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The North Line Jakarta Lrt: Operating System And Risk Analysis

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ABSTRACT

The North line Jakarta LRT is one of the light rail transportation modes implemented to address the complex traffic issues in DKI Jakarta, Indonesia. Initial studies indicate that the existing headway and travel time are perceived as ineffective by users. This study aims to examine the effective headway in operating the North line Jakarta LRT and identify associated risks and their mitigation. The research employed survey methods through questionnaires, interviews, direct observations, and collected secondary data and documentation related to the North line Jakarta LRT. The analysis results revealed that passengers prefer a waiting time of 5 minutes during peak hours at 05:30-08:30 AM and 04:00-07:00 PM. A comprehensive risk analysis was also carried out using the interview method with open questions. This process identifies 14 potential risks associated with proposed changes to operating system patterns. A series of action plans have also been designed to effectively mitigate the identified risks.

INTRODUCTION

Jakarta, the capital city of Indonesia, is facing severe transportation problems due to its growing population and increasing number of vehicles on the road. Congestion, air pollution, and long travel times are major issues that affect the daily lives of citizens and hinder the city's economic growth. To address these issues, the Indonesian government has initiated several transportation projects, including the development of the Light Rapid Transport (LRT) system. Based on the urgency above and relying on Presidential Regulation number 99 of 2015 concerning the Acceleration of Public Transportation Implementation in DKI Jakarta Province, then the DKI Jakarta government appointed PT-JPo and PT-PJ to build the Jakarta LRT. Furthermore, the Jakarta LRT began work on June 22, 2016 and as the implementing contractor at that time was PT-WK (Negara, 2007) (Nomor, 72 C.E.).

In the initial stage, two lines are planned, namely the north line and the south line. The northern line has been able to operate for public services since December 1, 2019, and the company appointed in operation is PT-LRT-J. The line has a rail length of 5.8 km, starting from Pengangsaan Dua Station (Kelapa Gading area) to Velodrome Station (Pulo Gadung area) (Pratama et al., 2020). It has been almost three years since the northern line has been in operation, the fact now also shows that during rush hour there are queues of crowded users. Preliminary studies through several respondents also showed that there was dissatisfaction with LRT users regarding the waiting period on the LRT, so studies related to the study of the operating system of the north line Jakarta LRT are urgent to be reviewed (Ramadianti & Widyaningsih, 2020) (Rahayu Putri, 2023).

Studies related to this topic were previously conducted by (TSURAYYA ZAHIRAH, 2011). Referring to the user satisfaction survey, (TSURAYYA ZAHIRAH, 2011) conducted an analysis related to the existing operating system by shortening the existing headway of the north line Jakarta LRT. However, the study has not confirmed how effective the proposed headway is for the northern line Jakarta LRT operating system, and what risks are likely to occur and how to mitigate these risks. Referring to this gap, this study aims to determine the effective headway of the north line Jakarta LRT, as well as identify potential risks that may occur and design risk mitigation due to changes in the north line Jakarta LRT operating system with a new headway.

METHOD

In this study, two research approaches were used, both quantitative and qualitative approaches. This research was carried out in the following stages:

1. Study of Passenger Waiting Time Expectations

   This stage aims to determine the expected waiting time from passengers within the research subject. Data was collected by the questionnaire method which was carried out by the online method. A set of questionnaires in the form of a google form link was submitted to respondents consisting of several questions related to demographics and main questions. The main question aims to identify the most expected waiting times of north line Jakarta LRT passengers. Based on the Slovin formula, the number of respondents used in this study was 100 LRT users. Slovin formula.

$$n = \frac{N}{(1 + Ne^2)}$$

   The results of filling out the questionnaire by respondents were then processed using statistical methods to obtain a description regarding the waiting time expected by north line Jakarta LRT passengers during rush hours.

2. Analysis of Existing Operating System

   Analysis of the existing operating system is carried out to obtain an overview of the existing operating conditions of the north line LRT Jakarta, as well as being used as a basis for proposing changes to operating parameters to achieve optimization of the operating system. The main goal at this stage is to find out the parameters of the existing operating system on the the north line Jakarta LRT. The data used are secondary data obtained from online official sources and the results of literature studies, including documentation studies. The formula is quoted from (Supriadi, 2008a) and (TSURAYYA ZAHIRAH, 2011) and is used to obtain the speed, headway, track capacity, circulation time (WPS), and number of LRT fleets required (Pasila et al., 2019). The formula used is as follows.

   a. Speed
      V = S/T
   b. Headway
      H = (60×(B+30))/V+0.25
   c. Track Capacity
      C = 1440/H×2×0.7
   d. Circulation Time
      WPS = 2×13+WTT departure+WTT arrival
   e. Number of LRT fleets
      Number of fleets = WPS/(H×0.85)× the number of carriages in one LRT fleet

3. Analysis of Proposed Operation System

   In this stage, we conduct an operating system analysis focused on the anticipated waiting time for LRT users. Similar to the previous stage, we rely on secondary data from the initial studies, online official sources, and literature including documentation studies. The formula used for this analysis is derived from (Supriadi, 2008b) and (TSURAYYA ZAHIRAH, 2011), which help determine acceleration and deceleration, braking distance, circulation time, and the required number of LRT fleets, as in the earlier phase.

4. Risk Analisys

   The main objective of this stage is to identify primary risks related to changes in the operating system of the north line of Jakarta LRT due to headway modifications and develop effective mitigation strategies. The chosen research approach is interviews. Participants include 5 expert practitioners with at least 10 years of LRT service experience and academic practitioners with similar experience. Their selection is based on extensive knowledge to provide valuable insights into risks linked to the north line's operating system changes (Salsabilla et al., 2023).

   Data was gathered through interviews using open-ended questions to encourage detailed responses. The three main questions covered the feasibility of proposed changes, primary risks, and mitigation efforts. Preparations were made for a smooth process, including scheduling, an appropriate interview environment, and obtaining consent and permissions. Data analysis involved qualitative techniques, noting detailed responses from audio or video recordings. Key risks and risk response plans were identified. To ensure reliability and validity, responses were cross-referenced, and multiple researchers assessed data consistency.

Expected results include identifying key risks and developing risk response plans based on insights from expert practitioners and academics, contributing to effective risk management for the north line of Jakarta LRT. Figure 1 below is a methodology diagram in this study (Wibowo, 2022).

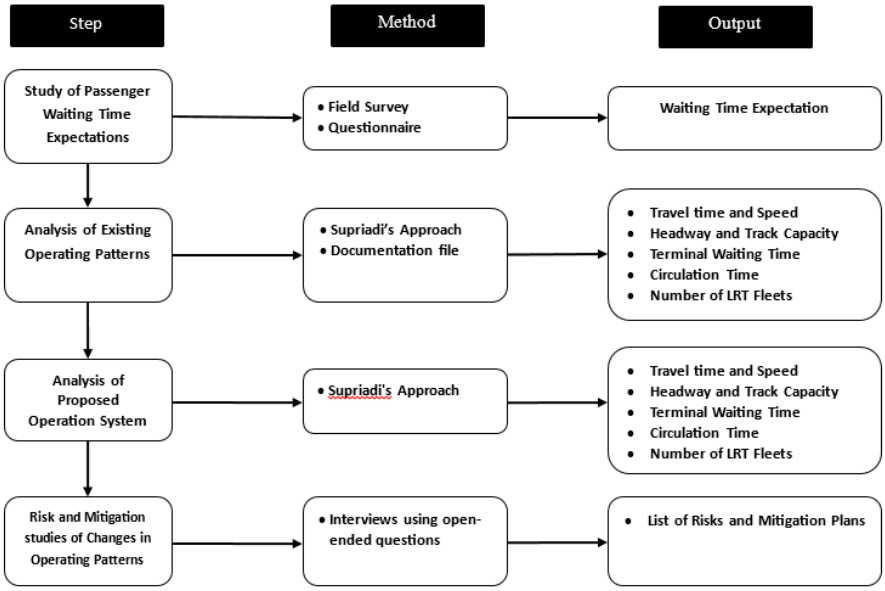

Figure. 1 Methodology Diagram

RESULTS AND DISCUSSION

The following description presents the results and discussion related to this research.

1. Waiting Time Expectations

Following are the results of collecting data on respondents using a questionnaire. Data was obtained on LRT operational days (Monday-Friday) during peak hours 05.30 AM - 08.30 AM and 16.00 PM - 19.00 PM, also on non-busy days (Saturday and Sunday).

Table 1. Jakarta LRT passenger survey results

NO	Survey passanger	Results
1	18 - 30 years old	59%
2	Private Employee	55%
3	Easy	37%
4	For Work	42%
5	Proposed Headway 5 minutes at 05.30 – 08.30 WIB	40%
6	Proposed Headway 5 minutes at 16.00 – 19.00 WIB	42%

2. Existing Operating System

An analysis of the existing operating system was conducted to depict the operational conditions of Jakarta LRT and assess the need for optimization through the addition of LRT train operations. Following the calculations using the equations above, here are the results of the analysis of the existing operating system pattern. Table 2 below shows travel time existing.

Table 2. Travel time – Existing

Station	Distance (m)	Dwell time (s)	Travel time (s)	Traveling time	
				s	m
Pegangsaan Dua Boulevard Utara	1338	30	210	240	4
Boulevard Utara	784	30	120	150	2.5

Boulevard Selatan					
Boulevard Selatan	1040	30	90	120	2
Pulomas					
Pulomas	650	30	90	120	2
Equestrian					
Equestrian	1313	30	120	150	2.5
Velodrome					
TOTAL	5425	150	630	780	13

Based on the speed formula, the existing speed is 25.04 km/hour. Referring to the farthest distance of the stake, which is 950 meters, a minimum headway of 6 minutes is obtained. Table 3 below shows some of the existing operating parameters consisting of minimum automatic block headway capability and track capacity.

Table 3. Headway Capability and Track Capacity

Time period	Time	Minimum Automatic Block Headway capability (minutes)	Track Capacity (minutes)
Morning rush hour	05.30 - 08.30	6	42
Non-Busy Hours	08.30 - 16.00	6	105
Afternoon rush hour	16.00 - 19.00	6	42
Non-Busy Hours	19.00 - 23.30	6	63
Total			252

The existing headway values consist of an equipment replacement time of 3 minutes and a facility cleaning time of 4 minutes, then the waiting time for the Jakarta LRT north line (WTT) terminal is shown in Table 4 below.

Table 4. Terminal waiting time (WTT)

No.	Activities	Required time (minutes)
1	Minimum Headway Waiting Time	
	a. The operator change cabin	2
	b. Changing the front cabin device	0,5
	c. Changing the rear cabin device	0,5
2	Cleaning vehicle	4
Total		7

3. Proposed Operation System

Following are the results of the analysis in the form of parameters of the operating system pattern based on the proposed headway:

a. Travel time

Referring to the technical specifications of the facility, with a maximum operational speed of 80 km/h, and with an acceleration and deceleration of 1.0 m/s2, the following description is the proposed graphical speed calculation with a maximum speed of 90%, as well as calculation of acceleration and deceleration.

$$v=80\times90\%=72 \text{ km/h}$$

Based on the calculation of the speed equation, the acceleration and deceleration for 20 seconds of the train are obtained as follows:

$$s = \frac{0^2 - \frac{\left(\frac{72 \times 1000}{3600}\right)^2 m}{s}}{2 \times 1 \ {}^{m}/_{s^2}} = 200 \ meter$$

Based on the service parameters above, the braking distance is 200 meters long, so the travel time can be obtained according to Table 6 below.

Table 6. Travel time

Station	Distance (m)	Acceleration time (s)	Deceleration time (s)	Dwell time (s)	Travel time (s)	Traveling time	
						s	m
Pegangsaan Dua	1338	20	20	30	46.9	116.9	1.9
Boulevard Utara							
Boulevard Utara	784	20	20	30	119.2	89.2	1.5
Boulevard Selatan							
Boulevard Selatan	1040	20	20	30	32	102.0	1.7
Pulomas							
Pulomas	650	20	20	30	27.5	97.5	1.6
Equestrian							
Equestrian	1313	20	20	30	45.7	115.7	1.9
Velodrome							
TOTAL	5425	100	100	150	171.3	521.3	8.7

The results of calculations using the speed equation with a travel time of 8.7 minutes obtained an operational speed of 37.41 km/hour.

b. Terminal waiting time

The proposed terminal waiting time can be reduced to 3 minutes, assuming that cleaning the internal facilities of the train can be done while the train is running, so there is no special time for cleaning when the train is stationary. Table 7 shows the terminal waiting time (WTT) for the proposed operating pattern system.

Table 7. Terminal waiting time (WTT)

No.	Activities	Required time (minutes)
1	Minimum Headway Waiting Time	
	a. The operator change cabin	2
	b. Changing the front cabin device	0,5
	c. Changing the rear cabin device	0,5
Total		3

c. Circulation time of train

The results of calculations using the WPS equation obtained a train circulation time of 23.4 minutes.

d. Proposed headway and number of fleets

The proposed headways consist of peak and non-peak periods. Also taking into account the operating time period, the number of fleets, and the number of trips. Table 8 below is the proposed headway which is calculated based on the equation for the number of fleets. Table 8 also shows that the proposed headway (5 minutes) during peak hours is still above the minimum headway threshold (3 minutes: according to Table 7).

Table 8. Headway and other proposed operating system parameters

Time period	Time	Headway (minutes)	Number of Fleets	Track Capacity

Morning rush hour	05.30 - 08.30	5	5	72
Non-Busy Hours	08.30 - 16.00	10	3	180
Afternoon rush hour	16.00 - 19.00	5	5	72
Non-Busy Hours	19.00 - 23.30	10	3	108
Total				432

4. Risk and Mitigation

Table 9 below is the result of an in-depth interview in identifying risks and their mitigation plans due to changes in the pattern of the operating system on the north line of Jakarta LRT - Indonesia.

Table 9. Resume of risks and mitigation plans

NO	RISK	MITIGATION
1	Train operators tired	• Reduced working hours • Routine Health Check before work
2	The concentration of train operators is disturbed	Operator rest time between working hours
3	Operation controller tired	• Reduced working hours • Routine Health Check before work
4	Controller operator concentration is impaired	Operator rest time between working hours
5	The carriage guards were tired	• Reduced working hours • Routine Health Check before work
6	The concentration of the carriage guards was disturbed	Operator rest time between working hours
7	Tired station security	Change shifts with other HR
8	LRT operating cost overruns	Increase passenger occupancy or increase passenger targets.
9	Railways over maintenance costs	Early identification of railway problems or tightened supervision
10	Train maintenance cost overruns	Early identification of train problems or tightened supervision
11	Swelling of station maintenance costs and other supporting facilities	Early identification of problems at stations and other supporting facilities or tightened supervision
12	There is an electrical disturbance	• Early identification of railway problems or tightened supervision • Procurement of electrical resource reserves
13	Limited supply of spare parts	• Better usage and supply of spare parts • Increase the number of facility parts
14	Signaling system malfunction	More routine periodic checking of signaling systems

CONCLUSION

Based on the results of the analysis and discussion in this study, the conclusions are as follows: There are 40% of north line Jakarta LRT users want the waiting time at peak time at 05.30 - 08.30 WIB for 5 minutes, and 42% want the peak time at 16.00 - 19.00 WIB to be 5 minutes. Based on the results of the analysis of the proposed pattern of operating system the north line Jakarta LRT by using a headway during peak hours for 5 minutes and non-peak hours for 10 minutes, this shows that it still meets operational feasibility. As a result of discussions with expert practitioners, 14 potential risks were identified as a result of changes in the proposed operating pattern. The results of discussions with expert practitioners also resulted in a set of action plans needed to mitigate these potential risks. Future studies can be continued by identifying the factors that affect passenger satisfaction and propose steps to improve the overall user experience.

REFERENCES

Negara, S. (2007). Undang-undang Nomor 23 Tahun 2007 Tentang Perkeretaapian. *Jakarta, Indonesia*.

Nomor, P. P. (72 C.E.). Tahun 2009 tentang Lalu Lintas dan Angkutan Kereta Api. *Lembaran Negara Nomor*, *175*.

Pasila, R., Rompis, S. Y. R., & Jansen, F. (2019). PEMODELAN AKSELERASI KENDARAAN RODA EMPAT DAN RODA DUA MENGGUNAKAN DATA KENDARAAN PENYIDIK DI KOTA MANADO. *JURNAL SIPIL STATIK*, *7*(5).

Pratama, A. W., Anggara, Y. S., Ibnu, H. W., & Putra, L. S. (2020). Analisis Efektifitas Implementasi Gapeka dan Standar Pelayanan Minimum di PT KAI Divisi Regional II Sumatera Barat. *Airman: Jurnal Teknik Dan Keselamatan Transportasi*, *3*(1), 9–15.

Rahayu Putri, A. (2023). *PENILAIAN KEPUASAN PENGGUNA LRT PALEMBANG PASCA REGULASI PPKM LEVEL 1 PROVINSI SUMATERA SELATAN PANDEMI COVID-19*. UNIVERSITAS LAMPUNG.

Ramadianti, K., & Widyaningsih, N. (2020). Kajian Preferensi Pengguna Moda Transportasi Kereta Api LRT Jakarta Menuju Stasiun LRT Velodrome. *Wahana Teknik Sipil: Jurnal Pengembangan Teknik Sipil*, *25*(2), 158–165.

Salsabilla, S., Hidayati, L. A., & Santosa, M. (2023). The Effect of Service Quality, Product Reviews, Risk Perception, and Usability Perception on Online Food Purchasing Decisions. *Enrichment: Journal of Multidisciplinary Research and Development*, *1*(3), 91–100.

Supriadi, U. (2008a). Kapasitas Lintas dan Permasalahannya. *Bandung: PT. Kereta Api (Persero)*.

Supriadi, U. (2008b). Perencanaan Perjalanan KA Dan Pelaksanaannya, PT. *Kereta Api (Persero), Bandung*.

TSURAYYA ZAHIRAH, T. Z. (2011). *EVALUASI POLA OPERASI LRT JAKARTA LINTAS PEGANGSAAN DUA–VELODROME*. Politeknik Transportasi Darat Indonesia-STTD.

Wibowo, A. (2022). Manajemen Risiko. *Penerbit Yayasan Prima Agus Teknik*, 1–392.