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IMPLEMENTATION OF MITIGATION POLICIES FOR EMERGENCY ACCIDENT PREPAREDNESS AND RESPONSE MANAGEMENT ON TRAINS

Endang Tirtana
Doctoral Program in Public Administration,
Universitas Muhammadiyah Jakarta

Azhari Aziz Samudra
Doctoral Program in Public Administration,
Universitas Muhammadiyah Jakarta

Evi Satispi
Doctoral Program in Public Administration,
Universitas Muhammadiyah Jakarta

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Corresponding Authors:
endang.tirtana@student.umj.ac.id
azhariazis.samudra@umj.ac.id
evi.satispi@umj.ac.id

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Abstract: The potential for accident disasters in rail transportation modes needs to be addressed through improvements in safety management policies, preparedness, and emergency response when an accident occurs. By carrying out disaster management for train accidents and looking at various facts that cause accidents, potential risks and operational actions that need to be taken when a disaster occurs will be imposed. In this study, we will look in more detail at policymakers' responses in compiling regulations, operational standards, risk assessments, and implementation of these policies to act on the fatality rate of accident victims due to accidents. This research will focus on contextual contributions and empirical policy implementation in handling, preparedness, and emergency response in dealing with potential disaster accidents on rail transportation modes. This study uses a qualitative and descriptive approach by taking information from studies, news, web channels, and regulations from the Department of Transportation, especially in this case, PT. KAI and PT. MRT. The results of the study show that train accidents are caused by many things, such as natural disasters, human error, weak railway infrastructure support, negligence at level crossings, vandalism and suicide, weak disaster prevention, passive and active disaster management, emergency management, and weak cross-collaboration, institutions in dealing with accidents on trains, including the still weak competence of train public transport operators.

Keywords: government policy, rail transportation, mitigation policies, accidents, potential risks

1. Introduction

Since 2009 Indonesian Railways have undergone significant reforms in providing services to the public. Since the issuance of Law Number 23 of 2007 concerning Railways, this mode of mass transportation has been improved to bridge people and goods in bulk safely, comfortably, quickly, and smoothly. Then to clarify the

implementation rules of the law, Government Regulation No. 56 of 2009 concerning the Implementation of Railways and Government Regulation Number 72 of 2009 concerning Rail Traffic and Transportation were issued.

This improvement in railway governance is due to the increasing public demand for this mode of transportation. The number of passengers using the railroad mode of transportation tends to increase yearly. From 2006 to 2009, passenger increases grew by 25% for Jakarta. Likewise, in other regions during the same period, Java and Sumatra grew significantly by 28% and 24%, respectively (Table 1). The increasing public demand for this mode of rail transportation results from the certainty of the departure schedule and the journey duration compared to other modes of transportation. Therefore, with the high demand and expectations of railroad users, rail services must be made as safe and comfortable as possible from various potential risks that result in accidents.

Table 1. Number of Train users

Railway Area	Number of passengers in thousand				
	2006	2007	2008	2009	2022
Jabodetabek (A)	104.425	118.095	125.451	130.508	217.965
Non Jabodetabek (Java) (B)	51.671	53.826	64.688	68.913	54.454
Java (Jabodetabek + Non Jabodetabek)	156.096	171.921	190.138	199.422	272.419
Sumatra (C)	3.323	3.415	3.939	4.119	4.696
Total (A+B+C)	159.419	175.336	194.076	203.070	277.115

Source: BPS, 2006-2022

Indonesia has experienced dramatic periods of accidents that have claimed many lives in the mode of fire transportation. In 2009 there were 90 train accidents. This number decreased compared to accidents in 2008, which amounted to 147 incidents, and in 2007 which reached 159 incidents. However, the death toll from train accidents rose during 2007-2009. In 2007 the death toll was 34 people. In 2008 there were 45 people. In 2009 there, 57 people were killed. Most of these accident factors are *human error* (Dephub, 2009). In addition to human error factors, in various countries, there are also accidents caused by several factors, including:

Table 2: Human Error Factors

1) Negligence	6) Broken tracks
2) *Human error*	7) Slipped/Slink away
3) Reckless pedestrians and drivers	8) Train Crossings without door bars
4) Mechanical failure	9) Vehicle congestion on the railway
5) Excessive Train Speed	10) Suicide

Source: www.sidgilreath.com

In various countries, the impact of accidents on modes of transportation has resulted in economic losses. The Czech Republic suffered economic losses of 782,358 euros (more than IDR 12 trillion) as a result of accidents in 2018, which resulted in death, minor and serious injuries, and delays in the transportation of people and goods (Hromádka et al., 2020). India also recorded sizable economic losses from 2000-2016, with 86,486 crore rupees or more than IDR 157 trillion (Aher et al., 2018). In Indonesia, there is no exact number of economic losses due to accidents. However, it is estimated that more than IDR 148 billion per year if each accident causes an economic loss of IDR 450 million. Therefore, with the high demand and the potential for accidents that may occur in rail transportation modes, comprehensive mitigation is needed by considering the factors that cause accidents.

The potential for accidents in other modes of transportation needs to be addressed by improving safety mitigation policies, preparedness, and emergency response when accidents occur. Mitigating accidents and looking at various facts that causes accident will map potential risks and operational actions that need to be taken when a disaster occurs. This study will look in more detail at the response of policymakers in formulating regulations (Samudra, Suradika, Andriansyah, et al., 2023), operational standards, and risk assessments and implementing these various policies to minimize the fatality rate of accident victims due to accidents. This research will focus on the conceptual contribution and empirical implementation of policies in mitigating Emergency Preparedness and emergency response in responding to potential accidents in modes of transportation, such as human error.

2. Method

This study uses a qualitative-descriptive approach by seeking various information from literature reviews (Zed, 2014), news, web channels, and regulations from transportation services (PT KAI and PT MRT). While secondary data are taken from official sources from the Central Statistics Agency, PT KAI, formulated to strengthen this study's argument.

3. Literature Review

Law Number 23 of 2007 concerning Railways has regulated the general arrangement of railways, which includes national, provincial, and district/city railways, in an integrated manner. In order to realize the integration of this arrangement, a railway master plan has been prepared from the district/city, provincial to national levels. The National Railway Master Plan (RIPNas) is prepared by considering the national spatial plan and master plans for other modes of transportation networks, which contain: 1) the policy direction and role of national railways in all modes of transportation, 2) estimates of the movement of people and goods, 3) plans for the needs of railway infrastructure and facilities, and 4) plans for human resource needs.

Regarding the strategy to improve the security and safety of railway transportation, RIPNas 2011 prepared 3 main policies, namely: 1) Improve guidance

(regulation, control, and supervision) of railway operations; 2) Improve the reliability of railway infrastructure and facilities in order to ensure railway safety; 3) Improve coordination in order to ensure the security of railway operations including monitoring and evaluation.

Operationally, RIPNas related to railway safety is regulated in the Minister of Transportation Regulation PM Number 69 of 2018 concerning the Railway Safety Management System (SMKP). The objectives of SMKP are to a) improve planned, structured, measurable, and integrated railway safety; b) prevent incidents and accidents from occurring in a Pi; and c) create a safe, safe, comfortable, and efficient railway HR workplace and work environment. This SMKP is more comprehensive than the RIPNas target to prevent potential disasters, which only sees the potential from natural factors and the preparation of disaster-prone maps. In SMKP, providing infrastructure, standard operating procedures, and human resources in disaster mitigation is important.

4. Analysis

4.1. Potential Train Accidents in Indonesia:

Natural Factors

In railway RIPNas, the potential for railway disasters is generally due to natural disasters, including disasters related to geological factors such as earthquakes and disasters related to hydrometeorology, such as rain and lightning, flash floods, and landslides (Roy et al., 2023) (Wang et al., 2021). This disaster not only disrupted the transportation traffic of the hotel but also damaged the railway infrastructure and facilities and even caused accidents that resulted in casualties. The transportation disruptions that often occur due to the weather in Indonesia are the rail rails that have plummeted and the electrical signal due to lightning strikes.

Human error

In 2006 there was a train accident allegedly caused by human error. This accident involved two Sembrani Trains and Kertajaya Trains, which collided at Gubug Station, Central Java. The KNKT's conclusion was a human error regarding the train departure procedure, which was not carried out (Kompas, 2022). Another accident caused by a human error occurred on the Jagorawi toll road in 2021, namely a train accident on the Jabodetabek Integrated Railroad (LRT) involving two trains being tested. Therefore, in RIPNas, human resource development is very important in improving railway safety.

Railway Infrastructure Support

Train accidents can also occur due to the lack of railway infrastructure. The accident can be seen from the high incidence of accidents at level crossings and

railroads. Data from level crossings as of December 31, 2022, states that 1,417 official and maintained level crossings exist. The remaining 1,316 unguarded level crossings and 928 illegal crossings (KAI, 2022). These illegal level crossings mean no official gates are not guarded at railroad level crossings. This condition is quite risky, with the potential for accidents that can occur when another vehicle hits a train at level crossings.

In 2022 there were 289 accidents at level crossings and railroads. This number continues to increase compared to accidents in 2021, which amounted to 285 incidents, and in 2020 which reached 269 incidents. Over the past three years, the number of victims who died from train accidents has also increased. In 2020 the death toll was 55 people. In 2021 there were 68 people. In 2022 it almost doubled to 110 people killed (KAI, 2022). From the accident in 2022, at least 110 people died. Seventy were seriously injured, and 104 were seriously injured.

Negligence Factor

The high number of accidents at level crossings aside from the suboptimal support of railway infrastructure, driver negligence at level crossings is also a trigger for accidents. The following are the obligations of drivers in testing level crossings or direct crossings (JPL) of trains, such as drivers are not aware of vehicles coming from two different directions; forced to cross JPL when the bell had already rung; bypassing JPL when the gate was completely closed before the train arrived; vehicles stop crossing the barrier when it has been closed; and breakthrough when the door latch has not been fully opened, and the alarm is still sounding (Samudra, Suradika, Evi, et al., 2023).

Vandalism and Suicide

Accidents at railroad crossings are also triggered by incidents that are indicated as suicides. The number of suicides on railroad tracks is quite high in Indonesia, amounting to 119 incidents throughout 2022. The dishonorable behavior of residents around railroad crossings also causes casualties for passing train passengers. The case that often occurs is throwing while the train is running. In 2022 this throwing number will reach 140 events.

By looking at the various factors that cause accidents in other modes of transportation, it is necessary to formulate a more comprehensive policy strategy (Soehodho, 2007). This policy aims to mitigate the risk of accidents due to natural disasters and beyond. Preparedness management strategies are not only *business* as usual according to standard standards but also need to anticipate changes in risks that may arise from usual such as security factors, weather changes, and terrorism. So that an unusual approach in responding to disasters from undetected factors also needs to be anticipated (Athiappan et al., 2022).

4.2. Management of Plans

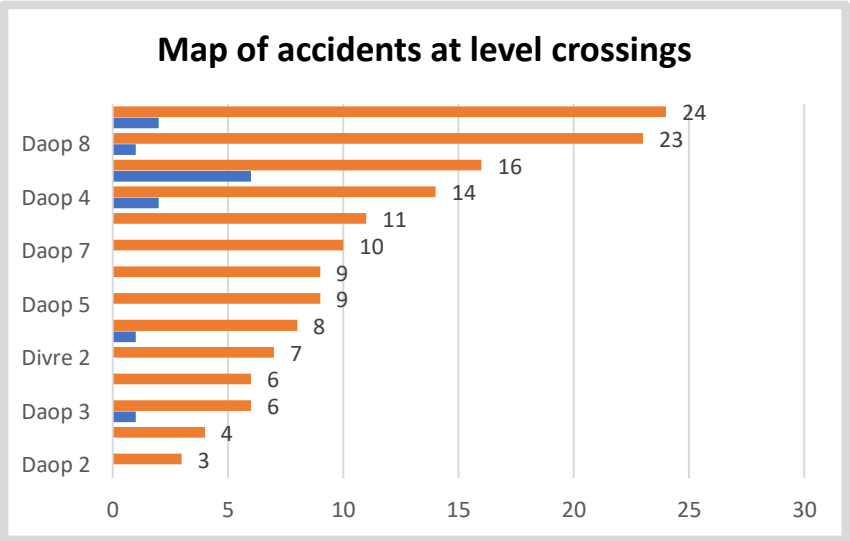
Based on the factors of potential accidents in rail transportation, the DGCA needs to take preventive and mitigation measures such as the following:

Prevention and Mitigation

The notions of disaster prevention and mitigation sometimes overlap in risk reduction efforts. However, policy-wise aspects of prevention and mitigation activities are separate in operational terms. In Law No. 24 of 2007 concerning Prevention Measures, prevention activities are defined as a series of activities to eliminate and reduce the threat of disaster. In contrast, mitigation is a series of efforts to reduce disaster risk through physical development and awareness and improvement of the ability to face disaster threats. Prevention in disaster management needs to be done on an ongoing basis to avoid or stop an event to protect life and property (Ismail-Zadeh & Takeuchi, 2007) (FEMA, 1995). Prevention and mitigation is the initial stage in disaster management, where natural and human hazards are identified as potential threats (Weichselgartner, 2001). Mitigation is important to estimate the potential disaster risk of each factor causing the disaster. Mitigation efforts in safety policies in Indonesia are carried out in two ways, namely passive mitigation and active mitigation (Fuady et al., 2021).

Passive Mitigation

Passive mitigation is carried out by retrospecting accident events and drafting regulatory tools as anticipatory steps. A retrospective of disaster events is carried out by conducting research or studies of characteristics and disasters that often occur and the potential risk of disaster events. This analysis can then be assessed disaster risk and map disaster-prone areas, necessary regulations, and preparation of operational standards or guidelines in handling disaster events.



Source: PT KAI 2019

Figure 2. Map of accidents in the plot trajectory

For example, in mitigating the potential for accidents at crossings, it is necessary to conduct a situation analysis to look at the fact map of accident occurrences in the area's operational area. Figure 2 shows a map of the accident hazard at the crossing located in Divre 1 Medan, which includes the Special Region of North Sumatra and Aceh. In contrast, the area with the smallest accident incident is operational 2, located in Bandung with the working area of West Java Province, which includes The Bandung Raya area and the southern region of West Java. The number of accidents in operational areas 8, 4, and 1 had the highest rate at the idle crossing, namely 23, 16, and 14 incidents, respectively. The large number of unmaintained track plots in the area is thought to be the trigger for many accidents.

Therefore, by looking at the potential risk of accidents at the crossing, PT KAI responded by compiling regulations, operating standards, and procedures to support safety at the crossing. Technically, the plot crossing road construction was regulated at PM 36 of 2011. Construction of a plot crossing road is built based on the following requirements the road surface should be one level with the rail head with a tolerance of 0.5 m; There is a flat surface 60 cm long measured from the outermost side of the railroad; and the maximum gradient for a vehicle to pass calculated from the highest point on the rail head is:

a. 2% is measured from the outermost side of the flat surface referred to in letter b for a distance of 9.4 meters;
b) The next 10% for the next 10 meters is calculated from the outermost point of point 1), as the intermediate gradient.
c) The crossing width for one lane of the road is a maximum of 7 meters;
d) The angle of intersection between the road and the rail with the road must be 90^0, and the length of the straight road must be at least 150 meters from the axle of the railroad.

Technically, components and construction, as well as the responsibility of regulators in plot crossings, are regulated in Regulation M94 of 2018 concerning Improving the Safety of Plot Crossings Between Railways and Roads. Technically, the construction components of the safety equipment of a plot crossing consist of the following:

a) Road user safety portal;
b) Warning/prohibition light cues;
c) Sound cues;
d) *Variable message sign* (VMS);
e) Railway detection devices;
f) The main controller per the safety control of the *crossing*;
g) and Power supply.

Active Mitigation

Active mitigation is carried out by carrying out various implementations of predetermined rules, such as:

a) Build construction, electrical, and signal systems that support safety along crossings, crossings, and disaster-prone areas.
b) Periodic training, certification, and psychological tests for operators of railroad transportation modes.
c) Periodic feasibility testing of the railway facilities includes the rejuvenation of the railway facilities.
d) Continuous socialization of the importance of safety to users of rail transportation modes and awareness of maintaining public facilities, especially residents along the railroad crossing route. Train users carry out active socialization through safety induction media which contains procedures for using railroad safety equipment, such as glass breakers, fire extinguishers, and emergency exits, and prohibiting passengers from smoking and standing at circuit joints during the trip.

Preparedness Management Strategy in Emergency Response

Emergencies are defined as any undesirable events that can cause significant death or *injury* to workers or users, can stop operational activities, and cause physical or environmental damage or company assets and the company's reputation in the eyes of the public (Law No. 24 of 2007). Efforts to deal with train accident emergencies and disasters must have procedures that include:

a) Train accident emergency response preparedness;
b) Normalization after an emergency;
c) Provision of adequate and proper First Aid personnel and facilities until medical assistance is obtained;
d) Advance the treatment process.
e) Procedures for handling emergencies must be periodically tested by personnel with work competence. For installations with great danger, coordination with the relevant authorities must be coordinated to determine reliability at the time of the incident (Regulation of the Minister of Transportation No. PM 69 of 2018).

Preparedness of Railways

In Law No. 24 of 2007, disaster preparedness is a series of activities to anticipate disasters through regular and targeted steps. Railroad accidents are handled and evaluated every time an accident occurs. PP No. 61 of 2016 states that handling accidents is carried out by the organizers of Railway Infrastructure. In this case, PT KAI as a control system and regulatory support for PP No. 61 of 2016 and Permenhub No. PM 69 of 2018, PT KAI has prepared Standard Operating Procedures (SOP) for handling emergency conditions at stations, depots, Balai Yasa, and train travel. This SOP covers various categories of emergency conditions, such as train accidents, fires, and natural disasters. In this SOP, the first step in responding to an emergency is to identify the potential hazards that may occur in an emergency.

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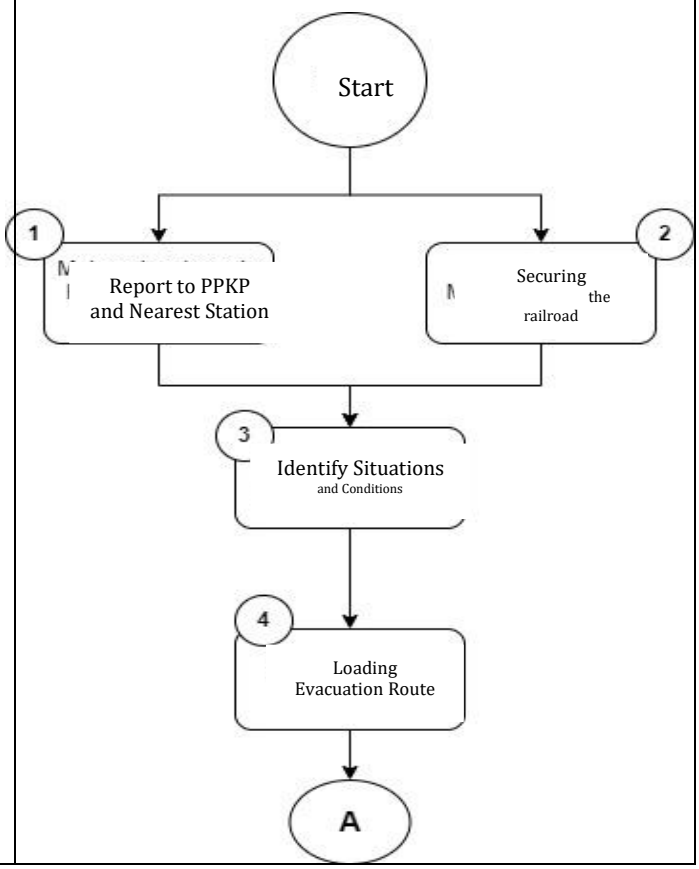
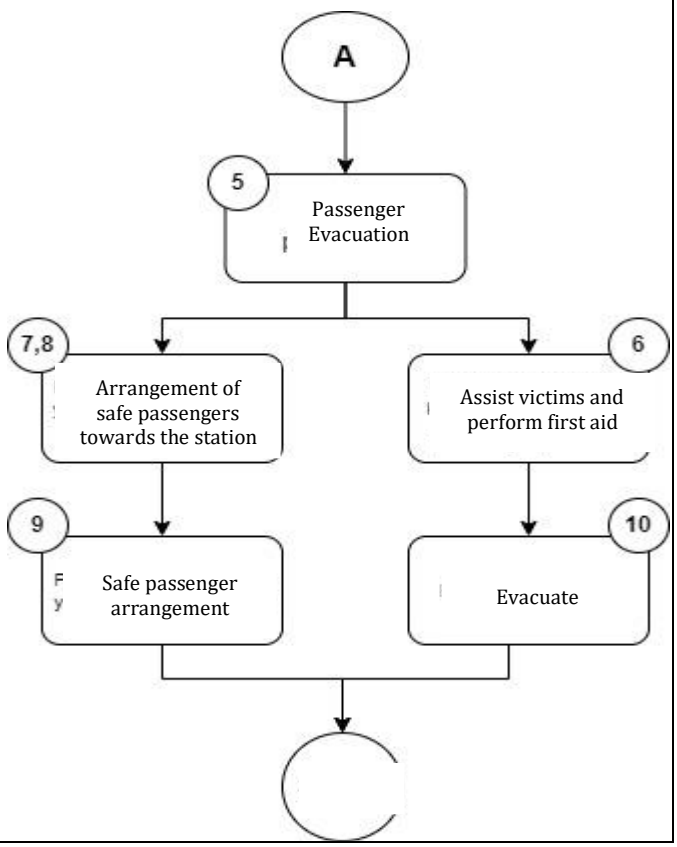
In this SOP, rapid response to the Preparedness of the Centralized Train Travel Controller (PPKP) is crucial in responding to emergencies. PPKP is an employee in charge of a centralized travel control office (PK) that controls travel using communication equipment in its control area. PPKP will manage all emergency information from the scene of the accident. Then PPKP distributes accurate and fast information to parties not responsible in the field.

The facility's crew then responds to the information obtained from PPKP to take necessary steps to reduce the impact of the risk of emergencies due to accidents. The train crew is an officer assigned to the train during the trip consisting of the Train crew, instructor, train operator, and other officers who serve as a train crew, such as security officers and other employees participating in the train journey. In addition to officers on duty during the trip, supporting facilities for handling emergency conditions are also needed, such as the existence of evacuation route is an emergency route used in case of emergencies; the existence of *an assembly point*; availability of light fire extinguisher (APAR); availability of P3K facilities; the availability of a Health Post as a place for first handling accidents and emergencies at the station; and facilities supporting emergency locomotive facilities include glass breakers, emergency brake facilities, stop blocks, and APAR. The diagram and Table 2 below are how to respond to emergency conditions of accidents that can potentially cause death or serious injury, as well as tangles of travel and curtains.

No	Activities	Emergency management
1)	The surviving crew members reported the incident to the nearest station and the Train Travel Monitoring Center (PPKP). Reports that need to be submitted regarding information: (a) Location of the incident (b) State railroad network (c) Preliminary estimates of the number and condition of the victims (d) It needs to be related to auxiliary locomotives or other things PPKP coordinates with the nearest post and or vice versa to immediately contact the health unit, hospital, or police as needed in the field.	
2)	The surviving crew immediately secured the train according to official regulations to prevent further accidents.	
3)	The surviving crew immediately identified the situation and conditions for the evacuation of passengers.	
4)	The surviving crew immediately arranged an evacuation route.	

No	Activities	Emergency management
5) 6) 7) 8) 9) 10)	The surviving crew immediately evacuated the passengers. The surviving train crew identified the victims and administered first aid. Arrangement of surviving passengers heading to the station. Responsibility for handling emergencies. Settings for surviving passengers (continued). The evacuation of victims who need it continues. Further handling steps for accidents are carried out if the initial handling steps for the evacuation situation can be handled, then proceed to the recovery stage. On the other hand, if the initial steps for evacuation cannot be handled, the head of the operational area of the village sub-district orders the relevant staff to handle it with an ambulance and other necessary equipment.	

Source: Decree of the Board of Directors of PT KAI, 2015

Dismantling accident victims requires mechanical equipment that can be placed at strategically located large stations. This equipment is used to evacuate victims affected by collapsed facilities or infrastructure and for lifting and repairing facilities or infrastructure to normalize rail traffic. The mechanical equipment includes *cranes*, equipment for cutting metal, lighting equipment, communication devices, preparation of railroad components to deal with damage to the railroad, and other equipment needed for picking up victims and railroad facilities.

Normalization After an Emergency

Normalization after an emergency is carried out to carry out a control system and train travel engineering that describes an emergency event. Minister of Transportation No. PM 123 of 2017 concerning railroad traffic in article 23 states that train travel can be diverted if there is a road obstacle on the railroad that will be traversed. The estimated time needed to overcome the road obstacle exceeds or is equal to the train's travel time on the railroad track to be diverted. Obstacles on the railroad tracks are caused by accidents or other reasons that threaten the safety of train travel. To overcome road obstacles due to accidents, train travel engineering can be carried

out, which includes: a) Train Delays, b) Train Cancellations, and c) Diversion of train travel. Arrangements for the smooth running and safety of the railway are the authority and responsibility of the infrastructure management agency.

In activities to normalize lanes that experience roadblocks, attention must be paid to the following points:

a) Coordination with investigators, in this case, is KNKT to sterilize the location of the accident to facilitate the investigation process and prevent loss of case evidence;
b) Immediate evacuation of human casualties;
c) The investigation process considers the availability of evidence of the incident, the length of the investigation, and the impact on Train travel;
d) The determination that operations have returned to normal is the authority of the site controlling manager.

The location controller then shows the train control center that the track that had an accident is passable. The train control center can take further steps, such as arranging the forwarding of trains that have experienced accidents and arranging trains in other areas affected by accidents (Djajasinga, 2022).

Provision of Personnel and Facility: First Aid in Accidents (P3K) with Jis only C and S compliant.

P3K facilities are all equipment, equipment, and materials used to implement P3K in the workplace, while P3K personnel are employees appointed by local leaders and assigned additional duties to carry out P3K in the workplace. The nearest station is equipped with a health post for first handling accidents and emergencies at the station. Every major station must own more complete health facilities. This large station is located strategically and adjacent to the center of activities related to railways. For large stations, it is necessary to equip equipment and officers for accident handling. Large stations must be equipped with emergency medical equipment that is easy to carry. Equipment needed during the accident included scanning devices, spinal restraints, bandages, wound covers, and other equipment such as airway opening pipes, resuscitators and ventilators, IV equipment, and others.

Advanced Handling Process

The follow-up treatment process is part of the recovery process and treatment of victims, both those who have suffered physical injuries and those who have not. For victims who still require further treatment, the operational area leaders and their staff can coordinate with the nearest referral health facility to treat accident victims. Ambulance facilities must be mobilized from the nearest health facility and major station as soon as possible. Meanwhile, on the other hand, the transportation process is also carried out to calculate the impact of fatalities and injuries due to accidents so that the process of reimbursing the health costs of accident victims is immediately carried

out. The following processes carry out a thorough investigation into the causes of the accident and recommendations for prevention so that similar incidents do not recur.

5. Conclusion

Nobody wants accidents to happen on public transportation like trains. Various efforts have been made to overcome the occurrence of accidents. Indonesia's dramatic accident experience has been responded to by improving rail safety policies, improving accident handling SOPs, and building rail safety management. On the other hand, train operators repair and supervise railroad facilities and infrastructure to prevent and mitigate emergencies and cross-institutional collaboration in dealing with accidents on trains, including increasing the competence of this railroad public transport operator.

Author contribution statement

ET, AAS, and ES are joint Senior authors; developing and designing research concepts: Conducting research, compiling and designing research; contributing data, materials, analytical data; and writing the paper.

Orcid

Endang Tirtana: https://orcid.org/0009-0009-3377-7071
Azhari Aziz Samudra: https://orcid.org/0000-0003-1867-4145
Evi Satispi: https://orcid.org/0000-0002-5326-4646

Data availability statement

Data will be made available on request.

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