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Tourism: Harnessing the Power of Green Finance and Green Technology Innovation

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Abstract

This study was conducted to investigate the influence between green finance and green technology on sustainable tourism in the country of Indonesia using time series data from 2012 to 2021. By using the MA (Moving Average) method as forecasting from 2021 to 2045 combined with the path analysis method to determine the role of green finance as an intermediary to support sustainable tourism, this study uses green finance variables, renewable energy sources and waste from the tourism sector as independent variables affecting sustainable tourism as the dependent variable. The result of this study is the importance of green finance as an intermediary to support environmentally friendly technology in building sustainable tourism in the long term.

Keywords: Green Finance; Green Technology Innovation; Waste; Tourism; Sustainable

1. Introduction

Tourism is one of the contributing sectors to Gross Domestic Product (GDP) in the world. Tourism directly contributes to GDP of around US$5.8 billion in 2021 (Statista, 2022). Therefore, it is important to implement sustainable tourism that plays a role in improving the economy and making it a cultural heritage that contributes positively to the environment, community welfare, economy and enhancing scientific heritage.One of the important roles in supporting sustainable tourism is green finance and green innovation technologies. Green finance is the process of allocating investment or lending capital with regard to environmental impacts, not just a matter of profit or loss (Volz et al., 2015). The financial sector will create a new capital channel for the world of tourism, which still has difficulty in obtaining funds to carry out expansion with respect to the environmental sector (Hailiang, Chau, & Wagas, 2023).

Green innovation technologies are technologies that carry out activities without creating negative effects that damage existing resources (Sriwardiningsih, 2014). By applying green innovation technologies that rely on renewable energy, it will reduce environmental impacts and can reduce the cost of sustainable damage from nonrenewable energy (Karabuga, A., Yakut, M., Yakut, G., Selbas, R., & Üçgül, İ., 2015). By applying renewable energy in tourism, it can attract many tourists who are interested in unique destinations with geothermal power plants and wind parks (Bir, M., Rybár, R., & Kaľavský, M., 2018). By implementing renewable energy, it is expected to reduce carbon emissions, which are currently increasing every year. Carbon emissions account for about 8% of global greenhouse gas emissions, from 3.9 to 4.5 GtCO2e (Lenzen, M., Sun, Y., Faturay, F., Ting, Y., Geschke, A., & Malik, A., 2018). With the integration between the principle of green finance which acts as a financial supporter with green innovation technology from companies that prioritize renewable energy as the basis for development accompanied by corporate awareness of waste reduction will increase sustainable tourism in Indonesia which has not been specifically studied. Whereas tourism in Indonesia has great potential in driving the economy where it is seen that the Indonesian tourism industry has contributed US$ 10 Billion of foreign exchange. The weak linkage of banks in supporting green finance, the lack of company awareness in implementing green innovation technology, and the increase in waste per year make researchers want to examine the influence of these three variables so that they can be taken into consideration for economic experts and the government in implementing sustainable tourism.

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Some researchers only examine green finance on sustainable tourism and some other researchers only examine green innovation technology on sustainable tourism separately. So, the researchers will analyze the influence of green finance as a capital supporter along with the influence of green innovation technology which acts as the formation of better infrastructure and awareness of decomposing waste in order to achieve sustainable tourism.

2. Literature Review

Sustainable tourism has become a hot topic in many parts of the world. The United Nations World Tourism Organization (UNWTO) defined sustainable tourism as "tourism that takes full account of its current and future economic, social, and environmental implications, addressing the requirements of visitors, the industry, the environment, and host communities" (UNWTO, 2021). Sustainable tourism means that tourism needs for the present but still does not reduce or sacrifice the needs for future generations (Obot & Setyawan, 2019).

Green finance has great potential in supporting green technology innovation with financial mechanisms designed to encourage investment in sustainable projects such as renewable energy and waste management. Research conducted by Chang K et al. (2024) confirmed that there is a positive relationship between green financial policies and green innovation. Green technology policies can increase green innovation through increased green investment efficiency.

Investment in green technology development can certainly reduce the amount of waste and carbon dioxide emissions that will support sustainable economic growth. This is related to the panel data research by Shao et al. (2023) at Kaiwang Chang et al (2023) which shows that green technology innovation and renewable energy have a negative effect on carbon dioxide emissions. Thus, green technology innovation (GTI) and renewable energy can help mitigate the basic consumption of c02 emissions in N-11 countries in the long term, not the short term.

Material Balance Model explains the existence of an economic cycle between households and firms shown in the output market and factor market. However, in every economic cycle, households and firms produce waste residues both from consumption and production that will be returned to nature. So that if not handled properly, the environment will experience sustainable damage which will affect tourism that relies on the beauty of the environment in it. Therefore, firms and households need to do recovery, recycling, reuse and reduce which we apply as variables X2 and X3, namely recovery using renewable energy variables and reduce using emission variables. This research also includes the role of banks as intermediaries in supporting sustainable tourism.

3. Research Method

In this research, the authors used quantitative research methods. The data were used in this study are secondary data in periods 2012-2021 and obtained from the official source of One Data for Tourism and Creative Economy (satudata.kemenparekraf.go.id), Financial Statements of BCA, BNI, BRI, and Bank Mandiri and the Our World in Data web site (https://ourworldindata.org). The analysis technique used in this research is time series analysis using the ARIMA model on EViews 12. In the research operational, the dependent variable is the progress of Indonesian tourism which explains sustainable tourism in Indonesia. Meanwhile, the independent variable that explains green finance is the financial reports of the 4 largest banks in Indonesia that support the development of sustainable development and the independent variable that explains green technology innovation is the number of carbon emissions and waste in Indonesia.

The analysis technique used in this research is time series analysis using the MA model on EViews 12. MA stands for Moving Average, which is a forecasting method that is often used to estimate future conditions using a collection of past data. This research use MA (Moving Average) model to forecast the tourism in Indonesia from 2021 to 2045 and also used Path Analysis to observe direct and indirect effect on each variable.

In general, the Moving Average model has the following form:

$$Yt = \theta_0 + \theta_1 et - 2 \ldots - \theta_n et - q \quad (1)$$

Description

Yt : Stationary time series

θ_0 : Constanta

θ_n : Coefficient of the moving average model that shows the weight. The coefficient may have a negative or positive sign, depending on the estimation results.

et : The past residuals used by the model, which are as many as q, determine the level of the model

3.1. Stationary Test

Stationary tests are usually carried out on time series data which tests whether the average and variance remain consistent over time without any discernible pattern of change. The stationarity test used in the study is at the second-difference level I(2).

Table 1. Stationary Test

Variable	Prob
X1	0,0378
X2	0,0069
X3	0,0381
Y	0,0124

The X1 variable shows a probability of 0.0378 <0.05 so it can be concluded that the green finance variable passes the stationarity test at the second-difference level. The X2 variable shows a probability of 0.0069 <0.05 so it can be concluded that the green finance variable passes the stationarity test at the second-difference level as well. The X3 variable shows a probability of 0.0381 <0.05 so it can be concluded that the green finance variable passes the stationarity test at the second-difference level. The X4 variable shows a probability of 0.0124 <0.05 so it can be concluded that the green finance variable passes the stationarity test at the second-difference level.

3.2. Model Determination

The model applied in this study is the MA (Moving Average) model which is shown from the AIC (Akaike Info Criterion) which is lower than other models. Table 2 shows that the AIC of each variable in the MA model is smaller than the AIC in the AR(1) and AR(1) MA(1) models so that in this study the MA model is applied.

Table 2. Akaike Info Criterion

Variable	AR(1)	MA(1)	AR(1) MA(1)
X1	33,97654	32,70771	33,79758
X2	4,117592	3,812236	4,307871
X3	10,46755	10,90844	10,65792
Y	24,41261	23,22319	24,37971

3.3. Heteroscedasticity Test

The heteroscedasticity test examines whether there is unequal variance of the residuals as the predictor value changes. Table 3 shows data that pass the heteroscedasticity test using the ARCH model of 0.3676 > 0.05.

Table 3. ARCH Heterocedasticity Test

Prob. F (1,7)	0,4323
Prob. Chi-Square(1)	0,3676

3.4. Forecasting Results

Forecasting in this study was carried out from 2022 to 2045 as an assumption that Indonesia has become a Golden Indonesia so that it can be used as a reference for economic actors and the government.

Table 5 indicates a significant decrease in the green finance variable, while the renewable energy variable and the waste emission variable that has increased affect the sustainable tourism variable which has decreased every year.

3.5. Measuring Forecasting Error

Measuring forecasting error is done to assess the strength of the forecasting model. If the range is less than 10%, it is considered an excellent forecasting ability. Meanwhile, if the range is between 10-20%, it is considered a good forecasting ability. If the range is between 20-50%, the forecasting model's capability is still deemed acceptable. Yet, if the range exceeds 50%, the forecasting model's performance is deemed inadequate.

From the results of the calculation of MAD, MSE, and MAPE, it can be concluded that the forecasting model's ability is good so that it can be used as a reference in determining forecasting from 2022 to 2045.

Table 4. Data Realization

Year	Y	X1	X2	X3
2012	591253.31	1700000.00	3.58	515.95
2013	625228.81	2847000.00	4.46	489.06
2014	657673.88	2815214.00	4.61	487.89
2015	686658.31	3488209.00	3.92	539.15
2016	721019.88	10266995.00	5.70	540.09
2017	757535.63	6612000.00	5.55	556.94
2018	791688.69	3964880.00	7.85	594.10
2019	829294.88	2757723.00	8.37	650.91
2020	809474.69	3001021.00	10.51	605.98
2021	823180.79	1559875.18	11.97	621.99
2022	833870.99	-237664.75	13.56	639.05
2023	841545.28	-2391598.77	15.28	657.17
2024	846203.66	-4901926.90	17.14	676.34

Table 5. Forecasting Results

Year	Y	X1	X2	X3
2025	847846.15	-7768649.12	19.13	696.57
2026	846472.72	-10991765.45	21.24	717.85
2027	842083.39	-14571275.87	23.49	740.20
2028	834678.16	-18507180.40	25.88	763.59
2029	824257.02	-22799479.02	28.39	788.05
2030	810819.98	-27448171.75	31.04	813.56
2031	794367.03	-32453258.57	33.82	840.12
2032	774898.18	-37814739.50	36.72	867.74

Table 6. Calculation Results of MAD, MSE, and MAPE

Variable	MAD	MSE	MAPE	PERSENTASE
X1	2.038.711	11.225.676	396,73	20,8 %
X2	3,09	3,76	352,83	18,57 %
X3	190,74	183,88	255,76	13,46 %
Y	26.685,86	79.746,93	26,73	1,41%

3.6. Regression Results

The long-term regression results in this study show the effect of green finance (X1) significantly affects sustainable tourism (Y), renewable energy (X2) significantly affects sustainable tourism (Y) and emissions (X3) significantly affects sustainable tourism (Y) because the probability data shows 0.000 < 0.05. Simultaneously, green finance variables (X1), renewable energy (X2) and emissions (X3) significantly affect sustainable tourism (Y) because the probability data shows 0.000 < 0.05.

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Table 7. Long-term effects

Variabel	Probabilitas
X1	0,0971
X2	0,0546
X3	0,0219
F prob	0,000502
R-squared	0.938309

Table 8. Short-term effects

Variabel	Probabilitas
X1	0,0971
X2	0,0546
X3	0,0219
F prob	0,000502
R-squared	0.938309

Based on the regression results above, we can observe the short-term effect between the independent variables on the dependent variable. Green finance (X1) with probability value of 0.0971 > 0.05 indicates that green finance has a non-significant effect on sustainable tourism. Renewable energy (X2) has a probability value at 0.0546>0.05, thus in the short-term renewable energy has a non-significant effect on sustainable tourism. Emissions (X3) significantly affect sustainable tourism in the short term, as shown by the probability value of 0.0219 < 0.05. Simultaneously, green finance (X1), renewable energy (X2), and emissions (X3) have significant effect on sustainable tourism, as shown by the probability value of 0.000502 <0.05.

3.7. Path Analysis

The short-term path analysis described in fig.1, the direct effect between X2 on Y is 0.389 and the effect between X3 on Y is 0.629. While the indirect effect between X2 on Y through X1 is (0.223 x -0.351 = 0.078) which shows 0.078 <0.389, indicating that the effect between X2 through the intermediary Y through X1 has no significant effect. While the indirect effect between X3 on Y through X1 is (0.223 x 0.169 = 0.038) which shows 0.038 < 0.389 indicating that the effect between X3 through the intermediary Y through X1 has no significant effect.

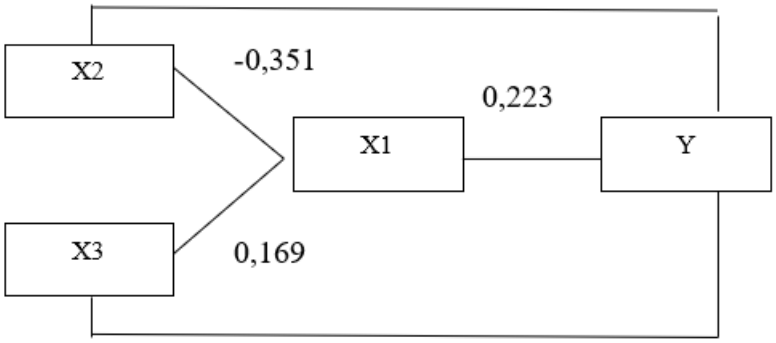

Figure 1. Path Analysis Short Term

The long-term path analysis described in Figure 2, the direct effect between X2 on Y is 2.023 and the effect between X3 on

Y is 1.453. While the indirect effect between X2 on Y through X1 is (-1.855 x 4.284 = 7.95) which shows 7.95> 2.023, indicating that theeffect between X2 through the intermediary Y through X1 has a significant effect. The indirect effect between X3 on Y through X1 is (0.866 x 4.284 = 3.70) which shows 3.70>2.023 indicating that the effect between X3 through the intermediary Y through X1 has a significant effect.

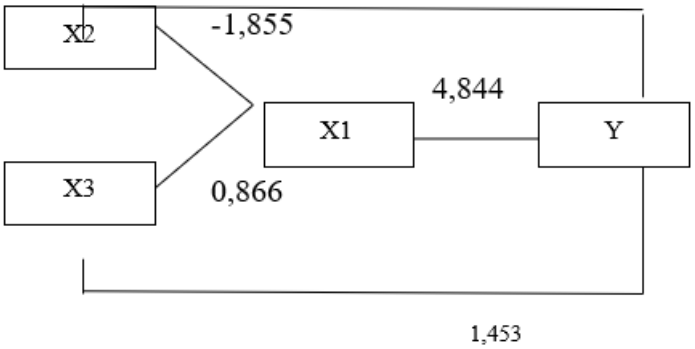

Figure 2. Path Analysis Long Term

4. Conclusion

From the research that has been reviewed, it can be concluded that the influence of X1, X2, and X3 has a simultaneous significant effect of 93.8% in the short term. Then after experiencing forecasting, X1 has decreased every year, X2 has increased every year, X3 has increased every year and Y has decreased every year. The influence of X1, X2, and X3 has a significant effect simultaneously by 99% and has a significant effect on each variable. The research conducted to determine the direct and indirect effects shows that the effects of X1, X2, and X3 have an insignificant effect on Y. Meanwhile, after going through long-term forecasting, the direct and indirect effects of X1, X2, and X3 have a significant effect on Y. This shows the importance of green finance as an intermediary between X2 and X3 to influence Y for the better.

From the research that has been reviewed, it is expected to determine the role of green finance and green innovation technologies that have an important contribution to sustainable tourism with different models to achieve better results. From this research, we hope for a better role of banks, companies and governments in supporting sustainable tourism.

References

[1] Bir, M., Rybár, R., & Kaľavský, M. (2018). Implementasi Energi Terbarukan di Destinasi Wisata: Studi Kasus Taman Angin dan Geotermal. Journal of Renewable Energy. 22(3): 45–55.
[2] Chang, K., Hailiang, C., & Wagas, M. (2024). Green Finance Policies and Their Role in Tourism Development. Journal of Environmental Economics. 18(2): 67–78.
[3] Karabuga, A., Yakut, M., & Selbas, R. (2015). Reducing Environmental Impacts Through Green Innovation. Renewable Energy and Sustainability Journal. 12(4): 210–225.
[4] Lenzen, M., Sun, Y., & Malik, A. (2018). Carbon Emission Contributions of Global Tourism. Environmental Research Letters. 13(6): 370–389.
[5] Obot, A., & Setyawan, R. (2019). Sustainable Tourism Development: A Case for the N-11 Countries. Journal of Tourism Sustainability. 15(5): 132–145.
[6] Shao, K., et al. (2023). Long-Term Impact of Renewable Energy on Sustainable Tourism. Journal of Climate and Economic Policy. 21(1): 85–100.
[7] Sriwardiningsih, E. (2014). Green Technology: A Catalyst for Sustainable Tourism. Journal of Environmental Innovations. 10(3): 150–160.
[8] Statista. (2022). Tourism and GDP Contribution Analysis. Global Economic Review. 28(1): 30–50.
[9] UNWTO. (2021). Defining and Promoting Sustainable Tourism. United Nations World Tourism Organization Report. 20(4): 75–88.
[10] Volz, U., & Schlegelmilch, K. (2015). Role of Green Finance in Supporting Sustainable Tourism. Journal of Green Economics. 14(2): 97–110.