Review Article

Trip Generation Analysis in Operating Stations for Revitalization Preparation (Case Study: Train Service Solo Prameks - Yogyakarta)

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Abstract - The number of passengers in the Prameks (Prambanan Ekspres) crossing Solo - Yogyakarta has increased every year. If this continues to happen, the people who will take the Prameks train will not be well served. Therefore the government electrified the railroad crossing Solo - Yogyakarta, which aims to replace the Prameks train facilities with Electric Rail Trains (KRL). To support KRL trips and facilitate access for people who want to ride the KRL, operating stations that do not yet have passenger boarding and altering facilities that cross the Solo -Yogyakarta area may also be revitalized. However, before being revitalized, it would be nice if the number of trip generation at each operating station and the number of passenger increases were sought if the station was revitalized. In this study, the number of generations of each station with results, Gawok 68 generation, Delanggu 63 station generation, Ceper Station 56 generation, and Srowot Station 46 generation, and train passenger coverage is 2022 - 2024 is 378,536, 419093, and 459,650.

Keywords - *Revitalization, Trip generation, forecasting, least square*

I. INTRODUCTION

A. Background

Prameks (Prambanan Ekspres) trains are local trains that run on the Solo - Klaten - Yogyakarta route. This train has a relatively increasing number of passengers each year. For example in 2016, the number of passengers for the Prameks Train was 2,983,891 passengers, in 2017 3,650,144 passengers, 2018 3,940671 passengers, and in 2019 3,882,858 passengers. If the increase in passengers continues, it is believed that the service towards people that will take the Prameks train will be less than optimal, such as not getting tickets.

The government has issued PM Number 43 of 2014 concerning the National Railway Master Plan (RIPNAS). It

states that the Solo - Yogyakarta railroad will be electrified, and in February 2020, this project started running. This indicates that the Prameks trains will be replaced with Electric Rail Trains (KRL). In this regard, operating stations currently do not have passenger boarding, and alighting facilities can reopen as KRL stations. Based on this, the authors researched the analysis of trip generation at the operating stations to prepare stations revitalization with a case study of the Prameks Solo - Yogyakarta railway service.

B. Research Purpose

This research aims to:

- 1. Calculating the number of trip generation at each operating station
- 2. Forecasting the number of passengers before and after the stations are revitalized

C. Literature Review

a) Revitalization

Revitalization attempts to reopen areas or parts of areas that have previously been opened but have been falling off (Danisworo, 2002 in Aldila et al., 2018). Station revitalization means improving available services at the station to facilitate passenger boarding and dropping.

b) Trip Generation

Trip generation is a transportation model that predicts the number of trips that leave certain areas to another in a certain time unit (Miro, F. 2005 in Frans H John et al., 2019).

c) Forecasting

Forecasting is an activity that aims to find something that will happen in the future using tested past data (Prasetya et al., 2009 in Jumadil et al., 2018).

d) Least Square

The least-square method is forecasting or predicting future sales based on a periodic series or time series of sales in the past (Ilham, 2018).

Y' = a + bx	 (3.1)
$a = \frac{(\Sigma Y)}{n}$	 (3. 2)
$b = \frac{(\Sigma Y x)}{(\Sigma x^2)}$	 (3.3)

Where:

- Y = Periodic sales data (*time series*)
- *Y'* = The variable to formulate the result of the forecast
- *a* = Trend values in the base year
- *b* = The average trend value growth per year
- x = Time variable (day, week, month, or year)
- n = the amount of data

The value of x at the time of calculation is usually replaced with a score to make it easier to calculate, and there are two kinds of replacements with this score, namely:

- 1) even data amount, the substitute scores: ..., -4, -3, -2, -1, 1, 2, 3, 4, ...
- 2) odd data amount, the replacement scores: ..., -4, -3, -2, -1, 0, 1, 2, 3, 4, ...

e) Home Interview

Home interviews collect data by conducting direct questions and answers between the surveyor and the respondents by surveyor going directly to the respondent's house, then recorded/written on the survey form sheet (Mahampang Noor, 2016).

II. METHODOLOGY

A. Data Collection Methods

This study uses two types of data, namely primary data and secondary data. Primary data collection was carried out using the home interview method, which was conducted with the community around the operating stations. This interview aims to find the number of trip generation at each operating station. Meanwhile, the secondary data is satellite images of settlements around the operating stations to determine the population and samples' locations, which are downloaded from the Sas Planet application. To calculate the forecast for the number of passengers in the coming year, the author needs data on the volume of Prameks train passengers from 2009 to 2019 obtained from the Passenger Transportation unit of PT. KAI Daop 6 Yogyakarta.

B. Population and Sampling Technique

The first step in determining the sample is determining the number of populations to be surveyed. The population to be surveyed was the houses of residents around the station with a radius of 800 meters from the operation stations, in accordance with the TOD concept ((Transit Cooperative Research Program, 2002 in Dwiki et al., 2017). To make it easier to observe the survey population, the authors made a simple map of the residences around the community, which was also used to count the number of houses as a population manually.

Fig. 1. Residence Map Around Gawok Station



Fig. 2 Residence Map Around Delanggu Station



Fig.3 Residence Map Around Ceper Station



Fig. 4 Residence Map Around Srowot Station

The results of calculating the population in each operating station are Gawok Station with 654 houses,



Delanggu Station with 620 houses, Ceper Station with 500 houses, and Srowot Station with 524 houses. Bruton (1985) in Rosdiyani, Noor (2019) suggests the number of samples used in home interviews with the following number:

Table1. Sample Size			
Population	Sample Size (Household)		
	Recommendation	Minimum	
Under 50.000	1:5	1:10	
50.000 - 150.000	1: 8	1:20	
150.000 - 300.000	1:10	1: 35	
300.000 - 500.000	1: 15	1: 50	
500.000 -	1:20	1:70	
1.000.000	1: 25	1:100	
Above 1.000.000			

Source: Briton (1985) in Tamin (2000)

This study's sample size is the minimum sample, and there are 2 family members to be surveyed per household because the population survey is limited by available resources (Directorate of City Road Development, 1990). The population in each survey area is less than 50,000; therefore, the sample used is 1:10 from the population. The number of respondents obtained was, respectively, Gawok Station 132 people, Delanggu Station 124 people, Low Station 100 people, and Srowot Station 104 people.

C. Data Analysis Methods

The number of community samples around the operating station obtained is then used as a reference in interviews with the community to find the number of trip generators generated at each operating station. The number of generation data obtained is then analyzed to find the number of passengers for each operating station, which will be used to calculate the forecast number of passengers in the coming year. Each trip generation is assumed to travel twice a day, namely departure and arrival, thus in one trip generation; it is assumed to be two passengers.

Forecasting in this study is carried out twice, i.e., before and after the operating station is revitalized. When the station has not been revitalized, forecasting will be carried out from 2020 to 2024, while when the station has been revitalized, the forecasting is carried out from 2022 to 2024. The number of passengers at the new station can be assumed to take a train in 2021 because KRL Solo - Yogyakarta is assumed to start running in 2021.

III. RESULT AND DISCUSSIONS

A. Trip Generation

After conducting a household interview survey in residence around the operation station, data on the number of generations at each operating station were obtained. The number of generation for each station was Gawok Station 68 trips, Delanggu Station 63 trips, 56 Ceper trips, and 46 Srowot trips.

B. Total Passengers

The number of generators that have been obtained is then analyzed to determine the number of passengers as the basis for calculating the forecast. This calculation is done by multiplying the number of generation by 10, because the number of samples is 1:10, from the population, while each trip generation is assumed that they travel twice a day; going to and returning from office on workdays so that in a month there are 22 days, which is then projected the number passengers per year at each station. The results of the calculation of the number of station passengers per year are:

After calculating the number of passengers at the four operating stations, the number of passengers at the four stations was 1,230,240 in 2021 because KRL is assumed to run in 2021.

C. Forecasting

Forecasting using the least square method is carried out twice. Firstly, in normal conditions, when the operating station has not been revitalized and, secondly, when the condition is not normal, that is when the station has been revitalized.

a) The operating station that has not been revitalized

Based on passenger volume data for 11 years, the variable x used a middle value of 0 because the amount of

data is odd. The following is a table of passenger volume and variables needed to forecast the number of passengers:

The next step after identifying each variable value is calculating the values of a and b.

After finding a and b values, the next step is to determine the Y value, namely predicting the number of passengers in 2020 to 2024, and for the x value in 2020 is 6, 2021 is 7, and successively until 2024 is 10. After being calculated, the results of the number of passengers in 2020 to 2024 are as follows:

Table 2. Passengers Volume from Forecast Result

NO.	Tahun	Volume
1	2009	2.108.288
2	2010	2.707.283
3	2011	2.620.393
4	2012	2.211.918
5	2013	1.822.655
6	2014	2.524.446
7	2015	2.638.942
8	2016	2.983.891
9	2017	3.650.144
10	2018	3.940.671
11	2019	3.882.858

b) The Operating station that has been revitalized

In contrast to the forecast carried out in normal circumstances, forecasting the number of passengers in an abnormal situation predicts passenger volume with basic data on the number of passengers from 2009 to 2021. Passenger volumes in 2020 and 2021 use the volume data forecast obtained, and for 2021 it is added by 1,230,240 as the calculation results of the generation of the four stations. This time, forecasting the number of passengers used 13 basic year data, meaning the variable x in the median value using 0 because the amount of basic data is odd.

Table 3. Passengers Volume Number

hun	Volume (Y)	x	xY	<i>x</i> ²
2009	2.108.288	-6	-12.649.728	36
2010	2.707.283	-5	-13.536.415	25
2011	2.620.393	-4	-10.481.572	16
2012	2.211.918	-3	-6.635.754	9
2013	1.822.655	-2	-3.645.310	4
2014	2.524.446	-1	-2.524.446	1
2015	2.638.942	0	0	0
2016	2.983.891	1	2.983.891	1
2017	3.650.144	2	7.300.288	4
2018	3.940.671	3	11.822.013	9
2019	3.882.858	4	15.531.432	16
2020	3.876.820	5	19.384.100	25
2021	5.282.114	6	31.692.684	36
Jumlah	40.250.423	0	39.241.183	182

just like forecasting calculations under normal circumstances, after identifying the variables needed, the next step is to calculate the values of a and b.

After finding the values of a and b, the next step is calculating the forecast passenger volume in 2022, 2023, and 2024. The value of x in 2022 is 7, 2023 is 8, and 2024 is 9. The results of the number of passengers in 2020 to 2024 are as follows:

Tahun	Volume (Y)	x	xY	<i>x</i> ²
2009	2.108.288	-5	-10.541.440	25
2010	2.707.283	-4	-10.829.132	16
2011	2.620.393	-3	-7.861.179	9
2012	2.211.918	-2	-4.423.836	4
2013	1.822.655	-1	-1.822.655	1
2014	2.524.446	0	0	0
2015	2.638.942	1	2.638.942	1
2016	2.983.891	2	5.967.782	4
2017	3.650.144	3	10.950.432	9
2018	3.940.671	4	15.762.684	16
2019	3.882.858	5	19.414.290	25
Jumlah	31.091.489	0	19.255.888	110

Table 4. Forecast passenger volume

D. Comparison of Number of Passengers

This comparison of the passengers' number compares the number of passengers at the operating station before and after being revitalized, and the difference finds out which one is greater. The following is a comparison of the number of passengers.

Year	Before Revitalization	After Revitalization	difference
2022	4.226.927	4.605.463	378.536
2023	4.401.981	4.821.074	419.093
2024	4.577.034	5.036.684	459.650

Table 5.	Comparison	of Forecasting	Volume
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Based on the table above, it turns out that the number of passengers will increase if the operating station is revitalized, more than when it is not revitalized.

IV. CONCLUSION

- 1. The number of trips at each operating station of the four operating stations is Gawok Station 68 trips, Delanggu Station 63 trips, Ceper Stations 56 trips, and 46 Srowot trips.
- 2. The forecasting result shows more passengers' number when an operating station is revitalized, so this can be a suggestion that it would be better if the operating stations in the study are revitalized.

REFERENCES

- [1] Aldila, Wiwik, & Yuni. Penerapan Arsitektur Konsektual Pada Revitalisasi Stasiun Lempuyangan Yogyakarta. (2018).
- [2] Ary Putra Iswanto et., al. (2020).Community Characteristics in the Use of the Madiun-Surabaya Railway and Bus Transportation Mode. 4(1) (2020): Jurnal Perkeretaapian Indonesia 4(1) Tahun 2020. DOI: https://doi.org/10.37367/jpi.v4i1.108
- [3] Alistyo, F. Prediksi Penjualan Motor Honda Dengan Metode Least Square. (2018).
- [4] Andiri. Kualitas Pelayanan Transportasi Publik (Studi Deskriptif Tentang Kualitas Pelayanan Kapal Penumpang Trayek Gresik-Bawean di Pelabuhan Gresik). (2015).
- [5] Dwiki, K., Nurhadi, K., & Fitria, E. (2017). Kesesuaian Kawasan Transit Di Kota Surakarta Berdasarkan Konsep Transit Oriented Development.
- [6] Gunawan, I. Metode Penelitian Kualitatif Teori Dan Praktek. PT .Bumi Aksara. (2015).

- [7] Jumadil, Indrianti, S. H., & Pramono, B. (2018). Metode Triple Exponential Smoothing (TES) (Studi Kasus : Instalasi Farmasi RSUD Kab. Muna). (2015).
- [8] KA Prameks Terapkan Tiket Online Mulai Besok. (2019). Retrieved from https://krjogja.com/ https://krjogja.com/web/news/read/90290/KA_Prameks_Terapkan_Ti ket Online Mulai Besok. (2015).
- [9] Kementrian, P. (2011). Jenis, Kelas, Dan Kegiatan Di Stasiun Kereta Api. Kementrian Perhubungan.
- [10] Kementrian, P. Standar Pelayanan Minimum Angkutan Orang Dengan Kereta Api. Kementrian Perhubungan.
- Kompas.com. Kabar Baik, KA Prameks Jogja Solo Akan Digantikan KRL. Retrieved from kompas.com: https://money.kompas.com/read/2020/06/27/070030326/kabar-baikka-prameks-jogja-solo-akan-diganti-krl?page=all. (2020)
- [12] Kuswati, A. S., Kriteria Penetapan Lokasi Stasiun Kereta Api Penumpang. (2015).
- [13] Lulu, K. R., Frans, J. H., & Hangge, E. E. Bangkitan Perjalanan Penduduk Di Kecamatan Alak Kota Kupang. (2019).
- [14] Nanda Ahda Imron., et. al.. Application of Automatic Level Crossing Technology in Indonesia. Vol. 2 No 2 (2018): Jurnal Perkeretaapian Indonesia Volume 2 Nomor 2 Tahun 2018. DOI: https://doi.org/10.37367/jpi.v2i2.55
- [15] Pamungkas, D. P. (2016). Implementasi Metode Least Square Untuk Prediksi Penjualan Tahu Pong.
- [16] Panduan Survei Wawancara Rumah. Direktorat Pembinaan Jalan Kota. (1990).
- [17] Peling, I. A., & Sedana, I. B. (2018). Pengaruh LDR, NPL, Dan BOPO Terhadap Profitabilitas Pada PT. BPD Bali Periode Tahun 2009 - 2016.
- [18] Pramiyati, T., Jayanta, & Yulnelly. Peran Data Primer Pada Pembentukan Skema Konseptual Yang Faktual (Studi Kasus : Skema Konseptual Basis Data Sisbumil). (2017).
- [19] Rosdiyani, T., & Noor, G. (2019). Pengaruh Kepusasan Pelayanan Angkutan Umum Terhadap Transportasi Go-jek Di Kota Serang.
- [20] Sugiarti, E. Pengaruh Kedisiplinan Terhadap Kinerja Pegawai Pada Badan Meteorologi Klimatologi Dan Geofisika Wilayah II Ciputat. (2018).
- [21] Sugito, & Fauzia, M. Analisis Sistem Antrian Kereta Api Di Stasiun Besar Cirebon Dan Stasiun Cirebon Prujakan. (2009).
- [22] Sunaryo, A. KRL Layani Rute Yogyakarta Solo, Bagaimana Nasib KA Prameks? Retrieved from merdeka.com: https://www.merdeka.com/uang/krl-layani-rute-yogyakarta-solobagaimana-nasib-ka-prameks.html. (2020)
- [23] Waode, Jumadil, & Tajidun. b. Aplikasi Forecasting Jumlah Frekuensi Penumpang Pesawat Terbang Lion Air pada Bandar Udara Halu Oleo Dengan Menggunakan Metode Least Square. (2018).
- [24] Winaldi, I. Perbandingan Reformasi Birokrasi Pelayanan Publik Di Vietnam Dan Indonesia. (2020).
- [25] Ziantono, D., & Suprayitno, H. Studi Hubungan Antara Koefisien Determinasi Dengan Kesalahan Prediksi Untuk Ukuran Sampel Tertentu Pada Model Bangkitan Perjlanan di WIlayah Perkotaan Gresik. (2018).