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Economic Viability Analysis of Centrifuge-type Virgin Coconut Oil (VCO) Processing Facility in Aklan, Philippines

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Abstract

The Philippine coconut industry faces enduring challenges, especially among economically marginalized smallholder farmers. In response, the government enacted Republic Act No. 11524, mandating the Coconut Farmers and Industry Development Plan (CFIDP) to enhance productivity, reduce rural poverty, and modernize the sector. A key strategy under the CFIDP is the establishment of Shared Processing Facilities (SPFs) for value-added products such as virgin coconut oil (VCO). This study aims to evaluate the economic viability of a centrifuge-type VCO processing facility in Aklan to guide investment and policy decisions. Capital expenditure and operating costs were estimated using data from the Philippine Center for Postharvest Development and Mechanization (PHilMech), interviews with six coconut farmer cooperatives in Aklan, and secondary online sources. Financial values were adjusted to economic values using standard conversion factors while benefits were based on VCO sales using its free-on-board (FOB) price. An economic cost-benefit analysis (CBA) was conducted to assess the facility's viability. The facility had a total economic cost of PHP 71.88 million (USD 1.29 million), comprising capital expenditures of PHP 47.15 million (USD 0.84 million) and operating costs of PHP 24.72 million (USD 0.44 million). In contrast, the projected economic benefits amount to PHP 46.40 million (USD 0.83 million) annually. The economic analysis yielded a positive net present value (ENPV) of PHP 96.56 million (USD 1.74 million), an internal rate of return (EIRR) of 33%, a benefit-cost ratio (BCR) of 1.46, and a payback period of 2 years and 2 months. A sensitivity analysis confirmed the facility's viability despite fluctuations in sales, costs, and discount rates. The results suggest that the centrifuge-type VCO processing facility in Aklan is economically viable and qualifies as a strategic investment under CFIDP.

Introduction

Coconut (Cocos nucifera)-based products play a crucial role in the Philippines' agricultural exports. Between 2017 and 2021, these products generated an average annual value of 1.77 billion USD, constituting 35% of the country's total agricultural exports (Aguilar *et al.*, 2022). Despite this economic contribution, coconut farmers endure significant poverty, with 60% of smallholder farmers living below the national poverty threshold (Herrera *et al.*, 2019). In the Western Visayas region, 83.8% of coconut farmers earn less than PHP 10,000 annually, reliance on copra production and lack of post-harvest and processing infrastructure exacerbate the farmers' financial instability

(Aguilar *et al.*, 2022). To address these challenges, the Philippine government enacted Republic Act No. 11524, otherwise known as the Coconut Farmers and Industry Trust Fund Act. This legislation mandates the implementation of the Coconut Farmers and Industry Development Plan (CFIDP), a comprehensive initiative aimed at improving the livelihoods of coconut farmers through increased productivity, poverty alleviation, and coconut industry modernization. One key strategy involves creating Shared Processing Facilities (SPFs) to produce high-value coconut-based products, including virgin coconut oil (VCO). The Philippines is a recognized global leader in VCO production, with increasing international demand driven by the oil's nutritional properties and perceived health benefits.

VCO is extracted from fresh coconut meat through mechanical or natural means that retain its natural flavor and nutrients, distinguishing it from refined coconut cooking oil. Among the available extraction methods, the centrifuge and fermentation techniques are the most commonly used. The centrifuge method utilizes high-speed equipment to separate oil from coconut milk efficiently, yielding a clear, premium-quality product with low contamination risk. Conversely, the fermentation method relies on natural microbial action over a 24–48-hour period to achieve separation, making it more accessible to small-scale producers but also more prone to inconsistencies and quality issues. Due to its efficiency, product quality, and alignment with CFIDP's modernization goals, the centrifuge method is better suited for commercial-scale operations (Dimzon *et al.*, 2020).

Given Aklan's status as the top coconut-producing province in Western Visayas, it presents an ideal setting for a centrifuge-type VCO processing facility. Such an initiative not only addresses the region's lack of processing infrastructure but may also provide substantial income improvements for poor coconut farmers. However, with limited government resources, selecting and prioritizing projects under CFIDP-SPF requires a thorough viability assessment, including economic analysis. Beyond profit considerations, this analysis assesses broader economic, social, and environmental impacts, ensuring optimal resource allocation and long-term project sustainability (Gittinger, 1982; Asian Development Bank, 2017). Applying economic analysis to a centrifuge-type virgin coconut oil (VCO) processing facility provides a comprehensive assessment of stakeholder benefits, risks, and overall economic contribution.

Therefore, this study aims to assess the economic viability of establishing a centrifuge-type VCO processing facility under the CFIDP in Aklan. Specifically, it seeks to (1) identify and (2) evaluate the economic costs and benefits of the facility. The findings are expected to inform policymakers and stakeholders in identifying sustainable investment opportunities that support inclusive growth in the coconut sector.

Materials and Methods

Time and Place of the Study

The study primarily focused on the province of Aklan, the top coconut-producing province in Western Visayas. Data collection involved face-to-face and phone interviews with target respondents. Subsequently, the analysis took place at the College of Agriculture, Central Luzon State University (CLSU), situated in the Science City of Munoz, Nueva Ecija, Philippines, from January to March 2024.

Data Collection and Respondents

The financial costs for capital expenditures—including the cost of the lot, building, and equipment—for the centrifuge-type VCO processing facility under the CFIDP were obtained from the Philippine Center for Postharvest Development and Mechanization (PHilMech) through formal written requests and interviews. Meanwhile, the financial data for operating costs were gathered through interviews with representatives of six (6) registered coconut farmers' cooperatives in Aklan, with the assistance of the Philippine Coconut Authority (n.d.) and credible online sources. Conversely, the economic benefits were derived from the aggregate returns generated by the facility from the projected sale of virgin coconut oil (VCO), with FOB pricing determined from credible online sources.

Data Analysis

a. Analytical Framework

The economic viability of the centrifuge-type Virgin Coconut Oil (VCO) processing facility in Aklan was assessed through an economic cost-benefit analysis (CBA). This method is widely used to evaluate the feasibility of public investment projects by comparing their economic costs and benefits over time (Mohapatra, n.d.).

The economic costs of the VCO facility, under the Coconut Farmers and Industry Development Plan (CFIDP), were derived from various components: the cost of land, building construction, processing equipment, depreciation, maintenance, registration and licensing, labor, materials, overhead, the opportunity cost of land, and environmental impacts. All financial costs were adjusted to reflect their

economic values. This adjustment involved applying a Standard Conversion Factor (SCF) for goods (Equation 1) and a Wage Rate Conversion Factor (WRCF) for labor (Equations 2 and 3), based on the guidelines of the Inter-American Development Bank and the Government of the Bahamas (1990).

$$SCF=(X\_2023+M\_2023)/((X\_2023-T\_x2023))+(M\_2023+T\_m2023)) \quad (1)$$

Where:

SFC= Standard conversion factor
X_2023= Philippines' export value in 2023 (PSA, 2024a)
M_2023= Philippines' import value in 2023 (PSA, 2024a)
T_x2023= Philippine government export tax earnings in 2023 (PSA, 2024a)
T_m2023= Philippine government import tax earnings in 2023 (PSA, 2024a)

$$WRCF=SWR/WR \quad (2)$$

Where:

WRCF= Wage rate conversion factor
WR= minimum wage rate in Aklan, PHP
SWR= Shadow wage rate, PHP

$$SWR=(\sum\_(j=1)^n\ D\_j/(\ S\_j\ ).\ 〖\ WR〗\ \_j)/n \quad (3)$$

Where:

SWR= shadow wage rate
D= Seasonal utilization of labor, 80% for peak season, 50% for lean season
S = Seasonal availability of labor, 100%
WR= wage rate in Aklan, PHP
J= 1, 2.....,n = number of seasonal periods

The opportunity cost of land—defined as the economic value of its next best alternative use—was also included in the analysis. Consistent with Asian Development Bank (2017) recommendations, the study accounted for environmental costs to fully capture the impact of using natural resources. Since the facility relies on non-renewable inputs like electricity and oil, carbon dioxide (CO_2) equivalent emissions were estimated using a specialized tool developed by the United States Environmental Protection Agency (2015) to reflect the environmental burden.

On the economic benefits side, the economic returns were estimated based on projected Virgin Coconut Oil (VCO) sales, using its free-on-board (FOB).

b. Economic Viability Indicators

The economic CBA utilized economic viability indicators to measure the investment worth of a facility. These indicators were the economic net present value (ENPV), economic internal rate of return (EIRR), benefit-cost ratio (BCR), and payback period. These indicators were detailed below:

Economic Net Present Value (ENPV)

Economic Net Present Value (ENPV) measures the difference between the present value of benefits and the present value of costs over the investment period, indicating the economic viability of the investment (Asian Development Bank, 2017). The facility will be considered economically viable if the ENPV calculated using the required minimum discount rate is positive. The formula for calculating the ENPV is presented in Equation 4.

$$ENPV = \sum (\ 〖CF〗\ \_t\ / (1+r)^t) - C_0 \quad (4)$$

Where:

〖CF〗 _t = Net benefits at time t
r = Discount rate or the required rate of return, 12%
t = Period
C_0= Costs at year 0

Economic Internal Rate of Return (EIRR)

The Economic Internal Rate of Return (EIRR) is a metric used to assess the return level of an investment. The facility will be considered economically viable if the EIRR exceeds the minimum required discount rate. This value was determined using Equation 5.

$$EIRR=Cash\ inflows\ /\ (1 + r)^1]+[Cash\ inflows\ /\ (1 + r)^2]...[Cash\ inflows\ /\ (1 + r)^n]-initial\ investment \quad (5)$$

Where:

Cash inflows = Expected benefits from the investment.
r = Discount rate or rate of return, 12%.
n = Period
Initial investment = Cost of the investment in year 0.

Benefit-cost ratio (BCR)

The BCR compares the discounted costs and benefits of investment cash flows. Results from the BCR are like the ENPV, but the former measures the relative profitability of the investment while the latter accounts for total net benefits (Adams *et al.*, 2019). When the BCR calculated using the minimum required discount rate is greater than one, the facility will be considered economically viable. The BCR was mathematically computed using Equation 6.

BCR=(discounted net benefits)/(discounted costs) (6)

Where:

BCR = Benefit-cost ratio
Discounted net benefits = Net benefits of the facility at a 12% discount rate.
Discounted net costs = Costs of the facility at a 12% discount rate.

Payback Period

The payback period indicates the time required to recoup the initial investment in the facility. Projects with shorter payback periods are prioritized (Awomewe & Ogundele, 2008). It is calculated using Equation 7.

PP=II/ACI (7)

Where:

PP = Payback period
II= Initial investment
ACI = Annual cash inflows

c. Sensitivity Analysis

Sensitivity analysis is a valuable method used to assess the impact of changes in specific conditions. These changes can stem from various factors, such as fluctuations in product selling prices, delays in business implementation, cost increases, and variations in production volume. The primary purpose of sensitivity analysis is to assess how changes in key variables (such as costs, revenues, and discount rates) affect a project's economic viability. It helps identify critical factors that influence investment feasibility and determine the project's resilience to uncertainties. The stimuli used in the sensitivity analysis of the study were a 10% decrease in sales, a 10% increase in operating costs, a 10% increase in the discount rate, and the combination of the three.

d. Analytical Assumptions

The following assumptions were used for the economic cost-benefit analysis (CBA) of the centrifuge-type VCO processing facility in Aklan:

Pricing and Valuation

- All prices and quantities used in the analysis were in constant 2023 values.
- Costs associated with raw materials, encompassing electricity, fuel, and water, were predicated on prevailing market valuations.
- The prevailing FOB selling price of VCO is 252 PHP (4.53 USD).
- The site designated for the processing facility was originally cultivated with coconut trees to reflect the opportunity cost of land.

Technical Assumptions

- The structural longevity of the building was presumed to span 60 years, while the operational lifespan of the equipment was conservatively estimated at 10 years.
- The operational capacity of the facility was envisaged to be optimized at 5,000 whole coconuts per day.
- Each coconut was estimated to yield approximately 0.15 liters of virgin coconut oil (VCO).
- Operational hours for the processing facility were set at 8 hours per day, 22 days per month, and operational for the entirety of the year.

Economic Parameters

- Depreciation was computed using a straight-line method with a salvage value set at 20%.
- Provisions for repairs and maintenance were allocated at 2% of the initial capital investment.
- Expenses regarding registration and licensing obligations were projected at 3% of the initial capital investment.
- Labor expenditure was forecasted to escalate by 6% annually, according to prevailing salary trends in Western Visayas (Department of Labor and Employment, 2023).
- Operational overheads were anticipated to increase by 4.12% annually to prevent inflationary pressures.
- A ten percent (10%) contingency provision of the total operating expenditure was incorporated to buffer against unforeseen eventualities.

Results and Discussion

Economic costs of a centrifuge-type virgin coconut oil processing facility

The economic cost of establishing a centrifuge-type VCO processing facility in Aklan was divided into two major categories: capital expenditure and annual operating cost. All costs were converted into their economic equivalents using the computed conversion factors as discussed in the methodology.

a. Capital Expenditure

Capital expenditure represented the upfront investment required to build and equip the facility. As

presented in Table 1, the total economic capital cost amounts to PHP 47,158,350 (approximately USD 847,714.36). The table details each cost item, including land, building construction, and specialized VCO processing equipment, along with their financial cost, conversion factors, and resulting economic cost.

Table 1 also showed that 69% of the total investment was allocated to building construction, followed by equipment (22%) and land acquisition. This cost structure positions the facility under the medium-scale category as defined by the Magna Carta for MSMEs (Official Gazette, 2008), underscoring the substantial capital intensity of such agro-industrial ventures.

Table 1. Capital expenditure of centrifuge-type VCO processing facility in financial costs and economic costs, 2024.

Item	Quantity	Unit	Lifespan (years)	Financial Cost (PHP)	Conversion Factor	Economic Cost (PHP)	Economic Cost (USD)
1000 sq. meter lot	1	Unit	-	1,500,000	1.0	1,500,000	26,963.86
Building	1	Unit	60	35,000,000	0.93	32,550,000	585,115.94
Transformer	3	Unit	10	435,000	0.93	404,550	7,272.16
Electric Line	1	Unit	10	500,000	0.93	465,000	8,358.80
Truck	1	Unit	10	2,000,000	0.93	1,860,000	33,435.20
Dehusking tool	5	Unit	10	25,000	0.93	23,250	417.94
Coconut water extractor	2	Unit	10	220,000	0.93	204,600	3,677.87
Holding tank for coco water	5	Unit	10	250,000	0.93	232,500	4,179.40
Coconut deshelling machine	2	Set	10	500,000	0.93	465,000	8,358.80
Working table	2	Unit	10	40,000	0.93	37,200	668.70
Coconut meat washing bin	2	Set	10	500,000	0.93	465,000	8,358.80
Hauling Cart	6	Unit	10	300,000	0.93	279,000	5,015.28
Coconut meat grinder	2	Unit	10	780,000	0.93	725,400	13,039.73
Coconut milk extractor	1	Set	10	700,000	0.93	651,000	11,702.32
Vibrating Screen	1	Set	10	295,000	0.93	274,350	4,931.69
Receiving tank with pump	5	Set	10	900,000	0.93	837,000	15,045.84
Coconut milk centrifuge	2	Set	10	4,000,000	0.93	3,720,000	66,870.39
Holding tank	2	Unit	10	210,000	0.93	195,300	3,510.70
Tubular centrifuge	1	Set	10	1,800,000	0.93	1,674,000	30,091.68
Automatic liquid filling machine	1	Unit	10	525,000	0.93	488,250	8,776.74
Filter press	1	Unit	10	115,000	0.93	106,950	1,922.52
Total						**47,158,350**	**847,714.36**

Official exchange rate: 1 USD = 55.63 PHP as of September 9, 2024.

Financial cost data were sourced from the Philippine Center for Postharvest Development and Mechanization (PHilMech).

b. Annual Operating Cost

Table 2. The annual operating cost of centrifuge-type VCO processing facility, 2024

Item	Financial Cost (PHP)	Conversion Factor	Economic Cost (PHP)	Economic Cost (USD)
Labor	5,040,000	0.65	3,276,000	58,889.09
Mature coconuts	9,240,000	0.93	8,593,200	154,470.61
Packaging materials	4,059,000	0.93	3,774,870	67,856.73
PPE	31,000	0.93	28,830	518.25
Fuel	374,400	0.93	348,192	6,259.07
Electricity	1,577,127.55	0.93	1,466,728.62	26,365.79
Water	20,793.60	0.93	19,338	347.62
Depreciation	1,482,668	-	1,482,668	26,652.31
Repair & Maintenance	941,067	-	941,067	16,916.54
Registration and License	1,411,600.50	-	1,411,600.50	25,374.81
Sub-total		-		
Contingency allowance (10 %)		-	2,214,249.42	39,803.15
The opportunity cost of land		-	16,388	294.59
Environmental Cost		-	1,151,1143. 89	206,923.31
Total			**24,724,245.48**	**444,440.87**

Official exchange rate: 1 USD = 55.63 PHP as of September 9, 2024.

Table 3. The projected operating cost for a 10-year centrifuge-type VCO processing facility investment, 2024

Items	Year 0 in PHP (USD)	Year 1 in PHP (USD)	Year 2 in PHP (USD)	Year 3 in PHP (USD)	Year 4 in PHP (USD)	Year 5 in PHP (USD)	Year 6 in PHP (USD)	Year 7 in PHP (USD)	Year 8 in PHP (USD)	Year 9 in PHP (USD)	Year 10 in PHP (USD)
Capital Expenditure	47,158,350 (847,714)										
Operating Costs		23,556,743.59 (423,454)	24,444,538.59 (439,413)	25,456,271.61 (457,600)	26,513,996.78 (476,613)	27,619,867.50 (496,492)	28,776,141.41 (517,277)	29,985,185.60 (539,011)	31,249,482.12 (561,738)	32,571,633.73 (585,505)	33,954,370.03 (610,361)
Depreciation		1,482,668 (26,652)	1,482,668 (26,652)	1,482,668 (26,652)	1,482,668 (26,652)	1,482,668 (26,652)	1,482,668 (26,652)	1,482,668 (26,652)	1,482,668 (26,652)	1,482,668 (26,652)	1,482,668 (26,652)
Repair & Maintenance		941,067 (16,916.54)	979,838.96 (17,613.50)	1,020,208.33 (18,339.18)	1,062,240.91 (19,094.75)	1,106,005.23 (19,881.45)	1,151,572.65 (20,700.57)	1,199,017.44 (21,553.43)	1,248,416.96 (22,441.43)	1,299,851.74 (23,366.02)	1,353,405.63 (24,328.70)
Registration and License		1,411,600.50 (25,374.81)	1,469,758.44 (26,420.25)	1,530,312.49 (27,508.76)	1,593,361.36 (28,642.12)	1,659,007.85 (29,822.18)	1,727,358.97 (31,050.85)	1,798,526.16 (32,330.15)	1,872,625.44 (33,662.15)	1,949,777.61 (35,049.03)	2,030,108.45 (36,493.05)
Labor		3,276,000.00 (58,889.09)	3,472,560.00 (62,422.43)	3,680,913.60 (66,167.78)	3,901,768.42 (70,137.85)	4,135,874.52 (74,346.12)	4,384,026.99 (78,806.88)	4,647,068.61 (83,535.30)	4,925,892.73 (88,547.42)	5,221,446.29 (93,860.26)	5,534,733.07 (99,491.88)
Mature coconuts		8,593,200.00 (154,470.61)	8,947,239.84 (160,834.80)	9,315,866.12 (167,461.19)	9,699,679.81 (174,360.59)	10,099,306.61 (181,544.25)	10,515,398.05 (189,023.87)	10,948,632.45 (196,811.66)	11,399,716.10 (204,920.30)	11,869,384.41 (213,363.01)	12,358,403.04 (222,153.57)
Packaging materials		3,774,870 (67,856.73)	3,930,394.64 (70,652.43)	4,092,326.90 (73,563.31)	4,260,930.77 (76,594.12)	4,436,481.12 (79,749.80)	4,619,264.14 (83,035.49)	4,809,577.82 (86,456.55)	5,007,732.43 (90,018.56)	5,214,051.01 (93,727.32)	5,428,869.91 (97,588.89)
PPEs		28,830.00 (518.25)	30,017.80 (539.60)	31,254.53 (561.83)	32,542.22 (584.98)	33,882.96 (609.08)	35,278.93 (634.17)	36,732.42 (660.30)	38,245.80 (687.50)	39,821.53 (715.83)	41,462.17 (745.32)
Fuel		348,192.00 (6,259.07)	362,537.51 (6,516.94)	377,474.06 (6,785.44)	393,025.99 (7,065.00)	409,218.66 (7,356.08)	426,078.47 (7,659.15)	443,632.90 (7,974.71)	461,910.57 (8,303.26)	480,941.29 (8,645.36)	500,756.07 (9,001.55)
Electricity		1,466,728.62 (26,365.79)	1,527,157.84 (27,452.06)	1,590,076.75 (28,583.08)	1,655,587.91 (29,760.70)	1,723,798.13 (30,986.84)	1,794,818.61 (32,263.50)	1,868,765.14 (33,592.76)	1,945,758.26 (34,976.78)	2,025,923.50 (36,417.82)	2,109,391.55 (37,918.24)
Water		19,338.05 (347.62)	20,134.78 (361.94)	20,964.33 (376.85)	21,828.06 (392.38)	22,727.37 (408.55)	23,663.74 (425.38)	24,638.69 (442.90)	25,653.80 (461.15)	26,710.74 (480.15)	27,811.22 (499.93)
Contingency Allowance (10%)		2,214,249.42 (39,803.15)	2,222,230.78 (39,946.63)	2,314,206.51 (41,599.97)	2,410,363.34 (43,328.48)	2,510,897.05 (45,135.67)	2,616,012.86 (47,025.22)	2,725,925.96 (49,001.01)	2,840,862.01 (51,067.09)	2,961,057.61 (53,227.71)	3,086,760.91 (55,487.34)
Other Costs		1,167,501.89 (20,986.91)	1,167,501.89 (20,986.91)	1,167,501.89 (20,986.91)	1,167,501.89 (20,986.91)	1,167,501.89 (20,986.91)	1,167,501.89 (20,986.91)	1,167,501.89 (20,986.91)	1,167,501.89 (20,986.91)	1,167,501.89 (20,986.91)	1,167,501.89 (20,986.91)
Opportunity Cost of Land		16,388.00 (294.59)	16,388.00 (294.59)	16,388.00 (294.59)	16,388.00 (294.59)	16,388.00 (294.59)	16,388.00 (294.59)	16,388.00 (294.59)	16,388.00 (294.59)	16,388.00 (294.59)	16,388.00 (294.59)
Environmental Cost		1,151,113.89 (20,692.32)	1,151,113.89 (20,692.32)	1,151,113.89 (20,692.32)	1,151,113.89 (20,692.32)	1,151,113.89 (20,692.32)	1,151,113.89 (20,692.32)	1,151,113.89 (20,692.32)	1,151,113.89 (20,692.32)	1,151,113.89 (20,692.32)	151,113.89 (20,692.32)
Total Operating Expenses		24,724,245.48 (444,440.87)	**25,612,040.48 (460,399.79)**	**26,623,773.50 (478,586.62)**	**27,681,498.67 (497,600.19)**	**28,787,369.39 (517,479.23)**	**29,943,643.30 (538,264.31)**	**31,152,687.49 (559,997.98)**	**32,416,984.01 (582,724.86)**	**33,739,135.62 (606,491.74)**	**35,121,871.92 (631,347.69)**

The annual operating cost of the facility was computed to reflect the cost of running the facility at full capacity. These include raw material procurement, labor, packaging, utilities, opportunity costs, environmental costs, and other operating overheads.

As detailed in Table 2, the total annual economic operating cost is PHP 24,724,245.48 (USD 444,440.87). Among all cost components, the procurement of mature coconuts emerged as the most significant, comprising roughly 35% of total operating expenses. This is followed by labor, packaging materials, and electricity.

The table also included important environmental and regulatory costs such as carbon emission equivalents, depreciation, maintenance, and the opportunity cost of land, reflecting the full economic burden of the facility's operation.

These operating costs were subject to annual adjustments to account for inflation, with an average annual inflation rate of 4.12% in the Philippines from 2019 to 2023. The projected operating costs spanning over a decade were illustrated in Table 3.

Economic benefits of a centrifuge-type virgin coconut oil processing facility

Table 4. The Projecting benefits for a 10-year centrifuge-type VCO processing facility investment, 2024

Items	Year 0 in PHP (USD)	Year 1 in PHP (USD)	Year 2 in PHP (USD)	Year 3 in PHP (USD)	Year 4 in PHP (USD)	Year 5 in PHP (USD)	Year 6 in PHP (USD)	Year 7 in PHP (USD)	Year 8 in PHP (USD)	Year 9 in PHP (USD)	Year 10 in PHP (USD)
Quantity (liters of VCO)	0	198,000 (3,559.23)	198,000 (3,559.23)	198,000 (3,559.23)	198,000 (3,559.23)	198,000 (3,559.23)	198,000 (3,559.23)	198,000 (3,559.23)	198,000 (3,559.23)	198,000 (3,559.23)	198,000 (3,559.23)
Unit Price (PHP)	0	234.36 (4.21)	244.02 (4.39)	254.07 (4.57)	264.54 (4.76)	275.44 (4.95)	286.78 (5.16)	298.60 (5.37)	310.90 (5.59)	323.71 (5.82)	337.05 (6.06)
Sales (PHP)	0	46,403,280 (834,141.29)	48,315,095 (868,507.91)	50,305,677 (904,290.44)	52,378,271 (941,547.20)	54,536,256 (980,338.95)	56,783,149 (1,020,728.91)	59,122,615 (1,062,782.94)	61,558,467 (1,106,569.60)	64,094,676 (1,152,160.27)	66,735,376 (1,199,629.26)

Official exchange rate: 1 USD = 55.63 PHP as of September 9, 2024.

The facility's revenue was generated primarily through the sale of VCO at a production capacity of 750 liters per day which was equivalent to 198,000 liters per year. Using the VCO's free-on-board (FOB) price of PHP 252 per liter, the projected gross revenue was PHP 46,403,280 (USD 834,141.29) per year.

Table 4 contains year-on-year projections of these revenues over the facility's operating lifespan, accounting for an anticipated annual price increase of 4.12% due to inflation.

Economic cost-benefit analysis (CBA) of centrifuge-type virgin coconut oil processing facility

The facility's long-term economic viability was assessed using discounted investment measures. A 12% discount rate was used to reflect the opportunity cost of capital, aligning with standard benchmarks by multilateral financing institutions such as the Asian Development Bank (1987).

Table 5. 10 years undiscounted and discounted cashflows, 2024

Items	Year 0 in PHP (USD)	Year 1 in PHP (USD)	Year 2 in PHP (USD)	Year 3 in PHP (USD)	Year 4 in PHP (USD)	Year 5 in PHP (USD)	Year 6 in PHP (USD)	Year 7 in PHP (USD)	Year 8 in PHP (USD)	Year 9 in PHP (USD)	Year 10 in PHP (USD)	Total in PHP (USD)
Benefit	0	46,403,280 (834,141.29)	48,315,095 (868,507.91)	50,305,677 (904,290.44)	52,378,271 (941,547.20)	54,536,256 (980,338.95)	56,783,149 (1,020,728.91)	59,122,615 (1,062,782.94)	61,558,467 (1,106,569.60)	64,094,676 (1,152,160.27)	66,735,376 (1,199,629.26)	560,232,862.69 (10,070,696.79)
Cost	47,158,350.00 (847,714.36)	24,724,245.48 (444,440.87)	25,612,040.48 (460,399.79)	26,623,773.50 (478,586.62)	27,681,498.67 (497,600.19)	28,787,369.39 (517,479.23)	29,943,643.30 (538,264.31)	31,152,687.49 (559,997.98)	32,416,984.01 (582,724.86)	33,739,135.62 (606,491.74)	35,121,871.92 (631,347.69)	343,024,983.79 (6,166,187.02)
Net Benefit	(47,053,350.00) (845,827)	21,679,034.52 (389,700.42)	22,703,054.66 (408,108.12)	23,681,903.56 (425,703.82)	24,696,772.28 (443,947.01)	25,748,886.32 (462,859.72)	26,839,506.15 (482,464.61)	27,969,927.71 (502,784.97)	29,141,482.95 (523,844.74)	30,355,540.17 (545,668.53)	31,613,504.51 (568,281.58)	217,207,878.90 (3,904,509.78)
Discount Factor (12%)	1	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404	0.361	0.322	

Discounted Benefit		41,431,500.000 (744,769.01)	38,516,498.036 (692,369.19)	35,806,587.281 (643,656.07)	33,287,338.104 (598,370.27)	30,945,336.102 (556,270.65)	28,768,110.669 (517,133.03)	26,744,068.597 (480,749.03)	24,862,432.342 (446,924.90)	23,113,182.638 (415,480.54)	21,487,005.145 (415,480.54)	304,962,058.92 (5,481,971.22)
Discounted Cost	47,158,350.00 (847,714.36)	22,075,219.18 (396,822.20)	20,417,761.86 (367,027.90)	18,950,276.10 (340,648.50)	17,592,092.84 (316,233.92)	16,334,726.50 (293,631.61)	15,170,381.58 (272,701.45)	14,091,893.74 (253,314.65)	13,092,676.14 (235,352.80)	12,166,670.54 (218,707.00)	11,308,302.78 (203,277.06)	208,392,854.22 (3,746,051.67)
Discounted Net Benefit	(47,158,350.00 (847,714.36)	19,356,280.82 (347,946.81)	18,098,736.17 (325,341.29)	16,856,311.18 (303,007.57)	15,695,245.26 (282,136.35)	14,610,609.60 (262,639.04)	13,597,729.09 (244,431.59)	12,652,174.85 (227,434.39)	11,769,756.20 (211,572.10)	10,946,512.10 (196,773.54)	10,178,702.37 (182,971.46)	96,569,204.7 (1,735,919.55)

Official exchange rate: 1 USD = 55.63 PHP as of September 9, 2024.

As summarized in Table 5, the total discounted economic benefits over 10 years were PHP 304,962,058.92 (USD 5,481,971.22), while the discounted costs are PHP 208,392,854.22 (USD 3,746,051.67). This resulted in a positive ENPV of PHP 96,569,204.70 (USD 1,737,816.06) as shown in Table 6. This value confirms the facility's economic soundness. Investment viability was further supported by other economic indicators. The EIRR of 33% significantly exceeds the 12% hurdle rate, demonstrating high returns on investment. The BCR of 1.46 indicates that for every peso invested, the facility yields PHP 1.46 in return. The payback period of 2 years and 2 months suggests a relatively quick recovery of initial capital.

These results align with findings from related studies. For instance, a similar project in Samoa showed an EIRR of 16.14% (Asian Development Bank, 2014), while VCO production in India yielded BCR values of 1.79 (hot process) and 1.65 (fermentation) (Chowdappa, 2016).

Sensitivity Analysis

To assess the robustness of the centrifuge-type Virgin Coconut Oil (VCO) processing facility under potential risks, a sensitivity analysis was conducted for three scenarios: a 10% decrease in VCO sales, a 10% increase in operating costs, and a 10% increase in the discount rate. Results, summarized in Table 7, show that all individual scenarios still yielded positive economic indicators. A 10% decline in sales reduced the ENPV to PHP 66.07 million (USD 1.18 million), EIRR to 24%, and BCR to 1.32, with the payback period extending to 2 years and 8 months. This scenario remains viable up to a 21% sales drop. A 10% rise in operating costs lowered the ENPV to PHP 80.44 million (USD 1.44 million), EIRR to 28%, and BCR to 1.36, with a slightly extended payback of 2 years and 5 months—remaining viable even with a 41% increase in costs. A 10% higher discount rate brought the ENPV down to PHP 49.98 million (USD 0.89 million), EIRR to 22%, and BCR to 1.32, still meeting viability thresholds and tolerating up to a 34% rate increase. However, when all three risks were combined, the ENPV dropped to PHP 18.43 million (0.33 million), EIRR fell to 9%, and BCR declined to 1.11, with the payback extending to 3 years and 3 months. This combined scenario rendered the project economically unviable, as the EIRR fell below the 12% benchmark. Overall, the investment is resilient under individual risk scenarios but sensitive to simultaneous adverse conditions, highlighting the importance of risk management in implementation.

Table 6. Economic Indicators

Indicator	Values
Economic net present value (ENPV)	PHP 96,569,204.70 (USD 1,737,816.06)
Economic internal rate of return (EIRR)	33%
Benefit-cost ratio (BCR),	1.46
Payback period	2 years and 2 months

Official exchange rate: 1 USD = 55.63 PHP as of September 9, 2024.

Table 7. Sensitivity analysis results for centrifuge-type VCO processing facility

Stimulus	ENPV	EIRR	BCR	Payback Period	Maximum Allowable Stimulus
10% decrease in sales	PHP 66,072,998.81 (1,187,722.43)	24%	1.32	2 years and 8 months	21% decrease in sales
10% increase in operating cost	PHP 80,445,754.28 (USD 1,446,085.82)	28%	1.36	2 years and 5 months	41% increase in operating costs

10% increase in discount rate	PHP 49,986,805.25 (USD 898,558.426)	22%	1.32	2 years and 2 months	34% increase in discount rate
Combination of all three	PHP 18,436,399.98 (USD 331,411.109)	9%	1.11	3 years and 3 months	Not applicable-already not viable

Official exchange rate: 1 USD = 55.63 PHP as of September 9, 2024.

Conclusion

The establishment of a centrifuge-type Virgin Coconut Oil (VCO) processing facility in Aklan under the Coconut Farmers and Industry Development Plan (CFIDP) involves a total economic cost of PHP 71.88 million (USD 1.29 million), comprising capital expenditures of PHP 47.15 million (USD 0.84 million) and operating costs of PHP 24.72 million (USD 0.44 million). In contrast, the projected economic benefits amount to PHP 46.40 million (USD 0.83 million) annually.

Cost-benefit analysis yielded a positive Economic Net Present Value (ENPV) of PHP 96.56 million (USD 1.74 million), an Economic Internal Rate of Return (EIRR) of 33%, and a Benefit-Cost Ratio (BCR) of 1.46—all of which confirm the project's economic viability. The initial capital investment is expected to be recovered within 2 years and 2 months.

Sensitivity analysis further demonstrated the project's financial resilience to individual risks such as declines in sales, increases in operating costs, and higher discount rates, all of which remained within acceptable thresholds. However, the investment showed vulnerability when multiple risks occurred simultaneously, emphasizing the need for risk management strategies when it occurs. Despite this, the overall analysis supports the viability of the facility and qualifies as a strategic investment under CFIDP.

Ethical Statement

The authors affirm that this study was conducted in accordance with the highest ethical standards of research. All procedures were carried out responsibly and with integrity. Where applicable, approval was obtained from the appropriate institutional ethics committee, and informed consent was secured from all participants. The authors declare that there are no conflicts of interest related to this work, and all sources of support have been properly acknowledged.

Conflict of Interest Statement

The authors declare no conflict of interest related to the conduct and publication of this research. All procedures followed were in accordance with institutional and ethical standards, and there were no financial or personal relationships that could have influenced the outcomes of this study.

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Declaration of Generative AI and AI-Assisted Technologies

In the preparation of this work, the author(s) used OpenAI for grammar correction. After utilizing this tool, the author(s) carefully reviewed and revised the text as necessary and assumed full responsibility for the final content of the publication.

Data Availability

All data supporting the findings of this study are available on paper.

Author Contributions

IJFS: Formal Analysis, Writing (Original Draft), Writing (Review and Editing); **RMB:** Writing (Original Draft) and Writing (Review and Editing); **PJR:** Formal Analysis and Writing (Review and Editing); **MJMB:** Writing (Original Draft) and Writing (Review and Editing); **AMT:** Investigation and Writing (Review and Editing)

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