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Managing Safety Risks at Uncontrolled Rail Crossings: The Case of JPL 87 KM 29+745 in Bekasi City

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Abstract : A level crossing is an intersection between a road and a railway line where the intersection is in a horizontal plane. To improve safety in railway operations, it is necessary to monitor both infrastructure, facilities, traffic and human resources. The level of safety is the main factor that is taken into consideration by service users when choosing the mode of transportation to use. Whether on land, sea or air, safety always comes first. Safety is an absolute factor that must be present in every situation, including rail transportation itself. There needs to be collaboration between parties to achieve safety at level crossings. Every level crossing has certain risks. Risk cannot be eliminated, but can be controlled. Risk control is the process of responding to and treating risks, as well as follow-up plans (Hanafi, 2006). It is necessary to identify risks as a basis for steps that must be taken by the relevant parties so that they can be controlled to reduce accidents at level crossings.

Keywords : level Crossing, Safety, Risk Identification.

Introduction

JPL 87 KM 29+745 is an official unguarded level crossing. This crossing is guarded by self-help communities whose income is given voluntarily from road users who pass through the crossing. Although it has been equipped with road safety facilities such as traffic signs, road users often ignore or do not understand the meaning of the signs. This leads to potential traffic violations that can lead to accidents, especially when trains are passing. This factor increases the likelihood of road users being unaware of trains until they get too close. In addition, motorcyclists and pedestrians tend to act in haste, without paying attention to the warning signs. Temperance at JPL 87 KM 29+745 occurs almost every year, compiled from various news sources, 3 people died and 5 people were injured due to temperance that occurred from 2020 to 2024. every temperance involves road users who drive motorised vehicles. The impact of these temperances is not only felt by the victims but also has an impact on railway operations, such as damaged railway facilities that require replacement of facilities, delays in train travel, and infrastructure disruption.

Level crossings (JPL) between roads and railways constitute accident-prone areas requiring serious attention, particularly at locations without official supervision (Prasetyo, 2023). concrete example is JPL 87 KM 29+745, which, despite being equipped with safety signs, still relies on community-based voluntary supervision funded by road users (Saputra & Wijaya, 2022). This condition creates various safety problems, where the lack of formal oversight and poor understanding of warning signs among road users often leads to traffic violations, especially when trains are passing (Kurniawan, 2024).

The problem becomes more complex with risky behavior from motorcyclists and pedestrians who tend to be in a hurry and ignore warning signs (Nugroho & Santoso, 2023). Statistical data collected from various news sources shows that during 2020-2024, several accidents occurred at this location, resulting in 3 fatalities and 5 injuries, with all incidents involving motor vehicles (Badan Pusat Statistik, 2024). he impact of these accidents is felt not only by victims and their families but also disrupts overall railway operational efficiency (Direktorat Jendral Perhubungan, 2022).

The main problems at JPL 87 KM 29+745 can be identified as three key factors. First, the supervision system relying on community volunteers has proven ineffective in enforcing traffic discipline (Rahman & Hidayat, 2024). Second, low safety awareness among road users, where many ignore or fail to understand the meaning of installed warning signs (Siregar, 2023). Third, risky behavior from road users, particularly motorcyclists and pedestrians who often dare to cross hastily without considering safety (Wibowo & Darmawan, 2025).

This research holds significant importance in efforts to improve transportation safety, particularly at level crossings without official supervision (Yulianto & Firdaus, 2023). By identifying root causes and formulating risk-based mitigation solutions, the findings are expected to serve as a reference for various stakeholders including government, railway operators, and the general public in creating safer transportation systems (Peraturan Menteri Perhubungan No. 45 Tahun 2022).

Several previous studies have contributed to understanding safety issues at level crossings. (Kurniawan, 2024) concluded in his study that although risks at crossings cannot be completely eliminated, they can be controlled through hazard identification processes and appropriate preventive measures. Similar findings were also revealed by (Andrianto, 2024) who emphasized that violations of traffic signs are the main contributing factor to accidents. Meanwhile, (Kurniawan, 2024) in their research suggested the importance of combining public education with early warning technology implementation. A recent study by (Andrianto, 2024) reinforced these findings by showing that technology-based approaches such as automatic warning systems can reduce violations by up to 40%. However, there remains a research gap regarding the development of more effective risk mitigation models specifically for level crossings with community-based supervision systems, as in the case of JPL 87 KM 29+745 (Fauzi & Maulana, 2025).

Based on the above description, this research has three main objectives. First, to comprehensively analyze the dominant factors causing accidents at JPL 87 KM 29+745 (Siregar, 2023). Second to develop and propose risk mitigation strategies focused on improving road user awareness and optimizing existing safety facilities (Yulianto & Firdaus, 2023). Third, to provide implementable policy recommendations to stakeholders for reducing accident rates at level crossings without official supervision, creating safer and more efficient transportation systems (Peraturan Direktur Jenderal Perkeretaapian No. 12 Tahun 2023).

Method

This comprehensive railway level crossing safety study employed a mixed-methods approach combining quantitative and qualitative methodologies to assess risks at grade crossing JPL 87 KM 29+745. The research utilized multiple instruments including systematic literature analysis, field observation protocols based on contemporary safety handbooks, and advanced documentation equipment (DSLR cameras and drone technology) following established technical standards(Gupta & Nair, 2023; Perera et al., 2022). Data collection incorporated three primary approaches: comprehensive literature review analyzing recent publications on level crossing safety, direct field observations using standardized protocols for physical measurements and behavioral(Hartwig et al., 2020; Sohail et al., 2023). The analytical framework integrated the ISO 31000:2018 risk management standard for hazard identification, employing risk matrices from transportation research authorities and human factors analysis models for comprehensive risk assessment(Azzahra et al., 2024; Barafort et al., 2017). Risk evaluation utilized current Transportation Research Board matrices and European Union railway risk assessment guideline (Paçacı et al., 2025). The methodology incorporated laser distance measurement tools (Leica DISTO D2), speed detection equipment (Bushnell Velocity)(Štuhec et al., 2022; Vasile et al., 2021). Validation procedures included expert peer review and stakeholder focus group discussions, with systematic verification through methodological triangulation following established research protocols(Jolivet et al., 2022; Lecours, 2020). This integrated approach provides a robust framework for developing evidence-based safety recommendations and contributes to advancing smart railway crossing system development(Marek et al., 2014; Mirza et al., 2023).

In this study, the author used several data collection techniques, including:

1. Literature Review Method
   This is a data collection technique that involves searching for data in books, literature, records, and various reports and laws and regulations related to the problem to be solved. Books, literature, and laws and regulations are listed in the bibliography.
2. Observation Method
   This is a data collection method that involves carefully and directly observing or reviewing the research location to understand the conditions that exist or to verify the validity of a research design being conducted.

From these data collection methods, quantitative and qualitative data were obtained, which include both primary and secondary data, as follows:

1. Primary data
   a. Inventory of the physical condition of JPL 87 KM 29+745 Jalan Pahlawan, Bekasi City;
   b. Inventory of the completeness of crossing sign facilities;
   c. Documentation of the condition of the JPL 87 KM 29+745 Jalan Pahlawan crossing in Bekasi City;

d. Timetable/schedule of trains passing through JPL 85A Pasar Baru Bekasi.

2. Secondary data
   a. Summary of incidents from 2020 to 2024;
   b. List of railway crossings in Daop 1–9 and Divre I–IV;
   c. List of railway crossings validated by the Railway Engineering Office;
   d. List of train journeys at Bekasi Station Gapeka 2023;
   e. Railway network map of Java Island 2022;
   f. Railway network map of the Jakarta Railway Engineering Office Class I area

Risk control for train tempering is carried out based on the risk management process in the international standard AS/NZS 4360:2004.

Results and Discussion

A. Analysis of JPL Conditions from the Perspective of Railway Tracks, Roads, and Signage

The following is data on the existing condition of JPL 87 KM 29+745:

1. Railway Track Side
   a. Number of Tracks : 2 Tracks (Double Track)
   b. Type of Fastener : E-Clip
   c. Type of Sleeper : Concrete
   d. Railway Track Position : Straight Track
   e. Railway Frequency : 360 Trains/day
   f. Headway : 15 Minutes
   g. Railway Speed : Max. 120 KM/H
   h. Track Section : Bekasi Timur Station – Tambun Station
   i. Route : Jatinegara – Cikampek
2. Road Side
   a. Road Name : Pahlawan
   b. Road Status : City Road
   c. Road Surface Type : Asphalt
   d. Road Condition at Crossing : Partially Damaged
   e. Road Width : 7 Metres
   f. Gradient : 8° Left and Right
   g. Intersection Angle : Perpendicular
   h. Signage : Incomplete
   i. Road Safety Measures : None
3. Surrounding Utilities
   a. PLN Overhead Cables.
   b. Buried Fibre Optic Cables at a depth of 1.5 metres, 3 metres from the outer edge.
4. Road Infrastructure Facilities

Table 1. Road Equipment Facilities on JPL 87 KM 29+475

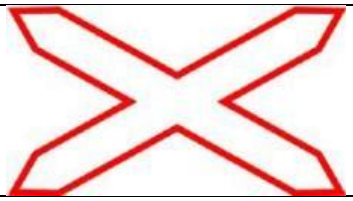
NO	SIGNAGE	REMARKS
FROM NORTH ROAD (JALAN PAHLAWAN)		
PROHIBITION SIGN		
1		Prohibition of continuing to walk because it is mandatory to stop for a moment and/or continue walking after ensuring safety from traffic conflicts from other directions. Condition : Good and clearly visible. Installed 10 metres from the outer edge of the rail.

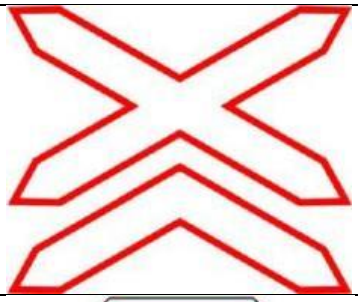
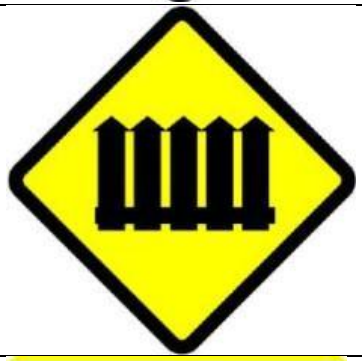
NO	SIGNAGE	REMARKS
2		Prohibition of Walking on Double Track Railway Crossings Before Confirming Safety from Conflict Condition : Partially damaged and clearly visible. Installed 15 metres from the outer edge of the track.
3		Prohibition sign (stating to look left and right before crossing the tracks) Condition : Good and clearly visible Installed 20 metres from the outer edge of the tracks
WARNING SIGN		
4		Warning of Obstacles or Dangerous Objects on the Left Side of the Road (Traffic can only move on the right side) Condition : Partially closed
5		Warning sign for level crossing without gates Condition: Good and clearly visible Installed 35 metres from the outer edge of the tracks
6		Warning sign for two-way level crossing Condition: Damaged and clearly visible Installed 40 metres from the outer edge of the track

NO	SIGNAGE	REMARKS
7		Warning sign (advising caution when approaching railway crossings) Condition: Partially damaged and clearly visible. Installed 45 metres from the outer edge of the tracks.
FROM SOUTH ROAD (JALAN IR H JUANDA)		
8		There is a warning sign located in front of two prohibition signs, which covers part/all of the surface of the prohibition signs, making it difficult for road users to see them. Installed 10 metres from the outer edge of the rail.
Roads Marking		
9	There are no road markings on JPL 87 KM 29+745.	
APILL (Traffic Light)		
10	There is no APILL on JPL 87 KM 29+745	

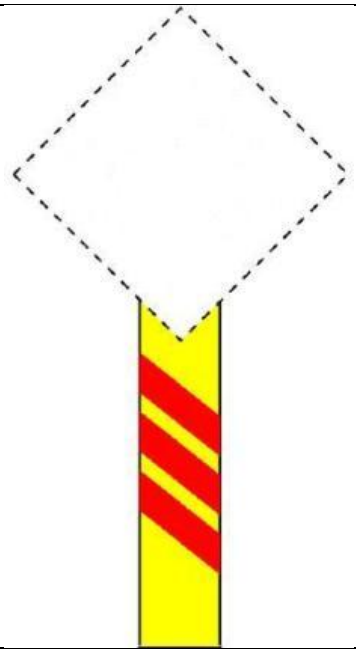
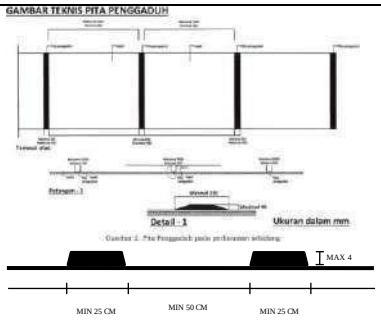
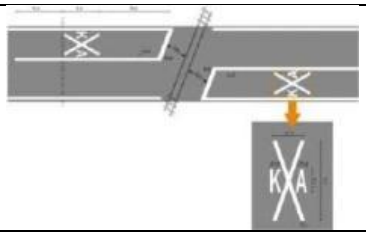
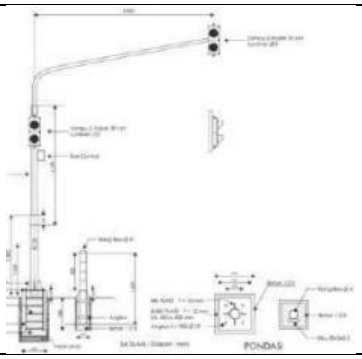
Based on the above conditions of the JPL, the following are the regulations for installing road equipment at level crossings in accordance with Director General of Land Transportation Regulation No. SK.770/KA.401/DRJD/2005 and Director General of Land Transportation Regulation No. SK.407/AJ.401/DRJD/2018:

Table 2. Requirements Signane on Level Crossing

No	TRAFFIC SIGN	SIGN
PROHIBITION SIGN		
1		Prohibition on continuing to walk on single-track railway crossings before confirming that it is safe to do so

No	TRAFFIC SIGN	SIGN
		Prohibition of Walking on Double Track Railway Crossings Before Confirming Safety from Conflict Installed at a distance of 2.5 metres from the end of the pavement or road
2		Prohibition on continuing to walk because it is mandatory to stop briefly and/or continue walking after ensuring that it is safe from traffic conflicts from other directions Installed at a distance of 4.5 metres from the end of the pavement, right at the stop line
WARNING SIGN		
3		Warning: Railway crossing without gates
		Railway Crossing Warning Sign Installed at a distance of 50 metres from the stop line
4		Warning signs (advising caution when approaching railway crossings). Installed 100 metres from the stop line.

No	TRAFFIC SIGN	SIGN
5		Warning of Obstacles or Dangerous Objects on the Left Side of the Road (Traffic can only move on the right side)
		Warning of Obstacles or Dangerous Objects on the Right Side of the Road (Traffic can only move on the left side)
6		Warning indicating that the critical location is 150 m from the sign location (type of warning explained by warning sign)
7		Warning indicating that the critical location is 300 m away from the sign location (type of warning explained with warning sign)

No	TRAFFIC SIGN	SIGN
8		Warning indicating that the critical location is 450 m from the sign location (type of warning explained by warning sign)
COMMAND SIGN		
9		Verbal command (telling you to stop and look left and right before crossing the tracks) Put up 25 metres from the stop line
MARKA JALAN		
10		Rumble strips that function as shock markers when approaching a railway crossing. Installed at a distance of 60 metres from the stop line.
11		Level crossing with railway tracks, installed 4.5 metres from the outer edge of the tracks, and adjusting the font size according to the image.
TRAFFIC LIGHT		
12		Warning Light (WL) is a warning light that indicates caution regarding environmental conditions, marked by a flashing yellow light. Installed at a distance of 450 metres from the stop line.

Risk Management Process in AS/NZS 4360:2004 International Standard

The first step to eliminating the risk of accidents is to understand and assess the risks associated with specific level crossings and follow up on them. The recommended framework involves several activities, including hazard identification, risk analysis, evaluation, and control. Risk analysis at level crossings is to identify and reduce the occurrence of accidents and their control, as well as to avoid and minimise risks in an appropriate manner at JPL 87 KM 29+745 Jalan Pahlawan Kota Bekasi. The high number of accidents occurring at JPL 87 KM 29+745 must be addressed immediately, and control measures must be implemented promptly. Risk analysis involves estimating the frequency of unintended incidents and their respective consequences. The frequency of unintended incidents can be estimated based on historical data from past incidents. Consequence analysis identifies both direct and indirect consequences that may arise after an unintended incident. All potential sequences following an unintended incident must be identified and explained. The study conducted at JPL 87 KM 29+745 used the HIRARC method. This method is divided into three stages, namely:

1. Hazard Identification

   The success of this analysis is very important because if someone eliminates some potential hazards, it can result in severe human losses, infrastructure damage, and misjudgement of risks. The hazards that occur at JPL 87 KM 29+745 can be seen in the following table:

Table 3. Hazard Identification

No	Hazard
1.	Road users break through when stopped by guards (general)
2.	Road users wait in the opposite lane
3.	Road users do not look around when crossing the level crossings.
4.	Limited visibility of road signs by road users
5.	Unguarded Crossing

2. Risk Assessment (Hazard Assessment)
   The potential hazards identified during the hazard identification stage will be assessed to determine the risk rating of the hazard. The assessment of identified hazards through analysis and evaluation is intended to determine the magnitude of risk by considering the likelihood of occurrence and the severity of the consequences. Risk assessment (Risk Assessment) comprises two stages of the process: risk analysis (Risk Analysis) and risk evaluation (Risk Evaluation). The parameters used for risk assessment are probability and severity. Probability refers to the likelihood of a workplace accident occurring. The measurement parameter for probability used in this study is how frequently activities that could trigger workplace accidents occur. Risk Rating describes the magnitude of the impact of the identified potential hazards, which is then assessed using a Risk Matrix table.

Table 4. Hazard Assessment

No	Source of Danger	Potential Hazards	Impact	Probability	Severity	Risk Level	Acceptability (A/U)
1.	Road users break through when stopped by guards (general)	Low discipline among road users, carelessness, rushing	Hit, Death	B	4	E	U
2.	Road users waiting in the opposite lane	In a rush, wanting to overtake	Hit, Death	B	4	E	U

No	Source of Danger	Potential Hazards	Impact	Probability	Severity	Risk Level	Acceptability (A/U)
3.	Road users do not look around when crossing level crossings	Not being careful when crossing a level crossing	Hit, Death	B	4	E	U
4.	Limited visibility of road signs by road users	Improper signage arrangement	Hit, Death	A	4	E	U
5.	Unguarded Level Crossing	No warning when a train is approaching	Hit, Death	A	4	E	U

Based on the results of the risk assessment conducted, it shows that the risk of accidents occurring at JPL 87 KM 29+745 has 5 potential extreme hazards (expect risk).

Risk Control

Risk control aims to minimise the level of risk from potential hazards. Risk control efforts at 87 KM 29+745 are aimed at improving safety at level crossings through mitigation. Mitigation is a series of efforts to reduce the risk of accidents, both through physical construction and awareness and improvement of the ability to deal with threats. The following mitigation measures need to be implemented at JPL 87 KM 29+745:

a. Improving and completing safety facilities such as signs and markings in accordance with applicable regulations;
b. Road engineering;
c. Conducting public awareness campaigns to always be vigilant when crossing level crossings by the relevant authorities.

. Conclusions

Based on the analysis and problem solving that has been carried out, the following conclusions can be drawn:

1. JPL 87 KM 29+745 Jalan Pahlawan Kota Bekasi does not yet meet minimum service standards due to the lack of safety facilities such as railway crossing signs, warning signs with words, warning signs for obstacles or hazardous objects on the side of the road, rumble strips, and warning signs indicating critical locations at distances of 150, 300, and 450 metres.
2. The risk assessment of JPL 87 KM 29+745 Jalan Pahlawan Kota Bekasi indicates that there are 5 potential extreme hazards (expert risk), including road users crossing when already stopped by a guard, road users waiting in the opposite lane, road users not looking around when crossing the level crossing, and limited visibility of road signs by road users,
3. Improving safety at JPL 87 KM 29+745 Jalan Pahlawan, Bekasi City, in the short term by meeting minimum service standards, including railway crossing signs, warning signs with words, warning signs for obstacles or hazardous objects on the roadside, rumble strips, and warning signs indicating critical locations at distances of 150, 300, and 450 metres, as well as traffic engineering measures such as creating medians and road bays. For the long term, the construction of an underpass will be carried out.

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