COMPARISON OF REGRESSION ANALYSIS FOR REGIONAL FREIGHT GENERATION MODELING OF TRANSPORT PLANNING

by

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ABSTRACT

This paper proposes a commodity trip generation model in such a way that the movement of commodities is explained by aggregate commodities production and attraction by zonal. The proposed model is a modification the first step of traditional four-step approach, which utilizes regression analysis. Regression analyses correlate freight production and freight attraction based on land use and natural resource productivity of the selected region. The analysis compared of eight regression model and within eight parameters. The research shows that the most significant variable is the length of asphalt road for freight production, and the covered industrial floor area for freight attraction.

KEYWORDS
Freight Generation, Archipelagic Region, Commodities, Non-Linear Regression Analysis

INTRODUCTION

Evolution in freight transport model has been made for decades to describe transport system. The earliest model estimated freight transportation as the percentage of passenger trips for the traditional four-step approach model. The current freight demand modeling tends to model truck flows explicitly. This type of models categorized into two groups: trip-based and commodity-based approaches (de Jong, Gunn, & Walker, 2002). Trip-based approached mostly deals with truck trips at the aggregate level. The truck trips are generated directly from the factors such as Gross Domestic Product (GDP) (Holguin-Veras, Sarmiento, Gonzalez, Thorson, & Sanchez, 2010), number of employees (Holguin-Veras, Jaller, Destro, Ban, Lawson, & Levinson, 2011), floor area, and any other related factors without concerning the amount of commodity production and consumption (Wisetjindawat, Sano, Matsumoto, & Raothanachonkun, 2007), where the most frequently used model is a constant freight trip generation (FTG) rate as function of a single independent variable (Holguin-Veras, Jaller, Destro, Ban, Lawson, & Levinson, 2011). The model applied the traditional four-step approach including trip generation, trip distribution, and traffic assignment. However, the limitation of trip-based approaches is that difficult to evaluate logistic policies because the trips are derived directly from the empirical data. In addition, it should be noted that the freight transportation is originated from the movement of commodities (Wisetjindawat, Sano, Matsumoto, & Raothanachonkun, 2007). To overcome the drawback of trip-based approach, commodity-based approach focuses on the movement of commodities. At the stage of trip generation, the approach generates the level of commodity production and consumption. Consequently, they require the additional stage for the conversion of the commodity flows to vehicle tours (Wisetjindawat, Sano, Matsumoto, & Raothanachonkun, 2007).

DESCRIPTION OF THE DATA

Geographic Conditions

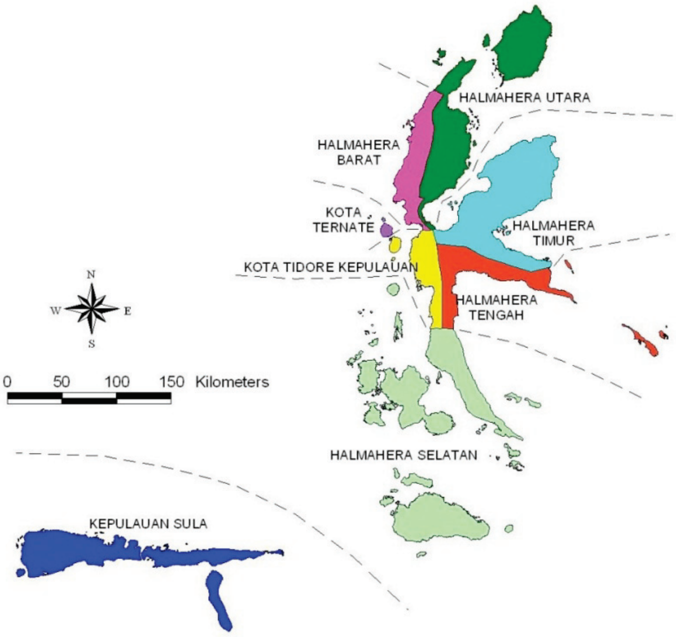
This section described the study area as outlined in the description of the administration area and archipelagoes in the North Maluku province, demographic, socioeconomic, transportation services, network services and transport infrastructure networks in North Maluku archipelago.

The geographical position North Maluku Province located between 3° North latitude - 3° South latitude and 124° - 129° East Longitude, with administrative boundaries as follows:

North :	Pacific Ocean
South :	Seram Sea
East :	Halmahera Sea
West :	Maluku Sea

As seen in figure 1, geographical conditions North Maluku Province concerning the whole the region is an area of land and sea, where approximately 76.2 percent of the province of North Maluku is the sea, the remaining 23.8 percent is land, while the remaining 23.8 percent of the islands consist of large and Small Island. For the purpose of calculation, we divide North Maluku into 9 zones, as seen in table 1. For further calculation, we divide North Maluku into 9 zone based on Regency or City as a small units (Indonesian Statistics, 2010).

FIGURE 1
ZONING CORDON SYSTEM (NORTH MALUKU PROVINCE OF INDONESIA)



The total area of the North Maluku province is 140,366.32 km^2, the provincial capital is Ternate. Administratively, the province is divided into 6 Regencies and 2 cities. The Regency/city consists of 109 Regencies and 1043 villages/urban village (Indonesian Statistics, 2010).

TABLE 1
NORTH MALUKU REGIONAL AREA BY DISTRICT YEAR 2006

Zone	Regency/City	Area (km2)	Land Area (km2)	Distance to capital (km)
1	West Halmahera	15.023,16	2.612,24	38,6
2	Central Halmahera	8.381,20	2.276,83	54,5
3	Sula Islands	19.698,28	9.632,92	360,9
4	South Halmahera	40.376,89	8779,32	153,2
5	North Halmahera	22.463,72	5447,30	118,2
6	East Halmahera	14.402,02	6.506,20	75,1
7	Morotai Island	2.314,90	2314,90	168,2
8	Ternate City	11.615,75	250,85	25,8
9	Tidore Island City	6.090,40	9.564,00	20,5
		140.366,32	45.069,66	

Source: North Maluku in Figures 2006

Population

In 2010, population of Maluku Utara according to the result of Population Census 2010 is 1.038.087 persons distributed into 9 regencies/ municipalities. Most of population is 198.911 people in South Halmahera Regency. The distribution of the population in the province of North Maluku is very uneven (see table 2). When the number of residents per Regency / city covers an area compared, it will be seen the highest population density per km2 in the city of Ternate, in the amount of 663.77 km2.

Population labor forces in North Maluku by year 2011 are 1.038.087 inhabitants, when the entire population of working age, who entered the labor force, numbered 411,361 or more than 39.62 percent of the entire population of working age (table 3). In terms of jobs, some of the residents North Maluku working in the agricultural sector that is 238,792 people 58.05 percent of the working population. Other sectors which also absorb considerable manpower are the trade and services sector (Indonesian Statistics, 2010).

TABLE 2
POPULATION COMPARISON AND FREIGHT PRODUCTION BY REGENCY

Regency/City	Capital Regency	Area (km²) 2006	Area (km²) 2011	Population year 2006 (person)	Population year 2011 (person)	Freight Production 2006 (ton)	Freight Attraction 2006 (ton)	Freight Production 2011 (ton)	Freight Attraction 2011 (ton)
West Halmahera	Jailolo	2.897,58	2.612,24	96.724	100.424	31.200	35.047	35.913	43.101
Central Halmahera	Weda	2.276,65	2.276,83	33.410	42.815	123.423	135.139	152.456	153.504
Sula Islands	Sanana	4.977,50	9.632,92	129.090	132.524	8.494	8.392	12.634	11.246
South Halmahera	Labuha	9.888,21	8.779,32	184.860	198.911	24.136	23.817	41.570	28.946
North Halmahera	Tobelo	10.497,72	5.447,30	187.375	161.874	30.918	28.777	32.544	27.553
East Halmahera	Maba	6.506,20	6.506,20	64.922	73.109	9.866	8.338	15.613	10.813
Morotai Island *)	Daruba	-	2.314,90	-	52.697	-	-	9.875	9.660
Ternate City	Ternate	1.122,98	250,85	166.506	185.705	113.845	89.365	114.969	111.444
Tidore Island City	Soa Sio	1.797,18	9.564,00	81.389	90.055	109.421	122.428	125.383	144.690
Total		39.964,02	45,070,66	944.276	1.038.087	451.303	451.303	540.957	540.957

Source: North Maluku in Figures; * regional expansion from North Halmahera into Morotai Island

TABLE 3
NUMBER OF LABOR BY REGENCY

Regency/City	Labor 2006	Labor 2011
West Halmahera	42 604	44 690
Central Halmahera	12 806	16 713
Sula Islands	53 482	45 545
South Halmahera	76 499	82 098
North Halmahera	81 116	60 099
East Halmahera	25 565	30 744
Morotai Island	-	19 544
Ternate City	71 085	75 301
Tidore Island City	33 165	36 627
Total	396 322	411 361

Source: North Maluku in Figures

Production of Natural Resources

In general, productions of natural resource in North Maluku province are paddy, cassava and sweet potato, while in agriculture sector North Maluku produce: orange, coconut, cocoa, coffee, clove and nutmeg. As an archipelagic province, North Maluku produced marine fisheries and inland water fisheries total 215.415 tons (Indonesian Statistics, 2010).

TABLE 4
PRODUCTION OF FOOD NATURAL RESOURCES AND NUMBER OF INDUSTRY

Regency/City	Food 2006 (Tons)	Food 2011 (Tons)	Agriculture 2006 (Tons)	Agriculture 2011 (Tons)	Fishery 2006 (Tons)	Fishery 2011 (Tons)	Industry 2006 (M²)	Industry 2011 (M²)
West Halmahera	31.110	22.710,0	19.022	25.171,0	130.895	17.063,7	7.571	4.462
Central Halmahera	30.729	32.836,0	8.093	23.913,0	9.144	11.650,6	1.112	1.233
Sula Islands	23.327	13.549,0	64.931	98.168,3	16.046	54.820,0	2.332	3.404
South Halmahera	34.260	37.457,0	22.000	36.216,0	28.938	54.047,1	9.795	1.581
North Halmahera	47.220	59.345,0	89.011	86.660,0	25.059	31.227,9	9.728	7.906
East Halmahera	51.850	40.142,0	5.964	10.951,0	11.479	11.286,0	5.454	1.729
Morotai Island	-	69,0	-	12 247,0	-	15 117,0	-	13
Ternate City	7.091	1.611,0	1.344	1.320,0	13.064	18.987,1	3.216	15.008
Tidore Island City	13.103	14.426,0	10.545	2.030,0	12.968	16.332,6	4.998	34.130
Total	238 690	222.076	220.910	284.429,3	247.595	215.415,0	44.207	69.466

Source: North Maluku in Figures

Economics Condition

In general it appears that the economy North Maluku Province on the basis of constant prices in 2010 increased by 7.96 percent from a year earlier. The highest portion contributed by the agricultural sector at 36.37 percent, followed by trade, hotels and restaurants with a contribution of 23.44 percent (Indonesian Statistics, 2010). While the highest sectoral growth experienced by the mining and excavation sector with 13.05 percent. Meanwhile based on National Social Economic Survey, it can be derived average monthly per capita expenditure for a region, which consists of two groups of commodity, Food and Non Food. In 2010, the percentage of Maluku Utara population expenditure to food is still lower than expenditure for non food, which is 56.72 percent and 43.28 percent respectively.

TABLE 5
COMPARISON OF GDP PER CAPITA OF NORTH MALUKU PROVINCE BY CONSTANT PRICE OF YEAR 2000 IN RUPIAH

Regency/City	GDP (MILLION Rp.) 2006	Expenditure 2006	GDP (MILLION Rp.) 2010	Expenditure 2010
West Halmahera	198 342	253 173	227.767,85	443 097
Central Halmahera	196 819	227 103	233.864,76	423 985
Sula Islands	282 367	235 825	332.792,56	547 398
South Halmahera	476 879	215 008	563.487,07	424 819
North Halmahera	413 917	238 676	501.283,67	324 384
East Halmahera	205 598	277 653	252.789,88	543 359
Morotai Island	-	-	104 437,13	350 195
Ternate City	478 659	511 616	602.510,46	730 575
Tidore Island City	225 730	339 297	267.094,52	508 711
Total	2 478 311	2 298 351	2.981.590,77	4 296 523

Source: North Maluku in Figures

Infrastructures

TABLE 6
COMPARISON OF LENGTH OF ROADS AND GOOD ASPHALT CONDITION BY REGENCY

Regency/City	LENGTH 2006	ASPHALT 2006	LENGTH 2010	ASPHALT 2010
West Halmahera	127,92	8,30	127,09	24,49
Central Halmahera	49,00	4,00	50,00	11,50
Sula Islands	122,23	12,05	367,23	66,23
South Halmahera	18,32	0	408,00	56,00
North Halmahera	283,73	35,00	231,30	38,30
East Halmahera	202,47	4,75	166,00	4,75
Morotai Island	-	-	55,08	10,00
Ternate City	48,70	00,00	16,60	16,60
Tidore Island City	160,68	16,01	16,01	16,01
Total	689,17	80,11	1 382,23	243,88

Source: North Maluku in Figures

REVIEW OF FREIGHT GENERATION RESEARCH

The existing literature about traffic generation has a strong focus on passenger transport. Freight demand modeling is still less advanced than passenger demand modeling (Ortuzar & Willumsen, 1994).

Geographically the North Maluku is an archipelagic province while the boundaries between city and regency are above the sea. This characteristic is one of particular concern in model implementation. To begin with, this research implements four steps model transportation (generally first step is freight generation, second step is freight distribution, third step is modal split and the fourth step is trip assignment).

There are four types in this model, where every type is distinguished from which step the modal split started. First type modal split start together with freight generation, second type modal split start after freight generation but before freight distribution, third type modal split start after freight generation and together with freight distribution, and fourth type modal split start after freight generation and freight distribution separately (Kusdian & Triwidodo, 2009), and this research tends to use the fourth type.

Freight Generation Model

Freight generation is used to predict the amount of freight generated for a particular zone conditions. The purpose of this step is to understand the reason behind the freight/trip-making behavior and to produce mathematical relationships to synthesize the freight making pattern on the basis of observed trips, land use and economic activity in a specific zone. There are two methods to predict freight generation, based on residential-based using category analysis and non-residential-based using regression analysis, and this research using non-residential-based and using regression as an analysis method.

In freight generation model, there are factors that affect the movement of freight which are labor force, numbers of commercial floor area, numbers of industrial floor area, total coverage areas per zone (Tamin O. Z., 2008). Since the number of natural resource in study area much higher than number of industrial area coverage, we consider to add the productivity of natural resources as predictor factors.

Movement patterns in the transport system is often described in terms of current movements (vehicles, passengers, and freight) that moves from the zone of origin to destination zone in certain areas and during certain periods. Movement patterns are usually displayed in a matrix form, better known as the matrix or matrices movement of Origin Destination.

If an area which divided into zones, two of which are the zones i and j, then the amount of movement of freight which come out of the zone i and j is denoted as O_i and O_j. The amount of movement of freight which go to zone i and j is denoted as Di and Dj. While the amount of movement of freight from zone i to j is denoted as T_{ij} (Research and Development Bureau of Ministry of Transportation, 2005).

According to (Tamin O. Z., 2000), the strong variables that affecting freight production and attraction logistics are: jobs availability, production of agriculture and fishery, numbers of trading, numbers of industry, and total regions.

Regression Analysis

The using of regression analysis as a method for obtaining model for trip generation and distribution, this is one of many method used by researcher. The regression analysis is to obtain a mathematical relationship by assuming the validity of a particular type of relationship, which is linear in the unknown parameters. The parameters of the unknown is then expected under other assumptions with the help of available data thus obtained the equation. Benefits derived equations that can be measured, and checks can be made to the assumptions underlying the estimates had to be seen whether the assumptions that seem to be acceptable or not.

There are two types of variables, i.e. variables forecasters (predictor variables) or independent variables (independent variables), and the response variable (response variable) or a variable are not free (independent variable). The meaning of forecasters variables usually are variables whose value can be determined or regulated or which its value can be observed but cannot be controlled. As a result of which intentional change, or which occur at variable forecaster, an influence or effect transmitted to the other variables, namely the response variable. Regression equations obtained can be used to determine the extent of the influence of free variables which not independent variables expected against.

The general form as follow:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n \quad \text{linear (1)}$$
$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_1^2 \quad \text{quadratic (2)}$$
$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_1^2 + \beta_3 X_1^3 \quad \text{cubic (3)}$$
$$Log\ Y = \beta_0 + \beta_1 \log X_1 \quad \text{logarithmic (4)}$$
$$Y = \beta_0 + (\beta_1 / X_1) + (\beta_2 / X_1^2) \quad \text{inverse (5)}$$

Where:

Y = dependent variable;
$X_1, X_2, ..., X_n$ = independent variable;
$\beta_0, \beta_1, ..., \beta_n$ = parameters/variables;

This model is trying to find a linear relationship between the number of trips generated which separated by a zone and socioeconomic characteristics of the population in each zone and to determine the appropriate model.

Determined of the regression model selected

We create option from the equation models from many alternatives model correlation result between variables, have to be chosen considered the most representative freight production and freight attraction model in the study area, with the limitation of criteria shown below:

- The correlation and coefficient determination (R^2) value is closed to 1 or more than 0.7 (in some transport research minimum 0.3 still take consider).
- The coefficient of independent from the equation have to be logic, it means that the value of independent variable have to be positive.
- The t-test.
- The F-test.
- The result of percentage deviation value from regression model 2006 compared to observed model 2011, with the value from trip generation and trip distribution closed to zero respectively.

RESULT AND ANALYSIS

Freight Generation

Based on the secondary data of North Maluku province, we tried to find appropriate linear model for freight generation analysis and based on many alternate regression model in equation (1) – (5). Since freight generation analysis divided into two model, freight production and freight attraction, the two models describe as follows:

Freight Production

TABLE 7
FREIGHT PRODUCTION CORRELATION RESULT FOR THE YEAR 2006

	production (Y)	**Total areas (X_1)**	**Labors (X_2)**	**Commercial (X_3)**	**Industrial (X_4)**	**Roads (X_5)**	**Fishery (X_6)**	**Plantation (X_7)**	**Agriculture (X_8)**
Y	1								
X_1	-0.70	1.00							
X_2	-0.30	0.55	1.00						
X_3	-0.60	**0.77**	0.60	1.00					
X_4	-0.52	0.74	0.59	0.58	1.00				
X_5	-0.56	0.59	0.66	0.71	0.35	1.00			
X_6	-0.29	-0.09	0.03	0.05	0.39	0.02	1.00		
X_7	-0.51	0.62	0.52	**0.96**	0.35	**0.76**	-0.02	1.00	
X_8	-0.65	0.73	-0.05	0.49	0.49	0.06	0.08	0.34	1.00

Source: Processed

TABLE 8
FREIGHT PRODUCTION REGRESSION MODEL 2006 POSSIBILITIES

No.	Alternate model	β_0	β_1	β_2	β_3	R^2	F	t
1.	Linear	103897.197	-9.505			0.486	5.671	-2.381
2.	quadratic	179395.362	- 49.579	0.003		0.823	11.657	-3.752, 3.091
3.	Linear	85882.715	-0.596			0.091	0.600	-0.774
4.	cubic	261415.150	-14.739	3.099E-4	-2.004E-9	0.287	0.537	-0.972, 0.836, 0
5.	linear	112818.91	-1.252			0.362	3.411	-1.847
6.	cubic	375978.310	-15.284	2.04E-4	-8.5945E-10	0.780	4.736	-1.169, 0.788
7.	linear	100147.331	-7.914			0.272	2.236	-1.495
8.	logarithmic	355189.129	-35531.769			0.292	2.470	-1.572
9.	linear	93241.556	-1.208			0.311	2.710	-1.646
10.	cubic	-3405.931	11.065	-3.67E-4	3.08E-9	0.553	1.647	1.311, -1.363,
11.	linear	67282.478	-0.351			0.083	0.545	-0.739
12.	quadratic	134383.563	-5.1067	3.300E-5		0.321	1.183	-1.411, 1.324
13.	linear	78467.202	-0.799			0.260	2.113	-1.453
14.	cubic	110598.538	-4.579	5.682E-5	-1.722E-10	0.433	1.016	-0.829, 0.383
15.	linear	119113.689	- 2.102			0.419	4.321	-2.079
16.	cubic	204126.712	-14.289	4.455E-4	-4.672E-9	0.469	1.176	-0.660, 0.527

Source: Processed

We simulate the freight production using regression analysis from equation (1) to (5), but before we reach into the alternate model, we limited the statistical tests as shown in subsection 3.3. This study try to determine the best model which affect freight generation in North Maluku Province using variables Trip Production as Y, total areas, labors, total commercial areas, total industrial area, roads, fishery, plantation, and agriculture. We represent the variables into notation (X_n), and the correlation analysis is shown in table 7.

Table 7 also shows the correlation result between variables, which the value of Y affected by the correlation value and sorted from the highest: X_1, X_8, X_3, X_5, X_4, X_7, X_2, and X_6. The co linearity must be avoided, we must make decision approach that the limit of co linearity assumes that has correlation value above 0, 75, so from the regression model that have not pairs between:

$X_1 - X_3$; $X_3 - X_7$; $X_5 - X_7$

From the three constraints above, we can make alternatives combined regression model possibilities: 2n-1, as seen in table 8.

Freight Attraction

TABLE 9
FREIGHT ATTRACTION CORRELATION RESULT FOR THE YEAR 2006

	Attraction (Y)	Total areas (X_1)	Commercial area (X_2)	Industrial (X_3)	Asphalt (X_4)	Fishery (X_5)	Plantation (X_6)	Agriculture (X_7)
Y	1.00							
X_1	-0.68	1.00						
X_2	-0.58	**0.77**	1.00					
X_3	-0.51	0.74	0.58	1.00				
X_4	-0.55	0.59	0.71	0.35	1.00			
X_5	-0.25	-0.09	0.05	0.39	0.02	1.00		
X_6	-0.49	0.62	**0.96**	0.35	**0.76**	-0.02	1.00	
X_7	-0.58	0.73	0.49	0.49	0.06	0.08	0.34	1.00

Source: Processed

TABLE 10
FREIGHT ATTRACTION REGRESSION MODEL 2006 POSSIBILITIES

No.	Alternate model	β_0	β_1	β_2	β_3	R²	F	t
1.	linear	104023.990	-9.531			0.458	5.073	-2.25
2.	cubic	137202.816	-15.937	-0.003	3.598E-7	0.718	0.968	-0.231, -0.223, 0.437
3.	linear	112670.103	-1.249			0.338	3.065	-1.75
4.	quadratic	257179.781	-7.448	5.321E-5		0.652	4.679	
5.	Linear	100447.1	-7.969			0.258	2.088	-1.44
6.	inverse	23824.484	1.105E8			0.333	2.994	1.73
7.	linear	94100.634	-1.236			0.306	2.640	-1.62
8.	cubic	-1568.532	10.979	-3.672E-4	3.109E-9	0.529	1.495	
9.	linear	66287.984	-0.319			0.065	0.414	-0.64
10.	quadratic	138030.660	-5.404	3.529E-5		0.320	1.174	
11.	linear	78237.981	-0.790			0.239	1.886	-1.37
12.	cubic	96449.190	-2.582	9.092E-6	1.304E-10	0.336	0.676	
13.	linear	113993.296	-1.930			0.331	2.970	-1.72
14.	cubic	136890.303	-5.630	1.48E-4	-1.675E-9	0.335	0.672	

Source: Processed

Meanwhile for determining freight attraction, we use the same procedure with freight production but we deleted labors variable because freight attraction zones attract people from production zones to move. The best model which affects trip attraction in North Maluku Province using variables Trip Attraction as Y, length areas, length of commercial floor, length of industrial floors, asphalt roads, fishery, plantation, and agriculture. We represent the variables into notation (X_n) and the result from correlation analysis is in table 9.

Table 9 shows the correlation result between variables that the value of Y affected by the correlation value and sorted from the highest: X_1, X_2, X_7, X_4, X_3, X_6, and X_5. Same with trip production above, the colinearity of trip attraction must be avoid, we must make decision approach that the limit of colinearity assume that has correlation value above 0,75, so from the regression model that have not pairs between:

$X_1 - X_2$; $X_2 - X_6$; $X_4 - X_6$

From the three constraints above, we can make alternatives combined regression model possibilities: 2n-1, as seen in table 10.

Development Regression Model

From the list of alternate regression model shown in table 8 and 10, we shorten the list from the criteria of deviation percentage mentioned above and we choose two models, each from trip production and trip attraction mentioned in table 8 and 10, and the trip generation chosen shown below:

Freight Production model

From many alternatives regression models in table 8, we choose four models that has the highest value of coefficient determination (R^2). Then the alternate model forecasted to 2011 socio economics data and we check the percentage deviation as seen on figure 2. The result of deviation shown in table 8, then we chooses the cubic model that has lowest deviation. Based on those criteria, the chosen model of trip production is:

$$Y=-3405.931 + 11.065X_5 -3.67E\text{-}4X_5^2+3.08E\text{-}9X_5^3$$

Where X^5 = asphalt roads

This model has coefficient determination (R^2) = 0.553. The t value X^5 = 1.36> from t table (1.143) for degree of freedom 5 and the level of confidence 95%, it means the coefficient value X_5 (asphalt roads) is significant attracted to freight and increased over time.

Freight Attraction model

From alternatives regression models in table 10, we has four models that has significant value of coefficient determination (R^2). Then the alternate model forecasted to 2011 socio economics data and we check the percentage deviation as seen on figure 3. The result of deviation shown in table 10, we choose inverse model that has lowest deviation. Based on those criteria, the chosen model of trip attraction is:

$$Y = 23824.484 + (1.105E8 / X_3)$$

Where X_3 = industrial floors

This model has coefficient determination (R^2) = 0.333. The t value X_3 = 1.73> from t table (1.70) for degree of freedom 4 and the level of confidence 95%, it means the coefficient value X_3 (industrial floor) is significant attracted to freight and increased over time.

Calibration Ratio of the regression model

From the freight production and attraction chosen models 2011 above, we predict and calibrated using observed OD data 2011. The best value of predicted regression model is intersect with the observed model, as seen on figure 2 and 3.Using criteria choose the determination coefficient value (R^2) > 0.3 (Tamin O. Z., 2000).

FIGURE 1
CORRELATION OF FREIGHT PRODUCTION OBSERVED AND PREDICTED

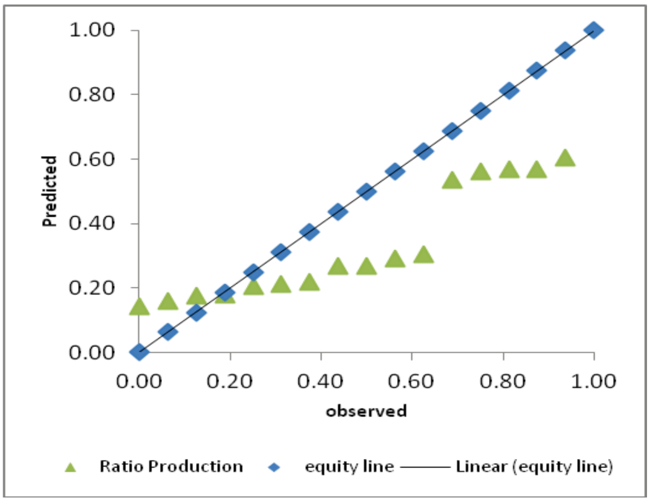
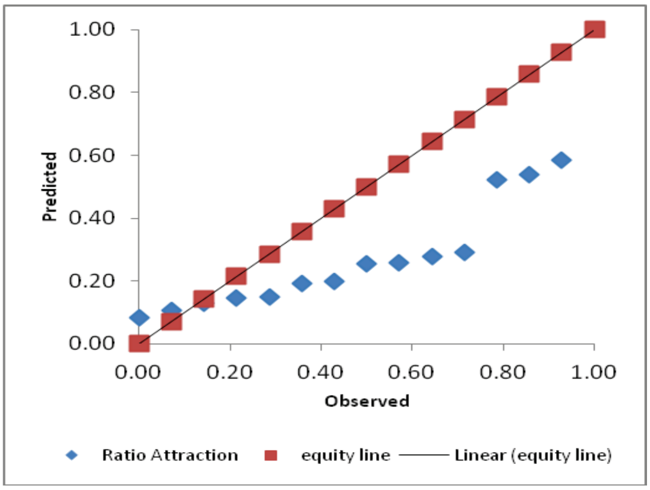


FIGURE 2
CORRELATION OF FREIGHT ATTRACTED OBSERVED AND PREDICTED



We figured out the best predicted freight production model ratio which is has lowest ratio value 0.19. and freight attraction model ratio, which is has the lowest ratio value 0.8 between predicted and observed data 2011.

CONCLUTION

The result of the research is a unique set of statistics about the pattern of freight generation model. The result shown here indicated that regression analysis provides as a basis for estimating the amount of freight generated model. Non-linear regression using cubic and inverse function result in this research show more accurate than the other regression analysis even they are not have the best coefficient determination (R_2).

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