



Study of economic and financial feasibility of appropriate technology for crab cultivation using the crab ball method as the development of the blue economy concept in mangrove areas

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ABSTRACT

In addition to implementing appropriate technology that corresponds to the character and potential of the region, which in this case is the mangrove area, and focusing on increasing the economic benefits for villages and communities, the implementation of TTG also must pay attention to the environmental ecosystem. It is accordance with the concept of the blue economy. An appropriate technology that can be used for developing economic activity in the mangrove area but does not interfere with ecosystems is the crab breeding system, using the crab ball method. Crab ball is one of the methods for inserting crabs into a tool called a crab ball, where the use of the tool is not only friendly to the forest ecosystem, but also does not require a large financial investment. One of the areas with mangrove potential is in Tirtihargo Village, Bantul District, Yogyakarta. In this study, a feasibility study was conducted from the economic and financial sides to look at the potential of the implementation of this TTG. To measure the viability of the implementation of technology for the proper cultivation of crabs using the crab ball method using two analyses namely economic feasibility and financial feasibility analysis. On economic feasibility analysis using the benefit-cost ratio approach as well as on financial feasibility analysis using the three financial ratio approaches (payback period, net present value, and internal rate of return). The results found that this implementation of appropriate technology is valid and profitable based on the principles of economic and financial analysis criteria.

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INTRODUCTION

Appropriate Technology, hereinafter referred to as TTG, is technology that meets the needs of the community, can answer community problems, does not damage the environment, can be used and maintained by the community easily, and generates added value from economic and environmental

aspects, even to address community problems that There is. Appropriate Technology is the equivalent of *appropriate technology*, which means appropriate or appropriate technology. The principle of appropriate technology being developed must be useful (*useful*), affordable (*affordable*), and profitable (*profitable*). (Jaidi et al., 2022)The development of TTG in Indonesia should be developed in accordance with regional priorities and potential as a manifestation of development in accordance with the Archipelagic Outlook. (Munaf et al., 2008)One of the potentials in Indonesia that has not been fully utilized is the Mangrove Area. As a maritime country with 108 thousand kilometers of coastline, and three-quarters of its territory is sea, Indonesia has enormous potential for mangrove forest ecosystems. From data obtained from the Directorate General of Marine Spatial Management, Ministry of Maritime Affairs and Fisheries of the Republic of Indonesia, the area of mangrove forests in Indonesia is 3,490,000 Ha or 21% of the world's mangroves or 16,530,000 Ha. (Yurike & Syafruddin, 2022)In the economic development strategy for the marine potential of the Indonesian archipelagic nation, in addition to exploiting marine resources and potential, it needs to be accompanied by the preservation of marine resources which will have an impact on sustainable reserves of food sources. This is in accordance with the *blue economy policy strategy* in the concept of sustainable development (SDGs) that was promoted by *the United Nations* by Indonesia during the era of President Joko Widodo's Administration. The (Y. A. Wahyuddin et al., 2022)*Blue Economy* concept is considered as the concept of separating socio-economic activities and development through optimizing the benefits that may be obtained from marine resources with the potential for environmental degradation. (Bari, 2017)Since the 21st century, the concept of "Blue Economy" has been gaining popularity. The international community believes that *the Blue Economy* is formed from three forms of economic activity, namely: the economy overcoming the global environmental crisis; innovative development economics and marine economic development. (Wenhai et al., 2019).

Based on the explanation above, it is necessary to develop TTGs that are in accordance with the character and potential of the region, in this case the mangrove area, which will be able to provide increased economic benefits for the village and community but still have to pay attention to the environmental ecosystem in accordance with the concept of the Blue Economy *itself*. One area that has considerable potential for mangroves is in Tirtiharga Village, Bantul Regency, Special Region of Yogyakarta. Tirtohargo Village has the potential for mangrove forests of 5 hectares where the area is an estuary area. Estuaries are semi-enclosed waters that are in free contact with the sea, so that seawater with high salinity can mix with fresh water. (Odum & Samingan, 1998)Under these natural conditions, Tirtohargo Village has potential for mangrove fisheries. One type of fish that can be found in mangrove forest areas is mud crab (*Scylla serrata*), which has high economic potential in the domestic market & global market. Data from the Indonesian Ministry of Maritime Affairs and Fisheries shows that of the large increase in the value of exports on average each year which reached 20.4 percent. (Humas UNY, 2021). In accordance with the *Blue Economy concept* where in developing the fisheries economy in the Mangrove Area it does not disturb the ecosystem and the environment, it is necessary to develop a mangrove crab cultivation system to reduce the activities of fishing fishermen exploiting mangrove crabs that exist in nature. One of the cultivation techniques for mud crabs (*Scylla spp.*) which can increase the production of mud crabs in mangroves is to use the *crab ball system*. *Crab ball* is one of the methods by inserting crabs into a tool called a *crab ball* and then placing it or connecting it to a mangrove tree. (Pasi et al., 2022)Utilization of *Crab Balls* is not only friendly to forest ecosystems, but also does not require large costs so that the application of this appropriate technology is seen as being able to boost the economy of small fishermen in mangrove forest areas.

In accordance with the *Blue Economy concept*, to ensure that the implementation of appropriate technology for crab cultivation using the *Crab ball method* is able to provide added value to the community, various analyzes need to be carried out to determine whether this method is feasible or not. One of the main analyzes carried out is an analysis study of the economic and also financial aspects of implementing appropriate technology for crab cultivation using the *Crab ball method*. This

economic and financial analysis needs to be carried out so that it can be seen whether the implementation of appropriate technology for crab cultivation using the *Crab ball method* will generate financial benefits or vice versa.

RESEARCH METHOD

In the economic and financial feasibility study of appropriate technology for crab cultivation using the *Crab ball method* at the case study location in Tirtohargo Village, Bantul Regency, Yogyakarta Special Region, the methodology used is to use two *frameworks*, namely an economic feasibility analysis and a financial feasibility analysis. (Liang & van Dijk, 2010) From these two analyzes, the feasibility of each aspect will be known which can be taken into consideration for the development of appropriate technology for crab cultivation using the *crab ball method*.

Economic analysis is carried out by estimating the economic, social and environmental impacts arising from the implementation of appropriate technology. For economic analysis, the criterion of an economic feasibility can be seen from the implementation of appropriate technology. For economic analysis, the criteria for economic feasibility can be seen from *the Benefit Cost Ratio (BCR analysis)*. (Liang & van Dijk, 2011). If in the calculation of economic analysis the value of the *Benefit Cost Ratio* is more than 1 (one) then a project can be said to be feasible, conversely if the value of the *Benefit Cost Ratio* is less than 1 (one) then a project is said to be economically infeasible because it shows the project is not profitable (*non-profitable project*). (Goel & Sharma, 2022)

Financial analysis of a project is the process of evaluating the attractiveness of investment in a project based on the aspects of solvency, financial stability, profitability, rate of return on investment, and estimates of financial activity in a project. (Binda et al., 2020) In financial analysis, it can be measured by several ratio measurements that can show whether a project has investment attractiveness or not. Some of the ratios used in the financial analysis of a project are *Payback Period (PP)* (Bhandari, 1989), *Net Present Value (NPV)*, and *Internal Rate of Return (IRR)*. (Nasution et al., 2019). In the financial analysis, a project can be said to have investment attractiveness if it has a positive (+) *Net Present Value (NPV)*, the *Internal Rate of Return (IRR)* is greater than the *Discount Rate*, and the *Payback Period* is faster than expected or determined. project owner.

Table 1. Economic and financial framework analysis

Analysis	Frameworks	
	Ratio	Eligibility Criteria
Economic Analysis	<i>Benefit Cost Ratio</i>	More than 1 (One)
	<i>Payback Period (PP)</i>	Faster than expectation
Financial Analysis	<i>Net Present Value (NPV)</i>	positive (+)
	<i>Internal Rate of Return (IRR)</i>	Bigger than <i>Discount Rate</i>

The data collection method in this study consisted of a field survey for primary data and literature study for secondary data. In the process, after the data has been collected, a validity test of the questionnaire will be carried out with expert judgment in the field of management expertise. The object of study is an individual appointed according to the criteria for each aspect as well as several figures outside the object of study appointed by the previous informant for the purposes of information triangulation. The data collection method can be done in several steps, including: (a). *Forum Group Discussion (FGD)*, (b). *In-depth interview (interview)*, (c). *Observation*.

RESULTS AND DISCUSSIONS

The location of this research is Tirtohargo Village, Bantul Regency, Yogyakarta Special Region. Tirtohargo Village is divided into 6 dukuh areas, namely: Baros Hamlet, Muneng Hamlet, Gunung Kunci Hamlet, Gegunung Hamlet, Kalangan Hamlet, and Karang Hamlet. The distance from the

Tirtohargo Village Office to Kretek District is around 4 KM, while the distance to the capital (Bantul Regency) is around 17 KM. Tirtohargo Village has an area according to use of 281.99 h. Tirtohargo Village has an area of 176.6 hectares of rice fields, 121.98 hectares of dry land, 5 hectares of conservation forest and 5 hectares of mangrove forest. The majority of the Tirtohargo Village Mangrove Forest Area is located on Baros beach which is an ecotourism area of mangrove forest and south coast tourism in Bantul Regency. In general, the Baros mangrove conservation area has a lowland topography. Mangrove plants can grow well there because the conservation area is located on the coast and close to the Opak river. Baros Beach is located in Baros Hamlet, Tirtohargo Village, Kretek District, Bantul Regency, Special Region of Yogyakarta. This beach is located near the mouth of the Opak River and is directly adjacent to the southern sea and is between Depok Beach and Samas Beach. This area was built on the basis of the initiative of the surrounding community who care about nature, especially on the banks of the Opak river estuary and Baros Beach. Gradually planting mangrove trees around the area in stages. Several years later, the planted mangroves grew thickly and managed to form a small mangrove forest. With the natural condition of the mangroves of Baros Beach which are in the form of an estuary, this place has the potential for mangrove fisheries. One type of fish that can be found in many mangrove forest areas is mud crab (*Scylla serrata*) which has high economic potential in the domestic market & global market.

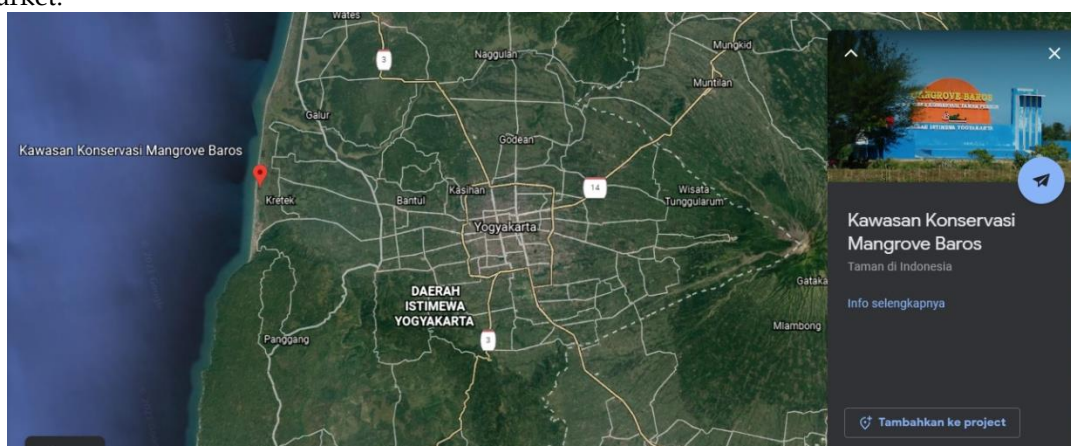


Figure 1. Location of mangrove forest on baros beach

The high market demand for mangrove crabs, especially in foreign markets, has resulted in a higher level of exploitation of this biota in nature. Irresponsible exploitation will threaten the sustainability of mangrove crab resources. To anticipate this, the Indonesian government through the Regulation of the Minister of Maritime Affairs and Fisheries Number 1/PERMEN-KP/2015 has determined mangrove crabs (*Scylla* spp.) as a type of fish (crustaceans) which are prohibited from catching or circulating in conditions of laying eggs and under size (worth catching). In order to increase the production of mud crabs (*Scylla* spp.) So as not to disturb the population by catching them directly in nature, mud crabs (*Scylla* spp.) cultivation technology is needed.

One of the cultivation techniques for mud crabs (*Scylla* spp.) which can increase the production of mud crabs in mangroves is to use the crab ball system. Crab ball is one of the methods by inserting crabs into a tool called a crab ball and then placing it or connecting it to a mangrove tree. Utilization of Crab Balls is not only friendly to forest ecosystems, but also does not require large costs so that the application of this appropriate technology is seen as being able to boost the economy of small fishermen in mangrove forest areas.



Figure 2. Application test of ttg crab cultivation with the crab ball method

The implementation of appropriate technology for crab cultivation using the *Crab ball method* at the case study location in Tirtohargo Village began in October 2021 starting with preparations, namely the *Preliminary Survey*, program outreach to the preparation process for the TTG application test for Crab Cultivation using the *Crab Ball Method*. Then proceed with the implementation test activities for TTG Crab Cultivation with the *Crab Ball Method* by designing applied test spots with a total capacity of 500 *Crab Balls* .

Cost Analysis & Revenue Forecast

From the implementation of appropriate technology for crab cultivation using the *Crab ball method* applied in Tirtohargo Village with a total capacity of 500 *Crab Balls* , we can calculate costs and income plans which will later be used to calculate Economic Analysis and Financial Analysis. Some important points in Cost Analysis & Revenue Forecast *can* be seen in the following list: (a). *The initial investment* that is taken into account is the investment to purchase *Crab Balls* . Total purchase of 500 *Crab Balls* at a price per unit of Rp. 100,000.00 is Rp. 50,000,000.00 (fifty million rupiah), (b). The selling price of crabs per kg for ready-to-harvest sizes is between Rp. 90.000,- up to Rp. 150,000, - then the calculation uses an average price of Rp. 120.000,- , (c). Feed costs per day are calculated from the need to purchase feed in the form of small fish of 7.5 kg in one day with an average expenditure of IDR 100,000 per day, (d). Crab Harvest Period 3 times a year or for 1 nursery cycle up to 4 months harvest size with an average weight of crab harvest per head is 4 ounces, (e). The workforce for an area of 150 square meters with 500 *Crab Balls* uses 3 workers from the Fishermen Group and Mangrove Managers who are paid *part time* Rp. 750,000 per month, (f). Atclimatization for crab adaptation is assumed to die by 30% according to calculations in the field, (g). *The discount rate* assumption used is 7%. Gittinger (1986) suggests using low interest rates of 6-12% to assess aquaculture in developing countries.(Gittinger, 1986).

Table 2. Estimated cash flow from project cost analysis and estimated revenue

Calculation	Year To						
	0	1	2	3	4	5	
Purchase Crab Balls	500 Crab Balls X IDR 100,000	(50,000,000)					
Crab Sale	500 x 4 x Selling Price x 3 Harvests a Year		90,000,000	90,000,000	90,000,000	90,000,000	90,000,000
Feed Cost	12 x 30 x IDR 100,000		36,000,000	36,000,000	36,000,000	36,000,000	36,000,000
Labor	12 x 30 x IDR 750,000		27,000,000	27,000,000	27,000,000	27,000,000	27,000,000
Purchase of Seeds	500 x 100,000		5,000,000	5,000,000	5,000,000	5,000,000	5,000,000

Dead Crab Assumption	1,500,000	1,500,000	1,500,000	1,500,000	1,500,000
30%					
Cashflow	20,500,000	20,500,000	20,500,000	20,500,000	20,500,000

Economic Analysis

Economic analysis is carried out by estimating the economic, social and environmental impacts arising from the implementation of appropriate technology for crab cultivation using the *crab ball method*. For economic analysis, the criterion of an economic feasibility can be seen from the implementation of appropriate technology. For economic analysis, the criteria for economic feasibility can be seen from the *Benefit Cost Ratio (BCR analysis)*. The *Benefit Cost Ratio* method is a method used to evaluate projects by comparing the present value of all benefits through income normally obtained by the project with the present value of all project costs or expenses. (Sururi & Agustapraja, 2020) The equation used to calculate the *Benefit Cost Ratio* is a comparison of the total present value of the project's revenue (*benefit*) and expenditure (*cost*) over its economic life. (Sulianti & Tilik, 2013)

$$Benefit\ Cost\ Ratio = \frac{(PV)Benefit}{(PV)Cost} \tag{1}$$

From the above equation approach and using Common Analysis (*Cost Analysis*) & *Revenue Forecast*, the calculation of the *Benefit Cost Ratio* can be seen in the following table:

Table 3. Estimated cash flow and *present value benefit and cost*

Benefit Cost Ratio Year	Estimated Cash Flow (IDR)		Present Value (IDR)	
	Cost	Benefits	PV (Cost)	PV (Benefits)
0	50,000,000		50,000,000	-
1		20,500,000	-	19,158,879
2		20,500,000	-	17,905,494
3		20,500,000	-	16,734,106
4		20,500,000	-	15,639,352
5		20,500,000	-	14,616,217
	50,000,000	102,500,000	50,000,000	84,054,047

$$Benefit\ Cost\ Ratio = \frac{(PV)Benefit}{(PV)Cost} = \frac{84.054.047}{50.000.000} = 1.68$$

If in the calculation of economic analysis the value of the *Benefit Cost Ratio* is more than 1 (one) then a project can be said to be feasible, conversely if the value of the *Benefit Cost Ratio* is less than 1 (one) then a project is said to be economically infeasible because it shows the project is not profitable (*non-profitable project*). From the calculation of the *Benefit Cost Ratio* in the implementation of appropriate technology for crab cultivation using the *Crab ball method*, the value of the *Benefit Cost Ratio* is 1.68. If viewed from the economic feasibility analysis, it can be said that this project is feasible and is a project that has profit potential.

Financial Analysis

Financial analysis can be measured by several ratio measurements that can show whether a project has investment attractiveness or not. Some of the ratios used in the financial analysis of a project are *Payback Period (PP)*, *Net Present Value (NPV)*, and *Internal Rate of Return (IRR)*. In the financial analysis, a project can be said to have investment attractiveness if it has a positive (+) *Net Present Value (NPV)*, the *Internal Rate of Return (IRR)* is greater than the *Discount Rate*, and the *Payback Period* is faster than expected or determined. project owner.

Payback Period (PP)

Payback Period is a method used to calculate the length of the period required to return the money invested from the annual cash inflows (proceeds) generated by the investment project. The eligibility criteria for receiving an investment using the (Giatman. M., 2017) *payback period* method is that an investment is declared feasible if *the payback period* is shorter than the maximum *payback period*. Conversely, if the payback period of an investment is longer than the maximum payback period, the investment is declared unfit. (Maria Abuk dan Yusuf Rumbino, 2020). The equation that can be used to measure *the Payback Period* is (Mahatma Ratri Moch Dzulkirom Achmad Husaini, 2013):

$$\text{Payback Period} = t + \frac{b - c}{d - c} \quad (2)$$

Information:

t = Period of the year before the Payback Period

b = *Initial Investment*

c = accumulated cash inflows until t

d = accumulated cash inflows up to t + 1

Calculation:

Table 4. Calculation of the value of t in the *payback period equation*

Year To	InflowCash	Initial Investment	Cum
0		(50,000,000)	(50,000,000)
1	20,500,000		(29,500,000)
2	20,500,000		(9,000,000)
3	20,500,000		11,500,000
4	20,500,000		32,000,000
5	20,500,000		52,500,000

$$\begin{aligned} &= 2 + \frac{50.000.000 - 41.000.000}{61.500.000 - 41.000.000} \\ &= 2 + \frac{9.000.000}{20.500.000} \\ &= 2 + 0.43 \\ &= 2.43 \end{aligned}$$

From the calculation of *the Payback Period*, it is found that investment will return at 2.43 years. The eligibility criteria for receiving an investment using the *payback period* method is that an investment is declared feasible if *the payback period* is shorter than the maximum *payback period*. Conversely, if the payback period of an investment is longer than the maximum payback period, the investment is declared unfit. If we look at the value of the maximum *payback period* based on the economic age of *the crab balls* for 5 years before there was a re-invasion of buying crab balls because they were damaged, the *Payback Period* figure of 2.43 years can be said to be feasible for an investment project.

Net Present Value (NPV)

The Net Present Value (NPV) criterion for a project is the difference between the Present Value of Proceeds and the Present Value of Initial Investment during its economic life at a certain Discount Rate. Net Present Value (NPV) is the only one of the techniques for determining the financial aspects of the feasibility of a project that considers the time value with the following calculations (Syamsuddin, 2009):

$$\text{Net Present Value (NPV)} = \text{Present Value Cash Inflow} - \text{Present Value Initial Investment} \quad (3)$$

The NPV calculation is obtained from *the Present Value Projected Cash Flow for 5 years and it can be concluded that the NPV value of this Crab Ball Appropriate Technology Product* is Rp. 34,054,047,-. The following is the NPV calculation for the implementation of appropriate technology for crab cultivation using the *Crab ball method*

Tabel 5. Calculations NPV

Year	Disc Rate 7%	Projected Cash Flow	Present Value
1	0.93	20,500,000	19,158,879
2	0.87	20,500,000	17,905,494
3	0.82	20,500,000	16,734,106
4	0.76	20,500,000	15,639,352
5	0.71	20,500,000	14,616,217
		PV Cash Inflow	84,054,047
		Initial Cost (Investment)	(50,000,000)
		NPV	34,054,047

In accordance with the criteria in financial analysis, a project can be said to have investment attractiveness if it has a positive (+) *Net Present Value* (NPV). The NPV calculation is obtained from the *Present Value Projected Cash Flow* for 5 years and it can be concluded that the NPV value of this Crab Ball Appropriate Technology Product is Rp. 34,054,047, - (positive) it can be said that the project is feasible and the project has investment attractiveness for investors.

Internal Rate of Return (IRR)

Calculation of the *Internal Rate of Return* (IRR) is obtained from the accumulation of the investment value of purchasing *Crab Balls* with the potential for incoming money from the difference between the sale of crabs and the costs incurred in *Crab Ball Cultivation* . To calculate the IRR value obtained by using the following equation (Grant Eugene L, 1996):

$$IRR = i_1 \frac{NPV1}{NPV1 - NPV2} (i_1 - i_2) \tag{4}$$

Information:

IRR = *Internal Rate of Return*

i1 = Discount rate resulting in NPV +

NPV1 = Net Present Value Positive

NPV 2 = Negative Net Present Value

To make it easier to calculate the *Internal Rate of Return* (IRR), we can use help from *Microsoft Excel* because to measure the IRR manually using the equation requires a trial and error method by measuring the *discount rate value* which is considered close to the actual IRR value, then calculating the NPV value of the current *benefits* and *costs*. If it produces a positive value, it means that the trial value is too low, we will try again with a higher value. If it produces a positive value, it means that the trial value is too low, we will try again with a higher value. (Fredrik et al., 2013)By using the help of *Microsoft Excel* the calculation will be done more quickly:

Table 6. Calculation of IRR using *Microsoft Excel*

Year To	Cashflow
0	(50,000,000)
1	20,500,000
2	20,500,000
3	20,500,000
4	20,500,000
5	20,500,000
IRR	30%

The *Internal Rate of Return* (IRR) value is 30% greater than the Discount Rate of 7%, meaning that it can be said that it is feasible and the project has investment attractiveness for investors.

CONCLUSION

The conclusions from the economic and financial feasibility study of appropriate technology for crab cultivation using the crab ball method as the development of the blue economy concept in the mangrove area. Case Study in Tirtohargo Village, Bantul Regency, namely: To measure the feasibility of implementing appropriate technology for crab cultivation using the crab ball method, two analyzes are used, namely economic feasibility analysis and financial feasibility analysis. Benefit Cost Ratio approach was used, and it was found that in the implementation of appropriate technology for crab cultivation using the Crab ball method, the value of the Benefit Cost Ratio was 1.68. If viewed from the economic feasibility analysis, it can be said that this project is feasible and is a project that has profit potential. In the financial feasibility analysis using three financial ratio approaches to see a project can be said to have investment attractiveness: a. Calculation of Payback Period obtained Investment will return at 2.43 years. If we look at the value of the maximum payback period based on the economic age of the crab balls for 5 years before there was a re-invasion of buying crab balls because they were damaged, the Payback Period figure of 2.43 years can be said to be feasible for an investment project. b. The NPV calculation is obtained from the Present Value Projected Cash Flow for 5 years and it can be concluded that the NPV value of this Crab Ball Appropriate Technology Product is Rp. 34,054,047, - (positive) it can be said that the project is feasible and the project has investment attractiveness for investors. The Internal Rate of Return (IRR) value is 30% greater than the Discount Rate of 7%, meaning that it can be said that it is feasible and the project has investment attractiveness for investors.

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