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ENVIRONMENTAL ECONOMIC VALUATION OF MANGROVE ECOSYSTEM IN LANTEBUNG, MAKASSAR CITY

Asriadi[1], Aris baso[2], Hamzah[2], Sri Suro Adhawati[2], Sitti Fakhriyyah[2], Amiluddin[2]

[1]Master student in Fisheries Science, FIKP – Hasanuddin University
[2]Lecturer in Fisheries Science, FIKP – Hasanuddin University

Corresponding author : asriadiyong@gmail.com

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ABSTRACT

This research aims to determine the economic value of the benefits of the mangrove forest ecosystem in Lantebung, Makassar City. This study was conducted from March to May 2024 using a survey method to obtain primary data from all respondents, sampling using the census method for fisherman respondents and the slovin method for visitor respondents. To determine the economic value of the ecosystem benefits using a total economic value analysis of 176 questionnaires distributed to respondents for data collection. The results of the analysis show the total utility value of direct benefits of IDR 1,005,550,000, total indirect benefits of IDR 3,800,809,735 and total optional benefits of IDR 5,318,478, non-utility value of total existence benefits of IDR 92,500,000 and total legacy benefits of IDR 100,031,640 so that the total economic value is IDR 5,004,209,853. This journal reveals the economic value of the benefits of mangrove ecosystems so that humans can utilize mangrove ecosystems according to existing values and can become government policy makers.
Keywords: Economic valuation, Mangrove, Fisherman, Travel

INTRODUCTION

Mangrove ecosystems provide functions both as natural resources and as environmental protectors, which have a very important role in the economic and ecological aspects of the surrounding environment. In addition to being a place of shelter and seeking meaning, mangroves are also a breeding ground for marine biota. Mangroves also function as a place to store carbon (carbon storage) both as biomass and substrate. On the other hand, mangroves also have economic benefits for coastal communities because they can be used as tourist attractions, sources of food, drinks, and medicines (Kabalu et al. 2022). Coastal communities are often highly dependent on mangrove ecosystems because mangroves provide a number of ecological, economic, and social benefits that are vital to their lives. The mangrove ecosystem as one of the coastal and marine ecosystems has great potential for community welfare both in terms of economy, social, and environment (Nurmadi et al 2021).

Regarding the benefits of mangrove forests, the Explanation of Law of the Republic of Indonesia No. 41 of 1999 concerning Forestry states that: Forests as capital for National Development have real benefits for the life and livelihood of the Indonesian Nation, both ecological, socio-cultural and economic benefits, in a balanced and dynamic manner, for that forests must be managed and managed, protected and utilized sustainably for the welfare of the Indonesian people, both the present and future generations (Alnursa, 2022).

Based on the explanation of the law governing the management of mangrove forests, there is controversy in the field. Where there are problems with the utilization of mangrove debt, namely the destruction of mangrove forests. Damage to mangrove debt causes a decline in mangrove ecosystem services. Mangrove ecosystems are very vulnerable to environmental change. This is evidenced by the fact that mangrove ecosystems around the world are damaged at an alarming rate of 12% per year. The decline in the area of mangrove ecosystems is faster in developing countries. The high rate of mangrove ecosystem destruction is caused by economic needs, the destructive nature of society, and also the lack of socialization regarding the potential of the mangrove ecosystem (Momo and Rahayu, 2018). Significant degradation indicates the large value of the direct benefits of these resources, making them more vulnerable to excessive exploitation. (Iswahyudi, 2019).

The area of the mangrove ecosystem in South Sulawesi in 1993 reached 104,030 ha. The latest monitoring results (Directorate General of Reforestation and Land Rehabilitation, 1994 in Saru 2007) stated that mangrove exploitation in South Sulawesi was around 75% or around 78,022 ha, generally not paying attention to environmental sustainability and the ecological conditions of the mangrove ecosystem. Of the 78,022 ha of mangroves that have been exploited, around 40,000 ha have been converted into ponds and 38,022 ha have been used as raw materials for home industries (Auliansyah 2018).

Mangrove forest damage is caused by the activities of the surrounding community and various natural disasters that occur. Coastal sand mining activities, mangrove felling,

deforestation, excessive fishing, and waste pollution are some of the anthropogenic factors that contribute to the decline in mangrove ecosystem services. For example, the impact of excessive exploitation of mangrove ecosystem resources has resulted in the degradation of the habitat around the mangroves, which has a negative impact on coastal communities who depend on natural resources and mangrove ecosystem services for their livelihoods. This situation is caused by the lack of knowledge and awareness of coastal communities regarding the integration of the concept of sustainable development and livelihood development (Setiawati, 2021).

Current knowledge regarding mangrove ecosystems in Indonesia in general and the city of Makassar in particular is still far from what is expected as a basis for sustainable management. This is due to limited information, knowledge and understanding of the community regarding the importance of mangrove forests. On the other hand, in terms of ecology, the mangrove forest ecosystem faces high environmental pressure, not only is it vulnerable to various activities, but also has limited carrying capacity of the resources it contains. If utilized or exploited, it will affect the function of the mangrove ecosystem itself (Fauzi et al. 2020).

Utilization of mangrove forests to meet human needs should be carried out in such a way that it provides benefits for the welfare of the local community, by paying attention to sustainability aspects, so that the benefits obtained can be sustainable and continuous. However, this utilization may not consider sustainability aspects and ultimately cause damage that is detrimental to the community itself.

Material and Method

Geographical, Temporal, and Data Research Characteristics

This research was conducted in Lantebung, Bira Village, Tamalanrea District, Makassar City from March to May 2024, covering various stages, including data collection, processing, analysis, and preparation of research results.

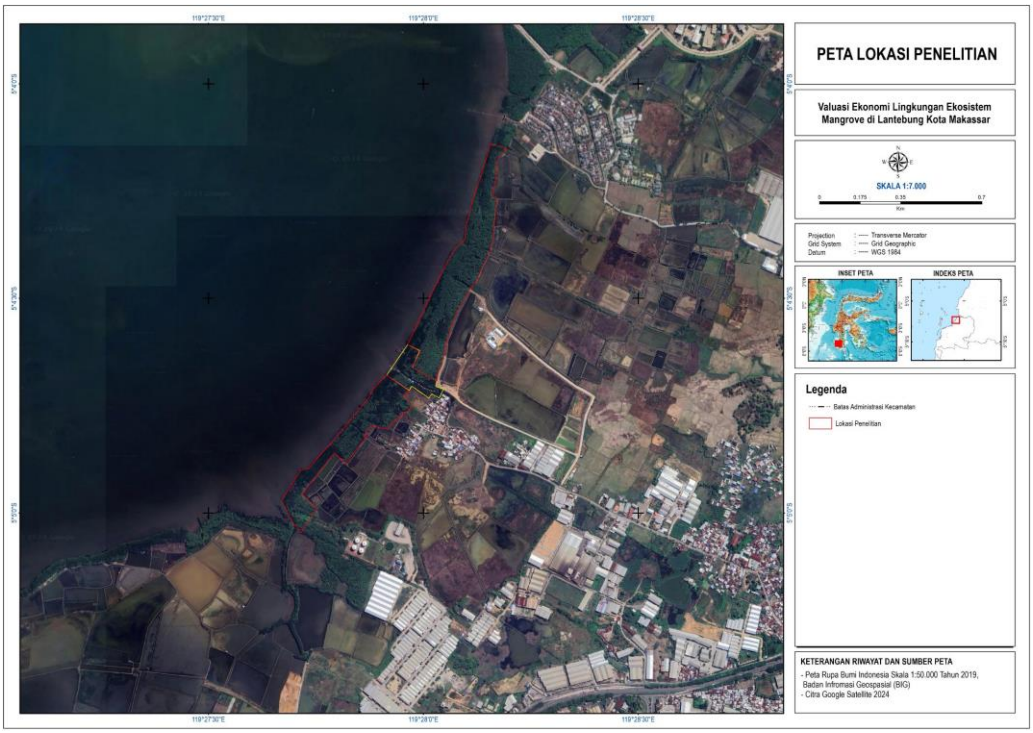

Figure 1. Map of total economic value sampling locations in Maros Regency, South Sulawesi Province, Indonesia.

The selection of the research location was carried out intentionally (purposively) with the consideration that the selected location is an area with potential mangrove ecosystems and the community is dependent on the mangrove ecosystem located (living) around the Lantebung mangroves based on data from the South Sulawesi Marine and Fisheries Service in 2022.

Primary data was obtained directly from respondents, fishermen were selected using the purposive sampling method and tourists were selected using the accidental sampling method using the Slovin formula (Ryan, 2013):

$$n = \frac{Z^2}{4\,(Moe)^2}$$

$$n = \frac{1{,}96^2}{4\,(5\%)^2}$$

$$n = 96{,}04$$

Information :
n = Number of samples
Z = Level of confidence required in determining the sample (95% = 1.96)
Moe = Margin of error, namely the maximum level of error that can be tolerated, is determined at 5%.

RESULT AND DISCUSSION

Mangrove ecosystem conditions

Mangrove density refers to the number of individual mangrove trees per unit area. Density is measured in the number of trees per hectare or per square meter. This density is

important for understanding the condition of the mangrove ecosystem, including its health and its ability to provide ecosystem services such as coastal protection, carbon sequestration, and habitat for various species.

The results of research conducted in Lantebung, Makassar City found two types of mangroves consisting of Rhizophora apiculate and Avisennia alba. Only two types of mangroves were found because each type of mangrove has a different area or environment and there is an uneven distribution pattern of mangroves. The results of the mangrove density analysis in table 5 show that the condition of the mangrove forest is classified as very dense because the value of mangrove density after analysis is 0.65 ind/m2 or 6,500 trees/hectare. Determination of mangrove density refers to the decision of the Minister of Environment in 2004, if a mangrove forest has more than one thousand five hundred mangrove trees per hectare then it is included in the criteria of very dense or is said to be very good.

Total Economic Value of Lantebung Mangrove Forest

1. The Utility Value of Mangrove Ecosystems

A. Direct benefit value

The values utilized by the community directly in the Lantebung mangrove ecosystem are: mullet fish, mangrove crabs and Lantebung ecotourism benefits. The direct benefit values in the mangrove forest carried out (Jabbar et al 2021) in Batu Ampar District Village, West Kalimantan consist of charcoal production, fish, crabs, cultivation and ecotourism.

a. Benefits of mullet fish

Based on the results of interviews with respondents, the total number of mullet catches in Lantebung mangrove forests was obtained, which is shown in the table below:

Table 1. Direct benefits value of mullet fish

Total Catch (kg/year)	Total Working Days (days/year)	Operational Costs (IDR/year)	Total Benefit (IDR/year)
5.310	177	IDR 8.448.000,00	IDR 97.752.000,00

The results of interviews with fishermen at the Lantebung research location in Makassar City as many as 22 respondents, obtained a total income from mullet catches of IDR 97,752,000.00 in a year with a total catch of 5,310 kg in a year, 177 working days in a year and total operational costs of IDR 8,448,000 in a year. Based on research conducted (Apriyanti et al 2021), it states that the mullet catch in Morosari Hamlet is IDR 1,733,580,000, with a catch of 118.5 kg/trip. The level of mullet catch obtained by the Lantebung community will certainly not be the same every day. This is because fish resources in an area will not continue to be high, there will be a time when the fish resources are in the growth stage so that they cannot be utilized. Factors that influence the catch that varies every day are also influenced by seasonal factors (Firmansyah 2019).

The fishing gear used by the Lantebung community based on the interview results is nets and trawls while the means of transportation they use is a small boat equipped with a small-powered boat engine. Where the mullet fishing area is on the coast near the mangrove ecosystem itself.

b. Direct Benefits of Mangrove Crabs

The Lantebung community utilizes mangrove forests as a fishery product by catching mangrove crabs using bubu fishing gear. Mangrove crabs that provide benefits to the Lantebung community are caught using bubu fishing gear and then sold. Based on the results of interviews with respondents, the total number of crab catches in the Lantebung mangrove forest is obtained as shown in the table below.

Table 2. Direct benefit value of crab

Total Catch (kg/year)	Total Working Days (days/year)	Operational Costs (IDR/year)	Total Benefit (IDR/year)
7779,6	372	IDR 22.968.000,00	IDR 832.788.000,00

The results of interviews with the Lantebung community showed that one of the direct benefits that can be felt by the Lantebung community is the benefits of crabs. The crab catch is not too much for each catch, but fishermen catch crabs almost every day. Based on table 2, it shows that the estimated amount of crab catch by Lantebung fishermen is around 7779.6 kg/year, with an average number of working days per year of 372 days, the selling price of crabs per kilogram is IDR. 110,000.00, the total operational costs incurred by fishermen each year are around IDR 22,968,000.00. So that the total benefit or income from mangrove crabs each year is IDR 832,788,000.00. The results of a study conducted by (Santri et al 2020), that the capture of mangrove crabs carried out by the Betahwalang community produced a value of IDR 56,815,000,-/year, the number of catches during a year was 951 kg / year, with an average price of IDR 85,000.00 per kilogram.

The direct benefit income of mangrove crabs is the highest income among other direct benefits. This is because the existence of mangroves is a supporting factor in the availability of food for mangrove crabs. Mangroves have roots that can be used as a place for mangrove crabs to take shelter from the pounding / impact of sea waves and become a hiding place for mangrove crabs when mating so that the mangrove crab population increases.

The tool used to catch crabs by lantebung fishermen is a trap. They catch using a trap fishing tool that is given fish in the trap which is used as bait for catching crabs.

c. Direct Benefits of Ecotourism

Mangrove ecotourism is an ecosystem located between the ebb and flow of sea water in coastal areas to around or above sea level in tropical areas. The direct benefits of Lantebung mangrove ecotourism can be known using the Travel Cost Method. The Travel Cost Method is the cost incurred by individuals (visitors) to visit tourist attractions. Travel costs in this study are the total travel costs incurred from the initial location to Lantebung Mangrove Ecotourism and back to the original location. The distribution of travel costs for respondents (visitors) can be seen in the following table

Table 3. Value of direct benefits of Lantebung mangrove ecotourism

No.	Description	Value (IDR/year)

1.	Entrance ticket	IDR 5.760.000,00
2.	Parking	IDR 2.304.000,00
3.	Transportation	IDR 18.492.000,00
4.	Other Fees	IDR 25.896.000,00
	Total	IDR 52.452.000,00

Based on the results of the study conducted in Lantebung, Makassar City, there were 96 visitors/respondents met during the study., the costs incurred by tourists visiting Lantebung ecotourism were an entrance ticket of IDR 5,760,000.00 with a ticket price of IDR 5,000.00 per person, parking fees that must be paid by visitors for cars of IDR 5,000.00 and for motorbikes of IDR 2,000.00 per motorbike, so that the total parking cost for a year is IDR 2,304,000.00, transportation costs incurred by visitors on average IDR 22,479.00 one person so that the total estimated transportation cost for a year is IDR 17,772,000.00, and other costs incurred by visitors during their visit amounted to IDR 25,896,000.00 for a year. Other costs in question are costs in the form of food, drinks, gazebo rental and photo location rental. The results of the study conducted by Masih (2022), the total income from the utilization of mangrove ecotourism in the essential ecosystem area (KEE) as a tourist attraction is IDR 8,349,343,920 in a year. These visitors are local tourists who come from the area around Lantebung with a distance ranging from 2-50km. There are also tourists from outside Makassar City such as from Maros Regency, Pangkep Regency and Barru Regency who were met at the location.

B. Indirect Benefit Value

The indirect benefit value of the Lantebung mangrove ecosystem is estimated based on the ecological function of the mangrove ecosystem as a wave breaker and carbon absorption. The function of the mangrove ecosystem will be replaced by the construction of sea wave retaining walls along the coastline.

a. Wave breaker value

Mangroves also have benefits known as wave breakers to protect the coast from waves. The value of mangrove forests as wave breakers is determined using the approach used to estimate mangrove forests as wave breakers, namely by using replacement cost. Replacement cost is the cost of building a wave breaker or breakwater. The value of the benefits of the wave breaker in Lantebung, Makassar City is presented in the following table.

Table 4. Breakwater value of lantebung mangrove forest

Wave breaker value (Rp/m3)	Length of Coastline	Durability (years)	Value (IDR/year)
Rp. 5.839.880	1.852	5	IDR 2.163.091.552,00

The value of mangroves as breakwaters is calculated using the approach of the cost of making concrete breakwaters. The calculation is based on the construction of embankments according to the Makassar Public Works and Urban Planning Agency (2024) The cost of making an embankment measuring 1m x 1.5 m x 2.5 m (p x l x t) is IDR 5,839,880 one meter with a durability of 5 years. The length of the coastline in Lantebung, Makassar City is 1,852 m, so the cost required for the construction of the breakwater is IDR 10,815,457,760. Based on the same data source, the durability of the embankment lasts for 5 years, so the benefits are divided by the durability of the embankment (5 years) to obtain the indirect benefit of the economic value of mangroves as breakwaters, which is IDR 2,163,091,552/year (Lestari et al 2024).

b. Carbon Absorption

The indirect use value of the Lantebung ecosystem area in Makassar City is estimated based on the ecological function of the mangrove ecosystem as a carbon absorber. The ability of the mangrove ecosystem to absorb carbon is estimated using the benefit transfer approach. The calculation of the carbon absorption value can be seen in the table below.

table 5. Carbon absorption value of the lantebung mangrove ecosystem

NO	Description	Value	Unit
1.	Carbon sequestration potential	0,823	Ton/ha
2.	Mangrove area	22,1	Ha
3.	Carbon Price	5.600	US$
4.	Rupiah exchange rate	IDR. 16.079.900	Rupiah
	Total	**IDR 1.637.718.183**	

Mangrove carbon sequestration is the process by which mangrove ecosystems remove and store carbon dioxide (CO_2) from the atmosphere through photosynthesis. The absorbed carbon is stored in mangrove biomass (roots, stems, and leaves) and in the surrounding sediment. Deep and extensive mangrove roots store large amounts of carbon for long periods of time (Rovai et al 2018). This process makes mangroves a very efficient carbon sink and important in mitigating climate change.

The amount of carbon that can be absorbed by mangrove forests is 0.823 tons per hectare per year (Harmawati 2018). Based on the results of research conducted in Lantebung, Makassar City regarding the absorption of carbon by mangrove ecosystems at that location with a benefit transfer approach of IDR 1,637,718,183. The economic value is estimated by multiplying the potential carbon absorbed by mangrove forests, by the area of mangrove areas, carbon prices, and the current rupiah exchange rate.

c. Benefits of choice

The optional benefit is a benefit that is used to maintain the use of goods and services and environmental resources in the future. The following are the optional benefits of the Lantebung mangrove forest in Makassar City:

Table 6. Benefit value of lantebung mangrove forest options

Choice value	Cost (IDR/ha)	Mangrove Area (ha)	Value the benefits of the option
Biodiversity	IDR 241.749	22	IDR 5.318.478

The value of the mangrove ecosystem option is estimated using the biodiversity value or biodiversity value. Diversity is a characteristic that characterizes a community, this characteristic is related to the number of species owned by the community and the number of individuals of each type in it. The total value of the benefits of the Lantebung mangrove ecosystem option in Makassar City is to multiply the Biodiversity value by the current rupiah exchange rate and the area of the Lantebung mangrove ecosystem. The biodiversity value that applies in Indonesia is US $ 15 / ha / year, with the current rupiah exchange rate against the dollar of IDR 16,116, so that IDR 241,749 is obtained. The area of the Lantebung mangrove ecosystem in Makassar City is 22 hectares. Based on this calculation, the total value of the benefits of the biodiversity option in the mangrove forest in Lantebung, Makassar City will be known as IDR 5,318,478, - / year. Research by (Dafani et al 2021) in Taddan Village, Camplong District, Sampang Regency was lower, which was IDR 4,211,730/year. This is because the mangrove area is lower, which is only 19 hectares and the rupiah exchange rate is also low, which is around IDR 14,778 in 2021. This is what makes the difference in the value of the benefits of choice at a mangrove ecosystem location. This choice value will remain as long as there is a mangrove ecosystem in Lantebung, Makassar City.

2. Non-Use Value of Mangrove Ecosystems

A. Benefits of Existence

The value of existence can be known from the availability of respondents to pay for a natural resource. The value of the existence of the Lantebung mangrove forest can be seen in the table below.

Table 7. Value of existence benefits

Respondent	Average Availability to pay (IDR/person)	Existence Value
80	IDR 1.156.250,00	IDR 92.500.000,00

Based on the interview results, the total existence value was obtained at IDR 92,500,000.00/year. These results were obtained using the Willingness to Pay (WTP) approach to 80 respondents who utilize the Lantebung mangrove ecosystem. Willingness to Pay is the maximum amount that consumers are willing to pay to obtain certain goods or services. The existence value of mangrove forests is obtained from the respondent's willingness to pay for the existence of mangrove forests in their area (Widiastuti et al 2016). Before this question was asked, respondents were given a scenario regarding the importance of mangrove ecosystems and a hypothetical market for the existence of mangrove forests. Based on the scenario that has been given, in order to obtain a mangrove forest that is maintained so that it can continue to be utilized, respondents are asked to contribute in the form of funds in the mangrove forest conservation program. Researchers have prepared a price range, namely between IDR 0 - IDR

1,000,000, - IDR 1,100,000 - 2,000,000, IDR. 2,100,000- IDR 3,000,000, and IDR 3,100,000- whatever. So that there are 30 respondents who pay IDR 1,100,000- IDR 2,000,000, there are 3 respondents willing to pay IDR 2,100,000- IDR 3,000,000, and the highest willingness to pay at IDR 0- IDR 1,000,000 is 47 respondents. So that the average willingness to pay of respondents is IDR 1,156,250.00, -. The factor that makes the difference in respondents in determining their willingness to pay is the level of education, where there is a lack of understanding of the mangrove ecosystem even though the scenario has been given first. This is in accordance with the research conducted (Firman et al 2024), the total value of Willingness to Pay (WTP) from the benefits of existence issued by respondents is IDR 197,520,000.00 or an average of IDR 13,622,069.00 The total number of respondents is 45 people with an average education level of elementary school (SD), so they have less knowledge about the mangrove ecosystem, all respondents are able to provide a value for the existence of the mangrove ecosystem of IDR 214,695.65 one hectare per year.

B. Heritage Benefits

This heritage value can use the calculation formula of 10% of the direct benefits of the mangrove forest ecosystem. According to Ruetenbeek (1992), the heritage value of mangrove forests is estimated to come from 10% of the direct benefits generated by the existence of the mangrove forest ecosystem (Wijayanti 2020).

Table 8. Value of inheritance benefits

Direct Benefit Value (IDR/year)		Inheritance Benefit (IDR/year)
IDR 1.003.164.000,00	10%	IDR 100.031.640,00

Heritage value is the economic value obtained from the benefits of preserving resources or ecosystems for the benefit of future generations. According to Ruitenbeek (1992), the heritage value of the mangrove forest ecosystem is estimated to come from 10% of the direct benefit value generated by the existence of the mangrove forest ecosystem. The heritage value of the Lantebung mangrove forest ecosystem in Makassar City is IDR 100,031,640.00. The heritage value is obtained from 10% of the direct benefits of the Lantebung mangrove forest in Makassar City of IDR 1,003,164,000.00. The heritage value is lower in Taddan Village, Camplong District, Sampang Regency in Dafani's research (2021), namely IDR 8,569,659 in a year. This is because the direct benefit value is only IDR 85,696,591 in a year.

3. Total economic value (TEV)

The total economic value is the sum of all economic values of the benefits of mangrove forests that have been identified and quantified. Based on the results of the data processing above, the total economic value of the mangrove ecosystem can be seen in the following table.

Table 9. Total economic value of lantebung mangrove forest

No.	Benefit Category	Benefit Value (IDR/year)
1.	Direct Benefit Value	IDR 1.005.550.000
2.	Value of Indirect Benefits	IDR 3.800.809.735

3.	Option Benefit Value	IDR 5.318.478
4.	Value of the Benefits of Existence	IDR 92.500.000
5.	Value of Inheritance Benefits	IDR 100.031.640
	Total	**IDR 5.004.209.853**

The total economic value of the Lantebung mangrove ecosystem in Makassar City is IDR 5,004,209,853 per year. The total economic value in Timbulsloko Village has a very large value as determined by Mayasari (2021), which is IDR 12,703,693,939/year. This value is because the mangrove ecosystem is the result of rehabilitation efforts.

CONCLUSION

Based on the objectives and results of the discussion in this study, it can be concluded that the results of the analysis show the total utility value of direct benefits of IDR 1,005,550,000, the total indirect benefits of IDR 3,800,809,735 and the total optional benefits of IDR 5,318,478, the total non-utility value of existence benefits of IDR 92,500,000 and the total inheritance benefits of IDR 100,031,640 so that the total economic value is IDR 5,004,209,853.

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