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Travel Growth Analysis of Activity Systems for the Need for A Mass Transport System in Serang Center

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ABSTRACT

Serang City is preparing for the development of infrastructure and road networks so that every area in Serang City can be well integrated. Serang City has 6 sub-districts, including the center of national activities, and is a big city because it has a population of around 652,192 people (BPS, 2019). By knowing the growth of the LHRT, the generation and attraction models of movement in the city center, are based on the direction of the zone under review, namely north, west, east, and south in the internal zone of Serang City and the external zone around Serang City. The multiple regression analysis methods on the generation and attraction models of movement which are analyzed based on socio, economic and demographic variables with dominant factors. The independent variables measured were the number of residents (X1), the number of health facilities (X2), the number of schools (X3), the number of workers (X4), GRDP (X5), and the dependent variable is the amount of daily average annual traffic (Y). The results of the equations of motion obtained are 4 generation equations, 4 pull equations, and the value of the determinant of each equation.

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1. BACKGROUND

Indonesia's well-developed economy has encouraged more massive infrastructure development in each region, especially the capital city which is the center of activity for each province, one of which is Serang City, which is the capital city of Banten province, Indonesia. The development of Serang City itself has not been so rapid, this is an advantage to prepare for the development of Serang City (Nurfindarti, 2019).

Serang City has 6 sub-districts with a total area of Serang City of around 266.7 km2. According to data of BPS, 2019 Serang City is a big city because it has a population of around 652,192 people. The city of Serang is a national activity center, where urban areas function as the main node for export-import activities, the center for industrial activities, and the main transportation node.

The city development concept for Serang City is Smart and Compact Cities (Rosalina et al., 2020; Wibowo, 2018). Technology that is advancing rapidly is the main reason, the purpose of the concept is to utilize technological advances and focus on high-density development, and the City of Serang must be transit-oriented development (TOD) by increasing the intensity of the basic coefficients and building coefficients.

City development also needs to be supported by infrastructure and road networks, so that every area in Serang City can be well integrated. Advanced urban infrastructure is essential for economic growth and quality of life (Salimi and Al-Ghamdi, 2020; Wang et al., 2020). An important part of this infrastructure is efficient urban mobility, which requires an effective public transportation system (Ceder, 2021; Currie, 2018; Golbabaei et al., 2021)

Based on the background that has been stated above, the formulation of the problem is made as follows:

1. Serang City is not ready to become a Modern City, because it has not implemented Transit-Oriented Development (TOD). (Ferza et al., 2019)
2. The population of Serang City increases every year, causing an increase in traffic density every year.

The research objectives are as follows:

1. Knowing and analyzing the increase in population, vehicles, and other variables reviewed in Serang City in 2030
2. Formulate the generation and attraction model of the movement generated in the center of Serang City

Annual average daily traffic data is used to express the generation and pull of current movements, which will be used to forecast future movements or the next 10 years in this study (Rahmawati et al., 2013). The variables analyzed were based on socio, economic and demographic variables with dominant factors, as well as growth values using the average method. [4,5,6]

2. LITERATURE REVIEW

2.1. Serang City Overview

Serang City is the capital city of Banten Province, Indonesia. The city is located in the northern part of Banten Province and is surrounded by Serang Regency in the south, west, and east, and the Java Sea in the north. The city of Serang is crossed by the Jakarta–Merak Toll Road. Serang City is an autonomous region resulting from the division of Serang Regency. Serang City consists of 6 sub-districts, namely Serang District, Cipocok Jaya District, Curug District, Kasemen District, Taktakan District, Walantaka District [4,5,9].

2.2. Transportation System Overview

Transportation is defined as the transfer of goods and people from their place of origin to their destination, while according to Miro (2012) transportation, in general, can be interpreted as an effort to move or move people or goods from a location called the location of origin, to another location which can be called the destination location. for certain purposes by using certain tools.

Transportation system planning predicts future transportation needs (Camacho et al., 2016). In planning the macro transportation system 4 micro transportation subsystems are interrelated and influence each other. (Harsritanto et al., 2021; Hermawan, 2020; Nur and Sabur, 2022)

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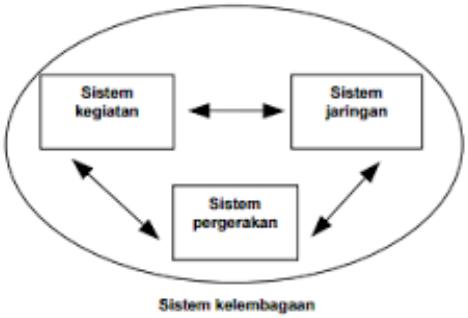

Figure 1.1. Macro transportation system
Source: Tamin (1992b, 1993a, 1994a, 1995e, 2000a)

According to Akbardin (2013), human movement is the result of a system of interconnected activities from one place to another.

2.3. Movement Awakening

Movement generation is a modeling stage that estimates the number of movements originating from a zone or land use and the number of movements attracted to a zone or land use. The generation in Figure 1.2 is on the left, while the right is in Figure 1.2 on the right.

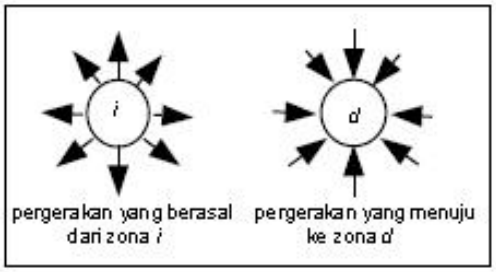

Figure 1.2 Travel Generation
Source: Tamin (2000)

2.4. Population Growth

To find out the number of residents in the coming year, the equation of the average method is used, namely

Pn = ((Pn-1) -Po)/Po……(1.1)

Where:

Pn = future amount
Po = current amount
n = next year
i = growth percentage

2.5. Correlation Coefficient

This statistical test must be carried out to meet the requirements of the mathematical model that the independent variables must not be correlated with each other, while between the dependent and independent variables there must be a strong correlation (both positive and negative) (Tamin 2003).

$$r = \frac{N\sum_{i=1}^{N}(X_iY_i) - \sum_{i=1}^{N}(X_i) * \sum_{i=1}^{N}(Y_i)}{\sqrt{(\sum_{i=1}^{N}(X_i)^2 - (\sum_{i=1}^{N}(X_i)^2) * (\sum_{i=1}^{N}(Y_i)^2)(\sum_{i=1}^{N}(Y_i)^2)}} \quad \textbf{(1.2)}$$

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Where :
r = Correlation coefficient
Xi = independent variable
Y = dependent variable
N = Sample size

The value of r = 1 means that the correlation between the variables y and x is positive (an increase in the value of x will result in the value of y). The following are guidelines for providing interpretation and analysis of the correlation coefficient according to Sugiyono, 2011:

0.00 - 0.199 = very low
0.20 - 0.3999 = low
0.40 - 0.5999 = moderate
0.60 - 0.799 = strong
0.80 - 1,000 = very strong

2.6. Multiple Linear Regression

This concept is a further development of the description above, especially in cases that have more independent variables. Equation (1.3) shows the general form of the method of multiple linear regression analysis

Y = A + B1X1 + B2X2 +…+BZXZ……(1.3)
Y = Change is not free
X1…Xz = free change
A = Regression constant
B1….Bz = Regression coefficient

After getting the equation, continue to calculate the coefficient of determination (R2)

$$R^2_{y.12} = \text{……(1.4)} \frac{b_1 \sum X_{1i}Y_i + b_1 \sum X_{2i}Y_i}{\sum Y_i{}^2}$$

R2 is getting closer to 1, playing well X1, X2, X3,…Xn explains Y or the more "fit" the regression of X against Y is.

3. RESEARCH METHODOLOGY

3.1. Research Sites

This research will be carried out on the main road segment in Serang City, Banten Province, West Java, but is divided into 2 zones, namely the internal zone for the generation equation and the external zone for the pull equation. The following is a map of the research location:

Figure 1.3 Research Locations
source: Google.com

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The zone is changed to north, west, east, and south according to the road that will be reviewed by looking at the boundaries of the area. The north direction is Serang District and Kasemen District, the west direction is Tatakan District and Serang District, the east direction is Walantaka District, Cipojok Jaya District and Serang District, south is Curug District and Serang District.

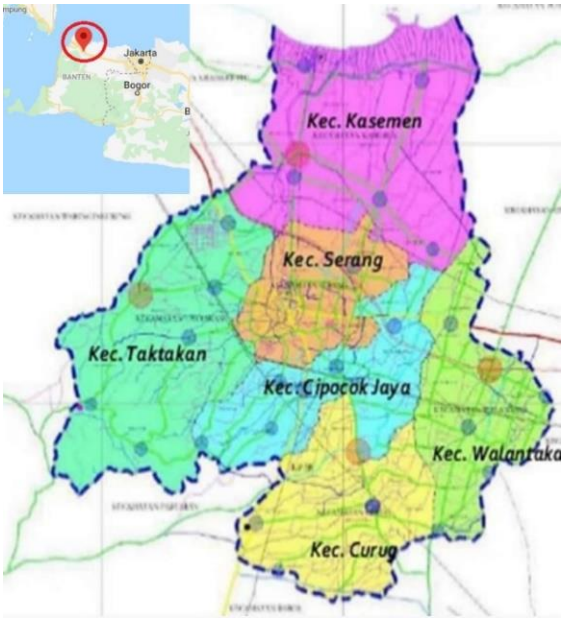

Figure 1.4 Internal Zone
source: Google.com

The External Zone includes regencies/cities that are close to Serang City, namely (1) Cilegon City, (2) Serang Regency, (3) Tanggerang Regency, (4) Lebak Regency, and (5) Pandegelang Regency.

Figure 1.5 External Zone
source: Google.com

3.2. Data Collection

The data needed to support the research process are secondary data. The data obtained are as follows:

Table 1.1 Secondary Data Collection

No	Data Type	Data source
1	Serang City Map	Google Earth
2	Total Population (X1)	BPS Kota Serang and BPS Banten Province
3	Number of Health Facilities (X2)	BPS Kota Serang and BPS Banten Province

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No	Data Type	Data source
4	Number of Schools (X3)	BPS Kota Serang and BPS Banten Province
5	Number of Workers (X4)	BPS Kota Serang and BPS Banten Province
6	GRDP (X5)	BPS Kota Serang and BPS Banten Province
7	Number of Places of Worship (X6)	BPS Kota Serang and BPS Banten Province
7	Number of Vehicle LHRT (Y)	IRMS

Then the data in Table 1.1 is processed using the stepwise method to find out which variables will be used in the modeling. This method begins by entering the independent variable which has the strongest correlation with the dependent variable. Then the independent variables that do not correlate with the dependent variable, are excluded and are not used in the modeling.

4. RESEARCH RESULTS AND DISCUSSION

4.1. Generating and Attractive Variable Data

The data used is 2019, so the data used is at least the past 5 years to find the growth value using the average method. The data used is divided into 2 internal zones for generation and external data for attraction, along with graphic data for each zone.

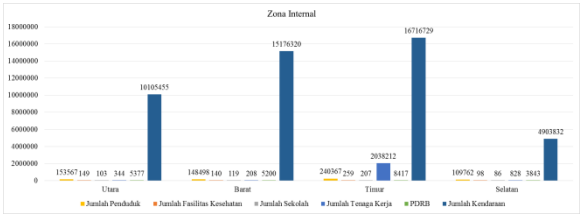

Figure 1.6 Graph of Internal Zone Data
Source: BPS Serang City

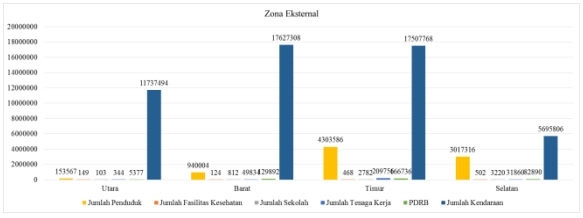

Figure 1.7 External Zone Data Graph
Source: BPS Banten Province

4.2. Correlation Test between Variables

A correlation test was conducted to determine the effect between independent and dependent variables or independent and independent variables. The independent variables used are independent variables that have a high correlation to the dependent variable. A correlation test can also be called step-wise. The formula used is in accordance with formula (1.2) and the results of the correlation value can be interpreted. The following are the results of the correlation test for each zone under review.

Table 1.2 Correlation between the dependent variable (Y) and independent variable (Xn) Internal Zone

	Y	X1	X2	X3	X4	X5	X6
Y	1.00						
X1	0.81	1.00					
X2	0.78	1.00	1.00				
X3	0.80	0.98	0.98	1.00			
X4	0.62	0.93	0.95	0.97	1.00		
X5	0.81	1.00	1.00	0.98	0.93	1.00	
X6	-0.97	-0.67	0.64	1.67	-0.43	-0.67	1.00

Source: Data Analysis Results

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The correlation value close to 1 means that it has a significant effect such as the population variable (X1) and GRDP (X5), with a correlation value of 0.81. If the correlation result is negative, it means that it must be removed because it has no effect, such as the number of places of worship (X6).

Table 1.3 Correlation between the dependent variable (Y) and independent variable (Xn) External Zone

	Y	X1	X2	X3	X4	X5	X6
Y	1.000						
X1	0.595	1.000					
X2	0.589	0.915	1.000				
X3	0.487	0.921	0.969	1.000			
X4	0.850	0.811	0.525	0.525	1.000		
X5	0.868	0.708	0.401	0.544	0.820	1.000	
X6	0.413	0.882	0.967	0.995	0.442	0.470	1.000

Source: Data Analysis Results

The correlation value close to 1 means that it has a significant effect, such as X4 and X5 variables, with a correlation value of 0.8. The X4 variable, namely the number of worships, was omitted because the correlation value was the smallest.

After testing the correlation and getting the independent variables that will be used for the generation and attraction models, namely the number of residents, the number of health facilities, the number of schools, the number of workers, and GRDP.

4.3. Generation Model Analysis

The data that has been collected and the correlation value has been calculated, then analyzes the generation using the multiple regression model method. The multiple regression model has 2 types of models to eliminate parameters and perform a determination test to get the best model, the data used in 2019 is according to the zone under review.

Table 1.4 Variable Data for Generation Model Analysis

No	Arah	Tahun 2019					
		Jumlah Penduduk	Jumlah Fasilitas Kesehatan	Jumlah Sekolah	Jumlah Tenaga Kerja	PDRB	Jumlah Kendaraan
		X1	X2	X3	X4	X5	Y
1	Utara	153567	149	103	344	5377	11737494
2	Barat	940004	124	812	49834	129892	17627308
3	Timur	4303586	468	2782	209756	166736	17507768
4	Selatan	3017316	502	3220	31860	82890	5695806
	Rerata	2103618.13	310.5	1728.875	72948.4	96223.7	13142093.83
	Jumlah	8414472.5	1242	6915.5	291793	384895	52568375.33

Source: BPS Serang City

a. Type 1 Awakening

Multiple linear regression calculation using the formula (1.3). After getting the next equation, perform elimination and substitution calculations, so that the coefficients and regression constants are obtained, then

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determine the parameter that has the smallest correlation value to the dependent variable and eliminate these parameters. Do the multiple linear regression analysis again so that only one parameter remains. The following is an example of the result of modeling the generation to the north of type 1.

Table 1.5 Results of generation modeling to the north with type 1

No	Peubah	Tanda Diharapkan	Parameter	Tahap			
				1	2	3	4
1.	Intersep	+/-	C	-12052986	-113115.2	**-505063.2**	-796130.8
2.	Jumlah Penduduk	+	X1	-153E+16	-60.186	**26.874**	-42.36
3.	Jumlah Fasilitas Kesehatan	+	X2	-194139			
4.	Jumlah Sekolah	+	X3	124840	-21795.53	**31590.7**	
5.	Jumlah Tenaga Kerja	+	X4	103706	17476.8		
6.	PDRB	+	X5	436E+17	3574.18	**2360.1**	3574.18
	R^2	+		0.985	0.969	**0.986**	0.97

Source: Data Analysis Results

b. Type 2 Awakening

In type 2, in principle, it is similar to the type 1 method, the difference is only when determining the parameter that has the smallest regression coefficient and omitting that parameter. Do the multiple-linear regression analysis again and get the value of the coefficient of determination again and the value of the constants and coefficients, so that only one parameter remains.

Table 1.6 Results of generation modeling to the north with type 2

No	Peubah	Tanda Diharapkan	Parameter	Tahap			
				1	2	3	4
1.	Intersep	+/-	C	-79754760.8	30632653.8	**3805643.4**	-31791094.6
2.	Jumlah Penduduk	+	X1	-107.05	-91.56		
3.	Jumlah Fasilitas Kesehatan	+	X2	-64663.23			
4.	Jumlah Sekolah	+	X3	524556.67	145078.511	**-64944.7**	
5.	Jumlah Tenaga Kerja	+	X4	-227663.348	16203.72	**161095.1**	-1708.2
6.	PDRB	+	X5	8121.35	0	**-6791.1**	7966.9
	R^2	+		0.71	0.893	**0.823**	0.92

Source: Data Analysis Results

c. Estimation of the Northward Rise Model

The results of type 1 and type 2 calculations, things that need to be studied are the sign of the regression coefficient (+/-) as expected, a better regression constant that is close to zero, the value of the determinant, and the logic of dependence on the generation.

So, the type 1 model was chosen, this is because the determination value of type 1 is still greater than type 2, and the variables that have more influence and are positive or as expected, then the equation used is type 1. Substitute the data into the equation that has been selected, to further calculate the percentage growth, the data used is at least 5 years back from the year under review. The following is a graph of the estimated results for the next 10 years.

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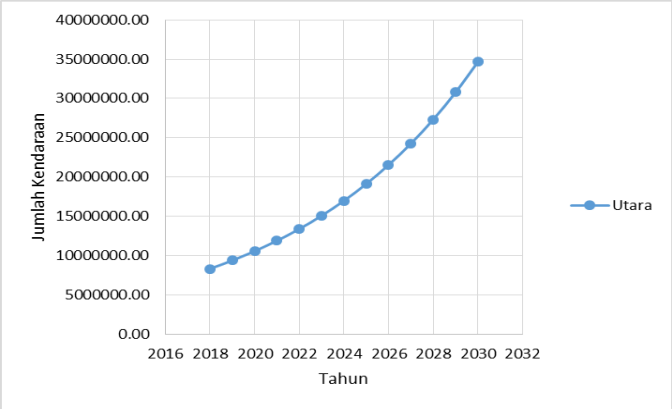

Figure 1.8. Estimated movement of generation to the north (Oi)
source: Results of data analysis

The growth value of the generation movement to the north is 12.64%. So, it was found that in 2019 to the north it reached 8,309,324 units of vehicles/year, furthermore, the growth of the generation movement in 2030 in the north direction reached 34,670,588 units of vehicles/year of generation of the movement of the generation to the north.

Calculations are carried out in each direction reviewed so that we get 4 generation equations. After that, it is estimated until 2030 or the year under review. The most generation from the east is dominated by the X3 variable or the number of schools, for the generation to the north and the generation to the west is dominated by the X3 variable, the number of schools, while the generation to the south is dominated by the X5 variable or GRDP.

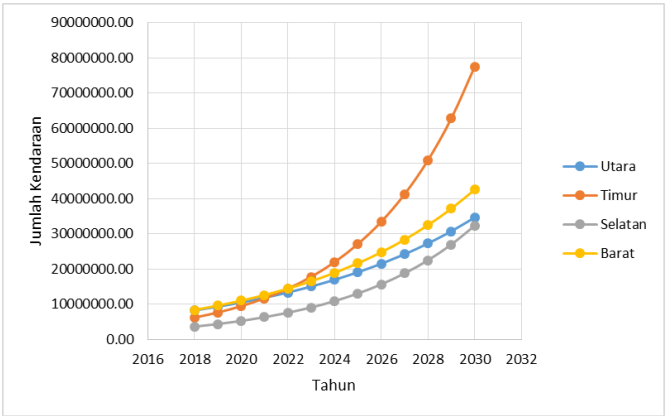

Figure 1.9 Graph of the Number of Vehicles in Each Generation Line
source: Results of data analysis

4.4. Pull Model Analysis

Analyzing the pull is the same as analyzing the generation, only here the data being reviewed is different. Pull analysis using multiple linear regression method, with 2 types. After that, calculate the determinant value to determine the best model for the tensile equation, the data used is 2019.

Table 1.7 Variable Data for Pull Model Analysis

No	Arah	Tahun 2019					
		Jumlah Penduduk	Jumlah Fasilitas Kesehatan	Jumlah Sekolah	Jumlah tenaga Kerja	PDRB	Jumlah Kendaraan
		X1	X2	X3	X4	X5	Y
1.	Utara	153567	149	103	344	5377	11737494
2.	Barat	940004	124	812	49834	129692	17627308
3.	Timur	4303586	468	2782	209756	166736	17507768
4.	Selatan	3017316	502	3220	31860	82890	5695806

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Rerata	2103618.125	310.5	1728.875	72948.37397	96223.74744	13142093.83
Jumlah	8414472.5	1242	6915.5	291793.4959	384894.9898	52568375.33

Source: BPS Banten Province

a. Type 1 Pull

Multiple linear regression calculation using the formula (1.3). After getting the next equation, perform elimination and substitution calculations, so that the coefficients and regression constants are obtained, then determine the parameter that has the smallest correlation value to the dependent variable and eliminate these parameters. Do the multiple linear regression analysis again so that only one parameter remains. The following is an example of the modeling results of type 1 northward pull.

Table 1.8 Modeling results of northward pull with type 1

No	Peubah	Tanda Diharapkan	Parameter	Tahap			
				1	2	3	4
1.	Intersep	+/-	C	-12052986	-113115.2	**-505063.2**	-796130.8
2.	Jumlah Penduduk	+	X1	-153E+16	-60.186	**26.874**	-42.36
3.	Jumlah Fasilitas Kesehatan	+	X2	-194139			
4.	Jumlah Sekolah	+	X3	124840	-21795.5	**31590.7**	
5.	Jumlah Tenaga Kerja	+	X4	103706	17476.8		
6.	PDRB	+	X5	436E+17	3574.18	**2360.1**	3574.18
R^2		+		0.922	0.962	**0.986**	0.985

Source: Data Analysis Results

b. Type 2 Pull

In type 2, in principle, it is similar to the type 1 method, the difference is only when determining the parameter that has the smallest regression coefficient and omitting that parameter. Do the multiple-linear regression analysis again and get the value of the coefficient of determination again and the value of the constants and coefficients, so that only one parameter remains.

Table 1.9 Modeling results of northward pull with type 2

No	Peubah	Tanda Diharapkan	Parameter	Tahap			
				1	2	3	4
1.	Intersep	+/-	C	-79754760	30632653.8	**3805643.4**	-31791094.6
2.	Jumlah Penduduk	+	X1	-107.05	-91.56		
3.	Jumlah Fasilitas Kesehatan	+	X2	-64663.23			
4.	Jumlah Sekolah	+	X3	524556.67	145078.51	**-64944.7**	
5.	Jumlah Tenaga Kerja	+	X4	-227663.34	16203.72	**161095.1**	-1708.2
6.	PDRB	+	X5	8121.35	0	**-6791.1**	7966.9
R^2		+		0.71	0.893	**0.823**	0.92

Source: Data Analysis Results

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c. Estimated Northward Drag Model

The results of type 1 and type 2 calculations, things that need to be studied are the sign of the regression coefficient (+/-) as expected, a better regression constant that is close to zero, the value of the determinant, and the logic of dependence on the pull.

So, the determination value of type 1 is still greater than type 2, which is 0.986 which means it is very influential and has independent variables that have more influence than type 2, so the equation used is type. Substitute the data into the equation that has been selected, to then calculate the percentage growth, the data used is at least 5 years back from the year under review. The following is a graph of the estimated results for the next 10 years.

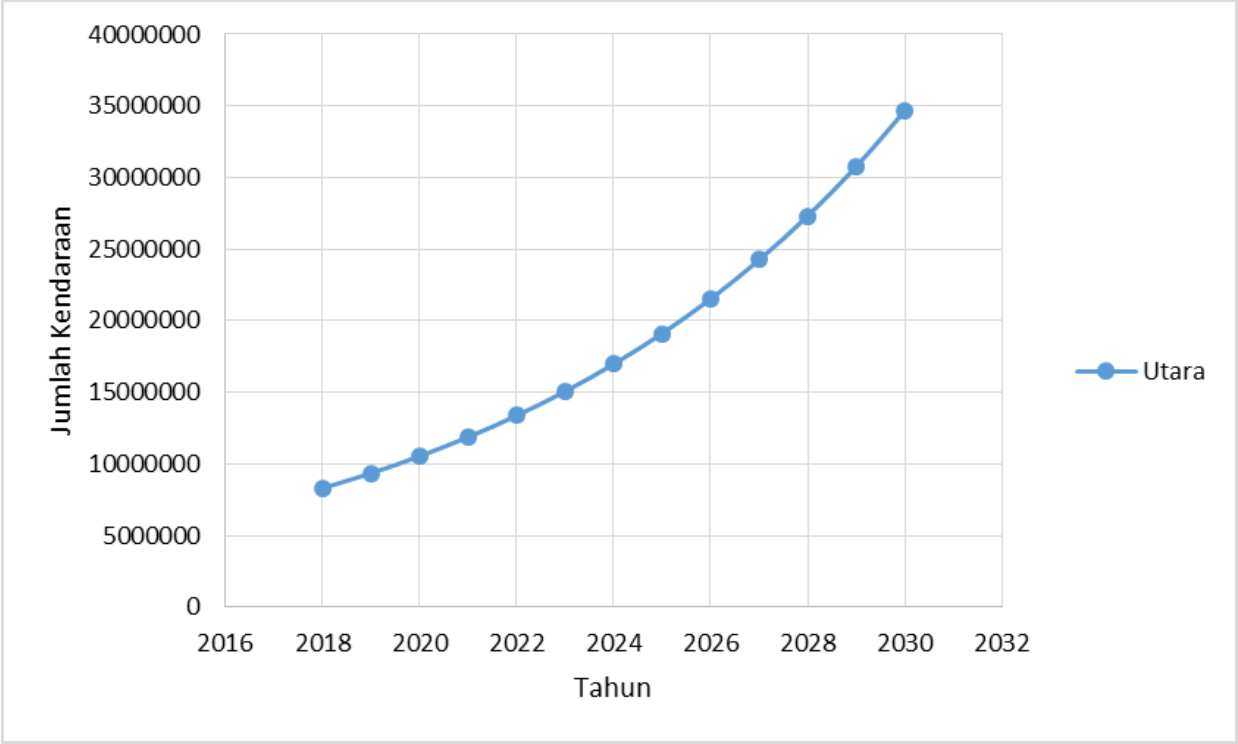

Figure 1.10. Estimated pull movement to the north (Dd)
source: Results of data analysis

The estimated result of the towing movement from the north direction is a growth percentage of 12.64%, attached in Appendix 9. The number of vehicles in 2019 reached 9,359,773 vehicles per year and in 2030 the north direction reached 34,670,588 vehicles per year for towing movements from the north.

Calculations are carried out in each direction reviewed so that we get 4 pull equations. After that, it is estimated until 2030 or the year under review. Most of the pull from the west is dominated by the X2 variable or the number of health facilities, for the northward pull is dominated by the X3 variable, the number of schools, the pull from the east and the south is dominated by the X2 variable, the number of health facilities.

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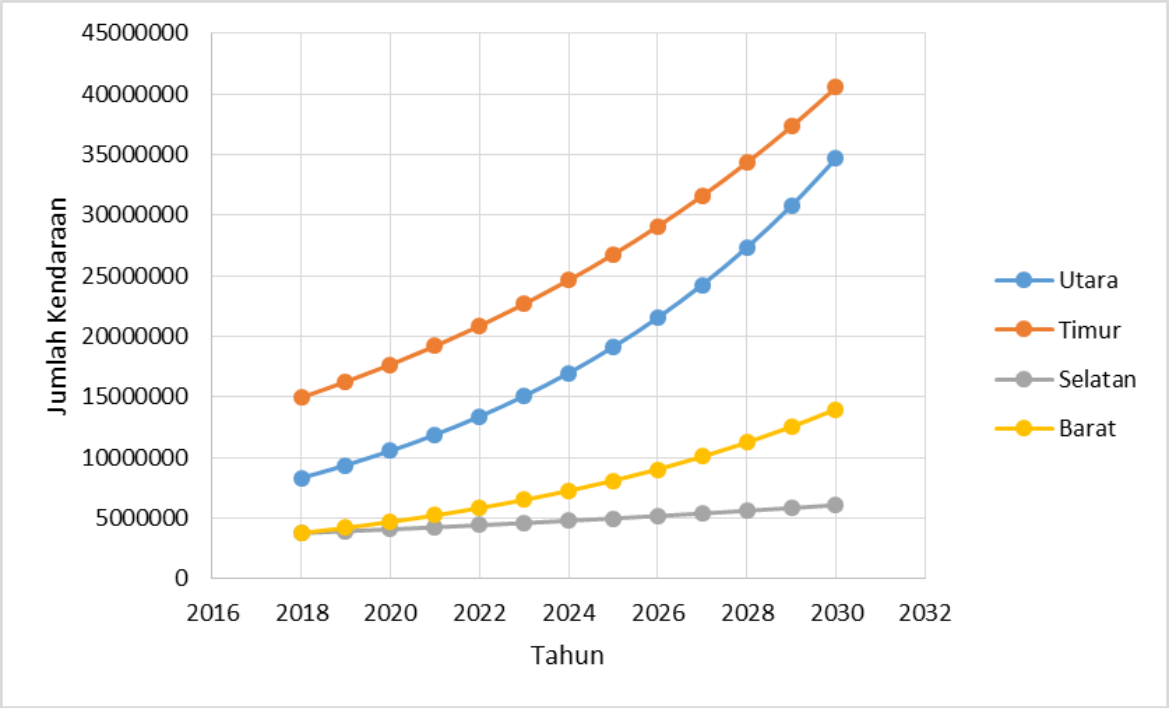

Figure 1.11 Graph of the Number of Vehicles in Each Towing Line
source: Results of data analysis

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusion

The conclusion of the research on the study of the need for mass transportation in the city of Serang based on the integration of the activity system in the city center is as follows:

1. A correlation value of annual daily traffic (Y), population (X1), number of health facilities (X2), number of schools (X3), number of workers (X4), GRDP (X5), and the percentage growth
   a) Internal Zone

      The correlation value between the dependent variable (Y) and the independent variable (X) which is closest to 1 means it is very strong, namely the X1 and X5 variables with a value of 0.81. The correlation value of the X2 variable is 0.78 strong, the X3 variable is 0.8 very strong and the X4 variable is 0.62 strong.

      The greatest growth value in the number of workers is 377.6%, because from 2013 to 2014 there was a drastic increase in the population, according to data from BPS. The population is 1.24% with a total of 729,436 people, the number of health facilities is 3% with a total of 979 health facilities, the number of schools is 1.3% with a total of 575 schools, GRDP 6.7% with a total of 46,030 billion and average daily traffic of 6.7% with a total number of 95,293,033 vehicles per year.

   b) External Zone

      The correlation value between the dependent variable (Y) and the independent variable (X) which is closest to 1 means that it is very strong, namely the X5 variable with a value of 0.86. The correlation value of X1 variable is 0.59 moderate, X2 variable is 0.58 moderate, X3 variable is 0.48 moderate and X4 variable is 0.85 very strong.

      The highest growth value is the number of health facilities, namely 11.41% with a total of 404 health facilities, while the population is 1.1% with a total number of 9,938,529 people, the number of schools is 2.26% with a total number of 9,548 schools, the number of workers is 8 % with a total

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number of 1,058,884 workers, GRDP 7.89% with a total number of 885,365 billion and an annual average daily traffic of 7.89% with a total number of 121,229,344 vehicles per year.

2. The modeling obtains four multiple regression generation equations and four multiple regression pull equations based on the direction reviewed and then used for modeling the LRT route. The multiple regression generation equations obtained are:

a. Awakening

i. North: Oi = -505063.22 + 26,874 X1 + 31590.71 X3 + 2360.11 X5
Dominant variable (X3) number of schools, R^2 = 0.98 (Very influential)

ii. West: Oi = 2866300459 – 12,204 X1 + 18777.3 X3 + 13417.2 X4 + 1242.15 X5
The dominant variable (X3) is the number of schools,R^2 = 0.961 (Very influential)

iii. East: Oi = 2516587.9 – 84.46 X1 + 127423.5 X3 – 6.86 X4 + 1731.79 X5
The dominant variable (X3) is the number of schools,R^2 = 0.992 (Very influential)

iv. South: Oi = -725639,227 + 0.006 X1 – 6.263 X3 + 2472.83 X5
Dominant variable (X5) GRDP,R^2 = 0.996 (Very influential)

b. Pull

i. North : Dd = -505063.22 + 26,874 X1 + 31590.71 X3 + 2360.11 X5
Dominant variable (X3) number of schools, R^2 = 0.98 (Very influential)

ii. West: Dd = 3055397.9 – 2,512 X1 + 16116 X2 + 180.49 X4 + 18.19 X5
The dominant variable (X2) is health facilities,R^2 = 0.93 (Highly Influential)

iii. East: Dd = -10114033.3 + 8.28 X1 + 6250.6 X2 – 1095.2 X3 – 248.6 X4
+195.1 X5
The dominant variable (X2) is the number of health facilities,R^2 = 0.87 (Effective)

iv. South: Dd = -24715768.4 – 34.8 X1 + 535215 X2 – 37277 X3 + 194 X4
+ 107.4 X5
The dominant variable (X2) is health facilities,R^2= 0.956 (Very influential)

The largest generation movement from the east is 7,746,2667 vehicles per year and the most pull is from the east 40,539,217 vehicles per year.

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