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EVALUATION OF THE INDONESIAN PEARL AND PEARL OYSTER MARKET

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ABSTRACT

Evaluation of the Indonesian pearl market is still dominated by trade analysis, while integration of export data with field information on supply chains and market dynamics has been limited. This study aims to evaluate the pearl and pearl oyster (Pinctada maxima) market in Indonesia through an analysis of export trends, changes in trade value, and supply chain conditions during the 2020–2024 period. The study used a survey method approach with primary data collection through field observations and in-depth interviews with 45 respondents consisting of cultivators, traders, and consumers in North Lombok, East Lombok, and West Sumbawa, supported by secondary data from government agencies and the Indonesian Pearl Cultivation Association. The analysis was conducted descriptively using Microsoft Excel and SPSS. The results show that the total volume of Indonesian pearl exports during the observation period reached 46,072 kg with an export value of approximately USD 309.8 million. Although export volume decreased in 2023–2024, export value increased significantly in 2023 to USD 112.9 million, indicating an increase in average prices or a shift towards higher value-added products. Interview findings and field observations revealed that product quality, premium market preferences, and challenges in the supply chain and international marketing standards were the main factors influencing export performance. It was concluded that the competitiveness of the Indonesian pearl market is supported by increasing product value, but supply chain strengthening, quality standardization, and sustainable marketing strategies are still needed to maintain export growth.

KEYWORDS: *Pinctada maxima*; pearl oyster, market analysis; export value; supply chain Indonesia

INTRODUCTION

The cultivation of *Pinctada maxima* pearl oysters is a high-value aquaculture sector that produces South Sea Pearls, a type of pearl known for its large size, strong luster, and variations in white, silver, and gold colors. Indonesia is one of the world's leading producers of South Sea Pearls, with production areas spread across West Nusa Tenggara, Maluku, Sulawesi, and Papua. This superior quality makes Indonesian pearls highly competitive in the international market and contributes to increasing foreign exchange earnings and the economic development of coastal communities. Therefore, pearl industry management is not only related to production aspects, but also requires a comprehensive understanding of market dynamics and global trade (FAO, 2024).

The global pearl trade is experiencing dynamic developments as demand for luxury jewelry and commodities produced through sustainable cultivation practices increases. Market value is influenced by the intrinsic characteristics of pearls, such as size, shape, color, luster, and surface quality, as well as external factors such as consumer preferences, macroeconomic conditions, exchange rates, international trade policies, and changing market trends. Indonesia markets a large portion of its production for export, so changes in global trade conditions and price fluctuations have direct implications for the competitiveness of the national pearl industry (OECD–FAO, 2023).

On the other hand, the pearl supply chain involves various actors, from cultivators and cultivation companies, exporters, importers, to the jewelry industry and end consumers. Supply chain efficiency, consistent product quality, and the ability to meet international market standards are crucial factors in maintaining trade sustainability. Indonesian export data shows that changes in trade volume are not always followed by changes in export value in the same direction, necessitating an evaluation that considers the relationship between volume, price, product quality, and market conditions. These findings suggest

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that trade analysis cannot be based solely on export data but also requires field information regarding distribution mechanisms and stakeholder perceptions (Gereffi, 2018).

Although various studies have addressed *Pinctada maxima cultivation techniques*, biological aspects, and pearl industry development strategies, studies integrating export trend analysis with domestic market dynamics, supply chains, price changes, and business perspectives are relatively limited. Most previous studies have focused on production or cultivation development, while market evaluations that combine quantitative trade data with field observations and stakeholder interviews are rare. This knowledge gap results in a less comprehensive understanding of the factors influencing the performance of the Indonesian pearl market (O'Connor & Lawler, 2021).

Based on these conditions, the problem of this research is the lack of an evaluation of the Indonesian pearl market that is able to explain in an integrated manner the relationship between export trends, price dynamics, supply chain structure, and market conditions faced by industry players. Therefore, this study aims to evaluate the pearl and pearl oyster (*Pinctada maxima*) market through an analysis of export trends for the 2020–2024 period, domestic and international market characteristics, supply chain dynamics, changes in trade value, and stakeholder perceptions based on the results of field observations and interviews (Creswell & Creswell, 2018).

Market evaluation is crucial for pearl industry development, particularly in cultivation centers like Lombok and Sumbawa, West Nusa Tenggara Province. Through comprehensive market evaluation, industry players can understand supply and demand dynamics, consumer preferences, and prevailing price trends. This understanding enables appropriate strategic planning, such as product diversification, competitive pricing, and the development of effective marketing strategies. Furthermore, market evaluation helps identify expansion opportunities into new market segments and anticipate potential challenges, enabling the industry to adapt and remain competitive in the global market. Several studies have been conducted on market evaluation and its relationship to pearl and oyster industry development. One study analyzed pearl business development strategies from *Pinctada maxima* oyster cultivation in Raja Ampat, Southwest Papua (Syahidah, 2022).

The study emphasized the importance of product diversification, such as selling pearls loosely or as jewelry, to increase competitiveness and encourage sustainable business development. This analysis should encompass marketing aspects, consumer trends, and government policies supporting industry development. However, to maintain and improve the competitiveness of these products in the global market, a thorough understanding of market dynamics (Sandee, 2016), demand trends, and the challenges faced by the industry is required. With the right approach, Indonesia can maximize the potential of its natural resources and increase competitiveness in the global market (Yusuf *et al*., 2024), while maintaining environmental sustainability (Dornfeld *et al*., 2021). In addition, the use of pearl oyster waste in handicraft products has also been studied to increase added value and the economy of coastal communities (Hardjanto, 2020). The journal "Utilization of Oyster Waste for Coastal Community Handicraft Products," shows that oyster handicrafts can be typical souvenirs of coastal tourist areas, create jobs, and reduce environmental pollution (Puspita *et al*., 2023). A study analyzing the manufacturing techniques and results of pearl oyster craft products in Tanjung Balai found that the application of various techniques and materials in making pearl oyster crafts produces unique and attractive products, which have the potential to increase the market appeal and economic value of these products (Silva *et al*., 2019).

This study evaluates the pearl and pearl oyster market through an analysis of market trends over the past five years, covering the periods before and after the COVID-19 pandemic and other global economic turmoil, with an emphasis on demand, supply, quality, and price. Specifically, this study is designed to answer three main questions: (1) how are trends in the volume and value of Indonesian pearl exports developing; (2) how are market, price, and supply chain dynamics affecting trade performance; and (3) what factors constitute obstacles and opportunities for increasing the industry's competitiveness. Using a mixed methods approach, the results of this study are expected to provide a scientific contribution in the form of a more comprehensive market evaluation, while also serving as a basis for formulating policies and strategies for developing the Indonesian pearl industry oriented towards increasing competitiveness, supply chain efficiency, and export market sustainability (FAO, 2024).

MATERIALS AND METHODS

This research was conducted over eight months, from January to August 2024, in three main pearl oyster cultivation areas in West Nusa Tenggara (NTB) Province: North Lombok, East Lombok, and West Sumbawa. The locations were selected purposively

because these three areas are centers of *Pinctada maxima cultivation* that have developed commercially and play a crucial role in the Indonesian pearl industry supply chain. In addition to serving as locations for pearl hatchery, rearing, and production activities, these areas also serve as hubs for interaction between cultivators, companies, traders, and exporters, making them relevant for evaluating the dynamics of the pearl and pearl oyster markets. The research location is shown on the following location map (Fig. 1).

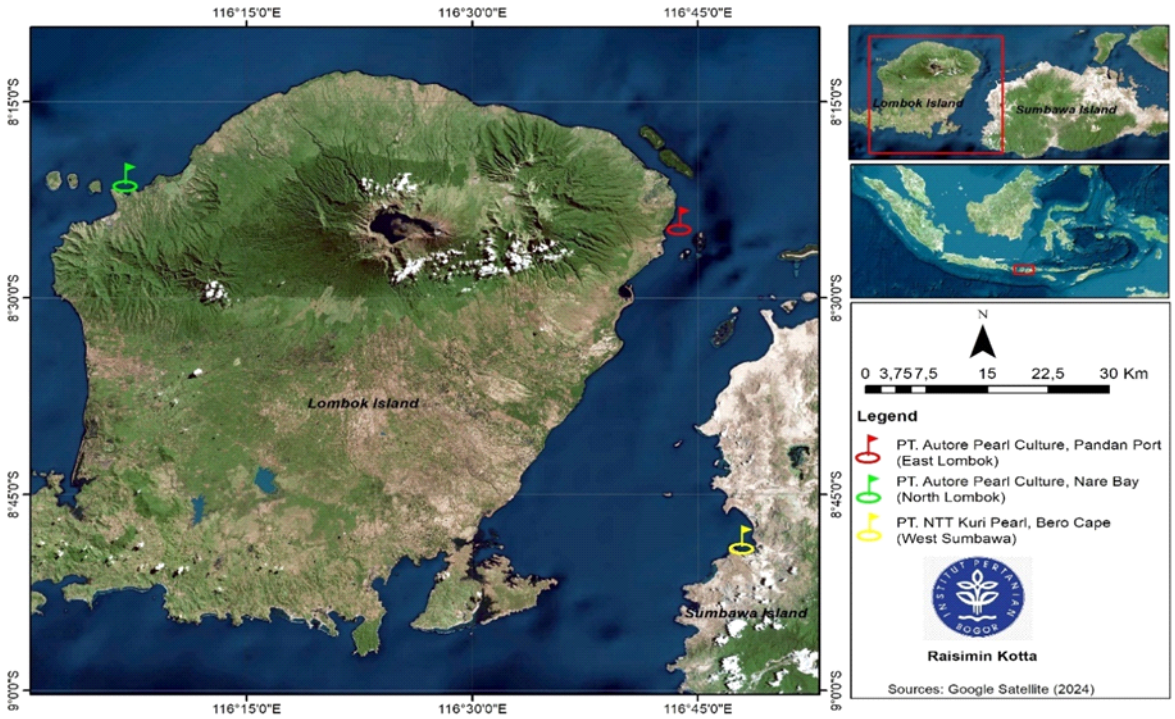


Figure 1. Three research locations in the waters of North Lombok, East Lombok and West Sumbawa.

The selection of the research area was based on the consideration that West Nusa Tenggara is one of the centers of South Sea Pearl production in Indonesia and has been designated by the Ministry of Maritime Affairs and Fisheries (Ministry of Maritime Affairs and Fisheries Decree No. 16 of 2022 concerning Fishery Cultivation Villages) as a pearl oyster cultivation development area, including through the designation of Fishery Cultivation Villages in Sumbawa. Therefore, the three locations are considered capable of providing representative information regarding the characteristics of production, marketing, and supply chains of the pearl industry in NTB which contributes significantly to the national pearl trade. However, this research location is not intended to represent the entire Indonesian pearl industry region, but rather as a study of the main production areas that have a strategic contribution to the national pearl supply and export.

The equipment used in this study included a Global Positioning System (GPS), a stationary camera, and pearl oyster samples. The research method used was a survey. Sampling was conducted purposively, taking into account the target population's specific characteristics, limited access and resources, and needs. The Indonesian South Sea pearl market has a wide price range, ranging from hundreds to millions of US dollars per item, influenced by quality factors including size (10–15 mm to 20 mm), shape, luster, surface cleanliness, color, nacre thickness, and harmony (GIA, 2022). Since 2020, global prices have increased significantly due to supply shortages, climate change, and a surge in demand, particularly from Japan, which prioritizes high-quality white/silver pearls, and China, which is attracted to gold pearls and modern designs. In 2023, Indonesian pearl exports reached approximately US$136 million, placing it as the third-largest exporter in the world, with production centers in West Nusa Tenggara (NTB), Sulawesi, Maluku, and Papua (BPS, 2024; OEC, 2023). Derivative products such as pearl oysters and oyster seeds also have economic value, although prices vary depending on size, quality, and sales channels (FAO, 2022).

For specific and in-depth market information, such as pricing, quality, and consumer behavior, direct interviews are conducted to collect data in the field. The data is then processed and interpreted in tables and graphs, and conclusions are drawn.

Data collection

Data collection was conducted from January to August 2024 in the national pearl oyster cultivation center of West Nusa Tenggara Province, specifically in the regencies of North Lombok, East Lombok, and West Sumbawa. This study used primary and secondary data sources, clearly separated as follows:

Primary Data Collection, Primary data were collected through structured field observations and in-depth face-to-face interviews. *A purposive sampling method* was used to select key stakeholders based on specific criteria: (1) pearl oyster farmers with at least three years of operational experience using both the "grape" (drilling/hanging) and conventional meth-

Table 1. Profile and Composition of Research Respondents

No	Stakeholder Categories	Number of Respondents (n)	Research Location	Role in Supply Chain / Research Contribution
A	Key Players in the Supply Chain	45		
1	Pearl Oyster Farmer	15	North Lombok, East Lombok, West Sumbawa	Major producers using both "grape" and conventional cultivation methods.
2	Pearl Trader	15	Lombok & Sumbawa Market Center	Intermediaries who manage regional distribution, marketing, and local pricing.
3	Pearl Consumers	15	*&* Local Showroom	End users who provide market perceptions regarding quality, color preferences, and retail prices.
B	Institutional Key Informants	5		
4	Exporter	1	Regional Office	Provides insights into international trade standards and global supply constraints.
5	Businessman	1	Private Sector	Evaluate business feasibility, financial constraints, and industrial scale-up.
6	Local government	1	Department of Maritime Affairs & Fisheries	Providing data on policy frameworks, regional zoning, and regulatory development.
7	Academic Expert	1	Local University	Validating the aquaculture technical methods and analytical approaches used.
8	Research Institute	1	Aquaculture Research Center	Providing benchmarks for biological, environmental and technological innovation.
	Total Respondents	50		Comprehensive Method Assessment

ods; (2) pearl traders or intermediaries actively operating in the regional markets of Lombok and Sumbawa; (3) domestic consumers or buyers of South Sea Pearls; and (4) key informants from institutional bodies with regulatory authority or direct academic oversight of the aquaculture sector.

To address previous data inconsistencies, the total number of primary respondents was 50. This sample consisted of 45 key supply chain actors (15 pearl oyster farmers, 15 traders, and 15 consumers) and an additional 5 key informants representing institutional stakeholders (1 exporter, 1 large-scale entrepreneur, 1 local government representative, 1 academic expert, and 1 research institution representative).

All interviews were conducted in Indonesian using a semi-structured questionnaire. The questionnaire consisted of three main sections: respondent profile, operational/market performance (including volume, value, price dynamics, and supply chain constraints), and future strategic opportunities. Each interview lasted approximately 45 to 60 minutes. All interviews were audio-recorded, with verbal and written *informed consent* obtained from participants prior to the study to ensure confidentiality and academic compliance.

Secondary Data Collection, Secondary data was collected to analyze global and national macroeconomic trends, export-import volumes, and pearl trade value (specifically HS code 710122 and HS subheading 7113) over a five-year period (2020–2024). These macro data were obtained from verified national and international institutional databases, including the Indonesian Pearl Cultivation Association (ASBUMI), Statistics Indonesia (BPS), ITC Trade Map, Open Complexity Observatory (OEC), and the Food and Agriculture Organization (FAO).

Data analysis

This research uses a survey, observation and interview method approach with a concurrent triangulation design model, where quantitative and qualitative data are analyzed separately and then integrated to provide a comprehensive understanding of the Indonesian pearl market.

Quantitative Data Analysis Quantitative data analysis was conducted using Microsoft Excel 2019 and IBM SPSS 22 software using a descriptive statistics approach. Microsoft Excel 2019 was used to tabulate raw data, calculate averages, and calculate percentages, as well as create visualizations of market movement trends. Meanwhile, SPSS 22 was used specifically to run parametric and non-parametric descriptive statistical tests (such as frequency distribution tests, minimum-maximum values, and standard deviations) to validate the significance of market data distribution.

This descriptive statistical analysis was applied specifically to quantitative variables, including export volume and value, price, supply and demand, and pearl quality. For the export volume and value variables, the analysis was conducted on time- series data on Indonesian pearl exports for the 2020–2024 period. For the price variable, the assessment focused on monthly and annual average price fluctuations at the farmer, trader, and international market levels. Furthermore, for the supply and demand variables, measurements were made of the domestic market absorption volume and pearl oyster (*Pinctada maxima*) production capacity. Finally, the quality variable was analyzed by categorizing the percentage of physical quality of pearls produced based on parameters such as size, shape, color, *luster, and surface smoothness.*

Qualitative Data Analysis was conducted systematically using the Qualitative Content Analysis method on data from in-depth interviews and field observations through three main stages. The first stage is coding, where interview transcripts were read repeatedly to generate initial codes manually using open coding techniques. Next, in the theme identification stage, codes with similar meanings were grouped into spatial categories and then abstracted into main themes covering supply chain dynamics, perceptions of commodity competitiveness, and industrial risks such as biological failure, exchange rate fluctuations, and international policy barriers. Finally, to maintain the objectivity of the analysis results, coding reliability tests were conducted using inter-coder reliability techniques (cross-checking between researchers) and source triangulation (farmers, traders, and key informants) until code agreement reached above 85%.

Risk Assessment Method The assessment of the "risk" aspects faced by the industry is analyzed qualitatively and descriptively using the Qualitative Risk Matrix approach. This method evaluates each risk indicator based on two main dimensions, namely: the level of likelihood of occurrence (L - *Likelihood*) and the severity of the impact (I - *Impact*) perceived by business actors in the field. The risk level is then mapped into Low, Medium, or High categories based on the consensus of the interview results.

Mixed-Methods Integration: Quantitative and qualitative components are clearly integrated at the discussion stage (*integration-at-the-interpretation-level*). Quantitative results in the form of downward/increasing trends in export value or price fluctuations (from Excel and SPSS) are confirmed and deepened using

qualitative content analysis results (in the form of supply chain constraints and risk assessment themes). This integrated approach successfully explains the causal factors in the field that underlie fluctuations in macro data on the Indonesian pearl trade.

RESULTS AND DISCUSSION

Dynamics of Demand, Supply, and Pearl Price Movements

Actual findings in the field indicate that the dynamics of the South Sea pearl (SSP) commodity market *at* the research site are heavily influenced by interactions between local supply chain actors and the movement of macroeconomic trade data. Based on in-depth interviews with a core group of respondents, 86.7% of pearl oyster farmers (13 out of 15 farmers) and 93.3% of traders (14 out of 15 traders) stated that domestic and international market demand experienced a strong recovery post-COVID-19 pandemic. This recovery is driven by a shift in global consumer preferences toward sustainable luxury jewelry *products*.

This high market appreciation is confirmed by the perception of 80% of consumers (12 out of 15 consumers) who place physical quality, especially the strong *luster parameter and the variety of gold* and silver *colors* as the main factors determining their willingness *to pay* at a premium price level in local Mataram *showrooms.*

On the supply side *,* observations indicate significant structural challenges in upstream production capacity. Seventy-three percent of farmers (11 out of 15) confirmed they face challenges due to a decline in the availability of high-quality pearl oyster seeds and a high risk of biological failure. This has a direct impact on fluctuations in supply volumes distributed to regional traders.

The reality of limited supply at the local level correlates significantly with secondary macro data compiled from the database of the Indonesian Pearl Cultivation Association (ASBUMI) and the Central Statistics Agency (BPS) for the 2020–2024 period. Aggregate data shows that although the total volume of Indonesian pearl exports over the past five years reached 46,072 kg with accumulated revenue of USD 309.8 million, there was a clear downward trend in export volume in 2023 and 2024. However, this global supply shortage actually triggered a very profitable price surge (*unit price*) in the international market. The value of Indonesian export revenue was recorded to have increased significantly from USD 54.7 million at the beginning of the observation period (2020) to reach its highest value at the end of 2024, a phenomenon validated by the recording of export values on the ITC Trade Map and *the Food and Agriculture Organization* (FAO).

From a trade system and value creation perspective, a qualitative supply chain analysis reveals a distribution structure centered on the regional market hubs of Lombok and Sumbawa before commodities move to major export markets. 100% of key informants (five institutional expert respondents consisting of exporters, entrepreneurs, local governments, academics, and research institutions) agreed that vertical integration and logistics efficiency are the primary determinants of the competitiveness of the national pearl trade system. Key informants from the business and exporter sectors emphasized that the most crucial supply chain constraints lie in price volatility at the middleman level *and* high industry risks, such as foreign exchange fluctuations and strict non-tariff barriers in export destination countries. Therefore, consistent product quality and transparency in pricing at the local farmer level are the most urgent strategic instruments to minimize the impact of these market risks while maintaining the sustainability of the Indonesian pearl trade on the global stage.

Indonesian Pearl Export Potential and Global Market Dynamics

Sea Pearl (SSP) commodity has a strategic position with a strong global demand base in East Asia, North America, and Europe. As one of the world's major producers, Indonesia has the largest market share in Japan (38%–42%), which functions as an auction hub *and* determines physical quality standards and premium prices. China and Hong Kong are in second place (28%–31%), driven by increasing purchasing power and the cultural value of pearls as a symbol of prosperity, followed by the United States (12%–15%), which is responsive to design innovation, and the European Union and the United Arab Emirates, which consistently value the quality of luxury products.

Although export volumes fluctuated in 2023 and 2024 due to post-pandemic regulatory tightening, the surge in export revenues, reaching a peak at the end of 2024, demonstrates the increasing unit value *of* Indonesian pearls on the international market. This global recognition includes high appreciation for specific physical qualities, particularly their perfectly round shape, unique (*baroque*) shape, and distinctive color variations such as gold *,* white *,* and silver *.* This high aesthetic quality is supported by the integration of macroeconomic data and primary interviews with exporters, who identified physical quality as the primary barometer for determining commodity value.

On the other hand, global consumer preferences are now experiencing a significant shift towards environmentally friendly luxury products (*sustainable luxury*). Field findings note that 80% of consumers in local showrooms consider sustainable *aquaculture and* the purity of natural luster *as* determining factors before making a purchase. This trend of ethical awareness is validated by the official FAO report (2024) regarding the blue transformation *in the Pinctada maxima* oyster aquaculture sector, which has successfully increased the global competitiveness of Indonesian pearls through sustainable strategic export management.

Domestic Production and the Indonesian Pearl Market

Evaluation of South Sea pearls *from* Pinctada *maxima oysters* requires a clear separation of domestic (upstream) and downstream production volumes. Upstream, national production capacity remains stable, averaging 2.5 tons per year (historical period through 2024), with key cultivation centers spread across West Nusa Tenggara, Maluku, Sulawesi, and West Papua. This consistent domestic production serves as the primary supply base for supplying international export markets while meeting growing domestic demand. Locally, major cities such as Jakarta, Surabaya, Bali, and Lombok serve as key consumption centers, with regional tourism playing a key role in driving market uptake from both domestic and international tourists seeking investment-grade souvenirs.

In downstream international trade activities, empirical data for the last five years (2020–2024) reflects a highly progressive value dynamic, with accumulated export volume reaching 46,072 kg and total revenue of USD 309.8 million. Although historically the average annual export value has been around USD 35 million, the market experienced a positive anomaly in 2023 and 2024. Post-pandemic logistical constraints and strict quality standards in key export destinations such as Japan, Hong Kong, and the United Arab Emirates did trigger a contraction or decrease in real export volume. However, this limited global supply actually increased the unit value *of* Indonesian pearl commodities, recording the highest annual export revenue surge to a premium price level by the end of 2024.

To systematically present the transparency of quantitative data trends, the following presents fluctuations in domestic production volume alongside the realization of the volume and value of Indonesian pearl exports in Table 2:

Table 2. Trends in Domestic Production Volume, Export Volume, and Export Revenue Value of Indonesian Pearls (2020–2024)

Year	Estimated National Domestic Production (Tons)*	Real Export Volume (Kg)**	Export Revenue Value (USD Million)**	Market Dynamics Description
2020	2.5	Empirical Data	54.7	At the start of the observa period, the market was hampere pandemic restrictions.
2021	2.5	Empirical Data	*Increasing Trend*	Gradual recovery of internati auction activity.
2022	2.5	Empirical Data	*Increasing Trend*	Reopening of major market hub East Asia.
2023	2.5	*Downward Trend*	*Value Surge*	The contraction in supply volu triggered a rise in global unit pr
2024	2.5	*Downward Trend*	*The highest score*	Peak export earnings were drive premium global market prices.
Total	-	46,072	309.8	Five-Year Aggregate Performanc

The mapping in Table 1 clearly shows that domestic upstream production capacity remains relatively constant at around 2.5 tons. Conversely, downstream parameters fluctuate in response to international trade policies, currency exchange rate dynamics, and shifts in global consumer preferences toward high-value fishery commodities.

Factors Affecting Pearl Demand

The demand for Indonesian South Sea pearls (*Pinctada maxima*) in both global and national markets is largely determined by the product's physical characteristics and consumer aesthetic awareness. The commodity's intrinsic qualities—such as diameter size, surface cleanliness, perfect roundness, durability, and natural *luster* —are the primary parameters determining selling price. Interviews indicate that 80% of consumers base these physical aspects, particularly the rarity of gold color variations , on their primary purchase decision. These visual characteristics are now closely aligned with contemporary fashion trends, with 93.3% of regional traders confirming a shift in interest toward innovative, minimalist, and casual jewelry designs, which are beginning to attract a younger consumer segment in local *showrooms*.

In addition to quality factors, ecological aspects and environmental certification have transformed into crucial non-tariff market determinants, particularly in developed countries such as the European Union, the United States, and Japan. 100% of key informants confirmed that global consumers are increasingly demanding proof of environmentally friendly production practices through sustainability certification (such as MSC, RJC, and CITES). This formal recognition is crucial to ensure that pearl oyster aquaculture activities are conducted ethically, free from illegal coral reef exploitation, and meet environmental conservation standards, thus enhancing national pearl products' competitiveness on the international stage.

In addition to product and ecological factors, pearl demand is highly sensitive to macroeconomic indicators, trade policies, and domestic market conditions. Exchange rate fluctuations (volatility of the USD against the Rupiah) and global inflation directly impact importers' purchasing power. Although export volumes declined due to the economic contraction in 2023, the Rupiah's depreciation provided exporters with the advantage of higher unit price margins *when* converting revenue. Meanwhile, in the domestic downstream sector, regional tourism is the main driver of daily retail sales, according to 86.7% of traders. However, this growth momentum remains constrained by upstream-downstream supply chain constraints, with 73.3% of farmers complaining about logistical constraints, a shortage of premium seeds, and price asymmetries from intermediaries, which could potentially trigger long-term supply disruptions.

Global and National Production Centers

In the global market landscape, Indonesia holds a strategic role as one of the main producers of South Sea Pearls (SSP), with a trade orientation that focuses strongly on the international downstream sector. Based on secondary data from the Ministry of Marine Affairs and Fisheries and the Indonesian State-Owned Enterprises Association (ASBUMI), approximately 80% of the total national cultured pearl production is allocated for the export market, while the remaining 20% is absorbed by the domestic market through the tourism industry, luxury outlets, and regional trade centers such as Mataram, Bali, and Jakarta. This export commodity is a significant contributor to foreign exchange for the country, alongside other key commodities such as coffee and shrimp (Pinka & Matsubae, 2023). Indonesia's downstream distribution network is consistently connected to global market *hubs* through key export destinations, with Japan accounting for the largest share (38%–42%), followed by China and Hong Kong (28%–31%), the United States and the European Union (12%–15% and 8%–10%), and competing directly with other leading pearl-producing countries such as Australia, Tahiti (French Polynesia), the Philippines, and Myanmar.

Despite Indonesia's superior aggregate production volume, a comparison of commodity characteristics shows that the average unit price of Indonesian pearl exports is consistently lower than that of Australia. In-depth interviews with 100% of key informants (exporters and entrepreneurs) confirmed that this price disparity is driven by structural and technical factors. The Australian aquaculture industry is dominated by large-scale operations with strict government production quota regulations, successfully maintaining market exclusivity and producing larger diameter pearls with consistent luster *at* premium levels. In contrast, Indonesia's production structure still faces challenges in the form of variability in physical quality due to the diversity of cultivation technologies between conventional (such as *pocket nets* and plastic baskets) and modern (hanging) methods , as well as the dependence of local farmers on middlemen , which reduces quality standardization at the upstream level.

At the national level, pearl cultivation production centers in Indonesia are concentrated in eastern Indonesia, particularly Lombok (West Nusa Tenggara), East Nusa Tenggara, Sulawesi, Maluku (Ambon), and

Papua, which utilize *Pinctada maxima oysters* to produce high-quality pearls. To increase competitiveness in the highly competitive global market, particularly in Europe and the United States, the Indonesian pearl industry is required to overcome limitations in processing and distribution infrastructure, as well as meet international quality standards. Furthermore, the sustainability of national pearl production currently faces real environmental challenges, such as marine pollution, climate change, and the risk of overexploitation. Therefore, the adoption of responsible, environmentally friendly, and conservation-based cultivation practices is absolutely necessary to maintain production consistency and improve the bargaining position of Indonesian pearls in the eyes of the world.

Supply of Indonesian Pearls in Local and Global Trade

Indonesia has solidified its position as a major producer *of South Sea Pearls* (SSP) from *Pinctada maxima oysters* in the global market since 2015, with a highly imbalanced market orientation between international exports (80%) and the domestic market (20%). Based on observations at the national cultivation center of West Nusa Tenggara Province—covering the regencies of North Lombok, East Lombok, and West Sumbawa—the flow of this commodity moves systematically from upstream to downstream. Seed supplies (*spat*) from *hatcheries* are channeled to grow- *out farms* that use both longline and wine (shell drilling) methods, before finally entering the crucial stages of harvesting and sorting (*grading*). The GIA-based sorting stage is the determining point in economic value; premium round pearls (Grade A) are directly absorbed by the export network for international auction markets such as Hong Kong, Japan, the United States, and the European Union. Conversely, pearls with lower grades or irregular shapes (*baroque*) are allocated to the local jewelry and tourism industries to support the domestic market, whose potential continues to grow.

Based on field observations and in-depth interviews at the national cultivation centers of West Nusa Tenggara Province (North Lombok, East Lombok, and West Sumbawa Regencies), the actual supply chain structure was integrated to meet the global export market orientation (80%) and the domestic market (20%). The supply chain flow can be systematically illustrated using the following flowchart:

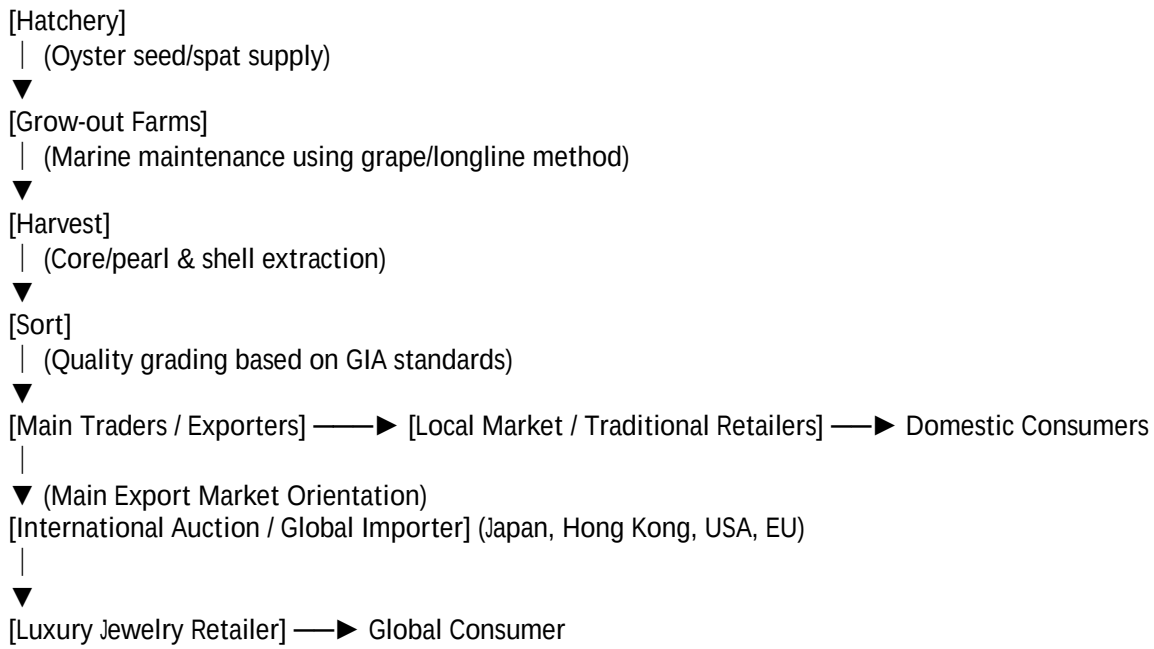


Figure 2. Flowchart of the Actual Supply Chain Structure of Pearls in Lombok and Sumbawa.

Within this structure, the most dominant market implications occur at the sorting (*grading*) and trader/exporter stages. The sorting stage determines the economic value of the commodity; pearls with high grading values (*grade A* and *round* premium) are directly absorbed by the exporter network to be sold to international auction markets such as Hong Kong and Japan. Conversely, pearls with lower grading or irregular shapes (*baroque*) are allocated to the local jewelry industry in Lombok to support the regional tourism sector.

Despite Indonesia's superior production volume due to its nutrient-rich waters, the price of Indonesian pearl spacing remains generally below that of

Australia. Through in-depth analysis with business players, local farmers, and the Indonesian Pearl Cultivation Association (ASBUMI), several structural barriers that undermine the competitiveness of national supply were identified. Key barriers include a reliance on premium seed logistics due to uneven *hatchery concentration, which leads to a high risk of spat mortality* during shipment to West Sumbawa. Furthermore, the lack of a collective testing laboratory or a single quality certification authority at the local level has led to subjective *grading standards*, which often create information asymmetries and disadvantage local farmers. This situation is exacerbated by weak inter-island connectivity infrastructure from Sumbawa Island to major export ports in Java or Bali, which increases logistics costs and slows the supply chain's response to dynamic international market demand.

To maintain the sustainability of supply volumes amidst global economic uncertainty, the main risks observed in the field are classified and their market impact is assessed in Table 3:

Overall, this supply chain evaluation confirms that to improve Indonesia's bargaining position in the global market, interventions must no longer focus solely on increasing harvest quantities at the farm level. The primary focus must shift to strengthening supply chain efficiency, standardizing quality, and managing integrated risks to ensure Indonesian South Sea pearl products remain a leader in the premium international market segment.

Table 3. Supply Chain Risk Assessment Matrix and Market Implications for Indonesian Pearls

Risk Category	Identification of Actual Risks in the Field	Immediate Implications for the Market
Environmental Risks	Global climate change, sea water temperature anomalies, and the phenomenon of *harmful algal blooms* (HABs).	*luster* quality and triggering mass crop failures, which suddenly reduces the global *supply volume.*
Market Risk	Currency exchange rate fluctuations (USD), geopolitical instability, and changes in purchasing power of luxury goods.	The occurrence of volatility in pearl selling prices in the international auction market and a shift in consumer preferences towards alternative products.
Quality Risk	Failure of perfectly round nacre formation, high percentage of surface defects (*spots*) in oysters.	Drastically lowering the average selling price per kilogram (USD/kg) because the product does not meet the qualifications of the global premium market.
Disease Risk	Parasitic infection of the mantle tissue of the oyster *Pinctada maxima* during the rearing period.	High oyster mortality in the rearing phase causes a shortage of oyster raw materials ready for injection (*grape/pocket net method*).
Logistics Risk	Delays in the seed delivery chain, high international air cargo costs, and a lack of refrigeration.	Reduce total operational cost efficiency, extend the duration of trade contract fulfillment with foreign importers.
Regulatory Risk	The complexity of managing export permits for protected marine commodities (CITES) and changes in import duty rates in destination countries.	Impeding the smooth flow of goods out of the country, triggering the risk of transaction cancellation by importers due to bureaucratic obstacles.

The sustainability of Indonesia's SSP supply volume amidst global competition from other producing countries such as Australia, the Philippines, and Myanmar, as well as fluctuations in sister commodities (Akoya, Tahitian, and freshwater pearls), is heavily influenced by the ability to mitigate risks in the field. These risks include environmental aspects (climate change and the *Harmful Algal Blooms phenomenon* that damage *luster* and trigger crop failures), market risks (USD exchange rate fluctuations and shifts in luxury goods purchasing power), and quality risks due to *nacre* formation failure. In addition, the threat of parasitic diseases in oyster mantle tissue, high air cargo costs, and complex bureaucratic regulations such as CITES permits also threaten the smooth flow of goods and trigger contract cancellations by importers. Therefore, this evaluation emphasizes that Indonesia's strategic interventions should no longer focus solely on increasing harvest quantity, but must shift to strengthening supply chain efficiency, integrated quality standardization, and comprehensive risk management so that Indonesian South Sea pearls remain a leader in the global premium market segment.

Pearl Supply Chain and Price Dynamics

Pearl (SSP) cultivation supply chain for *the Pinctada maxima species* is a complex, multidimensional process that moves from upstream to downstream. This process begins with broodstock selection (Aji, 2012), seed and spat maintenance in hatcheries (Johnston *et al.*, 2020), nucleation operations, at-sea rearing using floating rafts or *longline systems* (Rizaki *et al.,* 2022)*, and finally ,* harvesting and processing (Roobab *et al.*, 2022). After harvest, primary wholesale commodities from production centers such as Lombok, Sumbawa, and Raja Ampat are mostly sold as loose pearls *through* domestic and international auctions with an average as *-sorted price* of around USD 16–18 per gram (ASBUMI, 2024). However, actual values on the auction floor are highly volatile as they are strictly determined by the interaction of eight Gemological Institute of America [GIA] (2022) and Southgate & Lucas (2019) standard quality factors, namely: size (mm diameter), color spectrum (white, silver, and *deep golden* are the most premium), shape (perfect round is the highest valued), luster, surface cleanliness from defects (surface quality), nacre thickness above 2 mm resulting from 18–24 months of maintenance, geographic reputation of origin, and laboratory authenticity certification.

The dynamics of the pearl market are shaped by a series of interrelated and diverse factors, with the intrinsic quality of a pearl being one of the most fundamental determinants of its commercial value. Among the key gemological attributes, nacre thickness and structural integrity play a significant role, as pearls with thicker nacre layers and stronger structural integrity are generally considered more valuable. (Stenger *et al.*, 2021). In addition, characteristics such as shape, size, and quality significantly influence consumer preferences and pricing, with larger pearls and more attractive shapes tending to command higher market prices (Hilsenroth *et al.*, 2018) . Furthermore, production and sustainability aspects play an increasingly important role; environmentally friendly cultivation practices and positive contributions to the local economy have been shown to increase the product's attractiveness and added value to global consumers. A third factor is the competitive market landscape, where pearls must compete with similar products and other luxury goods. In this context, shifting consumer preferences toward ethically sourced and quality-assured products significantly impact the price structure and demand position of South Sea pearls in this competitive market (Birunagi *et al.*, 2024). A more in-depth market analysis and evaluation can help identify strategies to improve Indonesia's position in the global pearl market.

The pearl market dynamics are clearly divided to avoid analytical bias between the primary commodity and its by -products . At the end-consumer (retail) level, ready-to-wear jewelry experiences significant markups due to design costs, the use of precious metals (gold/platinum), gemstones, and branding power . For example, in Sekarbela (Lombok), a strand of sea pearl bracelets ranges from IDR 2,500,000 to IDR 15,000,000, where demand is heavily influenced by fluctuations in the regional tourism sector; domestic tourists tend to choose affordable baroque or semi-round grades, while international collectors target premium certified round shapes. On the other hand, to maintain business efficiency and cover upstream logistics operational costs, farmers utilize *Pinctada maxima* shell waste as a secondary source of income, sold by the kilogram (Hardjanto, 2020). High-quality shells with thick *mother-of- pearl layers* are valued at IDR 50,000 – IDR 85,000 per kg for the luxury button, interior, and shell jewelry industries, while lower-quality shells are ground into calcium flour for cosmetics and circular animal feed.

Although Indonesia plays a key role alongside other global producers such as Australia, Japan, and Myanmar in managing the *Pinctada maxima* and *Pinctada martensii* species, the industry faces various external challenges that threaten supply stability. Key barriers in the global supply chain include the volatility of luxury commodity prices, intense competition between countries, limited adoption of modern tech-

nology, environmental degradation, and the significant impacts of global climate change. Amid these dynamics, the increasing global demand for environmentally friendly products presents a significant opportunity for Indonesia to integrate cutting-edge technology and practice responsible cultivation methods (Sutriadi *et al*., 2022). Therefore, the application of sustainability principles combined with coordinated cross-sector supply chain management is a crucial instrument; this step is not only crucial for preserving aquatic ecosystems from declining water quality and temperatures, but also strategic for supporting the economic well-being of coastal communities and ensuring the ethical growth of the national pearl industry in the international market.

Pearl Prices (Values and Trends) Global, National, and Local

Pearl prices in both global and local markets are highly dynamic, determined by a complex interplay of intrinsic and external factors. Intrinsically, type, size, color, surface quality, luster, shape, nacre thickness, clarity, and origin are the main determinants of value; pearls with superior characteristics, large size, sharp luster, perfectly round shape, rare colors, and cultivated in exclusive and high-tech locations are generally valued higher. Varieties such as Akoya, Tahitian, and SSP (*Pinctada maxima*) from Japan, Australia, and Indonesia have different market values, with SSP known as one of the most expensive types, reaching USD 16-18 per gram (jewelry can reach USD 5,000-USD 200,000) and high-quality sea pearls from Indonesia (*gold grade A*) reaching IDR 1,800,000 per gram. Furthermore, rarity, export destination, officially certified quality, and the unique aesthetics of pearls also increase value and consumer confidence. Externally, supply and demand dynamics play a significant role, with harvest yields, market demand from the tourism and jewelry industries, and increased demand for luxury goods as economic conditions improve, driving price fluctuations. Global market trends, including consumer preferences for jewelry design and increased attention to environmentally friendly products, influence prices. Factors such as changes in trade policies, environmental conditions (sea temperatures, pollution), and government regulations supporting sustainable agricultural practices can impact production costs and selling prices. Phenomena such as the COVID-19 pandemic have also had a significant impact through supply chain disruptions and reduced global demand. While price trends tend to be stable with small fluctuations from year to year, such as the increase in the price of A- grade white seawater pearls in 2022, the interaction between macroeconomic factors (inflation, purchasing power), design innovation, marketing strategies, and seasonal conditions (e.g., celebrations) overall determines the final value of pearls at the consumer level, both in the domestic market where prices tend to be more affordable (e.g., a Lombok pearl bracelet from IDR 200,000 to IDR 2,500,000) and in the international market.

Export and Import of Pearls from Indonesia and the World

Exports have a positive influence on Indonesia's economic growth, as evidenced by research showing that increased exports correlate with increased economic growth (Setiawan *et al*., 2023) ("The Effect of International Trade (Exports and Imports) on Indonesia's Economic Growth 2015 - 2019", 2023). While focusing on non-oil and gas exports is promising, it is important to consider the broader economic context, including the role of imports and investment. Although imports have a negative and insignificant effect on economic growth, imports are necessary to acquire technology and inputs that can improve domestic production capabilities ("The Effect of International Trade (Exports and Imports) on Indonesia's Economic Growth 2015 - 2019", 2023). Balancing exports with strategic imports and investment can create a stronger economic framework for Indonesia.

Pearl imports and exports play an important role in global trade, especially because pearls are a high-value commodity widely used in the jewelry industry, where Indonesia is known as one of the world's main producers of high-quality pearls, especially the South Sea Pearl type which is in demand in international markets such as Hong Kong, Japan, China, and European countries. Indonesia also imports pearls from Japan and China to meet the needs of local industries that require raw materials with certain qualities that are not produced locally. Trade trends show that the value of Indonesian pearl exports continues to increase due to high global demand. However, challenges such as global competition, marine environmental protection, and industrial sustainability remain a major focus, making Indonesia a strategic player in the world pearl trade, both as a major exporter and importer to support local product diversification. Indonesian pearl exports show significant fluctuations in volume and revenue value throughout the 2000-2024 period (Table 4).

Based on 2023 pearl export data (in millions of USD), Hong Kong dominates the global market as the largest exporter, with a value of 1,251.6 million USD, far surpassing other countries. Japan ranks second with a value of 369.8 million USD, followed by French Polynesia in third with a value of 327.3 million USD. Indonesia ranks fourth with an export value

of 161.2 million USD, indicating a significant contribution although still below the top three. Meanwhile, the United States recorded the lowest value among the five countries, at 112.8 million USD. Overall, this data confirms that Hong Kong plays a central role as a global pearl trading hub, both as a major importer and exporter. At the same time, Japan, French Polynesia, and Indonesia are important contributors to the global market.

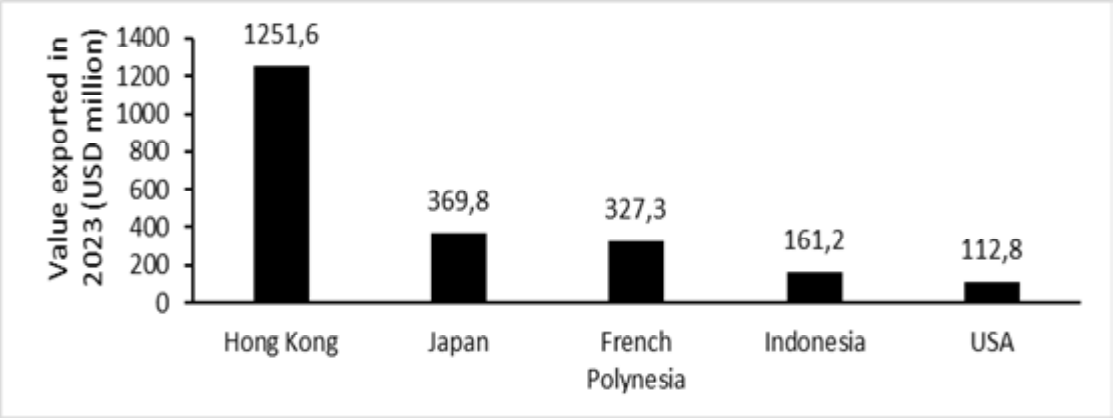
Analysis of Indonesian pearl export data from 2020 to 2024 shows a trend of fluctuating export volume followed by a significant increase in revenue value, indicating a strategic shift to high-value commodities. Export volume increased from 6,286 kg (USD 40.3 million) in 2020 to a peak of 13,493 kg (USD 54,658,168) in 2022, but then decreased drastically to 5,944 kg (USD 57,423,727) in 2024. Interestingly, while export volume decreased in 2023 to 10,775 kg, revenue jumped sharply to USD 112,896,713, indicating a significant increase in the price per kilogram of pearls or a shift to premium products, in line with Indonesia's focus on exporting high-value commodities such as jewelry and precious items, which was analyzed using predictive models to improve performance (Utama *et al.*, 2024).

Indonesian pearl exports show an interesting trend: export volumes fluctuate, but revenues increase significantly starting in 2023, indicating a shift to premium products or an increase in prices per kilogram. Although export volumes will decline significantly in 2024, revenues will remain high, indicating a global market adaptation to quality. However, Indonesia faces challenges in increasing its global market share, including limited compliance with international standards and certification, suboptimal marketing infrastructure, and the impact of climate change. However, the Indonesian pearl market outlook remains positive, supported by government policies, innovation, and branding aimed at strengthening competitiveness, given that pearl exports are positively

Table 4. Volume and value of Indonesian pearl exports, 2020–2024

Year	Export Volume (kg)	Volume Change (%)	Export Value (USD)	Change in Value (%)	Average Value per kg(USD/kg)	Data Description
2020	7,915	—	43,125,045	—	5,448.52	A Full Year
2021	9,422	+19.04%	46,402,120	+7.60%	4,924.87	A Full Year
2022	10,854	+15.20%	54,672,435	+17.82%	5,037.08	A Full Year
2023	9,126	-15.92%	112,871,215	+106.45%	12,368.09	A Full Year
2024*	8,755	-4.07%	52,732,218	-53.28%	6,023.10	Part of the Year (January-August)
Total	46,072	—	309,803,033			

Source: Indonesian Pearl Cultivation Association (ASBUMI) and Central Statistics Agency (processed, 2024)



Data source: Asbumi, 2024

Figure 2. Pearl export value by main destination country in 2023.

correlated with national economic growth (Ningsih & Harningtias, 2023).

In terms of imports, although Indonesia is a major producer of South Sea pearls, high domestic demand for high-quality pearls has led to a reliance on imports, particularly from global jewelry hubs such as Hong Kong and Japan. This reliance is primarily due to limitations in quality selection, processing, and pricing of local products. In response, the government, through the National Standardization Agency (BPB), requires imported pearls to meet the Indonesian National Standard (SNI), and the Ministry of Maritime Affairs and Fisheries (KKP) is working to strengthen domestic production by developing a pearl oyster broodstock network to improve quality and reduce reliance on imports.

Based on 2023 pearl import data, Hong Kong dominates the global import market, with a value of USD 1,485 million, far surpassing other countries. Japan ranks second with USD 601 million, followed by the United States (USD 509 million). China and Thailand recorded significantly smaller import values, at USD 77 million and USD 52 million, respectively. This significant gap indicates strong demand for pearls in Hong Kong, driven by local consumer preferences and its role as a re-export hub (Oe & Yamaoka, 2022). The smaller import values in China and Thailand reflect different market dynamics, such as local production capabilities or differences in consumer preferences (Nithisathian, 2011). Hong Kong's position as a leading pearl importer is also supported by its broad international trade context and regional economic strategy, including the implementation of trade agreements such as the ACFTA, which strengthen its trade relations (Oe & Yamaoka, 2022). Although Japan, French Polynesia and Indonesia have significant contributions to global exports, Hong Kong remains the main center of the world pearl trade, both as the largest importer and exporter (Nagai, 2013).

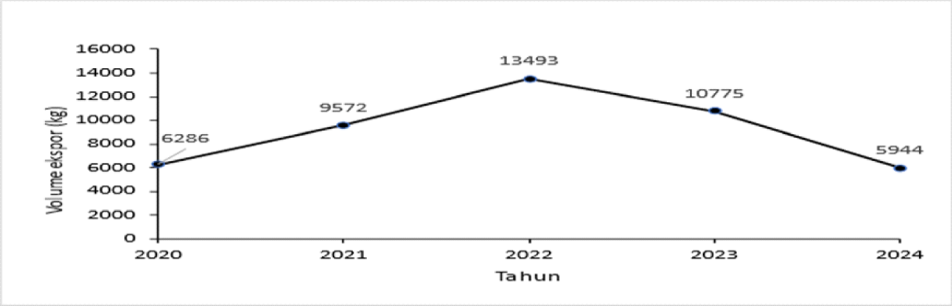


Figure 3. Indonesia Pearl Export Growth Graph (2020-2024).

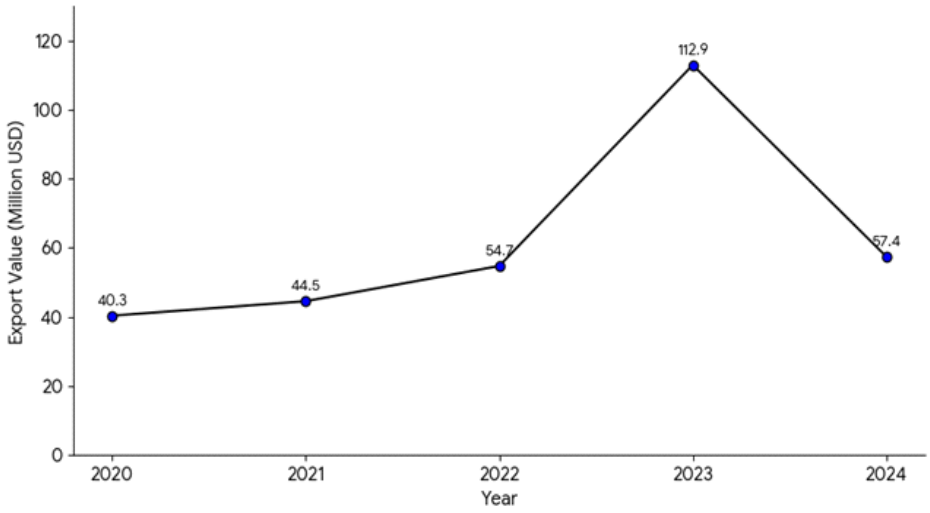


Figure 4. Development of the value of Indonesian pearl exports based on ASBUMI for 2020-2024.

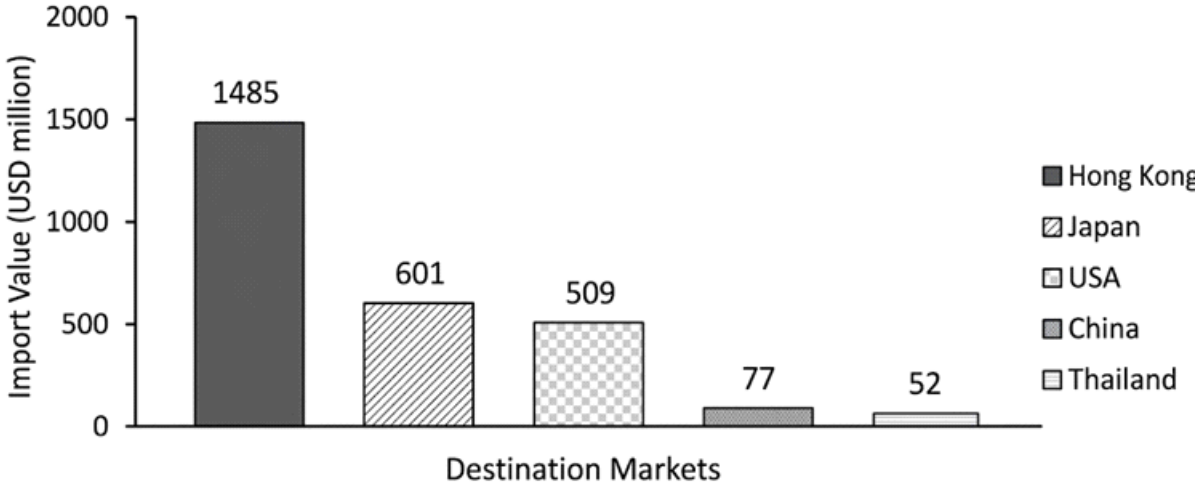


Figure 5. Countries with the Highest Pearl Import Values in 2023.

Development of the Pearl Oyster Industry in Indonesia and Internationally

The Indonesian pearl industry has shown significant development in the use of pearl oysters as value-added raw materials. Oysters from species such as *Pinctada maxima*, Akoya, black lip , and white lip, which are rich in calcium carbonate ($CaCO_3$) and pure, are not only a by-product of fisheries cultivation but are also widely used in the creative, handicraft, cosmetics, ceramics, and pharmaceutical industries (Rahayu *et al.*, 2018). In the last decade, industrial centers in Bali, Mataram, and Makassar have developed rapidly as centers for the production of pearl oyster-based handicrafts for export markets, particularly Japan, the United States, and Europe. Technological innovations also enable the use of oyster waste as a biofilter in composite materials to improve mechanical properties.

The shellfish industry is growing rapidly, with significant contributions from Japan, which is innovating in handicrafts, musical instruments, and cosmetics (Maulidia *et al.*, 2023; Yuridhista *et al.*, 2023). Nagai, 2013). China uses shells in the cosmetics and jewelry industry (Alves *et al.*, 2020), while Australia uses them for decoration and premium products (Silva *et al.*, 2019). Other countries such as the United States, Europe, and South Korea are exploring the use of shells in bioplastics and environmentally friendly products (Topiæ Popoviæ *et al.*, 2023). The pearl shell industry in Indonesia has excellent potential to support national economic growth. However, this industry still faces challenges in export strategies, mastery of market intelligence, workforce literacy, and integration of foreign investment to increase competitiveness and optimal contribution.

CONCLUSION

An evaluation of the Indonesian pearl market for the 2020–2024 period demonstrates strong and adaptive global trade dynamics. Over the five years, total export volume reached 46,072 kg with an accumulated value of USD 309.8 million. Although export volume declined in 2023 and 2024 after peaking in 2022 (10,854 kg), export value surged sharply in 2023 to USD 112.8 million from USD 54.7 million in 2022. This substantial increase in average value per kilogram was driven by limited global supply and a market shift toward premium products. Given that 80% of total production is destined for export, the industry's supply chain is highly sensitive to international quality preferences, climate change, and environmental risks in cultivation centers.

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