The feasibility of a cold storage facility for fish in Aceh during the COVID-19 pandemic

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Abstract. The majority of catches by fishermen in Aceh, Indonesia are sold raw, directly to consumers, and in the local market. This contributes to the low price of fish and low income for the fishermen, and the COVID-19 outbreak has made this situation even worse. One solution could be the establishment of a cold storage business in the area. This study assessed the financial feasibility of a 200-ton cold storage business in Banda Aceh, the capital of Aceh province. Using secondary data collected from online sources, we applied the most common financial indicators used in feasibility studies, namely Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit-Cost Ratio (BCR). A sensitivity test was also performed to predict the feasibility of the cold storage business if the basic assumptions are changed. We found that cold storage in Banda Aceh is financially feasible as the NPV was positive, the IRR was higher than the interest rate (i.e., the discount rate), and the BCR was higher than 1. Besides, the sensitivity test also suggested that cold storage would still be feasible even if there were a 20% increase or decrease in storage capacity and project costs.

1. Introduction

Indonesia is a maritime country and most Indonesians depend on the fishing industry for their livelihood. Indonesia’s coastline stretches for 104,000 km and the country controls 3.544 million km² of ocean, representing 70% of its territory [1]. Indonesia is blessed with rich sources of fish and diverse ocean life. For example, it is among the top five tuna producers in the world and contributed 17.9% of the total world production of tuna in 2016 [2]. The fishing industry contributed 12% of Indonesia’s GDP...
in 2019, with 25.32 tons of fish [3]. However, experts believe that Indonesia has not yet successfully leveraged the full potential of its ocean territory.

According to the United Nations Industrial Development Organisation (UNIDO), the Indonesian fishing industry lacks efficiency [4]. The Consultative Group for International Agricultural Research (CGIAP) and UNIDO reported that 40% of Indonesian fishermen’s catch (equal to US$7.28 billion/year) was unused or wasted [4]. One reason for this is the inappropriate storage of fish. Without adequate fish storage facilities, both fishers and fish sellers have to discard a significant amount of rotten fish [5,6].

Thus, every region and port in Indonesia should have a proper cold storage facility to improve the efficiency and productivity of the fishing industry. According to Hasanuddin Yasni, the General Chairman of the Indonesian Cold Storage Association (ARPI), the capacity of cold storage in Indonesia can only cover around 50% of the demand [7]. In addition to the challenges concerning fish, cold shortage for other products such as fruits and vegetables is also limited. Increasing the availability of cold storage would support other businesses in Indonesia and contribute to improved management in many industries [8–11].

Similar to other regions in Indonesia, the sea of Banda Aceh, the capital of Aceh province, has rich fishing potential, as it is located in the north-western tip of Indonesia and directly faces the Indian Ocean. Aceh fishery data shows that the total catch from Banda Aceh, Sabang, and Aceh Besar in 2017 was 27,860 tons. If it is assumed that only 80% [10] of this catch can be sold at the local markets, approximately 5,572 tons of fish per year (or 15 ton per day) needs to be frozen and stored. However, the existing cold storage capacity in Banda Aceh is very limited and cannot meet this demand [12]. Currently, there are two local government cold storage facilities in the city, but neither is in operation due to electrical problems and administrative issues [13]. The demand for cold storage is also increasing due to the restrictions associated with the COVID-19 pandemic, as fishermen and fish sellers cannot sell their products to markets outside Banda Aceh. As a result, most of the catch is currently being sold directly at the local markets.

Prior studies of cold storage feasibility have been conducted mostly outside Aceh province. For example, [6] analyzed the feasibility of building a 75-ton cold storage facility in Kabupaten Lingga, Kepulauan Riau, Indonesia. They found that the facility was feasible, as the net present value (NPV) was positive, the internal rate of return (IRR) was higher than the discount rate, and the net benefit-cost ratio (BCR) was greater than 1. Moreover, [14] studied the feasibility of an 80-ton cold storage facility in Lampulo Baru Fishery Port, Banda Aceh and also found that the project was feasible. Similar studies also found consistent results [15–17].

Unlike these previous studies, this study aimed to assess the financial feasibility of a 200-ton cold storage facility providing services for companies, individual fishers, and fish sellers in Banda Aceh and surrounded regions. The proposed facility will provide freezing and storage to customers without any weight limitations. Additionally, the facility will be equipped with a generator to provide electricity in the event of electricity shortages from the national provider. This private cold storage facility will help local fishermen and fish sellers to preserve their stock, add value, and increase the price of fish. Moreover, the business will also increase competition in the provision of cold storage, leading to improved prices and service quality.

2. Material and Methods
This study was based on data from secondary sources. Information concerning the materials, machinery, equipment, and other requirements for cold storage facilities was collected from similar studies that have previously been published. These specifications were modified to take into account the proposed maximum storage capacity of 200 tons. Our calculations were based on financial and other assumptions, as discussed in the following section. Moreover, the prices of materials, machinery, and other items were determined by referring to credible online vendors such as Alibaba, Astromesin, Monotaro, and Tokopedia.
To examine the feasibility of the business, we considered the three most widely used financial indicators, as shown in Table 1.

Table 1. Financial indicators used in the feasibility study

| No | Indicator                           | Interpretation                                               |
|----|-------------------------------------|--------------------------------------------------------------|
| 1  | Net present value (NPV)             | If NPV > 0 (using a specific discounted rate), the project is feasible. |
| 2  | Internal rate of return (IRR)       | If IRR > discounted rate, the project is feasible.           |
| 3  | Benefit-cost ratio (BCR)            | If BCR > 1, the project is feasible.                         |

Source: [17]

To examine the impact of our assumptions, we also conducted sensitivity tests. In doing so, we tested two possible changes: a 20% increase or decrease in capital costs and a 20% increase or decrease in storage capacity.

3. Results and Discussion

3.1. Assumptions and calculations

We assumed that a capacity of 200 tons is sufficient to meet the cold storage demand in Banda Aceh, Aceh Besar, and surrounding areas. According to [18], the total catch in 2017 from three regions (Banda Aceh, Sabang, and Aceh Besar) was 28,265 tons. [19] estimated that the catch in Pelabuhan Perikanan Samudera (Ocean Fishery Port) Kutaraja, the primary port in Banda Aceh, will reach 92,637.84 tons in 2020 and 272,978.67 tons in 2024. Table 2 lists the financial and non-financial assumptions used in this study.

The most expensive capital cost components for the facility will be plant and machinery (IDR 13,383,978,020), the 3,270 m² building (IDR 12,433,000,000), and 5000 m² of land (IDR 5,000,000,000). The duration of this project will be 10 years and it will be funded jointly (50:50) by owner capital and loans.

Moreover, we assumed that the cold storage business will generate income from both processing fees and cold storage rental. Based on the price of cold storage in other parts of Indonesia (e.g., IDR 2,000/kg/day in Malang), we set the initial rental price at IDR 200/kg/day, with an increase of IDR 100 annually due to inflation and increases in annual salaries and other operational expenses. The initial storage capacity was estimated to be 50%, increasing to a maximum storage capacity of 70% in the sixth year, as shown in Table 3. This forecast was calculated based on feasibility studies of similar businesses in other countries (e.g., [20]) with some modifications and adjustments.

Table 2. Financial and non-financial assumptions

| No | Indicator               | Value             | Description                                      |
|----|-------------------------|-------------------|-------------------------------------------------|
| 1  | Land (5,000m²)          | IDR 5,000,000,000 | -                                               |
| 2  | Building                | IDR 12,433,000,000| Cold storage room, air blast freezer (ABF) room, offices, labor room, generator room, warehouse, parking, etc. |
| 2  | Plant and machinery     | IDR 13,383,978,020| Cold storage, ABF, generator, ammonia compressor. |
| 3  | Office equipment        | IDR 26,000,000    | Desktop computers, printers, Internet connection, etc. |
4 Furniture and fixtures IDR 125,400,000 Tables, chairs, sofa, air-conditioning unit, etc.
5 Working capital IDR 1,007,160,931 Spare parts for equipment, upfront insurance payment, cash

**Total project cost** IDR **32,348,528,951**

6 Staff annual salaries IDR 1,092,000,000 Adjusted based on regional salary standards

| No | Indicator                        | Value                  | Description                                                                 |
|----|----------------------------------|------------------------|-----------------------------------------------------------------------------|
| 7  | Project life (years)             | 10                     | [20]                                                                       |
| 8  | Debt-equity ratio                | 50:50                  | [20]                                                                       |
| 9  | Interest rate on long-term debt  | 10%                    | Interest rate (long-term)                                                   |
| 10 | Discount rate for calculation of NPV | 11%                  | Interest rate (long-term) + 1% buffer                                       |
| 11 | Interest rate on working capital loan | 10%              | Interest rate (long-term)                                                   |
| 13 | Machinery and equipment maintenance (as % of machinery value) | 2% | [20]                                                                       |
| 14 | Depreciation method              | Straight line          | [20]                                                                       |
| 15 | Depreciation rate                | Building 5%, machinery 10% | [20]                                                                       |

| Year | Storage capacity | Daily storage price (IDR/kg/day) | Annual income (IDR/360 days) | Annual expenditure (IDR) |
|------|------------------|----------------------------------|-----------------------------|--------------------------|
| 1    | 50%              | 200                              | 7,300,000,000               | 10,665,290,897           |
| 2    | 50%              | 325                              | 10,950,000,000              | 10,566,746,049           |
| 3    | 60%              | 400                              | 17,520,000,000              | 10,650,696,049           |
| 4    | 60%              | 500                              | 21,900,000,000              | 10,694,496,049           |
| 5    | 60%              | 600                              | 30,660,000,000              | 10,800,346,049           |
| 6    | 70%              | 700                              | 35,770,000,000              | 10,632,924,549           |
| 7    | 70%              | 800                              | 40,880,000,000              | 10,684,024,549           |
| 8    | 70%              | 900                              | 45,990,000,000              | 10,735,124,549           |
| 9    | 70%              | 1,000                            | 51,100,000,000              | 10,786,224,549           |
| 10   | 70%              | 1,100                            | 56,210,000,000              | 10,837,324,549           |
|      | Total            |                                  | 318,280,000,000             | 107,053,197,838          |

Table 3. Annual income and expense

3.2. Feasibility study results

As outlined in section 2, the feasibility of the facility was determined by calculating the NPV, IRR, and BCR. The results of these calculations are shown in Table 4.

The NPV at a discount rate of 11% was IDR 59,026,684,732, meaning that the project is likely to generate more cash inflow than cash outflow. The IRR was 31%, greater than the discount rate. This
indicates that the project offers a higher rate of return than the expected return from other investments. Moreover, the gross BCR was greater than 1, meaning that the revenue gained is likely to be higher than the costs incurred. Based on these three indicators, we found that the construction of a 200-ton cold storage facility is feasible in Banda Aceh.

This study is consistent with the results of previous studies [6, 14, 16], although the storage capacity and the business model were different. Moreover, our assumed cold storage rental fees were significantly lower than in other studies. Thus, the proposed cold storage facility is expected to attract more customers than its competitors and contribute to strengthening the fishing industry, as well as improving food security in the region [10].

Table 4. Results of the feasibility study

| No | Indicator                    | Result                        |
|----|------------------------------|-------------------------------|
| 1  | Net present value            | IDR 59,026,684,732            |
| 2  | Internal rate of return      | 31%                           |
| 3  | Benefit-cost ratio           | 1.61                          |

3.3. Sensitivity results
The assumptions used in this study may differ from reality. For example, capital costs may increase due to inflation or a scarcity of equipment. Moreover, the storage capacity or occupancy rate may change due to an increase or decrease in the volume of fish caught in Banda Aceh. Thus, we performed a sensitivity test to recalculate the NPV and BCR based on changes of ± 20% in storage capacity and capital costs. Table 5 shows the results of the sensitivity test.

Table 5. Results of the sensitivity test

| No | Assumptions                          | Net present value (DF 17%) | Internal rate of return | Gross Benefit-cost ratio |
|----|--------------------------------------|---------------------------|-------------------------|-------------------------|
| 1  | Project cost (decrease of 20%)       | 67,511,804,256            | 37%                     | 1.81                    |
| 2  | Project cost (baseline)              | 59,026,684,732            | 31%                     | 1.61                    |
| 3  | Project cost (increase of 20%)       | 50,541,565,208            | 27%                     | 1.45                    |
| 4  | Capacity/revenue (decrease of 20%)   | 35,758,851,932            | 24%                     | 1.33                    |
| 5  | Capacity/revenue (base line)         | 59,026,684,732            | 31%                     | 1.61                    |
| 6  | Capacity/revenue (increase of 20%)   | 82,294,517,532            | 38%                     | 1.85                    |

As shown in Table 5, the NPV remained positive, the IRR was higher than 11%, and the BCR is greater than 1 in all scenarios. Thus, it can be concluded that the proposed cold storage facility is feasible even if fluctuations in capital costs and storage capacity are taken into account.

The sensitivity test results in this study are similar to the results of prior studies [6, 14, 16]. It may indicate that the cold storage business particularly in the pandemic situation is still feasible in case of a reduction of storage capacity or increase of the project cost.

4. Conclusion
This study found that the construction of a 200-ton cold storage facility is feasible in Banda Aceh, a finding that is particularly relevant during the COVID-19 pandemic. The oversupply of fish in Banda Aceh could be stored in cold storage by individual fishermen or fishermen’s cooperatives, and it could also be frozen to be sold in other regions. Given the assumed capital and operational costs, the NPV, IRR, and BCR results all supported the financial feasibility of the project. The sensitivity test confirmed that the feasibility indicators did not change significantly in response to changes in storage capacity and capital costs. However, the owners of the facility should adopt a modular construction approach and
consider different cold storage business models. The former would enable the adjustment of storage capacity based on demand, whereas the latter could include the offering of additional services, such as partnering with an e-commerce company to provide a platform for online fish sales.

References
[1] Rahmizal M 2017 Analysis of Indonesia Marine Fisheries with Economic Growth, Population and Effectiveness *Eur. J. Eng. Form. Sci.* **1** 17
[2] Hasna L 2019 Southeast Asia’s lucrative tuna industry *Asean Post*
[3] Hafidz F and Shidieq A 2018 Assessing the Efficiency of Health Facilities in Indonesia
[4] Thomas J 2019 Indonesia’s fisheries not managed efficiently *ASEAN post*
[5] Nurhasan M and Purnama R C Poor fishery management costs Indonesia $7 billion per year. Here’s how to stop it *INDO Marit.* **1**–6
[6] Hakim A R and Eriiza A 2019 Analisa Kelayakan Finansial Pembangunan Industri Cold Storage di Kabupaten Lingga *J. INTECH Tek. Ind. Univ. Serang Raya* **5** 51–9
[7] Anon 2016 Weak Infrastructure Blocks Investment in Indonesia’s Cold Storage Industry *Indones. Invest.* **1**–6
[8] Astari A, Saraswati E and Purwanti L 2020 The Role of Corporate Governance as a Moderating Variable on Earnings Management and Carbon Emission Disclosure *Jurnal Dinamika. Akuntansi dan Bisnis* **7** 69–86
[9] Lailossaw G W 2009 Studi Awal Design Model Sistem Rantai Dingin (Cold Chain System) Komoditas Unggulan Ekspor Sektor Perikanan Maluku (Ikan Beku/ Frozen Fish) *Seminar Nasional Teori dan Aplikasi Teknologi Kelautan* pp 103–10
[10] Bahri I and Pangastuti Y 2019 Analisis Kelayakan Finansial Usaha Perikanan Tangkap dan Trading Ikan PT Laot Aceh Marina Di Pelabuhan Perikanan Samudera Kutaraja Lampulo Banda Aceh *SEMIDI UNAYA* 505–23
[11] Asmawati and Nazamuddin 2013 Disequilibrium Pasar Ikan Luat Aceh *J. Ekon. Pembang.* **14** 38–51
[12] Khalis 2019 Hasil tangkapan ikan melimpah, Aceh masih butuh cold storage ikan *Antara*
[13] Anon 2018 Cold Storage belum Difungsikan *Serambi Indones.* **1**–6
[14] Juanda and Martunis 2014 c *J. Teknol. dan Ind. Pertan. Indones.* **6**
[15] Ramadhan M F, Prayogi U and Palang K 2018 Studi Perencanaan Cold Storage Ikan Laut Menggunakan Refrigerant Hydrocarbob di Pelabuhan Perikanan (PP) Bulu Tuban *Seminar Nasional Kelautan XIII*
[16] Syafrril M 2009 Kelayakan Finansial Pembangunan Cold Storage di Desa Senaken Kabupaten Paser *EPP* **1** 1–8
[17] Ahsan M, Umar A and Fachrudin Y 2019 Review on the Investment Evaluation on Department of Maritime Affairs and Fisheries Asset (Cold Storage) at Parigi Moutong Recency, Central Sulawesi, Indonesia *RJOAS* **2** 62–71
[18] Anon 2020 *Aceh dalam Angka 2019* (Banda Aceh)
[19] Kurnia, Mustaruddin and Lubis E 2019 Proyeksi produksi ikan hasil tangkapan di pelabuhan perikanan samudera kutaraja provinsi aceh *J. Teknol. Perikan. dan Kelaut.* **10** 69–77
[20] SMEDA 2015 *Pre-Feasibility Study Cold Storage (Fruit & Vegetable)* (Lahore)