Disaster Mitigation Assessment on Railway

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Abstract— Disaster is an event or series of events that threatens and disrupts people's lives and livelihoods which are caused, both by natural and/or non-natural factors as well as human factors, resulting in human casualties, environmental damage, property losses, and psychological impacts. Causes of disasters are grouped into three types, namely disasters caused by natural, non-natural, and social factors. Disaster risk reduction strategies should become a common understanding at the regional, national, regional, and international levels. Railways are one of the ones that will be affected by a disaster. This thought becomes the basis to conduct this study in the form of an in-depth study of various disaster threats on trains, to production planning in the railway sector that can be implemented with better disaster management. Based on the National Railway Master Plan (RIPNAS), in general, natural disasters that will impact the railways include disasters due to geological factors (earthquakes), and disasters due to hydrometeorology (floods, flash floods, landslides). The impacts on railways vary in addition to facilities and infrastructure, as well as on the programs or plans of the Directorate General of Railways (DJKA) as the operator of the national railways. By using the exploratory method of some literature and the Railroad Disaster Mitigation Management and Preparedness Matrix, it can be concluded that DJKA needs to recognize and prepare itself for disasters, by mitigating and adapting to disasters. During a natural disaster, what is generally disturbed is the supply side of railroad transportation, such as infrastructure (damaged rail), facilities (damaged locomotive), and infrastructure (damage to stations), while during non-natural disasters it is generally the demand side that is disturbed. In conditions of war or economic disaster, both supply and demand sides are severely disrupted.

Keywords— Natural disasters, Non-natural disasters, Social Disasters, Mitigation, Adaptation, Railroad Supply-Demand.

1 INTRODUCTION

Republic of Indonesia's Law Number 24/ 2007[1] states, that a disaster is an event or series of events that threatens and disrupts the life and livelihood of the community which is caused, both by natural and/or non-natural factors as well as human factors, resulting in human casualties, environmental damage, property loss, and psychological impact.

Based on this definition, the causes of disasters are grouped into three types, namely disasters due to natural, non-natural, and social factors. First, natural disasters are disasters caused by an event or series of events caused by nature such as earthquakes due to nature, volcanic eruptions, hurricanes, floods, landslides, drought, forest/land fires due to natural factors, plant pests, and space events / celestial bodies. Second, non-natural disasters are disasters caused by events or a series of non-natural events, including forest/land fires caused by humans, transportation accidents (including train accidents), construction/technology failures, disease outbreaks, industrial impacts, nuclear explosions, environmental pollution. and space activities. Third, social disasters are disasters caused by events or a series of events caused by humans.

Disaster conditions in the regions need to be recognized and understood, both the potential and possible impacts arising from these threats. Not only this, but the community must also know how to anticipate and cope with any possible hazards that may occur. Disaster risk reduction strategies should become a common understanding at the regional, national, regional, and international levels. Many studies and experiences have shown that through this strategy, casualties, losses, damage, and wider impacts can be suppressed after a disaster occurs. This thinking then needs to be realized by carrying out an in-depth study of various disaster threats, so that one day a mature plan will be born that can be implemented for better disaster management.

Railways are one of the ones that will be affected by a disaster. Based on the National Railway Master Plan (RIPNAS)[2], in general, natural disasters that will impact the railways include disasters due to geological factors (earthquakes), and disasters due to hydrometeorology (floods, flash floods, landslides). The resulting impact on the railways also varies in addition to facilities and infrastructure, it can also have an impact on the programs or plans of the Directorate General of Railways (hereinafter referred to as DJKA) as the national rail operator.

2 ISSUES AND PROBLEMS

Based on the National Railway Master Plan (RIPNAS)[2] the impact of a disaster will be very detrimental to the national railway service if it is not properly prepared. This is because the railway infrastructure is very expensive and there are reliable service standards.

Therefore, it is necessary to recognize and prepare for the occurrence of disasters, namely using disaster mitigation (minimizing the number of accidents caused by natural disasters)

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and adaptation (minimizing the number and fatalities of victims of accidents due to natural disaster.

3 Disaster Impact

In-Law Number 23/ 2007[3] concerning Railways, it is stated that Railways are a unitary system consisting of infrastructure, facilities, and human resources, as well as norms, criteria, requirements, and procedures for the operation of rail transportation. A railway infrastructure operator is a business entity operating public railways facilities.

The railway infrastructure operator in certain circumstances can cancel a train if there are things that endanger safety, order, and the public interest. One of them is the cancellation due to a disaster. Based on the National Railway Master Plan (RIPNAS)[2], disasters that have an impact on railways, namely natural disasters (earthquakes, floods, and landslides), in addition to the 3 (three) disasters other disasters have an impact on railways currently occurring in Indonesia, namely non-natural disasters. (epidemic of a disease)[4].

The resulting impact is due to natural disasters or non-natural disasters, namely on the supply side and demand side of railways. During a natural disaster, what is generally disturbed is the supply side of railway transportation, such as infrastructure (damaged rails), facilities (damaged locomotives), and infrastructure (damaged stations). If finances are strong, recovery on the supply side will not be too difficult. During non-natural disasters, it is generally the case that is disrupted, namely the demand side. In conditions of war or economic disaster, both supply and demand sides are severely disrupted. See Figure 1 for Disaster Mitigation Schemes.

a. Impact on Infrastructure

The development of railway infrastructure is of course very necessary, one of which is to accelerate the wheels of the economy. This is also following what is stated in the DJKA Railway Strategic Plan, that transportation sector infrastructure plays a strategic role in accelerating the growth and progress of a nation. The railway sector as one of the sectors in transportation is currently the prima donna because of its characteristics that can transport passengers in bulk and goods in large quantities and are environmentally friendly.

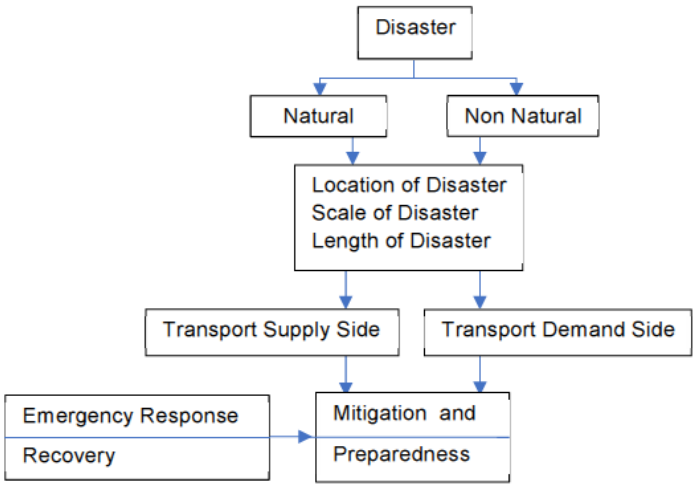

Figure 1. Disaster Mitigation Scheme

However, this development should pay attention to the potential disasters that exist. According to Davidson (1997)[5][6][7] and (The World Bank, 2012)[8][9], increasing growth without risk management and increasing infrastructure are the main causes of increased damage during disasters. This also has an impact on DJKA, which will suffer huge losses, due to the high cost of railway infrastructure. Nugroho (2013)[10][11][12][13] states that the amount of damage and losses due to the earthquake in Indonesia is 5 to 5 for each event. 8 times the cost of building a large bridge, so the impact of this natural disaster certainly affects the pace of development.

b. Impact on Work Programs at DJKA

The activity programs that have been planned by DJKA as a result of the disaster will not go according to plan. It could have been due to budget cuts by the central government to deal with the disaster. For example, currently, the President of the Republic of Indonesia has issued Perpres number 54/ 2020[14] concerning Posture Changes and Details of the 2020 State Budget.

The Presidential Decree is a follow-up to PERPU No.1 / 2020 concerning State Financial Policy and Financial System Stability for Handling the 2019 Corona Virus Disease (COVID-19) Pandemic and/or in the context of facing threats that endanger the national economy and/or financial system stability. there is a reduction in APBN funds in every Ministry and Institution, especially the Ministry of Transportation, which gets a cut or a cut of Rp. 7 trillion which was originally Rp. 43 trillion to Rp. 36 trillion or around 16.3%)[15]. The pruning will affect the DJKA. Therefore, DJKA must prioritize programs or activities that are ongoing and programs that have to be postponed due to budget cuts. Below is the output target of the main activities of DJKA for the 2020-2024 Strategic Plan period following the estimated public needs and capacity (delivery capacity) of work units within the DJKA. See Table 1 regarding the Directorate General of Railways Activities' Output Target 2020-2024.

The result of budget cuts to DJKA will result in output targets that are not as planned. but the number of achievements is not appropriate. Therefore, the Directorate General of Railways needs to prioritize output aspects that can meet the targets achieved and also achieve the mission of the Directorate General of Railways as stated in the 2020-2024 Strategic Plan (RENSTRA)[16], namely (1) Increase connectivity, capacity, and integration of the railway network. (2) Improve safety and security with renewable technology in the railway's sector and (3) Improve services with competent human resources to increase productivity in the railway sector

Table 1.
Target Output of the Directorate General of Railways Activities 2020-2024

No	Aspect	Unit	Total	
			2019	2024
1	The length of the railway line is built	Km	6.459,62	7.451
2	Passenger Car	Pax	453.486.720	624.934.903
3	Freight Car	Ton	47.622.000	114.288.322
4	Capacity of Passenger Transportation Facilities	Unit	3,368	22,802
5	Capacity of Freight Transportation Facilities	Unit	8,245	45,752
6	Railways Human Resources	Person	28,406	45,879
7	Facility / Infrastructure Administration Agency (active	Unit	3	12
8	Number of pioneer transport services	Rute	8	8
9	PKN / PKW connection, airport, port	Area	36	41

Source: RENSTRA Direktorat Jenderal Perkeretaapian 2020-2024

c. Impact on institutions

The institutional sector of the DJKA will also feel the impact of the disaster, one of which is the Directorate of Traffic and Transportation. The Traffic and Transport Directorate will undoubtedly reduce or limit rail travel due to a disaster. The cancellation of this train trip is under Law No. 6 of 2018[17] concerning Health Quarantine, in article 59 concerning Large-Scale Social Restrictions (PSBB) it is stated that in response to public health emergencies, large-scale social restrictions can be carried out including:
1) School and work vacations;
2) Restriction of religious activities; and
3) Restrictions on activities in public places or facilities.

d. Impact on socio-culture

Disasters can also have an impact on socio-culture, especially in railways, because disaster is a form of unplanned socio-cultural change. This change occurs beyond the reach of society. Apart from being an example of socio-cultural change, disaster is also an external factor causing socio-cultural change. The occurrence of a disaster forces the community to experience significant changes, one of which is a change in the mindset and behavior of the community, for example, if a train accident occurs it will result in the community preferring to use public transportation which is safer than using trains, because of trauma if it occurs another accident. This will also have an impact on reducing the number of train passengers.

4 Disaster Management

a. Disaster Management Stage

Based on the impacts resulting from the disaster on the railways previously described. DJKA needs to take disaster management steps as follows.

1) Prevention and Mitigation

Prevention is an effort to eliminate or reduce the possibility of a threat of disaster. Meanwhile, Mitigation is an effort made to reduce the bad impact of a disaster threat.
Prevention and mitigation are stages in pre-disaster management (before a disaster occurs). Mitigation is divided into two, namely passive mitigation and active mitigation.

a) Passive Mitigation

The steps are taken to carry out passive mitigation, especially in Railways, include:
1) Formulation of statutory regulations;
2) Preparation of disaster-prone maps and mapping of problems under existing railway lines or plans;
3) Preparation of guidelines / standards / procedures;
4) Research/assessment of disaster characteristics; and
5) Disaster risk assessment/analysis.

b) Active mitigation

The steps are taken to carry out active mitigation, especially in Railways, include:
1) Preparation and placement of warning signs, dangers, prohibitions on entering disaster-prone areas;
2) Basic disaster training for officials and the community; and
3) Public awareness and awareness-raising.

2) Disaster Emergency Response

Disaster emergency response is a series of activities that are carried out immediately at the time of a disaster, to deal with the bad impacts, including activities to rescue and evacuate victims, property, fulfillment of basic needs, protection, management of refugees, rescue, and restoration of infrastructure and facilities. Activities carried out in emergency response, especially in railways, include:
a) Quick and precise assessment of location, damage, losses/and resources;
b) Determination of the status of a disaster emergency;
c) fulfillment of basic needs;
d) Immediate recovery of vital infrastructure and facilities.

3) Recovery and Reconstruction Phase

The recovery phase includes the railway rehabilitation and reconstruction phase. The efforts made at the rehabilitation stage are to return the conditions affected by the disaster, which are completely uncertain, to a better normal condition. Meanwhile, the reconstruction phase is a stage to better rebuild facilities and infrastructure damaged by the disaster. Therefore, development must be carried out through a plan that is preceded by assessments from various experts and related sectors.

b. Mitigation Measures and Preparedness

The matrix for handling disaster mitigation and preparedness above is filled in based on a direct relationship to emergency response conditions or during recovery. The matrix for manag-

ing disaster mitigation and preparedness for railways can be seen in Table 2.

Table 2. Matrix for Railways Disaster Mitigation and Preparedness Management

HANDLING / TYPES OF MITIGATION	a. Emergency response	1. Determination of status disaster emergency	2. Determination of status disaster emergency	3. Salvation and community evacuation hit by a disaster	4. Meeting basic requirements	5. Protection for vulnerable groups	6. Immediate recovery of vital infrastructure and facilities	b. Recovery	1. Rehabilitation	2. Reconstruction
A. Passive Mitigation										
1. Formulation of laws and regulations		A1a1	A1a2	X	X	X	A1a6		A1b1	A1b2
2. Development of disaster-prone maps and problem mapping		X	A2a2	X	X	X	X		X	X
3. Creation guidelines / standards / procedures		X	A3a2	X	X	X	X		A3b1	A3b2
4. Research / assessment of disaster characteristics		A4a1	A4a2	X	X	X	X		A4b1	A4b2
5. Assessment / risk analysis disaster		A5a1	X	X	X	X	A5a6		A5b1	A5b2
B. Active Mitigation										
1. Creation and placement of warning signs, dangers, prohibitions on entering disaster-prone areas		X	B1a2	X	X	X	X		X	X
2. Basic training disaster for officials and society		X	X	X	X	X	B2a6		X	X
3. Counseling and increasing community awareness		B3a1	B3a2	X	X	X	X		X	X
C. Preparedness										
1. Activation of disaster preparedness posts with all the supporting elements		C1a1	X	X	X	X	X		X	X
2. Preparation and installation of early warning system instruments		C2a1	X	X	X	X	X		X	X
3. Mobilization of resources (personnel and infrastructure / equipment facilities)		X	X	X	X	X	C3a6		C3b1	C3b2

Information: X = Not Directly Related
Source: 2020 Analysis Results

Based on the disaster management and mitigation matrix table above, the results are as follows.

a. Active Mitigation

1) The drafting of laws is directly related to all types of handling during the emergency response or during recovery. On the scale of the Ministry of Transportation, it can issue (Ministerial Regulation), then if it is on a Directorate scale, especially DJKA, it can issue a Directorate-General Decree.
2) Making disaster-prone maps and mapping problems directly related to determining the status of a disaster emergency. DJKA as the one responsible for implementing the railways can ask BNPB (National Disaster Management Agency) and BIG (Geospatial Information Agency) to request disaster-prone maps and problem mapping overlaid with a railroad map (with the ArcGIS system), so they can find out areas prone to disasters and having an impact on railways
3) Preparation of guidelines/standards/procedures that are directly related to emergency response and post-disaster recovery. The Ministry of Transportation or the Directorate General of Railways can make guidelines or procedures in the event of a disaster because it will be very helpful in determining the status of a disaster emergency. Apart from that, it will also be of great help during post-disaster recovery through rehabilitation and reconstruction.
4) Research/assessment of disaster characteristics is directly related to emergency response and post-disaster recovery. The Ministry of Transportation, through the Directorate General of Railways, can conduct research or assessment of disaster characteristics for disaster management. Assessment of disaster characteristics will be very helpful for handling emergency response, namely a quick assessment of the location, damage, losses & resources and will also help when determining the status of a disaster emergency. In addition, this assessment will also assist in the post-disaster recovery period for rehabilitation and reconstruction.
5) Disaster risk assessment/analysis is directly related to emergency response and post-disaster recovery. This assessment will be very helpful for a quick assessment of the location, damage, losses, and resources as well as the immediate recovery of vital infrastructure. This assessment will be very helpful during the post-disaster recovery period. Therefore, the Director-General of Railways needs to carry out this assessment to assist in handling a disaster.

b. Passive Mitigation

1) Preparation and placement of warning signs, hazards, prohibitions on entering disaster-prone areas are directly related to emergency response management, namely determining the status of a disaster emergency.
2) Basic disaster training for officials and the community. The Directorate General of Railways can conduct basic disaster training for the community and railway employees because it will be very helpful when restoring vital infrastructure.
3) Community awareness and awareness level. The Ministry of Transportation or the Directorate General of Railways can provide community awareness level education because this extension will greatly assist in assessing quickly and precisely the location, damage, losses, and resources and determining the status of a disaster emergency.

c. Preparedness

1) Activation of disaster preparedness posts with all supporting elements is directly related to emergency response management. The Ministry of Transportation or the Directorate General of Railways can activate disaster alert posts because it will greatly assist in a quick and precise assessment of the location, damage, losses, and resources.
2) Similar to the activation of disaster preparedness posts, the preparation, and installation of early warning instruments will be very helpful for a quick and precise assessment of the location, damage, losses, and resources. Therefore, the Directorate General of Railways needs to install early warning instruments in operating railways in Indonesia.
3) Mobilization of resources (personnel and infrastructure/equipment facilities). The Directorate General of Railways needs to mobilize resources for disaster preparedness because it will be very helpful for meeting needs and restoring vital infrastructure. In addition, it will also be of great help during post-disaster recovery, namely rehabilitation and reconstruction.

Based on the matrix above, that to carry out mitigation and preparedness it is necessary to cooperate in each sector or level of the work unit, namely the Ministry of Transportation,

the Directorate General, and the Work Units (Satker). Below is the matrix result for the work unit level in Table 3 and Table 4.

Table 3 Matrix of Mitigation Measures Based on Work Unit Levels

Mitigation Measures	Level		
	Ministry	Directorat-General	Work Unit
A1a1	√	√	√
A1a2	√	√	
A1a6	√	√	√
A1b1	√	√	√
A1b2	√	√	√
A2a2		√	√
A3a2	√	√	
A3b1	√	√	
A3b2	√	√	
A4a1	√	√	
A4a2	√	√	√
A4b1		√	√
A4b2		√	√
A5a1		√	√
A5a6		√	√
A5b1		√	√
A5b2		√	√
B1a2	√	√	
B2a6	√	√	√
B3a1	√	√	
B3a2	√	√	
C1a1		√	
C2a1	√	√	
C3a6	√	√	
C3b1	√	√	
C3b2	√	√	

c. Handling Scenarios

Based on the results of the tables above, that in dealing with disasters, it is carried out in 2 stages of scenarios, namely during the emergency response and during recovery (post-disaster recovery). There are several ways to deal with emergency response and recovery that can be carried out by the Ministry of Transportation or DJKA, including:

a. Emergency response

Government Regulation Number 21 of 2008 concerning the Implementation of Disaster Management states who shall declare the emergency status, without any indication. In-Law Number 24 of 2007 concerning Disaster Management, it is stated that indicators of emergency status in Article 7 paragraph 2, namely:

1) Number of victims;
2) Property losses;
3) Damage to infrastructure and facilities;
4) Wide coverage of affected areas;
5) The resulting socio-economic impact.

A new emergency status is declared after a rapid assessment has been carried out and provides a rapid assessment analysis regarding the disaster event and the impact of the disaster that occurred. In this rapid assessment, it is following the mandate of Law no. 24 of 2007 article 49, which needs to be studied are:

1) coverage of disaster locations;
2) the number of victims;
3) damage to infrastructure and facilities;
4) disruption to the functions of public services and government;
5) the ability of natural and artificial resources

During the emergency response period, the Ministry of Transportation or DJKA can exercise control by:

1) Establishment of a Disaster Emergency Response Command

Based on the Regulation of the Head of BNPB No. 10/ 2008 concerning Command Guidelines for emergency response[18]. Disaster emergency response command is a disaster emergency response organization led by a disaster emergency response command and assisted by command staff and general staff, has a standard organizational structure that adheres to one command with clear links and lines of command, and has a single unit of command in coordinating agencies. / Institutions / organizations related to resource mobilization.

The establishment of a disaster emergency response command covers the following stages:

a) Initial event information;
b) Assignment of the Quick Reaction Team (TRC);
c) Determination of Disaster Status / Level;
d) Establishment of a Disaster Emergency Response Command.

2) Establishment of an Emergency Response Media Center

Based on the Regulation of the Head of BNPB No. 8 of 2013 concerning Guidelines for Disaster Emergency Response Media Center[19]. An emergency response media center is a policy information service vehicle for disaster emergency response command posts based on information and communication technology to provide the desired information, provide convenience, and speed in disseminating actual, objective, and factual information.

3) Limitation / Control of Railways

The Ministry of Transportation or DJKA can issue decisions regarding the limitation / and control of railways during a disaster. In issuing decisions related to restrictions / and control along with guidelines that can be carried out by the community when riding the train to reduce the risk of a disaster. For example, currently, Indonesia is experiencing the Covid-19 pandemic which has spread to several regions in Indonesia, be-

cause the Ministry of Transportation issued Ministerial Regulation No. 18 of 2020 concerning Transportation Control in Prevention of the Spread of Corona Virus Disease 2019 (Covid-19)[20]. The issuance of this regulation is not without reason, because currently, Indonesia has entered an emergency response period until May 2020 as stated in the Decree of the Head of BNPB No.13 A of 2020 concerning the extension of the status of certain emergency conditions for disease outbreaks due to the coronavirus in Indonesia[21].

b. Recovery

The recovery plan must be of high quality, compiled completely, and refined from year to year. The shorter the recovery period, the smaller the losses due to the disaster. Conversely, the longer the recovery period, the longer the productive period will resume. Recovery (recovery) is divided into 2 (two) namely rehabilitation and reconstruction.

Based on BNPB Regulation No.11 of 2008 concerning Guidelines for Post-Disaster Rehabilitation and Reconstruction[22], it is stated that rehabilitation is the repair and restoration of all aspects of public or community services to an adequate level in post-disaster areas with the main objective of normalizing or running fairly all aspects of government and community life in post-disaster area. Meanwhile, reconstruction is the formulation of policies and efforts as well as concrete, well-planned, consistent and sustainable steps to permanently rebuild all infrastructure, facilities, and institutional systems, both at the government and community levels, with the main means of growth and development of economic and social activities. , and culture.

The Ministry of Transportation or DJKA as the one responsible for the railway operator can take several post-disaster actions in the context of accelerating rehabilitation and reconstruction, as follows:

1) Coordinate with the head of BNPB, the Minister of Public Works and Public Housing, and the provincial and district/city governments in the framework of accelerating post-disaster rehabilitation and reconstruction of facilities and infrastructure in the transportation sector, especially railways damaged by disasters;
2) Creating a smooth service for the outflow of goods and people through transportation facilities and infrastructure;
3) Providing services for transporting aid and refugees as well as distributing aid; and
4) Preparing Human Resources (HR) and the resources they have to realize the implementation of transportation in a safe, smooth and orderly manner.

At the time of the earthquake in West Lombok Regency, North Lombok Regency, Central Lombok Regency, East Lombok Regency, and Mataram City. President Jokowi issued Presidential Instruction No.5 of 2018 concerning the Acceleration of Post-Earthquake Rehabilitation and Reconstruction in all Lombok Regencies and Mataram City. Instructing all ranks of Ministers, BNPB, Police, TNI, Local Government to accelerate rehabilitation and reconstruction due to the Lombok earthquake disaster

c. Risk management.

DJKA can take Risk Management steps, which is one way to reduce losses due to disasters. One of the risk management measures to reduce losses in infrastructure, especially in railways, is using risk financing. According to Rohman Juani (2019)[11], insurance is not the only risk management step. Insurance measures are taken to reduce the risk that remains after other risk management steps have been taken. Railway infrastructure in disaster-prone areas that have been built (existing) and has been strengthened still has risks, so it needs to be reduced by risk financing.

Risk financing measures include two things, namely, cost-saving and insurance. If the level of disaster risk from infrastructure is low, it is better to choose cost savings for the infrastructure reconstruction plan. With cost-saving, DJKA can save the budget in paying insurance premiums each year. Based on the study of damage to the Yogyakarta earthquake in Bantul, there are 17% of buildings are less effective when taking insurance measures. This is because the level of damage is smaller than the deductible value.

For infrastructure that has a high risk of disaster, insurance should be carried out. By doing this in the event of a disaster and serious infrastructure damage, DJKA can claim insurance to repair infrastructure or build new infrastructure to replace infrastructure that has been severely damaged

4 Conclusion

a. Natural disasters such as earthquakes, floods, landslides, and disease outbreaks can have an impact on the supply side and the demand side or both. Therefore it is necessary to have disaster mitigation as a way to minimize the potential consequences of a disaster.
b. The Directorate General of Railways can carry out mitigation and preparedness in the event of a disaster so that it can carry out emergency response and post-disaster recovery.
c. The Directorate General of Railways, which is responsible for conducting railways, can take Risk Management steps to reduce losses due to disasters. One of the risk management measures to reduce infrastructure losses, especially in railways, is risk financing.

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