, and Loka PSPL Serang should be formalized through a Ministerial Regulation from the Ministry of Marine Affairs and Fisheries. This regulation should clearly outline each institution's roles, responsibilities, and workflows in detail, ensuring that all three agencies adhere to and consistently commit to the execution of their respective duties. By establishing a formal framework, the collaboration among these institutions can be strengthened, leading to more effective surveillance and management of shark resources, ultimately contributing to the sustainability of fisheries in the region. Further studies are required on shark management strategies at fishing ports.

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