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An Analysis of Trip Generation and Distribution Models in the Tourism Regions of Morotai Island Regency

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ABSTRACT :*The COVID-19 pandemic has affected the world's tourism industry. This sector is one of the featured sectors of Indonesia's Morotai Island regency, supporting the region's economy. For its potential and advantages, the regency has been placed in the country's National Tourism Strategic Region and Special Economic Region. The objective of this research is to analyze tourist trip using trip generation and distribution models.*

This research begins with the procurement of primary and secondary data related to the Morotai Island regency tourism region. The trip generation model was analyzed using zonal linear regression, while Attraction Constrained Gravity (ACGR) was used to model the trip distribution with a rank resistance functionat a distance interval of five to ten kilometers.

The results of the analysis show that most tourists in the region are males (52%), people aged fifteen to twenty (49.5%), and have an income of less than IDR 500.000 per month (50.7%). Furthermore, motorcycles are mostly used to travel from zones of origin to the tourist destination (48.6%), and most of the tourists live six kilometers from the destination (51.6%), while most of the trip costs range from IDR 10-50 thousand (42.9%). The result of the trip production model is $Y = -0{,}618 + 1{,}662X_1 + 0{,}797X_2$ *with the* R^2 *value of 1, while the attraction model results in* $Y = 244{,}348 + 1{,}646X_3 - 5{,}350X_8$ *with the* R^2 *value of 1. The largest trip distribution belongs to Waterfront City, with 238 people per hour, and the least belongs to Moro Ma Doto, with 31 people per hour.*

KEYWORDS: *Tourism, Tourist Characteristics, Linear Regression Model, Gravity Model, Trip Generation Model, Trip Distribution Model*

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I. INTRODUCTION

Morotai Island regency is a part of North Maluku province, located at the northern tip of eastern Indonesia and directly bordered by the Pacific Ocean. One of the economic support sectors of this regency is tourism, including natural, artificial, cultural, and historical tourism of World War II. The regency is also known as "The Pearl of the Pacific Rim." Some of its tourist attractions are Dodola Island, Army Dock Beach, Waterfront City, and Moro Ma Doto.

For its potential and advantages, the regency has been stated as Indonesia's National Tourism Strategic Region according to Presidential Decree number 50 of 2011 and a Special Economic Region consisting of an export management region and fishery, logistics, and tourism industrial region according to Government Regulation Number 50 of 2014.

As a National Tourism Strategic Region, the regency is a destination prioritized by the government, along with nine other similar regions. Therefore, the government has organized various infrastructure developments to support it in order to attract domestic and foreign tourists. As COVID-19 spreads and hinders the tourism industry, analyses to identify tourists' characteristics and trips to the regency during the pandemic are required.

Akter et al. (2017)conducted research related to tourist visits by analyzing factors influencing tourism demand in Bangladesh based on tourism potential. Rodrigue's gravity model was used in the research to estimate the tourism demand level in the form of tourist arrivals.

A gravity model was also used by Chaeranita et al. (2017). They created a trip distribution model influenced by the integrated land usage entropy based on Tanner's resistance function. Another research was

conducted by Gunawan (2018); the objective was to analyze airplane passenger's trip distribution using Double Constrained Gravity (DCGR) based on three resistance functions and the result of trip generation modeling.

Studies related to trip generation were conducted by Wedagama et al. (2019) and Agustini et al. (2019). They created attraction models in tourism zones to predict tourist attractions and factors influencing the trip.

Based on previous studies, trip generation and distribution models can be used to analyze trips in tourism zones. Therefore, this research combines trip generation and distribution in a tourism zone using zonal linear regression and Attraction Constrained Gravity (ACGR) based on the rank resistance function at a distance interval of 5-10 kilometers.

II. METHOD

2.1. Location Selection and Data Collection Method

The research location is the coastal tourism regions in Morotai Island regency, i.e. Army Dock Beach, Dodola Island, Waterfront City, and Moro Ma Doto.

Figure 1. Tourism Map

Due to the pandemic condition, this research was conducted over four days, both weekdays and weekends, i.e., Thursday to Sunday, at the peak hours of the tourism sites.

The primary and secondary data requirements for this research were collected in the following ways:

a. Primary Survey

This survey was held by observing the research sites using a non-probability approach with an accidental sampling method. The sample number was determined by referring to Roscoe (1975) as cited by Sugiyono (2018).

b. Secondary Survey

During this survey, data was acquired from the Tourism Agency of Morotai Island regency. It consists of information regarding the area of the tourism sites, the number of cottages and homestays, culinary centers, workers, public facilities (gazebos, chairs, restrooms, sinks), and playground facilities, ticket prices, and distance from city centers.

2.2 Determination of Trip Origin Zones

Table 1. Division of Trip Origin Zones

Zone	Territory
1	South Morotai sub-district
2	East Morotai sub-district
3	North Morotai sub-district
	Morotai Jaya sub-district
4	South-West Morotai sub-district
	Rao Island sub-district
5	North Maluku
	Sulawesi
	Kalimantan
	Java

2.3 Variables of Research

Variables used during the trip generation phase are as follows:

a. *Trip Production*

The independent variables were determined based on the correlations of all the questions in the questionnaires. Table 2 details variables used in the creation of the trip production model.

Table 2. Trip Production

No	Variable	Notes
1	Y	*Trip Production*
2	X_1	Respondent' income of between IDR 1-2 million
3	X_2	The Number of transportation users
4	X_3	Trip distance of between 2 and 4 km.
5	X_4	Transportation cost of between IDR 10 and 50 thousand

b. *Trip Attraction*

Table 3. Trip Attraction

No	Variable	Notes
1	Y	*Trip Attraction*
2	X_1	Area of tourism site
3	X_2	Cottages and homestays
4	X_3	Culinary centers
5	X_4	Workers
6	X_5	Public facilities (gazebo, chairs and benches, restrooms)
7	X_6	Playground facilities
8	X_7	Ticket price
9	X_8	Distance form city centers

2.4 Data Analysis

The data analysis was performed on the primary and secondary data using Microsoft Excel and SPSS.

1. Evaluating the questionnaire forms
2. Analyzing tourists' characteristics
3. Analyzing the tourist's trip generation model

a. The analysis uses correlation analysis in order to create the trip production and attraction models.
b. Performing t-test
c. Performing F-test
d. Determining the best model
e. Estimating the number of tourist trips based on the best model of trip production and attraction
f. Validating the modeling result

4. Analyzing the tourist's trip distribution model

a. Using a gravity model with ACGR in an Origin-Destination Matrix (MAT) to obtain the tourist's trip distribution
b. Iterating the result of the tourism site modeling area

III. RESULT AND DISCUSSION

3.1 Identification of Tourist Trip's Characteristics

Table 4. Gender Identification

Gender	Number	Percentage (%)
Male	384	52
Female	355	48
Total	739	100

Table 5. Age Identification

Age (year)	Number	Percentage (%)
15 - 25	366	49.5
26 - 35	228	30.9
36 - 45	93	12.6
More than 45	52	7
Total	739	100

Table 6. Income Identification

Income Level	Number	Percentage (%)
Less than IDR 500,000	375	50.7
IDR 500,000 to 999,000	84	11.4
IDR 1 to 2 million	96	13
More than IDR 2 million	184	24.9
Total	739	100

Table 7. Transportation Mode Identification

Transportation Mode	Number	Percentage (%)
Motorcycle	359	48.6
Speed Boat	74	10
Multimode	163	22.1
Car	40	5.4
Motorized Pedicab	17	2.3
Traditional Boat	78	10.6
Others	8	1.1
Total	739	100

Table 8. Trip Distance Identification

Distance	Number	Percentage (%)
Less than 2 km	192	26
2 - 4 km	153	20.7
4,1- 6 km	13	1.8
More than 6 km	381	51.6
Total	739	100

Table 9. Transportation Cost Identification

Transportation Cost	Number	Percentage (%)
Less than IDR 10,000	190	25.7
IDR 10,000 – 50,000	317	42.9
IDR 51,000 – 100,000	45	6.1
More than IDR 100,000	187	25.3
Total	739	100

3.2 *Trip Generation Model*

The best model was determined based on the results of the t-test, F test, coefficient of determination value, and regression constant and coefficient. The result of the t-test is based on the significance value (CeGunawan, 2020).

- If the significance value is > 0.05, H_0 is accepted (independent variables do not affect the dependent variables).
- If the significance value is < 0.05, H_0 is rejected (independent variables affect the dependent variables),

According to CeGunawan (2020), the criteria of the F-test are based on the significance value as follows.

- If the significance value is > 0.05, H_0 is accepted (independent variables do not affect the dependent variables).
- If the significance value is < 0.05, H_0 is rejected (there is at least one influential independent variable),

Tamin (2000) stated that the best model is determined by the coefficient of determination, regression constant, and coefficient following the criteria below.

- The more the variables are used, the better the model becomes.
- The direction of the regression coefficient (+/-) follows the expected direction.
- The smaller the regression constant, or approaching zero, the better the model.
- The coefficient of determination (R^2) is between 0 and 1. The value being equalto 1 or approaching 1 indicates the soundness of the model. The value of 0 indicates that there is no relationship between the independent (or any) variables detected in the regression model.

a) Trip Production Model

Table 10. Trip Production Model

No	Equation	R^2	t-Test		F Test
			Coefficient of Correlation	Sig. Value	Sig. Value
1	$Y = -0.628 + 0.947x_2 + 0.090x_3 + 0.798x_4$	1	0.947	0.007	0.000
			0.090	0.061	
			0.798	0.123	
2	$Y = -0.051 + 1.343x_1 + 0.851x_2 - 0.266x_4$	1	1.343	0.156	0.001
			0.851	0.037	
			0.851	0.381	
3	$Y = -0.618 + 1.662x_1 + 0.797x_2$	1	1.662	0.036	0.001
			0.797	0.003	
4	$Y = -0.291 + 1.013x_2$	1	1.013	0.000	0.000

Based on the conditions for the best model determination, the following equation was selected.

$$Y = -0.618 + 1.662x_1 + 0.797x_2$$

Table 11. Validation Result of Trip Production Model

Zone	Survey Result	Analysis Result	Difference	Validation
1	502	501.93	0.01%	0.01% < 5%
2	16	16.32	2.02%	2.02% < 5%
3	5	5.03	0.58%	0.58% < 5%
4	16	15.46	3.39%	0.58% < 5%
5	200	200.33	0.17%	0.17% < 5%

b) Trip Attraction Model

Table 12. Trip Attraction Model

No	Form of Model	R^2	t-Test		F Test
			Coefficient of Correlation	Sig. Value	Sig. Value
1	$Y = 238.245 + (1.699\text{E}-5)x_1 + 1.735x_4 - 5.885x_8$	1	1.699E − 5	-	-
			1.735	-	
			5.885	-	
2	$Y = 250.926 - (6.826\text{E}-6)x_1 + 2.153x_6 - 5.386x_8$	1	6.826E − 6	-	-
			2.153	-	
			5.386	-	
3	$Y = 244{,}021 - (1{,}162\text{E}-7)x_1 + 1{,}691x_3 - 5{,}327x_8$	1	1.162E − 7	-	-
			1.691	-	
			5.327		
4	$Y = 244.014 - 0.110x_2 + 1.591x_3 - 5.325x_8$	1	0.110	-	-
			1.591	-	
			5.325	-	
5	$Y = 244.292 + 1.670x_3 + (1.538\text{E}-5)x_7 - 5.405x_8$	1	1.670	-	-
			1.538E − 5	-	
			5,405	-	
6	$Y = 243.215 + 1.660x_3 + 0.071x_5 - 5.503x_8$	1	1,660	-	-
			0,071	-	
			5,503	-	
7	$Y = 244.348 + 1.646x_3 - 5.350x_8$	1	1,646	0,017	0,002
			5,350	0,002	
8	$Y = 261.898 - 5.704x_8$	1	3,612	0,003	0,003

Next, based on the considerations that the best model be selected based on the criteria of coefficient of determination, regression constant and coefficient, the equation below was selected.

$$Y = 244.348 + 1.646x_3 - 5.350x_8$$

Table 13. Validation Result of Trip Attraction Model

Tourism Site	Survey Result	Analysis Result	Difference	Validation
Army Dock	238	238.09	0.04%	0.04% < 5%
Waterfront City	266	265.75	0.09%	0.09% < 5%
Dodola Island	204	204.22	0.11%	0.11% < 5%
Moro Ma Doto	31	30.92	0.24%	0.24% < 5%

3.3 Trip Distribution Model

a. Survey Result

The following data was acquired from the questionnaire.

Table 14. Actual Trip / Origin-Destination Matrix (MAT)

Destination / Zone of Origin	Army Dock	Waterfront City (Morotai Park)	Dodola Island	Moro Ma Doto	Number (O_i)
1	188	202	99	13	502
2	5	6	1	4	16
3	2	1	2	0	5
4	7	2	7	0	16
5	36	55	95	14	200
Total (D_i)	238	266	204	31	739

Table 15. Average Trip Distance (Cid)

Destination / Zone of Origin	Army Dock	Waterfront City (Morotai Park)	Dodola Island	Moro Ma Doto
1	3.84	1.48	13	40.76
2	31.36	29.50	39.80	4.82
3	61.60	63.60	66.8	0
4	19.79	20.62	15.20	0
5	567.42	500.65	266.34	1018.27

b. Modeling of Trip Distribution using Attraction Constrained Gravity (ACGR)

Trip distribution is a stage of transportation modeling that connects land usage, transportation networks, and traffic in a certain area and at a certain time (Tamin, 2000). According to Amijaya (2018), the modeling of trip distribution using the gravity method requires resistance function and distance matrix data in its process of analysis. The resistance function calculation in this research uses the trip distance data of tourists coming from Morotaiisland (the internal zone). Microsoft Excel was used in the creation of the gravity model and the resistance function at the distance interval of 5-10 km. The best distance interval was determined based on both the smallest chart result and the Sum Square Error, by which the following best exponential resistance function was acquired.

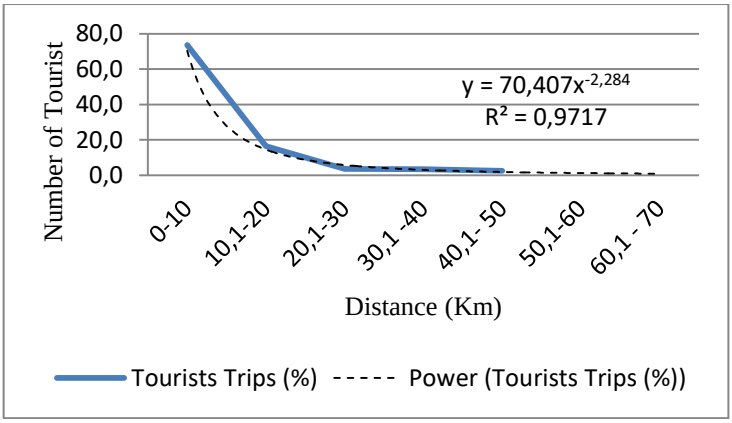

Figure 2. Chart of Rank Resistance Function at the Distance Interval of 10 km

Then, gravity model analysis was performed using the following equation.

$$T_{id} \approx Oi \,.\, Dd \,.\, A_i . B_d . f(C_{id}) \quad (1)$$

Where:

T_{id} = trip from zone of origin *i* to destination *d*
O_i = number of trips from zone *i*
D_d = number of trips to zone *d*
$f(C_{id})$ = resistance function
$A_i = 1$ for all *i*
$B_d = \frac{1}{\sum_i (A_i O_i f_{id})}$ for all *d*.

$B_d$is a constant stating that "the matrix's column number must equal the number of columns from the trip generation result".

The data and formula of ACGR were used in analyzing the trip distribution of tourists in Morotai Island regency, and the following results were obtained.

Table 16. Result of Trip Distribution using ACGR Model

Zone	Army Dock	Waterfront City (MorotaiPark)	Dodola Island	Moro Ma Doto	o_i	O_i	A_i	E_i
1	238	266	199	6	709	502	1	0.71
2	0	0	1	25	26	16	1	0.64
3	0	0	0	0	0	5	1	95.57
4	0	0	4	0	5	15	1	3.43
5	0	0	0	0	0	200	1	2406.30
d_d	238	266	204	31	739			
D_d	238	266	204	31		739		
B_d	0.000011	0.00002	0.00180	0.00476				
E_d	1	1	1	1				1

Then, iteration was conducted to obtain a convergent matrix. This research uses the following Detroit formula.

$$T_{id} = t_{id} \frac{E_i . E_d}{E} \quad (2)$$

Where;

T_{id} = future trip from zone i to destination zone d
t_{id} = present trip from zone i to destination zone d
E_i, E_d = growth rate of zones i and d
E = global growth rate

Following the ACGR matrix iteration, subsequent 22 iterations were performed, whose results are presented below.

Table 17. Final Result of Trip Distribution using ACGR

Zone	Army Dock	Waterfront City (MorotaiPark)	Dodola Island	Moro Ma Doto	o_i	O_i	E_i
1	217	259	24	3	503	502	1
2	0	0	0	16	16	16	1
3	2	0	3	0	5	5	1
4	3	1	11	0	15	15	1
5	16	5	166	12	199	200	1
d_d	238	266	204	31	739		
D_d	238	266	204	31		739	
E_d	1	1	1	1			1

IV. CONCLUSION

Based on the analysis and discussions in the estimation of trip generation and distribution modeling for the Morotai Island regency tourism region, the following conclusions were made.

1) Most of the trips to the tourism sites were made by males (52%), people considered as youth (49.5%), people with an income of less than IDR 500 thousand (50.7%). The trips were also made mostly by motorcycles (48.6%), by people living within 6 kilometers of the sites (51.6%), and by those who spent IDR 15 to 50 thousand on transportation (42.9%).

2) The trip generation was acquired from the results of zonal linear regression analyses. The trip production is in the range of 5 to 502 people per hour, obtained from the $Y = -0.618 + 1.662x_1 + 0.797x_2$

function with the $R^2 = 1$. The trip attraction is at the range of 31 to 239 people per hour, obtained from $Y = 244.348 + 1.646x_3 - 5.350x_8$ function with the $R^2 = 1$.

3) Factors affecting the tourist's trip are income and transportation modes, which means that the higher the income, the higher the trip to the destination. In addition, the availability of the transportation mode is also influential on the visit rate. The factors influencing the trip attraction based on the tourism site's land usage are number of culinary centers and distance from city centers, which means the location of the sites and the availability of culinary centers affect the tourist's trip attraction.

4) The form of the Origin-Destination Matrix (MAT) with the exponential resistance function's coefficient value at the 10 km distance interval is $Y = 70{,}407X^{-2{,}284}$ with the $R^2 = 0.9717$. The largest trip distribution was obtained by Waterfront City (Morotai Park), with a number of trips of 238 people per hour. Since this place is located at the city center (zone 1), most trips come from that area. The smallest trip distribution was obtained by Moro Ma Doto. As the place is in zone 5, far from the city center, and the as people should pay more for the ticket, the trip is dominantly from zone 5.

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