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Modeling commuter mode shift to electric railway services: an integrated performance analysis and stated preference approach for the Rangkasbitung – Merak line

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ABSTRACT

This study investigates the relationship between railway travel service characteristics and passenger demand on the Rangkasbitung – Merak commuter rail corridor. Secondary data on passenger volumes were obtained from PT Kereta Commuter Indonesia, while primary data were collected via on-board surveys conducted across multiple afternoon trips. Descriptive statistical analyses were performed to determine key performance indicators—namely load factor, travel time, dwell time, and commercial speed against established service standards. Subsequently, a binary logistic regression model was employed to assess the influence of travel cost and travel time on passengers' likelihood to choose electric commuter services over conventional local trains. Results reveal an average load factor of 2.40, indicating the existing service capacity is frequently exceeded during peak periods. Average dwell times ranged between 2–5 minutes per station, and observed commercial speeds fell below the stipulated benchmark. Logistic regression analysis showed that travel cost ($p = 0.316$) did not exert a statistically significant effect on mode choice, whereas travel time emerged as a significant determinant: improvements in travel time increased the probability of passengers opting for electric commuter services by approximately 72.1%. These findings suggest that enhancing operational speed and optimizing station dwell times are critical to meeting passenger demand and improving overall service attractiveness on the Rangkasbitung – Merak route.

Keywords : demand; capacity; travel; regression; ridership

1 Introduction

Urban transportation plays a critical role not only in facilitating rapid mobility across regions but also in driving socio-economic development. Efficient public transport systems integrating infrastructure, rolling stock, and operational procedures can reduce congestion, improve safety, and enhance passenger comfort [1]. Railway services, with their exclusive right-of-way and high capacity, offer competitive advantages over other land-based modes. Their ability to transport large volumes of passengers and goods concurrently makes them a strategic solution for growing urban populations [2]. In Indonesia, the Merak–Rangkasbitung local train provides vital connectivity along this corridor but faces limitations due to infrequent schedules and constrained capacity, resulting in overcrowding averaging 768 passengers per trip during peak hours.

Key performance metrics for rail operations include load factor, headway, travel time, and commercial speed. The load factor reflects capacity utilization, headway indicates service frequency while travel time and commercial speed measure operational efficiency [3]. International and national standards require minimum service benchmarks 70% load factor, 1–12 minutes headway, 1 – 1.5 hours travel time, and 80 km/h commercial speed [4].

Converting the local service to an electric commuter line (KRL) could improve acceleration, reduce dwell times, and increase train availability. KRL operations have demonstrated enhanced performance through modern rolling stock, e-

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ticketing systems, and dedicated commuter services [5]. Yet despite these advancements, challenges persist regarding fleet size, punctuality, and passenger comfort.

The operational performance of railway services and the factors influencing passengers' mode choice in Indonesia have been the subject of several prior studies [6]. In order to evaluate service quality against predetermined standards, research on railway operational performance has typically concentrated on technical indicators including load factor, headway, trip time, and commercial speed [7]. For example, assessed the operational performance of regional rail services in Java and discovered that low commercial speeds and infrequent service frequency considerably decreased rail transport's competitiveness when compared to road-based modes. Other research on local rail services have found similar results, highlighting the fact that operational inefficiencies limit railways' capacity to accommodate the increasing demand for passengers [8] [3].

Simultaneously, research on mode shift has mostly used revealed preference or stated preference methods to determine how socioeconomic factors and travel qualities influence passengers' choices of modes of transportation. The most important elements influencing passenger's decisions to switch from bus services to trains on intercity routes are journey time and cost [9], [10]. Mode choice modelling is rarely combined with an empirical assessment of the real operational performance of the railway services in question; instead, the majority of these researches concentrate on comparing road-based and rail-based modes.

By combining a stated preference-based mode shift analysis with empirical operational performance analysis which includes load factor, dwell time, journey time, and commercial speed into a single, cohesive framework, this study makes a unique contribution in contrast to earlier studies [11]. Additionally, this study explicitly looks at the possibility of customers switching from traditional local train services to electric commuter rail (KRL) operations in the Rangkasbitung – Merak corridor, a route that has not gotten much scholarly attention up to this point. In addition to identifying the degree to which current operations fall short of minimum service standards, this research reveals the key elements that could improve the appeal of KRL services by combining an assessment of current service performance with passenger mode choice behaviour [12].

This study aims to evaluate the performance of the Rangkasbitung – Merak corridor against established service standards. analyze the propensity of passengers to shift from the local train to KRL using a stated-preference survey and identify the dominant factors influencing modal choice between local trains and KRL [10]. The findings will inform operational strategies to align service capacity with passenger demand and enhance the attractiveness of commuter rail on this critical corridor.

2 Data and Methods

This study employs a quantitative research design grounded in positivist philosophy, aiming to test predetermined hypotheses through systematic data collection and statistical analysis. The investigation was carried out along the Rangkasbitung – Merak rail corridor, with fieldwork conducted from 09:00 to 17:00 WIB following approval of the institutional research permit.

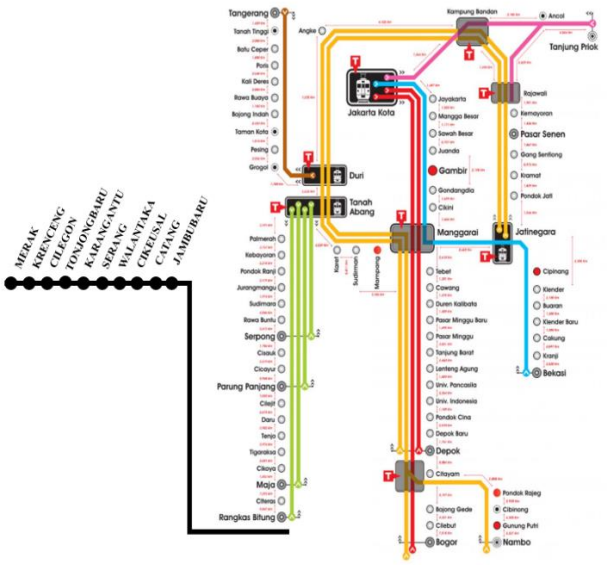


Figure 1. Site Research Location

The data used consists of primary data obtained from respondents and secondary data collected from relevant institutions, research studies, books, and relevant information [13]. Primary data consisted of passenger volume counts and stated-preference survey responses. The survey instrument, refined through initial unstructured interviews, comprised questions on travel cost, journey time, service comfort, and safety perceptions. Questionnaires were distributed on-board trains and at Rangkasbitung Station during peak hours to capture representative travel behavior.

Secondary data including official ridership figures and timetable information were obtained from PT Kereta Commuter Indonesia to contextualize service characteristics. With an estimated daily ridership of 181,469 passengers in 2022, the sample size was determined using Slovin's formula with a 10 % error margin, yielding 100 respondents. Respondents were selected through simple random sampling to ensure unbiased representation. Passenger Volume can be seen in **Table 1**.

Table 1. Passenger Volume on the Rangkasbitung-Merak KA Local in 2022

Station	Month	Volume Total (Person)	Average (Person)
Merak, Krenceng, Cilegon, Tonjong Baru, Karangantu, Serang, Walantaka, Cikeusal, Catang, Jambu Baru, Rangkasbitung,	January	108,756	181,468.8
	February	87,082	
	March	139,464	
	April	123,937	
	May	241,535	
	June	190,648	
	July	208,371	
	August	171,068	
	September	189,248	
	October	226,173	
	November	214,972	
	December	276,32	

Before distributing the research instruments, a validity and reliability test was conducted to evaluate the feasibility and consistency of each questionnaire item. The validity test was performed using the Product Moment Correlation Coefficient, while the reliability test employed Alpha Cronbach's [14]. Both analyses were processed using SPSS version 27.

Operational definitions follow established conventions: load factor is the ratio of passengers aboard to seating capacity; headway denotes the time interval between consecutive train departures; travel time encompasses total door-to-door journey duration; and commercial speed is computed as distance traveled divided by travel time. Data analysis began with descriptive statistics mean and standard deviation to summarize service metrics [15]. Subsequently, binary logistic regression was applied to model passengers' mode choice between the local train and KRL, with significance evaluated at $\alpha = 0.05$. Variables exhibiting p-values below this threshold were deemed significant predictors of modal preference.

The overall research procedure, from problem identification through data analysis and interpretation, is illustrated on the flowchart in **Figure 2**.

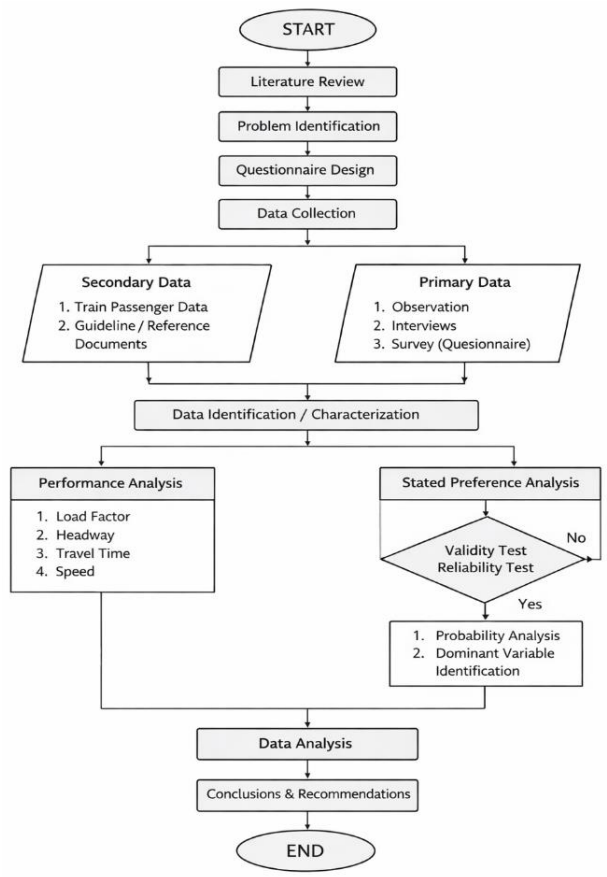


Figure 2. Flowchart

3 Results and Discussion

3.1 Total Passengers on the Rangkasbitung – Merak Railway Line

The Rangkasbitung–Merak railway line serves a sizable and continuously high number of passengers year-round, according to the examination of secondary passenger data. Merak Station records significantly greater departure numbers than arrivals, whereas Rangkasbitung Station averages over 70,000 arrivals and 67,000 departures per month. Strong commuter flows toward Rangkasbitung during peak working hours are shown in this directional imbalance, indicating that the corridor predominantly serves as a work-oriented travel route.

Approximately 2,392 passengers per service are demanded during peak periods when passenger volumes are totaled each train trip. With 636 passengers per trainset as the fixed seating capacity, this yields an average load factor of 240%, with peak values above 370% – 430%. The maximum load factor suggested by PERMENHUB No. 48/2015, which establishes a comfort-oriented baseline of roughly 70%, is greatly exceeded by these numbers [16]. The current local train service cannot meet demand at a satisfactory level of service, as evidenced by such severe overcapacity problems.

Previous conditions, where restricted service frequency and rolling stock availability leading to excessive load factors and overcrowding, have been observed in previous research on regional rail services in Indonesia [3]. In addition to decreasing passenger comfort, chronic overcrowding may deter potential passengers, particularly those who have other transportation options. Thus, the necessity for capacity expansion or service upgrades along the Rangkasbitung – Merak corridor is amply justified by the observed passenger demand.

Table 2. Total of Train Passengers at Rangkasbitung Station

Year	Month	Volume (Average departures and arrivals/day)	
		Departure	Arrival
2022	January	40.987	44.952
	February	32.826	35.619
	March	51.066	55.740
	April	48.859	48.476
	May	84.869	96.759
	June	69.730	75.637
	July	78.718	84.205
	August	64.701	69.589
	September	70.831	76.292
	October	84.356	90.589
	November	79.038	85.171
	December	102.923	110.220
Total Average		67.409	72.771

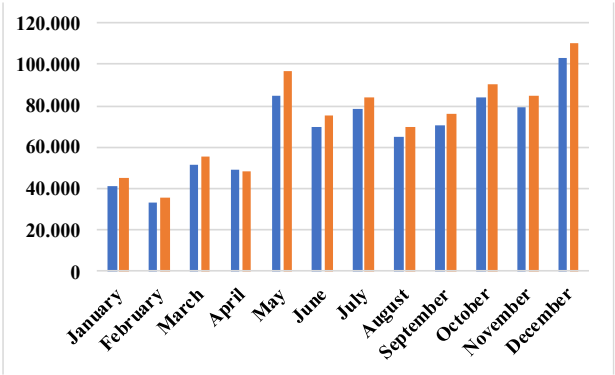


Figure 3. Graph Total of KA Lokal Passengers at Rangkasbitung Station

At Merak Station, similar monthly trends were observed, with departures marginally exceeding arrivals averaging 70.123 versus 68.540 passengers respectively suggesting evening peak flows toward Rangkasbitung.

Table 3. Total of Train Passengers at Merak Station

Year	Month	Volume (Average departures and arrivals/day)	
		Departure	Arrival
2022	January	7.942	13.800
	February	5.870	10.878
	March	12.221	23.233
	April	8.145	20.292
	May	33.052	45.890
	June	19.537	31.753
	July	20.759	35.706
	August	13.824	25.610
	September	15.121	28.673
	October	19.268	34.256
	November	18.405	33.722
	December	27.355	45.165
Total Average		16.792	29.082

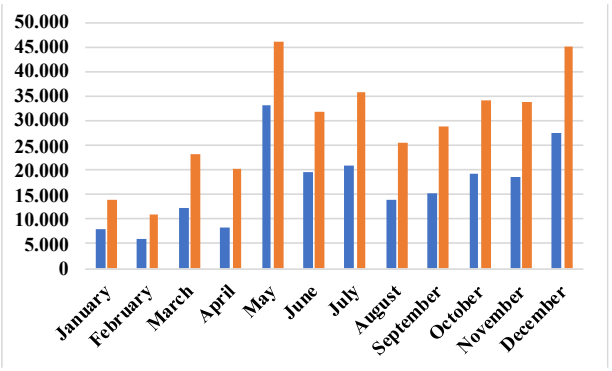


Figure 4. Graph Total of KA Lokal Passengers at Merak Station

When aggregated across all services, the corridor handles approximately 2.392 boardings per trip during peak periods Against a fixed seating capacity of 636 passengers (6 cars × 106 seats), this yields a mean load factor of 376% peaking at 433% during the 17:00 service demonstrating chronic overcapacity and resultant crowding. Service frequency and punctuality were assessed via operational schedules.

Table 4. Merak–Rangkasbitung Train Departure Schedule

Station	PT. KAI Schedule		Travel Time 1 Survey Result		Travel Time 1 Survey Result	
	Arrival	Departure	Arrival	Departure	Arrival	Departure
Merak	16:00	16:20	16:00	16:20	15:55	16:18
Krencang	16:31	16:33	16:32	16:34	16:31	16:32
Cilegon	16:39	16:41	16:43	16:43	16:42	16:43

Tonjongbaru	16:50	16:52	16:52	16:53	16:51	16:52
Karangantu	17:00	17:01	17:01	17:02	17:01	17:03
Serang	17:01	17:13	17:12	17:15	17:11	17:15
Walantaka	17:25	17:26	17:28	17:29	17:26	17:27
Cikeusal	17:36	17:38	17:39	17:39	17:36	17:37
Catang	17:46	17:49	17:45	17:46	17:44	17:46
Jambu	17:55	17:56	17:53	17:55	17:56	17:57
Rangkasbitung	18:04	18:08	18:02	18:10	18:06	18:12

Table 5. Rangkasbitung - Merak Train Departure Schedule

Station	PT. KAI Schedule		Travel Time 1 (Saturday, 08-07-2023) Survey Result		Travel Time 1 (Monday, 10-07-2023) Survey Result	
	Arrival Time	Departure Time	Arrival Time	Departure Time	Arrival Time	Departure Time
Rangkasbitung	16:20	16:45	16:20	16:45	16:20	16:45
Jambu	16:54	16:56	16:53	16:54	16:55	16:56
Catang	17:02	17:04	17:00	17:01	17:01	17:03
Cikeusal	17:13	17:15	17:10	17:12	17:13	17:15
Walantaka	17:26	17:27	17:22	17:23	17:26	17:27
Serang	17:36	17:38	17:33	17:37	17:37	17:40
Karangantu	17:48	17:50	17:47	17:49	17:49	17:50
Tonjongbaru	17:58	17:59	17:56	17:57	17:58	17:59
Cilegon	18:08	18:10	18:07	18:10	18:09	18:11
Krenceng	18:16	18:18	18:16	18:17	18:17	18:19
Merak	18:30	18:40	18:28	18:37	18:31	18:35

On-board observations of four afternoon runs. Headways span 120 minutes in the morning off-peak, widen to 240 minutes mid-day, and narrow again to 120 minutes during evening peaks far above the 12-minute maximum prescribed by Permenhub No. 48/2015. Travel times were measured both from PT KCI timetables and direct on-train surveys. Fastest interstation runs average 330 seconds (5 min 30 s) outbound and 360 seconds (6 min) inbound.

Table 6. Time Between Stations and Passenger Boarding and Alighting Time for the Rangkasbitung-Merak Railway

Station	PT. KAI Schedule		Travel Time 1 (Saturday, 08-07-2023) Survey Result		Travel Time 1 (Sunday, 10-07-2023) Survey Result	
	Inter Station Time (Minutes)	Up and Down Time (Minutes)	Inter Station Time (Minutes)	Up and Down Time (Minutes)	Inter Station Time (Minutes)	Up and Down Time (Minutes)
Rangkasbitung	–	00:25:00	–	00:25:00	–	00:25:00
Jambu	00:09:00	00:02:00	00:08:00	00:01:00	00:10:00	00:01:00
Catang	00:06:00	00:02:00	00:02:00	00:01:00	00:05:00	00:02:00
Cikeusal	00:09:00	00:02:00	00:09:00	00:02:00	00:10:00	00:02:00
Walantaka	00:11:00	00:01:00	00:10:00	00:01:00	00:11:00	00:01:00
Serang	00:09:00	00:02:00	00:09:00	00:04:00	00:10:00	00:03:00
Karangantu	00:10:00	00:02:00	00:10:00	00:02:00	00:09:00	00:01:00
Tonjongbaru	00:08:00	00:01:00	00:07:00	00:01:00	00:08:00	00:01:00
Cilegon	00:09:00	00:02:00	00:10:00	00:03:00	00:10:00	00:02:00
Krenceng	00:06:00	00:02:00	00:06:00	00:01:00	00:06:00	00:02:00
Merak	00:12:00	00:10:00	00:12:00	00:08:00	00:12:00	00:04:00

Overall corridor journey times average 110,5 minutes (1 h 50 m 30 s) from Rangkasbitung to Merak and 117.5 minutes (1 h 57 m 30 s) on the return leg compared with the scheduled 107 minutes, indicating mean delays of 3 and 10 minutes respectively due to prolonged crossings and extended dwell times.

Table 7. Speed of the Rangkasbitung–Merak Railway

Station	PT KAI Schedule			Survey 1		Survey 2	
	Distance (Km)	Time (Hours)	Speed (Km/Hour)	Time (Hours)	Speed (Km/Hours)	Time (Hours)	Speed (Km/Hours)
Rangkasbitung	0	0	0	0	0	0	0
Jambubaru	6,84	0,15	45,6	0,14	48,86	0,17	40,24
Catang	4,11	0,1	41,1	0,1	41,1	0,09	45,67
Cikeusal	6,68	0,15	44,53	0,15	44,53	0,17	39,29
Walantaka	7,58	0,16	47,38	0,17	44,59	0,19	39,89
Serang	8,54	0,16	53,38	0,17	50,24	0,17	50,24
Karangantu	8,18	0,16	51,13	0,17	48,12	0,15	54,53
Tonjongbaru	4,91	0,12	40,92	0,12	40,92	0,14	35,07
Cilegon	7,73	0,15	51,53	0,17	45,47	0,17	45,47
Krenceng	3,64	0,1	36,4	0,1	36,4	0,1	36,4
Merak	9,19	0,2	45,95	0,19	48,37	0,2	45,95
Average	–	–	41,63	–	40,78	–	39,34

Consequently, observed commercial speeds are subdued, averaging 33 km/h outbound and 31 km/h inbound. Markedly below the 80 km/h regulatory benchmark. These deficiencies in frequency, punctuality, and speed directly undermine service attractiveness.

3.2 Characteristics of KA Lokal Passengers on the Rangkasbitung – Merak

The Rangkasbitung–Merak local train's users are primarily of working age, with the majority being between the ages of 19 and 45, according to the results of the passenger survey. The majority of respondents work in the private sector, and the majority of travel is done for job-related reasons. This profile demonstrates that, as opposed to infrequent or recreational travel, the local train is an essential means of daily commuting [17].

The need of dependable and effective peak-hour service is further highlighted by the prevalence of weekday travel. According to earlier research on Indonesian commuter rail users, working-age passengers are especially sensitive to factors including crowding, journey time consistency, and service reliability [18]. In this regard, the service's main user base is directly impacted by the existing operational flaws, which include lengthy headways, crowding, and delays.

Table 8. Respondent Characteristics

Variabel	Details	Precentage
Gender	Man	52%
	Women	48%
Age	<18 Years	0%
	19-30 Years	46%
	31-45 Years	41%
	46-55 Years	13%
Occupation	Student	8%
	Civil servant / State-owned enterprise employee	8%
	Private sector employee	42%
	Housewife	32%
	Entrepreneur	4%
	Others	6%
Travel Cost	<Rp10.000	54%
	Rp30.000	31%
	Rp50.000	9%
	Rp75.000	4%
	>Rp100.000	2%
Travel Duration	<30 Minutes	61%
	30-60 Minutes	23%
	60-90 Minutes	13%
	>90 Minutes	3%
Purpose of Travel	Work	32%
	Familly Matters	11%
	Recreation	26%
	College/School	19%
	Others	12%
Transport used before the Local Train	Public Transportation	23%
	Taxi	4%
	Motorcycle	40%
	Private Car	21%
	Others	12%
Reason used before the Local Train	Faster travel time	42%
	Lower Cost	24%
	Saafety and	21%

	Comfort	
	Distance between destination and station	11%
	Others	2%
Transport to the Station	Walking	6%
	Motorcycle	40%
	Private Car	20%
	Public Transportation	24%
	Others	11%
Transport leaving the Station	Walking	4%
	Motorcycle	45%
	Private Car	21%
	Public Transportation	28%
	Others	2%
Travel Frequency	Every day	19%
	Weekend Saturday-Sunday)	13%
	Once a Week	26%
	Weekdays (Monday-Friday)	30%
	Others	12%

Based on **Table 8**. above, it can be seen that the respondents in this study have characteristics, namely the majority of respondents are male with a percentage of 52%, with the most age ranging from 19-30 years as much as 46%, work as private employees 42%, with the need for travel for work as much as 32% and the highest frequency of using local trains is the use of working days as much as 30%.

3.3 Probability of Mode Selection

The practical significance of journey time should not be understated, even though it did not appear as a statistically significant variable in the final model. Due to lengthy dwell periods and operational delays, observed travel times on the Rangkasbitung–Merak line are longer than planned. Travel time has been regularly found to be a significant factor of mode choice in previous studies, especially for commuter and work-related trips [19]. The study's lack of statistical significance could be explained by the respondents' rather uniform travel times in the current operating environment.

This study offers more insight by looking at mode shift within rail-based services, specifically from conventional local trains to electric commuter rail, in contrast to previous mode choice studies that mostly concentrated on competition between buses and trains. The results indicate that service enhancement, particularly through electrification, has a high potential to increase ridership and passenger satisfaction on the Rangkasbitung – Merak corridor by connecting passenger's expressed preferences with real operational performance gaps.

Based on the Wald test using binary logistic regression for the independent variable, it can be seen that the independent variable significantly influences the dependent variable because the p-value of the Wald test is $<\alpha$, where $\alpha = 0.05$. The following assumptions can be made in the test based on the p-value:

Reject α if significance $\leq \alpha$, which means the independent variable has a significant effect on the dependent variable.

Accept α if significance $> \alpha$, which means the independent variable does not significantly influence the dependent variable.

Table 9. Independent Variables Affecting Travel Mode Selection Rail and Electric Rail

Variabel Bebas	*p-value*	α = 5%	Keputusan
Age	0.474	0.05	Agree H_0
Occupation	0.284	0.05	Agree H_0
Four-wheeled vehicle ownership	0.722	0.05	Agree H_0
Two-wheeled vehicle ownership	0.631	0.05	Agree H_0
Travel cost	0.003	0.05	Disagree H_0
Travel Duration	0.045	0.05	Agree H_0
Purpose of Travel	0.421	0.05	Agree H_0
Transport used before the Local Train	0.457	0.05	Agree H_0
Reason used before the Local Train	0.780	0.05	Agree H_0
Transport to the Station	0.916	0.05	Agree H_0
Transport leaving the Station	0.863	0.05	Agree H_0
Travel Frequency	0.608	0.05	Agree H_0
Harapan Aksebilitas	0.389	0.05	Agree H_0

Table 9 shows that the travel cost variable significantly influences the dependent variable of local train and electric rail mode choice, as the Wald test p-value is sig. $< \alpha$, i.e., $0.003 < 0.05$. Therefore, the decision is rejected.

To analyze the probability of choosing local train or electric rail on the Rangkasbitung-Merak route, a binary logistic regression method was used, where the variable is dichotomous with two possible outcomes: 0: Choosing electric rail and 1: Choosing local rail.

This analysis aims to determine the influence of the probability of using a mode of travel between the variables that significantly influence mode choice, namely travel cost. The following is the calculation of the probability of choosing local train and electric rail modes, with the independent variables that most influence the choice of local train and electric rail modes [20]. Based on the analysis, the income variable significantly influences the mode shift between local trains and electric rail trains. The results of the Wald test using logistic regression on this variable are as follows.

Table 10. Results of the Wald Test of Binary Logistic Regression for Cost Variables

Variables in the Equation							
		B	S,E	Wald	df	Sig	Exp (B)
Step 1[a]	Travel Cost	-0.288	0.335	0.736	1	0.391	0.750
	constant	1.359	0.627	0.327	1	0.568	2.431

Table 10 shows the logit modeling equation for local train and electric rail mode choice as follows:

$$\text{Logit (p)} = ln\ = \frac{p}{1-p} \quad (1)$$

$$= \beta 0 + \beta 1X1 + \beta 2X2$$
$$= 1.359 - 0.288_{\text{travel cost}}$$

Therefore, the opportunity cost and travel time significantly influence the probability of switching modes. Based on the variables of travel cost and travel time, the opportunity to switch will be greater.

$$\text{Logit (p)} = ln\ = \frac{p}{1-p} \quad (2)$$

$$= \beta 0 \pm \sum_k^p - 1^{\beta_k x_k}$$
$$= 1.359 - 0.288_{\text{travel cost}}$$
$$= 1.071$$
$$\text{P} = \frac{e^{1.071}}{1+e^{1.071}}$$
$$= \frac{2{,}431^{1{,}071}}{1+2{,}431^{1{,}071}}$$
$$= 0.721\ (72.1\%)$$

Based on calculation, it can be seen that the respondents in this study have characteristics, namely the majority of respondents are men with a percentage of 52%, with the most age ranging from 19-30 years as much as 46%, work as private employees 42%, with the need for travel for work at 32% and the highest frequency of using local trains is the use of weekdays at 30%. The results of the analysis obtained that the travel cost variable is the most influential factor, with a probability value of mode transfer of 72.1% of local train users will be willing to switch to using the electric rail train on the Rangkasbitung-Merak route.

Before a variable is declared fit, it must be statistically tested according to **Table 11**. The Hosmer-Lemesshow test is used to test the binary logistic regression model variables, with the following assumptions:

H0 : The model is sufficiently able to explain the data (Goodness of Fit).

H1 : The model is not sufficiently able to explain the data.

Test criteria:

1. Accept H0 if the p-value is sig. > 0.05
2. Reject H0 if the p-value is sig. < 0.05

Table 11. Hosmer and Lemeshow Test Based on Travel Cost Variables

Step	Chi-square	df	Sig.
1	1.379	5	0.316

Table 11 shows that the sig. $0.316 > 0.05$, so the decision is accepted. It is believed that the logistic regression model used is adequate to explain the test data. This proves that the logistic regression model is suitable for interpretation. The calculation results show that the travel cost variable influences passenger willingness to use electric rail transportation with a probability value of 72.1%.

3.4 Most Dominant Indicators Influencing the Probability of Mode Choice

Descriptive statistical tests revealed the most dominant factor. This is evidenced by the results of the mean test, which shows that the most dominant variable, train travel demand (independent) versus passenger demand (dependent), is an increase, with the largest mean value of 3.65 and a standard deviation of 1.085.

Data collection was conducted directly at Rangkasbitung, Serang, and Merak Stations, the study locations. This study required a minimum sample size of 100 respondents; the larger the number of respondents, the better the model results for analysis.

The survey data was then summarized, and the results were then described using descriptive statistical techniques. The following are the results of the survey and interviews regarding the characteristics of local train users on the Rangkasbitung-Merak route.

Table 12. The Results of the Validity Test of the Accepted Reality Data

Indicator	r – Value	r – Table	Details
A. *Cost*			
KD1	0,427	0,196	Valid
KD2	0,540	0,196	Valid
B. *Time*			
KD3	0,456	0,196	Valid
KD4	0,663	0,196	Valid
KD5	0,645	0,196	Valid
C. *Service*			
KD6	0,679	0,196	Valid
KD7	0,513	0,196	Valid
KD8	0,381	0,196	Valid
KD9	0,567	0,196	Valid
KD10	0,455	0,196	Valid
KD11	0,441	0,196	Valid
D. *Safety*			
KD12	0,461	0,196	Valid
KD13	0,466	0,196	Valid
KD14	0,492	0,196	Valid

Based on **Table 12** after the re-validation test, the 14 statements in the Accepted Reality variable showed a change from KD13 to KD12 to KD14. The calculated r-value for all questions in the questionnaire using SPSS analysis on the Accepted Reality by Passengers was greater than the r-table of 0.196. Therefore, it can be concluded that all questions are valid.

Next, in the validity test, the 14 statements were distributed to 100 respondents, with each question indicator coded using Consumer Expectations (CE) as the Performance variable. Each statement item was deemed valid if the correlation coefficient value was greater than the r-table or significantly greater than 0.196. This was then carried out using SPSS version 27, as shown in **Table 13**.

Table 13. Consumer Expectation Data Validity Test Results

Indicators	r – Value	r – Table	Detail
HK1	0,489	0,196	Valid
HK2	0,481	0,196	Valid
B. *Time*			
HK3	0,398	0,196	Valid
HK4	0,402	0,196	Valid
HK5	0,475	0,196	Valid
C. *Service*			
HK6	0,492	0,196	Valid
HK7	0,280	0,196	Valid
HK8	0,572	0,196	Valid
HK9	0,510	0,196	Valid
HK10	0,567	0,196	Valid
HK11	0,458	0,196	Valid
D. *Safety*			
HK12	0,407	0,196	Valid
HK13	0,588	0,196	Valid
HK14	0,482	0,196	Valid

Based on **Table 13** above, all of these 14 statements are declared valid for Consumer Expectations because it can be seen that all of these items have a calculated r-value greater than r - Table of 0.196. For more details, see the validity of the Accepted Reality in the SPSS version 27 output attachment for the Validity test. Thus, it can be concluded that all questions are valid.

Next is the reliability test. Reliability is the test or accuracy demonstrated by the measurement instrument used to determine the consistency of the measuring instrument [14]. To conduct the reliability test in this study, SPSS version 27 was used with the following criteria:

1. If the Cronbach's Alpha value is $\geqslant$ 0.6, the data in this study is considered reliable.
2. If the Cronbach's Alpha value is $\geqslant$ 0.6, the data in this study is considered unreliable.

Table 14. Reliability Test Results of Reality Accepted by Respondents

Realibility Statistics	
Cronbach's Alpha	*N of Items*
0,775	14

Based on the SPSS test results in **Table 14**, it can be seen that the Cronbach's Alpha value of the 14 indicators is 0,775, which means it is greater than 0,6. Thus, it can be declared reliable and can be used for the next testing stage.

Table 15. Results of Reliability Test of Consumer Expectation Data by Respondents

Realibility Statistics	
Cronbach's Alpha	*N of Items*
0.731	14

Based on the SPSS test results in **Table 15** it can be seen that the Cronbach's Alpha value of 14 indicators is 0.731, which means it is greater than $>$ 0.6. Thus, it can be declared reliable and can be used for the next testing stage.

4 Conclusion

Based on the objectives of this study, which were to evaluate the operational performance of the Rangkasbitung–Merak local train service and to analyze passenger travel behavior and the potential shift to electric rail services, several conclusions can be drawn.

First, the assessment of operational performance shows that the current local rail service cannot provide a sufficient level of service to meet passenger demand. The current service capacity is inadequate, as evidenced by the average load factor of 2.40 and exceptionally high peak load circumstances, which show ongoing overcrowding and decreased passenger comfort. Further limiting service availability are lengthy headways (two to four hours) and a restricted service frequency of only 14 round trips daily. Analysis of travel times reveals that, mostly as a result of operational delays such extended wait times at train crossings, actual trip times are longer than the official schedule established by PT KAI. These results show notable discrepancies between current operations and anticipated service standards, which directly addresses the study's goal of evaluating service performance.

Second, a study of the characteristics of the passengers shows that the local train mainly carries working-age commuters, with males between the ages of 19 and 30 making up the majority. These commuters are mostly weekday private sector workers. This outcome validates that the Rangkasbitung – Merak route operates as a rail corridor focused on commuters, where capacity,

dependability, and service effectiveness are essential for meeting daily mobility demands.

Third, the results show that the most important element influencing passengers' readiness to switch from local trains to the Rangkasbitung–Merak electric rail line is trip cost, which is relevant to the goal of assessing travel behavior and modal shift potential. There is a high potential demand for better rail services if they are provided at reasonable fares, as indicated by the analysis's 72.1% probability of modal shift. Operational analysis demonstrates that time reliability is still a major concern impacting service performance and customer experience, even though statistical analysis did not show trip time to be the most dominant variable.

According to the study's overall findings, there is a great chance that the Rangkasbitung–Merak corridor's existing performance issues—such as overcapacity, poor service frequency, and operational delays—will be resolved by implementing electric commuter rail services. Future planning and policy decisions aimed at enhancing regional rail services to better meet passenger demand and travel needs are empirically supported by the findings.

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