Oyster Mussels (Crassostrea gigas) Analys Financial Feasibility (Case Study in Seishin Company) in Hyogo, Japan

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Abstract

Japan is known as one of the largest oyster cultivitation in the world. This research aims to analyze the financial feasibility of prospects of cultivitation oyster in Sakoshi, Hyogo prefecture, Japan. The analysis of investment evalution criteria in this study based on financial analysis methods which include, investments cost, operasional costs, Revenue Cost Ratio(R/C) and Break Even Point (BEP). To analyza financial feasibility, investment assessment criteria are used including Net Present Value (NPV), Internal Rate Return (IRR), Net Benefit Cost Ratio (Net B/C) and Payback Period (PP). Based on data analysis, it was obtained that the R/C value was 2.154 and Break Even Point was 3.421 kg. In the calculation of financial feasibility analysis, NPV value was obtained at ¥ 96,788,973, IRR value of 83%, Net B/C value of 2.154 and the Paypack Period for 1.17 years. Base from results of this research, oyster cultivation in Sakoshi, Hoyogo Prefecture, Japan is very feasible and profitable to do and develop in the future.

INTRODUCTION

Oysters are one of the most widely consumed shellfish in the world because they are found almost everywhere and have been cultivated globally (Crassostrea gigas) (Hasegawa et al., 2021). Oysters are shellfish with high nutritional and medicinal value, making them widely consumed around the world (Ulagesan et al., 2022). Oysters live in shallow waters and reproduce on rocks. (Octavina et al., 2014) state that oysters prefer substrates such as sandy loam, gravel, and rocks. Pacific oysters are highly favored in countries with a raw food culture; in Japan, half of all shellfish cultivation is oysters. Oysters have nutritional content such as low calories (78 kcal), protein 9.70g, fat 1.80g, sugar 5g, calcium 55mg, iron 3.60g, vitamin A 55 IU, vitamin B1 0.16mg, vitamin B2 0.32mg, and vitamin C 4mg, so oyster meat is often traded by the community as a nutritious food (Tan et al., 2021).

Japanese oyster farming is carried out in calm waters or bays. In 2017, Japanese oysters recorded a production volume of around 600,000 tons in global farming (Treviño et al., 2020) and became the third largest country in oyster production in 2016 (Botta et al., 2020). This shellfish farming is most successful in the fisheries industry in 70 countries, with Japan and the United States being the most dominant (Hasegawa et al., 2021). This species can adapt to various environmental conditions such as temperature, salinity, and other factors that affect the physiology

of marine invertebrates (Flores-Vergara et al., 2004). Additionally, oysters exhibit significant growth (Taris et al., 2007), good meat quality (Langdon et al., 2003), and easy and efficient feeding (Bayne et al., 1999). Therefore, oysters can thrive in various latitudes and environments, including estuaries, lagoons, coastal areas, and offshore regions (Laurence et al., 2009).

Sakoshi Bay in the city of Ako is one of the bays used for aquaculture in Hyogo Prefecture, Japan, due to its nutrient-rich waters and relatively calm waves. Oyster aquaculture production in Japan has grown rapidly since the mid-1960s, but has gradually slowed down to the present due to various factors, such as a shortage of labor for aquaculture operations and post-harvest activities, as well as issues related to global warming and coastal water oligotrophication (Hasegawa et al., 2021).

In terms of national production, the prefectures with the highest production volumes are Hiroshima, Miyagi, Okayama, Hyogo, and Iwate. According to (Fujii et al., 2023), oyster production plays a significant role in the domestic fisheries industry. In 2018, the value of oyster production from marine aquaculture was approximately ¥35,000,000,000, contributing around 7% of Japan's total marine aquaculture production. Since oysters are filter feeders, oyster farming must be conducted in nutrient-rich areas with ideal depths to promote faster growth. However, growth periods vary by region. In Sakoshi, the harvest cycle is conducted once a year, but in other regions, the harvest cycle may be inconsistent. Oysters cultivated in Sakoshi Bay are utilized and distributed beyond Hyogo Prefecture. There has been an annual increase in market demand for oyster resources, with Japan's oyster production recorded at 158,925 tons per year in 2016 (Koike & Seki, 2020).

Due to the high global demand for oysters, which increases every year, and the enormous potential of oyster farming in the Sakoshi region, this study aims to analyze the financial feasibility of oyster farming in Japan. It is hoped that the results of this study can serve as a basis for analysis and comparison in assessing the financial viability of oyster farming businesses, as well as contribute to the future development of oyster farming in Indonesia.

METHODS

The research was conducted from December to June 2022 in Sakoshi, Hyogo, Japan. The research method used was descriptive research with a quantitative approach conducted at an oyster farming company in Sakoshi, Hyogo, Japan. Descriptive research is a research method aimed at describing an object of study with the purpose of describing an existing phenomenon (Zellatifanny & Mudjiyanto, 2018).

Data was collected through several methods, namely direct observation of Pacific oyster cultivation at Seishin, interviews with parties involved in Pacific oyster cultivation at Seishin, and

documentation from the company's financial reports. The data analyzed for the quantitative method approach includes aspects required by the company, such as business capital, investment costs, operational costs, R/C, and BEP. Additionally, the financial feasibility analysis includes Net, NPV, IRR, Net B/C, and PP.

1. Revenue Cost Ratio

   Revenue Cost Ratio is a calculation tool to measure the relative profit level of a business in each period against the costs incurred (Primyastanto, 2016). The following is the formula for calculating the Revenue Cost Ratio:

$$\text{Ratio} = \frac{TR}{TC}$$

   Explanation: :

   TR = *Total Revenue*

   TC = *Total Cost*

   If R/C > 1, the business is considered profitable and worth developing. Conversely, if R/C < 1, the business is considered unprofitable or unable to generate profits for its owners.

2. Break Even Point

   Break-even point is a calculation analysis method to find the break-even point achieved by a company (Herjanto, 2007). The main purpose of BEP itself is to determine the lowest level of production and price at which a business can be run without jeopardizing its continuity. The following is the formula for calculating BEP:

$$BEP\ Unit = \frac{Fixed\ Cost}{Price\ (Per\ unit) - Variable\ Cost\ (Per\ Unit}$$

   BEP = Break Even Point

   FC = Fixed Cost

   P = Selling price per unit

   VC = Variabel Cost

3. Net Present Value

   Net Present Value is the reduction of project profits between project costs in a given year and the interest rate on costs at a given deposit interest rate (Gaspars-Wieloch, 2019). The following is the formula for calculating Net Present Value:

$$NPV = \sum_{t=0/1}^{n} \frac{Bt}{(1+i)^t} - \sum_{t=0/1}^{n} \frac{Ct}{(1+i)^t} = \sum_{t=0/1}^{n} \frac{(Bt - Ct)}{(1+i)^t}$$

NPV = *Net Present Value*

Bt = Profit in year t

Ct = Cost in year t

i = Bank interest rate (discount rate) (%)

t = Year of business activity, the initial year can be year 0 or 1

Generally, the NPV criterion is NPV > 0, then the business is considered feasible to run. If NPV < 0, then the business is considered not feasible to run.

4. Internal Rate of Return

Internal Rate of Return is a method of calculating the interest rate from the net present value (NPV) that is equal to the project investment amount (Magni & Marchioni, 2020; Shultz, 2020; Zhang et al., 2024). IRR is the interest rate that equates the present value of the investment with the present value of net cash receipts. IRR can also account for information about net cash flow, but the difference is that in the IRR concept, what is sought is the rate of return that will be generated by the present value where the inflow of cash is equal to the outflow of cash. An investment can be considered profitable if the IRR is greater than the agreed margin/fee/profit-sharing rate or IRR > cost of money. The following is the formula for calculating the Internal Rate of Return:

$$IRR = \mathrm{rr} + \frac{\mathrm{NPV_{rr}}}{\mathrm{TPV_{rr}} - \mathrm{TPV_{rt}}}\ x\ (\mathrm{rt} - \mathrm{rr})$$

rr = Lower discount rate (r)

rt = Higher discount rate (r)

TPV = Total Present Value

NPV = Net Present Value

The IRR value criterion is that if IRR > the applicable interest rate, then the business is feasible, whereas if IRR < the applicable interest rate, then the business is not feasible.

5. Net Benefit Cost Ratio

The Net Benefit Cost Ratio is a calculation tool used to measure the relative benefit of an endeavor in each period against the costs incurred (Primyastanto, 2016). The Benefit-Cost Ratio (B/C Ratio) is the comparison between the net benefits of the relevant years, which have been present-valued (numerator with a positive value), and the net costs in the year where Bt - Ct (denominator with a negative value) have been present-valued, i.e., gross costs > gross benefits (Ruminta, 2020). The following is the formula for calculating the Net Benefit-Cost Ratio:

$$Net\ B/C = \frac{\sum_{t=1}^{n} \frac{Bt}{(1+i)^t} (Bt - Ct) > 0}{\sum_{t=1}^{n} \frac{Ct}{(1+i)^t} (Bt - Ct) < 0}$$

Bt = Benefit in year t

Ct = Cost in year t

N = Economic life

i = Discount rate (%)

t = Year

If Net B/C > 1, then the project is feasible. However, if Net B/C < 1, then the project is not feasible.

6. Payback Period

Payback period is the time required for a company to return its initial capital, calculated using cash inflows or net cash flow (Gorshkov et al., 2018; Imteaz et al., 2021; Wangi et al., 2023). The following is the formula for calculating the payback period:

$$\text{Payback Period} = \frac{\text{Investment}}{\text{Profit}} \text{ x 1 year}$$

RESULTS AND DISCUSSION

Oyster farming is one of the largest sectors in global aquaculture (Botta et al., 2020). It is believed that oyster cultivation began prior to the 1st century in ancient Rome, making it one of the oldest aquaculture methods in human history. In 2002, Japan recorded an oyster aquaculture production volume of 234,151 tons, establishing the country as one of the world's leading oyster producers (Lungren et al., 2006). One of the active and continuously developing oyster farming sites is located in Sakoshi, Hyogo Prefecture, Japan, at coordinates 34º 46' 4.2954" N & 134º 26' 37.68" E. Seishin Company is one of the oyster farming enterprises operating in this region, employing the suspended raft method for cultivation. This technique involves hanging ropes used as a substrate for oyster attachment from bamboo rafts. The suspended raft method, used for spat settlement, grow-out, and harvesting, has been implemented since 1920 (Hasegawa et al., 2021). Oyster farmers in Sakoshi typically purchase oyster seeds (spat) from Hiroshima, as their farming activities are primarily focused on grow-out rather than hatchery production. The number of rafts used in cultivation varies depending on each company's capital, and an annual lottery system is held to allocate farming raft locations within the area. The main oyster commodity cultivated in Sakoshi is the Igashi oyster.

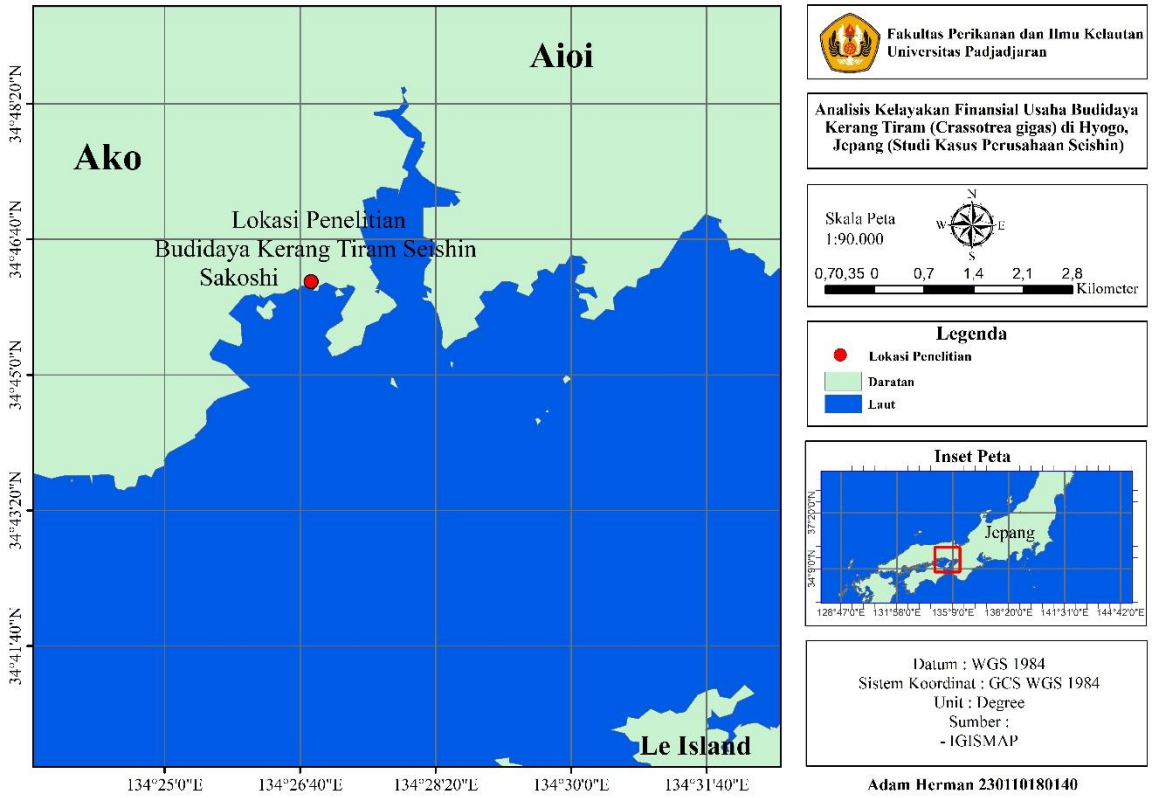

Figure 1. Map of the Research Location

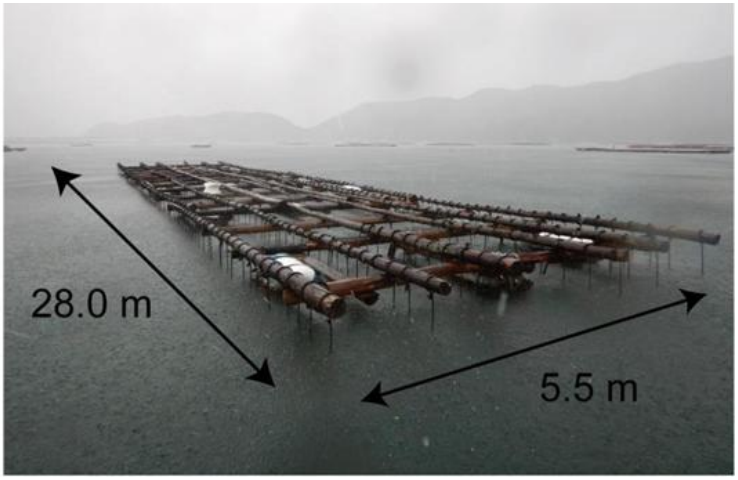

Figure 2. Suspended Raft for Oyster Cultivation

Investment Cost

The investment capital for this company originates from internal fundraising efforts conducted by the enterprise. The total initial investment disbursed amounts to ¥45,175,500, with an asset lifespan ranging from 1 to 25 years.

Table 1. Investment Funds

No.	Item Description	Quantity	Cost (¥)
1	Land	1	2,500,000
2	Building	1	6,000,000

No.	Item Description	Quantity	Cost (¥)
3	Large Vessel	1	20,000,000
4	Ship Crane	1	1,250,000
5	Small Vessel	1	8,500,000
6	Fish Cages	16	3,200,000
7	Vacuum Machine	1	300,000
8	Scallop Shells	26,500	795,000
9	Refrigerated Cabinet	1	200,000
10	Pump	1	24,000
11	Oyster Washing Machine	1	100,000
12	Pulley Machine	2	330,000
13	Conveyor Belt	5	500,000
14	Fiber Tank	3	90,000
15	Shovel	2	6,000
16	Cultivation Baskets	150	225,000
17	Large Crate Containers	50	100,000
18	100 kg Scale	1	7,000
19	15 kg Scale	1	3,000
20	Goods Trolley	4	24,000
21	Large Buckets	11	22,000
22	Oyster Knives	15	4,500
23	Gloves	100	150,000
24	Rubber Boots	18	27,000
25	Rope	100	800,000
	Total	26,987	45,157,500

Based on Table 1, it can be observed that the highest investment cost is for the large vessel, amounting to ¥20,000,000, followed by the small vessel with a cost of ¥8,500,000. These vessels play a crucial role in transporting cultivated oysters from the sea on a daily basis, particularly during the harvest season (winter). The large vessel has an estimated useful life of 25 years, while the small vessel has a lifespan of approximately 15 years. The lowest investment costs are for the 15 kg scale and the oyster knives, valued at ¥3,000 and ¥4,500, respectively. The highest quantity item in this investment is scallop shells, totaling 26,500 units, with an investment duration of one year. These scallop shells function as a medium for oyster spat attachment. Oyster spat can be obtained in two ways: either by collecting them directly from the sea or by purchasing them from hatchery companies. Most oyster farming companies in Ako purchase oyster spat from hatchery enterprises located in Miyagi Prefecture. The total capital investment amounts to ¥45,157,500, with asset lifespans ranging from 1 to 25 years. The second highest quantity item is cultivation baskets, totaling 150 units, with an investment cost of ¥225,000 and a useful life of five years. According to (Tandelilin, 2010), investment is defined as a commitment of a certain amount of funds or other resources made in the present with the expectation of gaining future returns.

Operating Costs

Operating costs are expenses incurred in connection with the company's core operations to generate revenue, which essentially have a useful life of no more than one year (Jusuf, 2007). The operating costs incurred by this company refer to expenditures for carrying out production activities. These costs consist of fixed costs and variable costs.

Table 2. Fixed Costs

No.	Description	Monthly Cost (¥)	Annual Cost (¥)
1	Vessel Maintenance	30,000	210,000
2	Utility Bills	40,000	280,000
3	Labor Costs	4,000,000	28,000,000
4	Depreciation	-	4,453,667
Total		4,070,000	32,943,667

Fixed costs are expenses that remain constant and are incurred regularly during each production period (annually) (Winarko et al., 2020). The fixed costs in this oyster farming enterprise include vessel maintenance, utility bills (including diesel fuel), labor wages, and depreciation. The annual cost for vessel maintenance is ¥210,000, while utility expenses amount to ¥280,000 per year. The highest fixed cost is labor, totaling ¥28,000,000 annually. The business employs 20 workers from the surrounding community, consisting of both male and female employees. Each worker receives a monthly wage of ¥200,000, based on 22 working days per month. In total, the annual fixed operating cost for this oyster farming operation is ¥32,943,667.

Table 3. Variable Costs

No.	Description	Quantity	Annual Cost (¥)
1	Gloves	100	150000
2	Oyster Seeds	265000	795,000
3	Packaging Plastic	7000	3,000
4	Diesel Fuel	1	245000
5	*Styrofoam*	700	56,000
Total		272801	1,249,000

Variable costs are expenses incurred by the company that fluctuate depending on the production needs (Winarko et al., 2020). The total variable cost amounts to ¥1,249,000, with the largest expenditure being the purchase of scallop shells, costing ¥795,000. These scallop shells serve as a medium for attaching oyster seeds ready for cultivation. The Prefectures of Hiroshima and Miyagi specialize in oyster seed production. Typically, seeds from Hiroshima are exported outside of Japan, whereas those from Miyagi are designated for Japan's domestic oyster industry. The diesel fuel cost for operating both large and small vessels is ¥245,000. The cost for 100 pairs

of gloves is ¥150,000. Additionally, 700 styrofoam boxes are used, costing ¥56,000, and 7,000 sheets of packaging plastic are purchased at a cost of ¥3,000.

Monthly Revenue

Table 4. Monthly Revenue

No.	Item	Quantity	Price/kg	Total (¥)
1	Tiram	8.750 kg	¥ 1200	¥ 10,500,000
Total				¥ 10,500,000

Based on Table 4, the estimated monthly income amounts to ¥10,500,000, with the selling price of oysters set at ¥1,200 per kilogram. This price is determined according to prevailing market rates. From this data, a financial feasibility analysis was conducted, including the Revenue-Cost (R/C) Ratio, Break-Even Point (BEP), Investment Feasibility Criteria, Net Present Value (NPV), Internal Rate of Return (IRR), Net B/C, and Payback Period, as outlined below;

Revenue Cost Ratio

The Revenue-Cost (R/C) Ratio is a financial indicator used to determine how much revenue a business earns relative to the total costs incurred.

$$Revenue\ Cost\ Ratio = \frac{Total\ Revenue}{\text{Total Cost}}$$

$$= \frac{73.500.000}{34.192.667}$$

$$= 2{,}15$$

The obtained R/C value is 2.231, indicating that the oyster farming business is profitable, feasible to operate, and has strong potential for development. According to (Dewi et al., 2022; Rachmadina et al., 2021), a higher R/C Ratio reflects a greater level of profitability in a business. An R/C Ratio greater than 1 is considered economically feasible. This finding suggests that the oyster farming business in Hyogo, Japan is worthy of further expansion, particularly through additional working capital investment to support business growth.

Break Even Point

Break Even Point is the position where the company neither makes a profit nor incurs a loss a point of equilibrium that is useful for making strategic decisions, such as whether to discontinue a product, expand a product line, or shut down an unprofitable subsidiary. The calculation of the Break Even Point (BEP) in terms of production volume is presented below:

$$BEP\ Unit = \frac{Fixed\ Cost}{Price\ (Per\ unit) - Variable\ Cost\ (Per\ Unit} = \frac{4{,}070{,}000}{1057} = 3{,}848\ \text{kg}$$

If the company is able to produce up to 3,848 kg, it means the monthly break-even point (BEP) has been reached. According to (Fauzi et al., 2024; Manuho et al., 2021), the break-even point is an analytical tool used to understand the relationship between various business variables, such as production output, costs incurred, and revenue generated.

Investment Feasibility Criteria

Feasibility analysis is essential when developing or establishing a new business. This is done to determine whether an investment is financially profitable or potentially detrimental (Putri et al., 2024). The most commonly used methods for investment feasibility include Net Present Value (NPV), Internal Rate of Return (IRR), Net Benefit Cost Ratio (Net B/C), and Payback Period (PP).

Table 5. Investment Feasibility Criteria

No.	Investment Criteria	Value	Unit
1	Net Present Value (NPV)	97,481,639	Yen
2	Internal Rate of Return (IRR)	65	%
3	Net Benefit Cost Ratio (Net B/C)	3,20	-
4	Payback Period (PP)	1,12	Years

Based on the results of the calculations (Table 5), the investment feasibility criteria show that the Net Present Value (NPV) for oyster farming in Sakoshi amounts to ¥97,481,639. This value indicates the level of profit gained from the oyster cultivation business in Sakoshi over a business lifespan of five years, using a discount rate of 12%. The positive NPV signifies that the oyster farming venture is financially feasible and worth pursuing, as the NPV is greater than zero (> 0) (Hidayat, 2021). The Internal Rate of Return (IRR) for oyster farming in Sakoshi is calculated at 65%. This value exceeds the predetermined discount rate, indicating that the financial feasibility of the oyster farming venture, based on the IRR criterion, is considered viable. In other words, the investment is expected to generate returns greater than the applied discount rate, making it financially sound (Sutrisno, 2012).

The Net Benefit Cost Ratio (Net B/C) for the oyster farming business in Sakoshi is calculated at 3.20. This indicates that for every ¥1 invested, the company gains ¥3.20 in return. This value demonstrates that the business is financially feasible and profitable, in line with the Net B/C assessment criteria, which state that a project is viable if the Net B/C value is greater than

one (>1) (Nurmalina et al., 2013). The Payback Period method yields a result of 1.12 years for the oyster farming business in Sakoshi. This means that the investment will reach the break-even point in approximately 1 year and 2 months. This relatively short payback duration implies that the financial cash flow of the business will circulate quickly (Sutrisno, 2012). According to (Ernawati et al., 2020; Pranoto et al., 2025), an investment is considered feasible based on the Payback Period method if the actual payback duration is shorter than the maximum acceptable payback period. Otherwise, the investment is deemed not viable.

CONCLUSION

This research is based on financial analysis methods including investment costs, operational costs, Revenue Cost Ratio (R/C), and Break Even Point (BEP). To assess financial feasibility, investment evaluation criteria were applied, including Net Present Value (NPV), Internal Rate of Return (IRR), Net Benefit Cost Ratio (Net B/C), and Payback Period (PP). The results of this study conclude that the oyster sales business conducted in the Sakoshi area is feasible to operate and expand in the future. The investment feasibility indicators showed a Net Present Value of ¥97,481,639, an Internal Rate of Return of 65%, a Net Benefit Cost Ratio of 3.20, and a Payback Period of 1 year and 2 months. These findings indicate that the oyster farming business in Sakoshi, Hyogo, Japan, is highly feasible to implement due to its promising financial prospects.

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