Journal of Environmental and Development Studies

Service Potential Analysis of Passenger Train Operations On Medan – Belawan Route in Order to Develop Northern Medan Region

Eli Daniel Sembiring[1], Sirojuzilam[2], Agus Purwoko[3]

[1]*Postgraduate Student, Universitas Sumatera Utara, Indonesia*
[2]*Faculty of Economics and Business, Universitas Sumatera Utara, Indonesia*
[3]*Faculty of Forestry, Universitas Sumatera Utara, Indonesia*

Abstract. The strategy to overcome traffic jam in Medan City is by using train transportation mode. PT. Kereta Api Indonesia (Persero) Regional Division I of North Sumatera as the operator has operated passengers train with Medan-Belawan route, however the train only operated for 2 years (2010-2011). The objective of the research is to analyze potential of passenger train, revenue of train operator, feasibility of train project investment, as the effort to re-operate passenger train. Based on analysis result, it can be concluded that a concept of transit oriented development (tod) around the Belawan station is required to increase potential of total passengers.

Keyword: Railway operations, regional development, service potential

Abstrak. *Strategi untuk mengatasi kemacetan di Kota Medan adalah dengan menggunakan moda transportasi kereta api. PT. Kereta Api Indonesia (Persero) Divisi Regional 1 Sumatera Utara selaku operator pernah mengoperasikan kereta api penumpang rute Medan-Belawan, namun kereta api tersebut hanya beroperasi selama 2 tahun (2010-2011). Penelitian ini bertujuan untuk menganalisis potensi calon penumpang kereta api, pendapatan operator kereta api, kelayakan investasi proyek kereta api, sebagai upaya pengoperasian kembali layanan kereta api. Berdasarkan hasil analisis, disimpulkan bahwa untuk meningkatkan potensi jumlah penumpang diperlukan konsep transit oriented development (tod) di sekitar stasiun Belawan.*

Kata Kunci: Operasi kereta api, pengembangan wilayah, potensi layanan

Received date month year | Revised date month year | Accepted date month year

1. Introduction

Medan city is one of the largest cities in Indonesia, has a strategic location as a business and government center in North Sumatra Province, making Medan city densely populated and vehicles. According to Analisadaily in (2019) the number of motor vehicles in Medan city reached about 2.700.000 units with a growth of 5.4%, one of the strategies to overcome

*Corresponding author at: Universitas Sumatera Utara, Medan, Indonesia

E-mail address: sembiringelidaniel9@gmail.com

Journal Homepage: http://jeds.usu.ac.id

congestion in Medan City, is to establish the implementation of rail-based urban mass public transportation, with train transportation modes [2].

PT. Kereta Api Indonesia (Persero) Division Regional 1 of Sumatera Utara has conducted operational trials of passenger trains route Medan - Belawan in 2018, the main purpose of which is to transport KM Kelud passengers to and from Bandar Deli Passenger Terminal which has been integrated with Belawan Station. The time of the train trial operation is once a week, when KM Kelud arrives and departs. The frequency of train travel at that time as much as 1 (one) trip, namely from Medan Station at 08.15 WIB and arrived at Belawan Station at 08.55 WIB, in contrast from Belawan Station at 09.30 WIB and arrived at Medan Big Station at 10.10 WIB. However, the train has stopped operations again until now due to the low occupancy rate of passengers [3].

If we look at the Medan-Belawan railway route that crosses services there are many places of economic activity such as trade and services, industry, factories, warehousing and shipping, then the route has the potential for movement of people, but in real conditions, the occupancy rate of passengers remains low, resulting in a lack of operator income, so that it has an impact on the amount of expenditure on railway operating costs.

PT. Kereta Api Indonesia (Persero) Division Regional 1 of Sumatera Utara as a passenger train operator of the Medan-Belawan route, it is necessary to seek the re-operation of the train service in accordance with the development of technology until finally able to transport passengers quickly, on time, safely, comfortably at affordable costs. PT. KAI feels the importance of train operating costs incurred must be at least the same as the receipt obtained (Break Event Point or BEP) so that the company does not experience losses.

Based on the description above, it takes an analysis of efficiency and business feasibility on the Medan-Belawan route passenger train, which can help the company's management in re-operating the railway and can give the right decision to the company to carry out what strategies must be done so that it is able to run the business properly and profitably. To measure what factors are most important that the company must do, it is necessary to analyze the potential of passenger rail operating services on the Medan-Belawan route to the company

According to the results of the author's survey in the field as well as the collection of secondary data obtained, the author is interested in discussing in writing this thesis by taking the title "Analysis of The Potential of Medan-Belawan Route Passenger Railway Operations Service in the Framework of The Development of The Northern Medan Area".

2. Methodology

The research was conducted in the administrative area of Medan City village served by Medan-Belawan route passenger trains and was conducted from May to June 2021. The sample number in this study was 100 household. The time needed for each household survey ranges from 20-30 minutes. Type of this research on the analysis of potential rail passengers is quantitative with a descriptive approach. According to Tamin (2008) analysis of passenger potential is calculated

by obtaining a linear relationship between the number of movements raised or attracted by the zone and the average socio-economic traits in each zone, namely:

$$Y_{Sample} = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 \quad (1)$$

Information:

Y_{Sampel} = Sample travel rises or pulls

A = Constant

X_1 = Number of samples per zone

X_2 = Ownership of sample vehicles per zone

X_3 = Sample revenue per zone

X_4 = Sample travel expenses per zone

X_5 = Sample travel distance per zone

$b_1, b_2 \ldots b_5$ = Regression coefficient

Analysis of the revenue of passenger train operators of Medan-Belawan routes before the termination of operating services, using the methods of: railway operating expenses capital (BOKA), operating costs, facilities maintenance costs and benefits, tariffs, operator's profit loss statement before the termination of operating services (2010-2011).

Analysis of the investment feasibility of medan route passenger rail project as an effort to re-operate, using methods: Ability to Pay (ATP), Willingness to pay or Willingnes to Pay (WTP), ideal tariff recommendation, profit loss statement, cash flow statement, Net Present Value, Internal Rate of Return (IRR), Benefit Cost Ratio (BCR) and Load Factor Break Event Point.

3. Result and Discussion

3.1. Analysis of Potential Pasanggers of Medan-Belawan Route

According to Tamin (2000), the calculation of potential passengers can be done by calculating the volume of passengers during travel as can be seen in Table 1 below:

Table 1. Result of potential passengers of Medan-Belawan route in 2021-2026

Year	Volume of ocean passengers	Rise/Pull of population travel	Mode Share Potential Passengers		Sum
			Passengers of the ship	On the entire population travel	
2021	510.531	692.142	51.053	69.214	120.267
2022	632.937	701.748	63.294	70.175	133.468
2023	784.691	711.487	78.469	71.149	149.618
2024	972.831	721.362	97.283	72.136	169.419
2025	1.206.079	731.374	120.608	73.137	193.745
2026	1.495.251	741.525	149.525	74.152	223.678

Source: Primary data processing results, 2021

The potential of prospective passengers on the Medan-Belawan route is obtained from the assumption of train share mode against the rise or pull of the travel of the population that uses various modes of transportation on the route and the number of passengers on the ship. Forecasting the assumption of train share mode to the rise or pull of travel of the population using various modes of transportation on the route and the number of passengers of ships using

growth projections. The growth rate of ship passenger volume per year amounted to 0.24, where the growth rate was obtained from the previous chapter data. The potential for prospective passengers on the Medan-Belawan route in 2021 and forecasting in 2022-2026 can be seen in Table 1 the average number of potential passengers from 2021 to 2026 was 165.033 passengers.

The total pull of population travel per zone was 692.142 trips, which is the same value as the rise of travel. The potential of prospective passengers with train share mode to sea ship passengers is obtained from 10% multiplied by the volume of passengers of the ship and for the mode of rail share of the entire population journey obtained 10% multiplied by the rise or pull of the population journey. According to Balai Teknik Perkeretaapian Wilayah Sumatera Bagian Utara (2021), urban railway share mode amounted to 10% of the number of people traveling.

The linear regression model of multiple travel pulls with R^2=0.65491763, is: Y= 17.8897052 + 1.58497106X_2 + 0.06245812X_4 and the linear regression model multiple ride with a value of R^2=6496895, is Y= 18.579828 + 1.5088661X_2+0.0652444X_4. After obtaining the regression equation of the sample, it is necessary to obtain the number of pulls and resurgent populations of each zone through expansion factors. The estimated existing population of pull and rise of travel in 2021 is the result of multiplication of each sample-free change per zone with expansion factor per zone, then the result of the multiplication is subsubtused into the linear regression model of multiple pulls and journey awakenings that have been obtained.

3.2. Analysis of Train Operator's Revenue of Medan-Belawan Route The Cessation of Operating Services

According to the Regulation of the Minister of Transportation of the Republic of Indonesia Number PM 17 of 2018, to obtain income in this study is to calculate the cost of railway operations, tariff and number of passengers, as seen in Table 2 below:

Table 2. Result of calculation the passenger train operator

Year	Passenger volume	Income (Rupiah)	BOKA (Rupiah)	Difference (Rupiah)
2010	70.314	Rp703.140.000	Rp4.477.607.029	3.774.467.028,60
2011	17.071	Rp170.710.000	Rp1.187.638.491	1.016.928.490,56
Total				4.791.395.519,16

Source: Primary data processing results, 2021

Based on Table 2 it can be concluded that the operator's revenue before the termination of operating services in 2010 and 2011 experienced inefficiencies due to the lack of users of these transportation services, bringing the total inefficiencies for 2 years amounted to (Rp.4.791.395.519.16). Medan-Belawan route passenger train in Medan City is an Electric Diesel Railway (KRDE) managed by PT. KAI as the operator, which was inaugurated in 2010 and stopped serving at the end of 2011 or in other words only operated for 2 years. The termination of train operating services is due to the lack of passenger numbers, which has an impact on the operator's revenue.

Based on information from the Balai Teknik Perkeretaapian Wilayah Sumatera Bagian Utara, the comparison of subsidies between those provided by the government and those charged to the

community of transportation service users is usually 70:30, which means 70% government subsidies and 30% is the burden of the user community, if the assumption of government subsidies amounted to Rp 7.000 then the assumption of the total fare from the Medan-Belawan route passenger train at the time before the cessation of operating services, amounted to Rp 10.000 and still below the upper limit fare.

3.3. Analysis of Invesment Feasibility of Medan-Belawan Route Railway Project as an Effort to Re-Operate

After learning that the operational activities of the Medan-Belawan route passenger train at the time before the termination of operating services experienced inefficiencies due to the lack of users of the transportation service, it is necessary to analyze the feasibility of investing in the railway project as an effort to re-operate.

3.3.1 *Ability To Pay* (ATP)

Based on the analysis of the factors that affect Ability To Pay (ATP), it was obtained the results of atp calculations of passenger trains Medan-Belawan route can be seen in Table 3 below:

Table 3. Result of ATP Medan-Belawan route

Interval (Rp)	Frequency	Percentage (%)
1416-2497	4	17%
2498-3580	3	13%
3581-4662	9	38%
4663-5745	5	21%
5746-6827	0	0%
6828-7910	3	13%
Sum	24	100%

Source: Primary data processing results, 2021

The approach used in analyzing ATP value is based on the allocation of funds for transportation and travel intensity. Atp values are the result of a comparison between transportation funds and travel intensity. Based on Table 3, it was concluded that the interval of the ability to pay someone for the Medan-Belawan route passenger train was dominated by Rp 3.581- Rp 4.662 which had the largest percentage, which was 38% (9 people) while the highest interval of Rp 6.828 – Rp 7.910 had a percentage of 13% (3 people). The average ability to pay per person amounted to Rp.4.230. The ability to pay the minimum per person amounted to Rp 1.416 and the maximum amounted to Rp 7.462 and the median value of the ability to pay per person was Rp 4.064.

3.3.2 Willingnes To Pay (WTP)

Analysis of WTP calculations of passenger trains on Medan-Belawan route can be seen in Table 4 below:

Table 4. Result of WTP Medan-Belawan route

Interval (Rp)	Frequency	Percentage (%)

140-716	19	79%
717-1293	2	8%
1294-1869	1	4%
1870-2446	1	4%
2447-3023	0	0%
3024-3599	1	4%
Sum	24	100%

Source: Primary data processing results, 2021

From Table 4, it was concluded that the willingness interval to pay someone for the Medan-Belawan route passenger train is dominated by Rp 140 - Rp 716 which has the largest percentage, which is 79% (19 people) while the highest interval of Rp 3.024 - Rp 3.599 has a percentage of 4% (1 person). The average ability to pay per person amounted to Rp 613. The ability to pay the minimum per person amounted to Rp 140 and the maximum amounted to Rp 3.361 and the median value of the ability to pay per person was Rp 342. According to Permata in [4] the WTP analysis is based on the user's perception of the fare for public transportation services that are influenced by several factors, namely the quantity and quality of transportation services, user utilities and user income. The reason or perception factor was obtained from 473 samples with 1177 trips for 24 zones.

3.3.3 Net Present Value

Analysis of NPV calculations of passenger trains on Medan-Belawan route can be seen in Table 5 below:

Table 5. Result of NPV Medan-Belawan route

Year	Factor PV	Present Value (Rupiah)	
		Rp. 4.844	Rp. 11.302
2021	1	1.187.638,491	1.187.638,491
2022	0.89	483.181,702	286.431,375
2023	0.80	369.054,123	401.244,558
2024	0.71	261.244,944	517.545,289
2025	0.64	158.373,424	636.816,319
2026	0.57	59.138,313	760.541,236
Sum		2.518.630,997	1.414.940,286

Source: Primary data processing results, 2021

Calculation of net present value, based on revenue component (cash inflow), train operating costs (cash outflow) and factor Present Value (DF) and Present Value (PV). The amount of DF depends on the Discount Rate (R). Discount Rate (R) is currently assumed to be 12% per year. The total present value in 2021 to 2026 for the tariff of Rp 4.844 was Rp 2.518.630,997 which means NPV<0, it is concluded that the business is "Not Feasible". While the total present value of Rp 11.302 tariff was Rp 1.414.940,286 which means NPV>0, it is concluded that the business is "feasible".

A positive NPV value (NPV > 0) indicates that the receipt is greater than the value invested while the negative NPV value (NPV<0) indicates that the receipt is smaller than the expenditure or will experience a loss on the investment after considering the Time Value of Money. According to Nurdin and Hendra in [5] research about economic feasibility analysis of the

development of the Minang Kabau International Airport (MIA) Railway in West Sumatra" where the results showed that the construction of the Minang Kabau International Airport Railway was not feasible to build economically.

3.3.4 Internal Rate of Return

Analysis of IRR calculations of passenger trains on Medan-Belawan route can be seen in Table 6 below:

Table 6. Result of IRR Medan-Belawan route

Year	Discounted Cashflow IRR (Rp. 4.844)		Discounted Cashflow IRR (Rp. 11.302)	
	r = - 57% (Rp)	r = 12% (Rp)	r = - 137% (Rp)	r = 12% (Rp)
2021	1.187.638,491	1.187.638,491	1.187.638,491	1.187.638,491
2022	344.907,426	483.181,702	135.555,923	286.431,375
2023	188.050,371	369.054,123	89.867,979	401.244,558
2024	95.021,984	261.244,944	54.858,268	517.545,289
2025	41.119,760	158.373,424	31.945,216	636.816,319
2026	10.960,472	59.138,313	18.055,616	760.541,236
Sum	1.867.698,503	2.518.630,997	857.355,488	1.414.940,286

Source: Primary data processing results, 2021

IRR is an indicator of the level of efficiency of an investment. Calculation of Internal Rate of Return (IRR), based on revenue component (cash inflow), train operating costs (cash outflow) and Factor Present Value (DF), the amount of DF fare Rp4844 in the determination of IRR divided into 2 parts, namely: DF with the smallest negative NPV (r = 57%) and DF with the smallest negative positive NPV (r = 12%). While the amount of DF tariff Rp 11.302 in the determination of IRR is divided also in 2 parts, namely DF with the smallest negative NPV (r = 137%) and DF with the smallest negative postif NPV (r = 12%).

The total IRR in 2021 to 2026 for the tariff of Rp 4.844 is (141%) which means IRR < Discount Rate 12%, it is concluded that the business is "Not Feasible". While the Total IRR in 2021 to 2026 for the tariff of Rp 11.302 is 193% which means IRR > Discount Rate 12%, it was concluded that the business was "Feasible". This is in accordance with Tamin in [6] if an alternative shows the value of BCR>1, then the alternative is economically feasible to implement.

3.3.5 Benefit Cost Ratio

Analysis BCR of passenger trains on Medan-Belawan route can be seen in Table 7 below:

Table 7. Result of BCR Medan-Belawan route

Year	*Net Cashflow* (A/F,12%,5) (Rp)		*Cost* (A/P,12%,5) (Rp)	
	Rp. 4.844	Rp. 11.302	Rp. 4.844	Rp. 11.302
2021	1.187.638,491	1.187.638,491	1.187,638,491	1.187.638,491
2022	85.184,547	50.497,622	329.462,794	329.462,794
2023	72.871,620	79.227,786	329.462,794	329.462,794
2024	57.774,245	114.454,994	329.462,794	329.462,794
2025	39.227,146	157.731,558	329.462,794	329.462,794

2026	16.405,571	210.981,900	329.462,794	329.462,794
Sum	271.463,131	612.893,860	459.675,478	459.675,478

Source: Primary data processing results, 2021

Calculation of Cost Profit Ratio (BCR), based on revenue component (cash inflow), train operating expenses (cash outflow) and discrete drabing net cash flow (A/F,12%,5) and discrete drabing interest costs (A/P,12%,5) at a rate of Rp 4.844 total net cash flow (A/F,12%,5) was Rp 271.463,131, while total cost (A/P,12%,5) was Rp 459.675,478. At a rate of Rp 11.302, total net cash flow (A/F,12%,5) was Rp 612.893,860 and total cost (A/P.12%,5) was Rp 459.675,478. The total BCR in 2021 to 2026 for Rp 4.844 tariff was 0.59 which means BCR<1, it is concluded that the business is "Not Feasible". While the Total BCR in 2021 to 2026 for a tariff of Rp 11.302 was 1.33 which means BCR>1, it is concluded that the business is "Feasible".

3.3.5 Load Factor Break Event Point

Calculation of LF BEP for each rate can be seen in the Table 8 below:

Table 8. Result of LF BEP Medan-Belawan route

Year	Load Faktor Harapan		LF BEP	
	Rp.4.844	Rp.11.302	Rp.4.844	Rp.11.302
2021	0.85	0.85	0.00	0.00
2022	0.85	0.85	0.46	1.08
2023	0.85	0.85	0.52	1.21
2024	0.85	0.85	0.59	1.37
2025	0.85	0.85	0.67	1.57
2026	0.85	0.85	0.78	1.81
Average	0.85	0.85	0.50	1.17

Source: Primary data processing results, 2021

Calculation of load factor break event point, based on revenue component (cash inflow), train operating costs (cash outflow), load factor expectation (LFH) and Load Factor BEP. At a rate of Rp 4.844 the average LF BEP of 0.50 with the average LF expectation is 0.85. At a rate of Rp 11.302, the average LF BEP of 1.17 with the average LF expectation is 0.85. The average LF BEP in 2021 to 2026 for tariffs of Rp 4.844 is 0.50 which means LF BEP < LF expectations, it is concluded that the business is "Not Feasible". While the Total LF BEP in 2021 to 2026 for the tariff of Rp 11.302 is 1.17 which means LF BEP > LF hope, then concluded the business is "Feasible".

The feasibility of investment in the Medan-Belawan route passenger rail project, must be reviewed in terms of the evaluation of transportation projects. According to Tamin in [7] project evaluation is an activity that is carried out comprehensively from various aspects in an effort to assess the feasibility level of a project. According to Papulele in [8] investment criteria are used to determine a project proposal after an evaluation that is a go project or no go project where the criteria reviewed in this study are Net Present Value, Internal Rate of return and Break Event Point.

3.4. Development of The North Medan Region

Based on the results of the analysis, that the estimated number of potential passengers on the Medan-Belawan route as an effort to re-operate is considered too small so that it risks the inefficiency of operator revenue. To increase the number of potential passengers on the Medan-Belawan route, connectivity is needed with other activity centers, through the concept of Transit Oriented Development (TOD) in the station or transit area, because the station or transit is not the final destination of the trip. The concept of Transit Oriented Development (TOD) is expected to encourage public interest around the station or transit to use train transportation modes, which can ultimately reduce the use of private vehicles and the development of the Medan City area especially northern Medan whose discussion is focused on Belawan Stations.

Some concepts are the concept of Transit Oriented Development (TOD) around Belawan Station, the area around Belawan Station with a radius of 800 meters, public function of the concept of transit oriented development around Belawan Station, commercial area of Transit Oriented Development concept around Belawan Station, such as the construction of parks, sports fields, urban forests, the provision of a centralized market on the station road in lieu of Belawan market, the provision of flats connected to the station through pedestrian and cyclist lines. To realize the concept, it is necessary to cooperate between the government and operators, in order to increase the number of potential Medan-Belawan train passengers, reduce the use of private vehicles and road traffic congestion and pollution in the city of Medan. This concept will affect other areas in the city of Medan because it concerns the policies that will be implemented by the government.

4. Conclusion

Based on the results of the discussion of the research results, the following conclusions can be drawn:

a. The average number of potential passengers from 2021 to 2026 is 165,033 passengers.

b. The revenue of the passenger train operator of Medan - Belawan route in 2010 was (Rp3.774.467,028.60) and the revenue in 2011 was (Rp1.016.928,490.56) which means inefficiency.

c. Investment feasibility to the recommendation of ATP and WTP tariffs of Rp. 4.844, is not feasible, in order for the investment to be feasible, it is necessary to assume a subsidy rate from the government of Rp. 6.458, bringing the total tariff recommendation to Rp. 11.302.

References

[1] "Menakar Kemacetan Kota Medan di Tahun 2019," Apr. 2, 2019. Available: *https://analisadaily.com*. [Accessed: July. 15, 2021].

[2] M.Z. Irawan, *Perencanaan Angkutan Umum (Frekuensi, Headway dan Jumlah Armada*. Depatemen Teknik Sipil dan Lingkungan, Universitas Gadjah Mada. Yogyakarta. 2016.

[3] M. Nasution, *Manajemen Transportasi*. Ghalia, Jakarta. 2004.

[4] R.M. Permata, "Analisis Ability To Pay Dan Willingness To Pay Pengguna Jasa Kereta Api, Bandara Soekarno Hatta-Maggarai," *Thesis,* Progam Studi Teknik Sipil, Depok. 2012.

[5] R. Nulvi & T. Hendra, "Analisa Kelayakan Ekonomi Pembangunan Jalur Kereta Api Minang Kabau International Airport (MIA) Sumatera Barat," *Journal Jurusan Teknik Sipil, Fakultas Teknik,* Universitas Riau, vol. 1, no. 2. 2014.

[6] O.Z. Tamin, *Perencanaan, Pemodelan dan Rekayasa Transportasi: Teori, Contoh Soal dan Aplikasi*. Institut Teknologi Bandung, Bandung. 2008.

[7] O.Z. Tamin, *Perencanaan dan Pemodelan Transportasi*, Institut Teknologi Bandung, Bandung. 2000.

[8] W. Papulele, *Analisa Biaya Investasi Proyek Perumahan*. Fakultas Teknik, Manado. 2011.