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Economic Valuation of Traditional Mining Cruide Oil in Wonocolo Village

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Abstract

This research aims to identify the mining activities of crude oil resources in Wonocolo Village. The government will identify the benefits and impacts of already-known activities will be identified from this activity. Economic valuation analysis calculates These benefits and impacts in monetary terms. The aim is to find out the monetary value of benefits and impact so that they can be used to develop a related policy. The primary and secondary data are collected through interviews and observation. The sampling method uses purposive sampling, and the research method is quantitative descriptive using analysis techniques in the form of economic valuation. The results of this study indicate that the economic valuation of the traditional mining activities of crude oil resources in Wonocolo Village has a positive Rp value. 33,214,795,622.-/year. This positive value is because the value of benefits is greater than the impacts they are Rp. 33,478,992,56.,-/year and Rp. 273,196,940.-/year.

Key words : Economic Valuation, Traditional Mining; Environmental Impact, Health Impact, Benefit And Impact, Crude Oil

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INTRODUCTION

In the report of the Special Task Force for Upstream Oil and Gas Business Activities (SKK Migas) regarding work areas producing the most oil in Indonesia, one of the areas as part of the Cepu Block working area in 2020 contributed the most significant oil yield funds in Indonesia was Bojonegoro Regency. It also made the Cepu Block working area the largest oil-producing region in Indonesia. Besides, this largest profit-sharing fund has elevated the Bojonegoro Regency economy growth by around 4.41% according to the Gross Regional Domestic Product (GRDP) measurements and contributed 3.32% to the East Java economy. Table 1 show the recipients of revenue-sharing funds for petroleum resources in Indonesia in 2020.

Table 1. Regency/City Recipients of the Largest Oil Resources Revenue- Sharing Funds in Indonesia in 2020

Rank	Regency/City	Revenue-Sharing Funds
1	Bojonegoro Regency	1,096.85
2	Bengkalis Regency	664.13
3	Rokan Hilir Regency	410.45
4	Siak Regency	326.26
5	Kampar Regency	286.13
6	Indragiri Hilir Regency	186.24
7	Kuantan Singingi Regency	186.24
8	Dumai City	186.24
9	Pekanbaru City	186.24
10	Musi Banyuasin Regency	173.82

Source: Ministry of Finance, 2021

Based on the data presented in Table 1, Bojonegoro Regency is a district with abundant crude oil reserves. These crude oil reserves are scattered in several sub-districts, such as Nggayam, Ngasem, and Kedewan. The oil distribution in Bojonegoro Regency is also traditionally managed by the local community, as in Wonocolo Village, Kedewan Sub-district.

Traditional management is activity of taking and producing crude oil simply or traditionally (Naumi & Trilaksana, 2015). The community takes crude oil from a place called old oil well; such terms exist because the drilling of this oil well was carried out before Indonesia's independence and was then closed as it was not economical enough to be produced by Pertamina (Naumi & Trilaksana, 2015).

As time passed, the society in Wonocolo Village opened the closed oil well. In Kedewan Sub-district, five villages have the potential for old oil well: Wonocolo, Kawengan, Kedewan, Hargomulyo, and Beji. Wonocolo Village have the highest number of wells, with 453 wells and producing 354 barrels of oil per day. When this research was conducted in 2020, only 68 old oil wells in Wonocolo Village were still actively operating. The arising problems result in environmental imbalances causing social issues (Tuzyahroya & Sariffuddin, 2018). The significant impact that has been felt from this oil mining activity comprises land damage due to the use of hill forest land as a mining location. Soil contamination also occurs as a result the use of land as a place to drain crude oil/lantung. In addition, air pollution happens because of the process of refining crude oil and oil dipping machines that emit smoke. Even water/river pollution occurs due to contamination with liquid oil (Arthur et al., 2016; Amoako et al., 2022).

Moreover, social problem stemming from oil mining giving impact on health (Bansah et al., 2018). Oil mining has the characteristic smell of oil, which is very pungent when

entering the mining location. The impact of such smell is indeed not so disturbing to residential areas since the locations are not close to each other. The miners are also primarily unbothered because they are used to it and wear nose covers. Nevertheless, in the long term the smell produced has a negative impact on health (Harnani, 2018). However, it is differs from non-mining communities, they are feel disturb by the smell when they cross the mining site. Fundamentally, this mining area is a highway that connects Wonocolo Village and Kedewan Sub-district.

Aside from the impact of traditional oil mining activities, it also provides benefits and contributes a lot to the community's economy and surrounding. Arthur et al. (2016) explained that mining could quickly increase family income. This contribution then needs to be studied further regarding this traditional oil mining activity, it is need investigated using an economic valuation approach. Several studies have been conducted explaining the benefits of mining and the negative impacts of mining Amoako et al. (2022); Donoghue (2004); Bansah et al. (2018); Mancini & Sala (2018); Pertiwi et al. (2015), and on environmental impacts Rissamasu (2012). However, lot of previous research has not examined the total benefit (benefit-cost) approach. This approach aims to quantify the value of benefits and costs in the form of monetary value to provide a concrete overview of the economic value of the benefits and impact of these mining activities. Hence, the community will know the value of the benefits and costs obtained. The result in total economic value can be used as a decision-related government policy and environmental assessment document.

RESEARCH METHOD

This study used a field survey method, with the research object are society who live around old oil well mining, especially those who work as traditional miners. Then, the respondents were selected by purposive sampling, considering the diversity of the population and the community around the traditional old well oil mining activities and locations. In addition, the number of research samples was determined using the Slovin formula (Sugiyono, 2012). This research was also conducted with a mixed method by combining quantitative and qualitative data. Quantitative data analysis was carried out to answer the third objective using Total Economic Value (TEV) analysis.

Moreover, the community provided information through questionnaires by answering a list of questions provided by researchers. This research was conducted at an old well oil mining site in Wonocolo Village, Kedewan Sub-district, Bojonegoro Regency. The data use is primary and secondary data, which were collected through interviews and observation. Table 2 show the data and source of data that use in this study.

A descriptive analysis was carried out to answer the first and second objectives, i.e., the traditional processing of old oil wells and the benefits and impacts of oil mining. The data collected from distributing questionnaires were then processed and analyzed using Total Economic Value (TEV) to answer the third objective (Finlayson et al., 2018). This analysis was used to determine the magnitude of the economic valuation of the benefits and impacts of the traditional mining of petroleum resources in Wonocolo Village. The NET result would show a positive or negative value.

Table 2. Source of Data

Data	Data Sources
Overview of Wonocolo Village	Secondary data (List of contents of the village and urban village potential and level of development)
Fundamental of old well oil mining management	Secondary data (Regulation of the Minister of Energy and Mineral Resources No. 1 of 2008 and Law No. 22 of 2001 on Oil and Gas
Management of traditional oil mining in Wonocolo Village	Primary data (interviews at PT BBS Bojonegoro Regency and interviews with miners)
The benefits and impacts of traditional oil mining activities in Wonocolo Village	Primary and secondary data (interviews with miners and non-miners and a review of previous research literature)
Calculating the total economic value of traditional oil mining activities in Wonocolo Village	Primary and secondary data (interviews and distributing questionnaires to miners and non-miners)

Source: Primary Data

Table 3. Benefit Variable of Traditional Old Oil Mining Resources in Wonocolo Village

Variables		Economic Valuation Approach	Data Collection Technique
Usage/Benefit Variables			
Crude oil/*langgang*		Market price	Structured interview/Questionnaire
Kerosene		Market price	Structured interview/Questionnaire
Solar		Market price	Structured interview/Questionnaire
Kereng waste		Market price	Structured interview/Questionnaire
Improving the miner's economy		Survey	Structured interview/Questionnaire
Option benefits		Survey simulation values	Structured interview/Questionnaire
Benefits of existence		Survey simulation values	Structured interview/Questionnaire
Impact Variables			
Declining Health	Respiratory disorders	Health costs	Structured interview/Questionnaire
	Noise	Health costs	Structured interview/Questionnaire
	Land damage	Willingness to pay	Structured interview/Questionnaire
Environmental pollution	Soil pollutio	Willingness to pay	Structured interview/Questionnaire
	Air pollution	Willingness to pay	Structured interview/Questionnaire
	Water/river pollution	Willingness to pay	Structured interview/Questionnaire

Source: Primary Data

The economic valuation analysis formula guiding this research is:

TEV = (DUV+ IUV+ EV+OV) – (HI+ EI) (1)

Total Economic Valuation (TEV) is determined using various components, where DUV is Direct Use Value, IUV is Indirect Use Value, EV is Existence Value, OV is Option Value, HI is Health Impact, and EI is Environmental Impact.

Benefit from direct use value obtained from:

1. Direct use value (DUV)
   To obtain direct benefits, use the formula:
   $$DUV = \sum_{i=1}^{n} \text{DUVi} \quad (2)$$
   Where DUV is total direct use value, DUVi is benefit direct use value from i to n, and i is number of direct benefit (1,2,3,n)
2. Indirect Use Value (IUV)
   To obtain direct benefits, use the formula:
   $$IUV = \sum_{i=1}^{n} \text{IUVi} \quad (3)$$
   Where IUV is total indirect value, IUVi is number of indirect value from i to n, and i is number of indirect benefit (1,2,3,n).

Value of non-use value consists of:

1. Benefit of option value (OV)
   To obtain option value, use the formula:
   $$OV = \frac{1}{n} \sum_{i=1}^{n} \text{WTPi} \quad (4)$$
   Where OV is total of benefit option value, WTPi is willingness to pay from respondent and i is respondent (1,2,3,…,n).
2. Benefit of existence value (EV)
   To obtain existence value, use the formula:
   $$EV = \frac{1}{n} \sum_{i=1}^{n} \text{WTPi} \quad (5)$$
   Where EV is total of existence value, WTPi is willingness to pay from respondent i to n, and i is respondent (1,2,3,..,n).
3. Health Impact (HI) and Environmental Impact (EI)
   With the same method we obtain health impact and environmental impact values using the IUV calculation approach.

RESULT AND DISCUSSION

In fact, petroleum mining activities traditionally generate benefits and impacts, which certainly have a quantifiable monetary value. Various approaches based on economic valuation theory were then carried out to calculate the monetary amount of the benefits and impacts of this activity. The approach, of course, used diverse ways depending on each type of benefit and impact. Using different approach would not change existing monetary value since the result remained the same, indicating the size of the benefits and impacts. Then, the total economic value of these benefits and impacts was employed to analyze the gains or losses of activity from economic and environmental aspects.

Most community in Wonocolo Village have a livelihood as oil miners. The existence of old wells managed again by the community really helps their economy. This job as a miner This traditional oil mining existed before Indonesian independence. Over time, these oil wells were no longer productive in producing crude oil.

Therefore, its existence was closed. After years passed, Wonocolo Village people tried to open and manage the closed wells. Some oil wells overflow with crude oil again, but others do not generate oil. In addition, it is said that the management is simple since extracting crude oil/nimbo employs human power, and the refining has been carried out simply or traditionally until now (Naumi & Trilaksana, 2015).

Systematically, the management process from opening old wells to production started with repairing old wells, which took around 1-6 months. It is necessary because damage to the flow can occur in wells that have been closed for a long time. Draining the well was then carried out as it allowed for a large amount of water/mud in the flow of the oil well. The last process was taking petroleum/mluntur using a bucket in the form of an iron pipe pulled by slings utilizing a diesel engine from a modified car/truck. Crude oil scooped up was then flowed to the ground surface to be filtered so that the oil and water were separated. Crude oil separated from water could be concentrated to produce kerosene and diesel.

Activities to produce kerosene and diesel fuel from crude oil are called refining/cooking/nggodok. As much as 245 liters of crude oil was put into a furnace as a 300-liter drum. Under it, a burning fire was ready to cook crude oil. The distillation process took about 3-5 hours to produce kerosene and diesel. The fire used by the refiners came from burning wood/rencek, or if they were lucky, the distillers got natural gas from the mining area, so they did not incur additional costs to buy rencek since natural gas was obtained free of charge from nature. During these 3-5 hours, the liquid from the cooking furnace pipe was 35 liters of kerosene, and then the rest became 140 liters of diesel.

In short, one distillation required 245 liters of crude oil or seven jerrycans (35-liter capacity). Through the refining process, one jerrycan, or 35 liters of kerosene, was produced, and four jerrycans of diesel, or 140 liters, were generated. For market prices at the time this research was conducted, crude oil was IDR 1,700/liter, kerosene was IDR 5,000/liter, and diesel was IDR 3,428/liter. This price was much lower than in previous years, where kerosene in the Wonocolo Village mine was IDR 8,000/liter. At that time, the Woncolo Village people could earn tens of millions of rupiah in only a week's work.

Moreover, economic activities, including mining activities, undoubtedly provide benefits and impacts, likewise for the traditional mining of petroleum resources (Macháč et al., 2020). Oil will be even more helpful if mined as it can be processed again into kerosene and diesel. Identification of the types of benefits and impacts was carried out on the community of all respondents and used to analyze community knowledge regarding this matter. Following are some benefits of petroleum resources and the benefits of traditional mining of petroleum resources: as a producer of crude oil, a producer of kerosene, a producer of diesel fuel, a producer of waste, an addition to the uniqueness of Wonocolo Village, a tourist attraction, and an increasing economy of the Wonocolo Village people.

The impact of mining activities will also lead to the environment and humans or human health (Arthur et al., 2016; Kadafa, 2012; Mundaca, 2024). Impact on the environment includes damage to land or environmental pollution (Ndubuisi & Asia, 2007). Besides, the impact that leads to humans can be a decrease in health due to environmental pollution. Oil mining activities traditionally have an impact on humans and the environment, including: (1) Health impacts: respiratory and noise disturbances; (2) Environmental impacts: land damage, soil pollution, air pollution, and water or river pollution.

The direct benefit that the community from old wells could utilize was crude oil. Crude oil was calculated using the market price method by observing crude oil wholesalers. Observation results provided information that the price of crude oil was IDR 1,700/liter. Meanwhile, the questionnaire results revealed that the total production of crude oil in Wonocolo Village was 1,848,720 liters/year and had a product value in the form of crude oil of IDR 2,436,344,000/year.

The product value was then divided by the number of respondents to obtain the average and then multiplied by the 68 wells still operating in the Wonocolo Village area. This calculation produced a direct use value from crude oil of IDR 4,359,773,474/year.

After the crude oil was processed, it was then broken down into the benefits of producing several commodities, such as kerosene, diesel, and kereng waste. In Table 4, the direct benefits of mining are presented.

Table 4. Tabulation of Direct Use Value

No	Benefit Type	Value (IDR)
1	Crude oil producer	4,359,773,474
2	Kerosene producer	7,472,640,000
3	Diesel producer	21,117,444,000
4	Kereng waste producer	6,307,840
5	Miner's economy booster	46,939,248
	Total	33,003,104,562

Indirect use values that could be identified were from welding workshops/mining mechanics and grocery stalls. The use of mechanical tools is what made workshops around mining established. The goal was that if the machine broke down, they did not have to go to town to fix it. The handling of this workshop varied, such as maintenance of buckets, pulley providers, machines, welding, and replacing lacquers. The cost ranged between IDR 150.000 to IDR 250.000. In addition, the intensity of work could not be ascertained, around 1-3 times a week, depending on the damaged well. Further, the questionnaire results revealed that respondents who worked in mechanical repair shops had an average income of IDR 1,875,000/month. This average was then multiplied by the number of workshops in the old well mining area, i.e., eight workshops, which yielded a total benefit of IDR 15,000,000/month or IDR 180,000,000/year.

Also, the grocery stalls benefited from being visited by many people, both the miners and others interested in the location. It encouraged non-mining communities to open grocery stalls to meet the needs of miners. This stall sold various foods, drinks, and cigarettes, and during the day, miners rested there. It could also be used as a resting place over lunch.

The average income for each stall was IDR 1,566,667/month, which was then multiplied by the total number of grocery stalls at the mining site, i.e., 18 stalls. The calculation result showed that the total indirect use value from the grocery stalls at the mining site was IDR 28,200,000/month or IDR 225,600,000/year.

This value was gained using the contingent valuation method (CVM) to get the willingness to pay (WTP) results. This WTP value was then obtained on average and multiplied by the number of household heads in Wonocolo Village. The calculation got the total value of the option benefits of IDR 38,126,000/year.

The value of this benefit was obtained from the community's willingness to pay to maintain the uniqueness of this traditionally managed oil mining. The fees paid by the community were those earned to improve the environment and add infrastructure facilities around the Wonocolo Village area. This handling would also help the tourism sector

since it makes the oil and gas education tourism area in Wonocolo Village more unique and interesting. The average value of the community's willingness to pay was then multiplied by the number of household heads in Wonocolo Village to calculate the total existence benefit value of IDR 41,162,000/year.

Impact value can be divided into two: environmental and health impact values. From the investigation results in the field, information was obtained that the community had a negative impact from this mining.

Health problems that oil miners may experience are respiratory and noise disturbances. Respiratory disorders are due to the pungent smell of oil and the cooking process of crude oil, which emits smoke. Meanwhile, noise exists because the process of extracting crude oil produces the roar of a diesel engine, which disturbs one's hearing. The average cost spent by each community to maintain health was IDR 52,240/year, which was then multiplied by the number of residents of Wonocolo Village, resulting in a calculation of the total health impact cost of IDR 118,216,480/year.

The economic value of environmental impacts was attained from the willingness of the community to pay a replacement cost for the community to defend itself against the environmental impacts. This WTP value was to determine how much the community was willing to pay to maintain, preserve, and repair a polluted environment. In this case, the WTP variant was due to differences in age, education level, and the sensitivity level of the community towards the environment. The average WTP for the environment that the community was willing to pay was IDR 73,730/year, multiplied by the number of residents of Wonocolo Village, resulting in a mining environmental impact value of IDR 154,980,460/year.

Total economic valuation (TEV) was obtained from the sum of identified benefits, such as direct, indirect, option, and existence benefits. The sum of the values of these benefits was then subtracted from the sum of the impacts identified in this research on traditional petroleum mining activities. The result of subtracting the value of the benefits and the value of the impact became the amount of the total economic value of mining activities from an economic and environmental perspective. The mathematical formula for calculating the total economic value used in this study is as stated in the research method:

$$TEV = (DUV + IUV + EV + OV) - (HI + EI) \quad (6)$$

Calculations carried out with this formula produced a total economic value of traditional oil resource mining activities in the old wells of Wonocolo Village, amounting to IDR 33,214,795,622/year. This result indicates a positive total economic value since the total value of the benefits was more significant than the total value of the impacts. A positive final value also suggests that this traditional petroleum resource mining activity positively improved society and the environment. The impact was not too significant compared to the value of the benefits. It is also due to the allocation of funds from PT BBS as the institution that accommodates the crude oil distribution from miners to PT Pertamina. The existence of a commitment from the government to preserve the environment is a good thing. This commitment must be continuously improved, in line with the opening of more and more oil wells, which causes environmental damage. Efforts to protect the environment must also be carried out according to environmental needs so that it is not only a formality.

Table 7 presents the value of the benefits and impacts of traditional oil resources mining activities in detail.

Table 7. TEV Recapitulation of Oil Resources Mining Activities in Old Wells in Wonocolo Village

No	Benefit Type	Benefit Value (M)
1	Direct Benefits	IDR 33,003,104,562
2	Indirect Penents	IDR 405,600,000
3	Option Benefits	IDR 38,126,000
4	Existence Benefits	IDR 41,162,000
Total Benefits		IDR 33,487,992,562

No	Impact Type	Impact Value (M)
1	Health Impact	IDR 118,216,480
2	Environmental Impact	IDR 154,980,460
Total Impact		**IDR 273,196,940**
Total Economic Value (M-D)		**IDR 33,214,795,622**

Source: Processing Data

Based on TEV calculation, the community receives an amount of impact in addition to the benefits of IDR 33,487,992,562. The health impact amounted to IDR 118,216,480, and the environmental impact amounted to IDR 154,980,460. The benefits of using economic valuation can be used to reduce the negative impacts received by the community (Naumi & Trilaksana, 2015; Kunzli et al., 2000; and Pearce, 1996). According to Naumi & Trilaksana (2015), these negative impacts can result in poor health for Wonocolo Villagers. Therefore, paying attention to environmental sustainability is necessary even though mining activities are carried out as well as the need to pay attention to aspects of the economic and social life of people live in areas that have abundant natural resources. This was also conveyed by Kunzli et al. (2000) and Pearce (1996). Some studies then apply economic valuations in order to see if health damage from air pollution should be treated as a priority concern in the countries to which the coefficients are applied. Preliminary work suggests that some forms of air pollution, notably inhalable particulate matter and ambient lead, are serious concerns in the developing world (Pearce, 1996).

CONCLUSION

Traditional oil resource management activities have started since the colonial era. The local community still maintains the use of simple technology. According to the economies of scale, mining is actually inefficient. However, the community continues mining for several reasons, including the lack of options for economic activity. The second reason is the attractiveness of tourism. The value of benefits and costs that could be calculated from mining activities is still positive. It denotes that the value of economic losses caused by mining activities was still lower than the benefits obtained by the community.

Thus, the activity feasible to be developed is tourism development by the government and the Wonocolo Village people. In addition, the total economic value of mining activities for petroleum resources has traditionally shown a positive value, amounting to IDR 33,214,795,622/year.

On the other hand, the impacts that arise from oil mining activities include health impacts in the form of respiratory problems and noise. For environmental impacts, land damage, soil, air, and water/river pollution occur.

Moreover, mining activities do not have environmental permits, allegedly causing the community not to manage this negative impact.

The policy implication the government can carry out is to minimize the polluted environment. The government can also assist mining actors with an environmental management statement (SPPL). Having an SPPL allows every actor to carry out better environmental management. Further, traditional mining activities in Wonocolo Village are worth continuing for tourism purposes. The community should take advantage of the existing uniqueness and work together with the Bojonegoro Regency Tourism Office. In fact, oil mining may no longer be economically efficient, but tourist attractions can replace people's economic activities.

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