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Effectiveness of Traffic Signal System Policy for Railway Transportation Safety on the Padang City–Pariaman City Line, West Sumatra, Indonesia

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ABSTRACT

This study aims to explain the effectiveness of the Traffic Signal System Policy on Railway Transportation Safety on the Padang City-Pariaman City Line. The approach used in this study is qualitative with descriptive methods. The study results explain that implementing the traffic signal system for the safety of the Padang-Pariaman railway line is effective. This can be seen in the fulfillment of aspects such as target accuracy, socialisation, objectives, and monitoring carried out by the relevant parties responsible for implementing this policy. This article also recommends several measures to further optimise the effectiveness of implementing the traffic signal system for the safety of the Padang-Pariaman railway line. First, to achieve the objectives, monitoring and supervision by the Indonesian Railway Company, the Railway Engineering Center, and the Post Guard Officers should be further improved. Second, it is recommended that monitoring be designed to specialise in the traffic signal system so that no damage occurs in the field. Third, an approach is needed from the Railway Engineering Center to the community regarding the development of the traffic signal system to increase public compliance and support for railway traffic regulations.

1. INTRODUCTION

Transportation is an integral part of people's lives. Increasing population density significantly impacts transportation's ability to meet people's needs [1-5]. Local public transportation remains a vital necessity for the community. Some public transportation options that remain the community's preferred choice for land transportation services include city or public transportation, buses, taxis, mini-metros, and others [6]. Public transportation is a service that aims to provide comfort, convenience, and a sense of security to its users during travel activities. Discussing public transportation cannot be separated from the availability of public transportation services and the users of these services who travel from one place to various destinations [7-9]. Public transportation is an essential service that underscores the importance of this public transportation system, which is readily apparent. In addition, public transportation must be planned, organised, arranged, and coordinated as much as possible so that public transportation services can reach all existing areas, especially areas in the surrounding area [10-14].

Over time, Indonesia has experienced significant growth and development in nearly all sectors, particularly in transportation. Transportation is a vital industry in the lives of the Indonesian people. Transportation refers to the movement of people or goods using vehicles operated by humans or machines. Transportation can be interpreted as an effort to move an object from one place to another where the object is more useful or can be used for specific purposes [15-20].

One type of transportation is trains; trains are one of the land transportations that has characteristics and advantages, especially their ability to transport people and goods in large numbers, energy efficient, space efficient, fuel efficient, high safety factor, and low pollution levels and much more efficient in the long-term distance and urban traffic. Public transportation by train must be safe in its operation. For the implementation of train transportation to provide services with a high level of safety, security, accuracy, smoothness, and comfort, railway facilities must be reliable and meet safety requirements. This ensures that the facilities are always in a ready-to-use condition and technically feasible to operate. Therefore, the provision and construction of railway facilities must be based on the requirements determined, and testing,

inspection, maintenance, or maintenance and certification must be carried out [21-28].

Rail transport is a form of transportation that utilises vehicles with the power to move either alone or in conjunction with other vehicles to transport goods or passengers. As the name suggests, trains can only move or run on rails or networks. Train tracks typically consist of two, three, or four rails, powered by separate locomotives or individual engines, all part of a single unit. The train or carriage is relatively wide, accommodating a large number of passengers and goods. Trains are typically used for medium distances, ranging from 3 to 4 hours, or to transport large quantities of goods. The government continues to implement a railway traffic safety system with the help of regulations from the Department of Transportation. The Regulation of the Minister of Transportation Number 69 of 2018 states that the Railway Safety Management System is part of the general management system of railway operators. The railway operators encompass a diverse range of professionals, including testing personnel, inspectors, maintenance personnel, railway infrastructure managers, railway installation teams, accident officers, accident inspectors, accident analysis officers, assessors, and implementers.

In railway transportation, a traffic light or traffic signalling device is used, which is an electronic device that utilises light signals and sound signals to regulate the flow of people and vehicles at intersections or highways (Law No. 22 of 2009 - Traffic and Road Transportation). This traffic light is designed to regulate the density and safety of cars at an intersection, as well as to control pedestrian crossings. The time the traffic light remains on is often referred to as a traffic light delay. The late traffic light arrangement is designed to prevent a long queue of vehicles from forming and to minimise the wait time for drivers and pedestrians at the crossing.

Each intersection has its green light delay. Likewise, each stage has a different delay at each checkpoint. The stage is situated at the intersection, with parts of the road in each direction. Therefore, it is necessary to set a green light delay schedule for each phase at each intersection, depending on the number of vehicles passing at a particular time [29].

Traffic signal systems regulate the flow of vehicles at intersections. It is not known when a traffic signal system can be damaged, as it is an electronic device with a fixed service life. Therefore, the traffic signal system can be damaged by various factors at any time. Damage to the traffic signal system can lead to irregular traffic patterns and various traffic issues, including congestion and even the potential for accidents.

The role of the traffic signal system in the land transportation network is vital. In this case, if damage to the traffic signal system can be identified and addressed quickly through good maintenance, the possibility of traffic problems at each intersection can be reduced, allowing drivers to use the highway more comfortably.

The implementation of a traffic signal system, in this case, coordination or regulation of traffic lights, can also be referred to as signs at intersections in traffic regulation, which are very important and significantly influence traffic flow. Traffic light settings include green time, green time, yellow time, and cycle time settings. On the other hand, traffic light coordination involves coordinating the initial green time between the intersection's traffic lights and the start of the green time at the next intersection, allowing most vehicles to pass through the intersection without stopping. For the traffic signal system to function correctly at all times, efforts must be made to minimise delays in repairing the system if it is damaged.

The signal system comprises traffic flow indicator lights installed at intersections, pedestrian crossings, and other key locations where traffic flow is affected. This light indicates when vehicles must start and stop alternately from different directions. Traffic regulation at an intersection aims to regulate vehicle movement in each group of vehicle movements so that they move alternately, thereby avoiding interference with existing traffic. The traffic signal system functions to regulate the flow of vehicle movement at road intersections. It is undeniable that damage to the traffic signal system can occur at any time, as it is an electronic object with a specific service life. Traffic lights have been introduced in nearly all cities worldwide. These lights use standard colours to indicate stop, namely red, caution marked with yellow, and green, which means safe to drive. The system operates as follows: First, it navigates around obstacles due to differences in road flow that affect vehicle movement. Second, intersections between main roads for vehicles and pedestrians should be facilitated with secondary roads, ensuring smooth traffic flow. Third, the level of accidents caused by collisions should be reduced due to differences in road flow.

In this case, the coordination or regulation of traffic lights can also be referred to as signs at intersections in traffic regulation, which are very important and have a significant impact on traffic flow. Traffic light regulations include green time, green time, yellow time, and cycle time. Traffic light coordination, on the other hand, involves the synchronisation of the initial green time between the intersection's traffic lights and the beginning of the green time at the next intersection, allowing most vehicles to pass through the intersection without stopping. The Transportation Agency, as the authorised authority, can take steps, including establishing a public complaint system, to ensure that all public services operate effectively. One of the railway lines studied is the Padang-Pariaman railway [6]. The use of the Padang-Pariaman train continues to increase annually, as reflected in the train's extended departure times.

Based on Table 1, the number of train passengers increased from 2021 to 2023 as the government implemented a new standard policy. This is inseparable from the annual increase in passenger numbers on the Padang-Pariaman railway line. A traffic signal system is needed to facilitate and maintain the safety of trains to Pariaman. People use trains because they are more affordable and take less time than buses. Tourists or train users who want to be creative in Pariaman also prefer the train because the last stop is on the beach.

Table 1. Number of train passengers in West Sumatra

Year	Number of Passengers
2020	595,509
2021	642,827
2022	1,292,250

Source: https://www.bps.go.id

Nevertheless, the number of traffic accidents at railroad crossings in the West Sumatra region increased again in 2023. The Padang Class II Railway Engineering Center noted that in 2023, there were 29 accidents at level crossings. This figure is an increase compared to 2022, when there were only 14 cases. Moreover, from 2017 to 2023, 29 people died due to the accidents in question; 60 were seriously injured, and 52 were slightly wounded. Due to the large number of accidents caused by the absence of a traffic signal system, a policy was

implemented to provide a traffic signal system at every intersection of highways that also serve as railroad crossings. This policy aims to reduce the number of accidents that occur on railroad tracks. The traffic signal system is divided into two parts: the traffic sign system, which includes signs, and the system without signs. The Padang-Pariaman railway line has both types of traffic signal systems.

One example of a point where the traffic signal system with signs is used is at the Tunggul Hitam Intersection. This traffic signal system is operated directly by officers. Meanwhile, the traffic signal systems without signs are located at the Tabing Singgalang and Marabau Pariaman Intersections. The traffic signal system, without a sign, operates automatically under the supervision of officers at each station. The traffic signal system lights and sound activate when the train approaches the track.

Based on initial observations, several obstacles exist to implementing the Padang-Pariaman Railway Line. First, there is a traffic signal system without officers at the POS point. Second, there are limitations for the traffic signal system technicians in the railway sector. Third, there are limitations on violations still committed by drivers. Based on the background information above, this research focuses on the effectiveness of implementing a traffic signal system to enhance the safety of the Padang-Pariaman railway line in Indonesia.

Although the traffic signal system has been implemented, an in-depth understanding of its effectiveness in various operational scenarios and its impact on accident reduction on the Padang-Pariaman railway line remains lacking, which is why this research is essential. Thus, in this study, the effectiveness of implementing a traffic signal system in enhancing the safety of the Padang-Pariaman railway line can be determined.

2. LITERATURE REVIEW

Effectiveness refers to the achievement of previously set goals [30]. If the goals and objectives are determined, then the policy is considered effective; however, if the goals and objectives are not achieved, the policy will be deemed ineffective. According to Kićanović et al. [31], effectiveness is the level of organisational achievement both in the short and long term. Effectiveness is a measure that provides an overview of how far the goals are achieved, both in terms of quality and time; its orientation is on the output produced [32]. And effectiveness is a measure that provides an overview of how far the target can be achieved [33]. AM and Yuliani [34] explain that effectiveness in organisational activities can be formulated as the level of target realisation, which shows the extent to which the target has been achieved. Measuring effectiveness is not easy; appropriate indicators are needed, and the assessment depends on who is evaluating it. From several definitions of effectiveness, it can be concluded that effectiveness is a measure that determines how far the actual achievement of targets deviates from the previously formulated targets. This means that the closer an activity is to its target, the higher it is.

2.1 Policy effectiveness

Policy effectiveness is an assessment or measurement of the extent to which activities outlined in policies have been implemented and can achieve the policy's initial objectives. The success of a policy can be measured by the effectiveness with which it achieves the objectives previously planned by the related organisation. Policy effectiveness can be determined by comparing output with policy objectives, and the opinions of policy participants can be used as a measure to assess policy effectiveness. According to Budiani [35] in his book on policy effectiveness, it is stated that to measure what factors can affect whether or not a policy is running, the following variables can be used:

a) Policy Target Accuracy. Policy target accuracy refers to the extent to which policy participants align with previously set targets.
b) Policy Socialization. Policy socialisation refers to the ability of policy implementers to communicate the policy to the general public and specific target groups of policy participants.
c) Policy Objectives. The policy's goal is to reach an agreement on implementing its results and the previously set policy objectives.
d) Policy Monitoring. Policy monitoring is an activity carried out after implementing the policy as a form of attention to policy participants.

2.2 Relevant research

a) Research conducted by Sekarsari and Dwiatmoko [6] on the Effectiveness of Countdown Timers at traffic signal system Intersections at the National Civil Engineering Conference. This counter-timer is designed to maintain the safety of railway lines and vehicles on the road, including motorbikes, cars, and pedestrians. The results of this study indicate that using countdown timers can enhance the effectiveness of traffic signal systems at intersections. This research is similar to the author's planned study, with the primary difference being that the author's study focuses more on the Effectiveness of implementing the traffic signal system for the safety of the Padang-Pariaman Railway Line.
b) The research aims to address the safety issues at railway level crossings in developing countries. It focuses on reducing accidents that result in fatalities, injuries, and vehicle damage. The study proposes a novel system that integrates IoT and machine learning to enhance traffic management at railway crossings. It seeks to optimize traffic flow, reduce waiting times, and improve overall safety for both vehicles and pedestrians.The research also aims to provide users with notifications about the nearest railway station and suggest alternative routes to minimize travel time [36].
c) The effectiveness of traffic signaling system governance policies in railway safety hinges on integrating advanced communication technologies and interoperability standards. Implementing systems like Communication-Based Train Control (CBTC) enhances real-time data exchange between trains and infrastructure, significantly improving safety by preventing accidents and optimising traffic flow. Adopting open-standard wireless communication technologies can facilitate a more cost-effective and reliable signalling infrastructure, ultimately leading to enhanced safety measures and operational efficiency in railway systems [37].
d) A systematic approach to traffic safety management in

railway transport is necessary, which involves analysing traffic safety violations and identifying associated risks. While it does not explicitly address the effectiveness of traffic signaling device governance policies, it suggests that improved management decisions, supported by data-driven algorithms, can enhance overall safety and efficiency. The proposed approach aims to reduce human error and increase the objectivity of safety measures, which could indirectly improve the governance of traffic signaling devices in railway transportation [38].

e) The paper emphasises the importance of a systematic security analysis for the European Rail Traffic Management System (ERTMS), highlighting that safety is paramount while security often receives less attention. Effective governance policies for traffic signaling devices in railway transportation must integrate robust security measures to address vulnerabilities identified in ERTMS protocols. By implementing a holistic security assessment process and proposing solutions like the TRAKS key management scheme, the governance policy can enhance safety and security, ensuring the resilience of railway operations against current and future threats [39].

f) The paper emphasises the importance of implementing security-by-design principles in railway signalling management, which can enhance the effectiveness of traffic signalling device governance policies. By utilising the Controlled Natural Language for Data Sharing Agreement (CNL4DSA), the automatic generation of enforceable access control policies can be achieved, thereby improving safety and reliability in railway transportation. This approach addresses traditional hardware faults and emerging cybersecurity threats, ensuring that governance policies are robust and adaptable to the evolving landscape of railway safety challenges [40].

g) The article highlights a gap in the railway transport safety management system, precisely the absence of a control algorithm, which is crucial for the effective governance of traffic signaling devices. This lack of a structured control mechanism can hinder the implementation of effective policies for railway transportation safety. Regulatory documents in Ukraine and the EU emphasise the need for comprehensive safety management, suggesting that enhancing governance policies requires integrating systematic control algorithms to improve the effectiveness of traffic signalling devices in ensuring safety [41].

h) The paper emphasises the importance of an integrated management system for ensuring safety in railway transport, which includes traffic safety as a critical component. Effective governance policies for traffic signaling devices are crucial in minimising risks associated with hazardous events, thereby enhancing overall railway safety. By implementing comprehensive regulations and monitoring systems for signaling devices, the likelihood of accidents can be significantly reduced, contributing to the strategic goal of increasing safety levels on domestic railways [42].

i) The effectiveness of traffic signaling device governance policies in railway safety is crucial, as these policies ensure the reliable operation of signaling systems, such as CBTC. By implementing decentralized-hierarchical control approaches, these policies enhance the coordination between subsystems, such as Automatic Train Protection (ATP), which is vital for maintaining safe train operations. Proper governance facilitates real-time communication and decision-making, reducing the risk of accidents and improving overall system efficiency and safety in increasingly dense urban rail networks [43].

j) The paper does not specifically address the effectiveness of governance policies for traffic signaling devices in railway transportation safety. However, it emphasises the importance of policy management within the Future Railway Mobile Communication System (FRMCS) to enhance communication reliability and safety. The design of a policy service allows railway operators to manage operational rules effectively, which could indirectly support the governance of traffic signaling devices by ensuring that communication related to safety protocols is prioritised and managed according to established policies [44].

k) The effectiveness of traffic signaling device governance policies in railway transportation safety hinges on integrating comprehensive diagnostics and monitoring systems for infrastructure and rolling stock. By synthesising safety control systems that account for internal and external failures, these policies can enhance the reliability of signalling devices. The proposed theoretical principles emphasise the need for a holistic approach to safety, ensuring that all transportation process components are monitored and diagnosed, ultimately leading to a higher level of train traffic safety [45].

l) Cognitive biases and insufficient consideration of human and organisational factors during the planning stages critically undermine the effectiveness of traffic signalling device governance policies in railway transportation safety. The SIRI Cybernetic Risk Model highlights those existing frameworks, such as the Guide to Railway Investment Process, fail to incorporate necessary measures to address deficiencies identified in safety analyses. Consequently, these policies do not adequately meet the regulatory requirements of the Common Safety Method-Risk Assessment, leading to potential safety risks in real-time operations. Addressing these biases is essential for improving governance and safety outcomes [46].

m) The effectiveness of traffic signaling device governance policies in railway transportation safety hinges on the continual improvement of technical and economic indicators of traffic safety alongside robust risk management mechanisms. The paper highlights the necessity of addressing the technical condition of alarm systems and emphasises the importance of identifying and analysing emergencies to enhance safety. By implementing a systematic approach to crisis prevention and ensuring the reliability of signalling and communication systems; the governance policy can significantly mitigate risks and improve overall railway safety [47].

n) The paper does not specifically address the effectiveness of governance policies for traffic signaling devices in railway transportation safety. It focuses on Adaptive Traffic Signal Control (ATSC) systems for urban traffic management, emphasising their integration with ICT and IoT to enhance vehicle flow and reduce congestion. While the principles of real-time data processing and optimisation discussed may have implications for transportation safety, the study does not provide insights

into railway signalling governance or effectiveness [48].

o) The study highlights the significant impact of integrating railway information into traffic signal control systems, suggesting that effective governance policies for traffic signaling devices can enhance railway transportation safety. By employing reinforcement learning algorithms, the research demonstrates improved traffic flow efficiency, particularly during train crossings, which can mitigate risks associated with vehicle and train interactions. Thus, implementing intelligent traffic signal control that considers railway operations can lead to safer urban transportation environments and better management of potential hazards at railroad crossings [49].

p) The effectiveness of traffic signaling device governance policies in railway safety can be significantly enhanced through comprehensive risk assessments, as demonstrated in the study. By employing methods such as FMEA and fuzzy sets, the analysis identifies and evaluates potential hazards in the design of control, command, and signalling devices. Engaging experts and utilising structured surveys ensures that diverse perspectives contribute to the risk assessment process, ultimately leading to improved safety measures and more reliable signalling systems in railway operations [50].

q) The article emphasises the importance of improving automatic locomotive signaling systems to enhance railway transportation safety, particularly by addressing the issue of rail lash demagnetisation. Developing a wagon platform utilising a pulse method for demagnetisation is a significant advancement, as it directly impacts the reliability of signalling devices. By implementing effective governance policies incorporating such technological improvements, the safety and timeliness of train operations can be significantly enhanced, thereby reducing the risk of accidents and ensuring efficient railway transport [51].

This study explicitly explains the policy of implementing the traffic signal system for the safety of the Padang-Pariaman Railway line, viewed from the perspective of governance effectiveness, which encompasses indicators such as target accuracy, socialisation, objectives, and policy monitoring, using a qualitative approach. This differs from previous studies, which are relevant in terms of variables, indicators, loci, and research methods used.

3. METHODS

The researcher used a qualitative method with a descriptive approach. This type of descriptive research aims to describe and clearly explain the effectiveness of implementing the traffic signal system in enhancing the safety of the Padang-Pariaman railway line. The researcher used this qualitative method for several reasons, which, according to the researcher, are as follows: First, qualitative methods are more straightforward to adapt when dealing with natural facts. This method directly describes the relationship between researchers and respondents. Second, this method makes researchers more sensitive and adaptive to the value models they encounter. Researchers employ qualitative methods to describe existing conditions and articulate them in written words or documents. In collecting informants, researchers determine who the key informants will be, as well as the subjects and informants from the objects, to facilitate the collection of research data.

The informants in this study were selected using the purposive sampling technique, a sampling method that selects data sources based on specific considerations. This means that particular considerations are chosen as samples that are considered to provide the best understanding of what is being studied, making it easier for researchers to conduct their research. The summary made by the researcher regarding the informants in this study is shown in Table 2.

Table 2. Research informants

No.	Informants
1	Head of Sub-Section of TU Class II Railway Engineering Center, West Sumatra Region
2	Transportation Management Expert
3	Railway Level Crossing Guard Officer
4	Community Members

The data acquired is subjected to verification of its validity through the triangulation methodology. Triangulation represents a sophisticated data collection methodology that integrates various data-gathering techniques alongside existing data repositories. In the present research, the investigator employed the source triangulation methodology, as the data collected emanates from a multitude of sources, rendering the source triangulation approach the most suitable for this investigation. The triangulation methodology serves as a mechanism for comparing and reassessing the credibility or veracity of information obtained from disparate individuals or sources. This is accomplished by juxtaposing observational data with the outcomes of interviews, contrasting public statements with private discourse, and subsequently comparing the interview findings with the pertinent content or documentation associated with the research aims.

4. RESULTS AND DISCUSSION

Padang City is the capital of West Sumatra, which already has railway transportation. The train used by the people of Padang City who do not have private vehicles is a means of transportation for those who want to go to Pariaman. In 1889, this station officially began operation 1890. The Dutch East Indies Government specifically established this station to facilitate the distribution of commodities such as copra and gambir, which were distributed to Padang and cities in the interior of Minangkabau. The construction of this station was in line with the construction of a railway line from Padang to Sawahlunto, which began on July 6, 1889, to facilitate the transportation of coal from Sawahlunto to the port of Teluk Bayur. The construction of the railway line started with the Pulau Aie (Muaro Padang) to Padang Panjang line, followed by the Padang Panjang to Bukittinggi line (completed in 1891), and was then extended to the Padang Panjang to Solok line (completed in 1892). Additionally, the Solok to Muaro Kalaban and Padang to Teluk Bayur lines were also completed in 1892.

The construction of the railway station at that time was used to facilitate the transportation of agricultural products from the people of West Sumatra. Governor General Johannes Van Den Bosch, who visited West Sumatra in 1833, provided territorial expansion for economic purposes. Then, the transportation network expanded due to the forced cultivation of coffee,

especially following the discovery of coal mines in Sawahlunto. The development of Padang City in the fields of industry, trade, and tourism has gradually improved the welfare of the people. Still, this development has also had implications for city problems that require serious handling. The problem is the issue of traffic transportation, which is becoming increasingly congested daily.

One of the efforts to reduce traffic density in Padang City is the government's attempt to develop railway transportation by reactivating the central station located at Simpang Haru. At the same time, it can help the government overcome income problems and improve the economy in Padang City. A railway line was built to connect Padang City with Pariaman City. The line starts in Lubuk Alung and ends in Pariaman. The line was completed on December 9, 1908, and continued to Naras and Sungai Limau on January 1, 1911. The Naras-Sungai Limau segment was closed during the Dutch colonial era due to the collapse of the bridge on the line, and the line was subsequently dismantled. Although dismantled, the train station remains partly intact, and the Indonesian Railway Company still controls the land. In 2004, the Padang City Government began developing passenger trains in Padang with a station at Simpang Haru; the results grew because of the many enthusiasts of train transportation, so supporting stations were built in Padang City such as Indarung Shelter (IDA), Pauhlima Station (IMA), Kampung Jua Shelter (KJA), Bukitputus Shelter (BKP), Teluk Bayur Harbor Shelter, Pulau Air Station (PA), Tarandam Shelter (ST), Pasar Alai Shelter (PAL), Air Tawar Shelter (ATR), Tabing Station. Furthermore, the Lubuk Alung-Naras-Sungai Limau railway line connects Lubuk Alung Station and Naras Station. This line is still active, except for the Naras-Sungai Limau line. Various figures can be accepted.

Based on data from the Indonesian Railway Company, the number of people using train transportation in West Sumatra Province is shown in Table 3.

Table 3. Volume of passenger railway traffic and number of passengers in West Sumatra Province

Month	Information					
	Train (Number of Trains)			Passenger (Person)		
	2020	2021	2022	2020	2021	2022
Jan	624	918	918	140.667	68.517	82.790
Feb	754	885	885	125.619	65.594	79.030
March	86	980	980	89.823	75.428	91.810
April	624	960	960	15.983	66.281	64.900
May	-	990	990	-	77.863	140.200
June	-	960	960	-	87.939	133.990
July	-	920	920	-	32.656	112.930
August	248	638	638	45.375	5.185	86.170
Sept	240	780	780	34.996	11.401	101.040
Oct	248	806	806	40.103	29.030	121.920
Nov	240	780	780	46.681	46.479	109.710
Dec	248	806	806	56.262	76.454	167.760
Annual	**3.312**	**10.423**	**10.423**	**595.509**	**642.827**	**1.292.250**

Source: Indonesian Railway Company Reg. Div II

Based on a field survey, several passengers reported experiencing complaints, including the absence of flashing lights for crossing, which can compromise the safety of passengers, pedestrians, and vehicles. Based on a field survey, there are 54 points along the railroad crossing from Padang to Pariaman that should have traffic signal system signs. However, currently, there are only 39 signs, including illegal crossings, some of which are located at Pulau Aie, Simpang Haru, Alai, Lapai, Tunggul Hitam, Tabing, Lubuak Buaya, Airport, Batang Anai, Lubuk Alung, Pauh Kamba, Pariaman, and the APA Intersection. The 15 points that do not have the traffic signal system signs include Jati, Pasir Putih, Limbo Panjang, and Marabou. For data on freight trains operating in West Sumatra Province, see Table 4.

Table 4. Freight train traffic volume and number of goods in West Sumatra Province

Month	Information					
	Train (Number of Trains)			Goods (Tons)		
	2020	2021	2022	2020	2021	2022
Jan	420	564	564	259.960	176.350	184.690
Feb	323	589	589	205.855	164.580	169.500
March	439	655	655	273.990	187.390	204.540
April	243	500	500	151.770	149.610	199.740
May	321	708	708	203.130	199.760	105.560
June	313	711	711	198.600	194.100	177.840
July	230	675	675	142.525	172.245	184.770
August	384	383	383	240.850	111.330	172.260
Sept	364	584	584	239.915	145.800	184.170
Oct	290	852	852	178.415	247.015	163.280
Nov	379	391	391	238.385	125.340	150.860
Dec	307	651	651	187.860	191.970	156.520
Annual	**4.013**	**7.263**	**7.263**	**2.521.255**	**2.065.490**	**2.053.730**

Source: Indonesian Railway Company Reg. Div II

The sign was lowered 1 km from the railway crossing, following the procedure when the field conditions do not comply with applicable standards. However, the problem that occurred was the absence of signs on the Padang-Pariaman railway line in the Pasia Putih area. This is one of the primary causes of frequent accidents involving trains, motorcyclists, cars, and pedestrians. This can be seen in Figure 1.

Figure 1. Illegal crossing without guard post

In the train's traffic signal system, this light reminds us when a train is approaching. The name of this light is the early warning system (EWS). The traffic signal system EWS has two colour codes: yellow and red lights. The yellow light indicates caution, and the red light means stop (Figure 2). The EWS pole, also known as the yellow light, is equipped with a sensor that triggers a sound and lights up when the train steps on it, depending on the step. Not all have this EWS; there are only a few points, such as near Tabing Station and along the Adinegoro Lubuk Buaya journey.

Figure 2. Early warning system

4.1 Effectiveness of implementing the traffic signal system for the safety of the Padang-Pariaman railway line

In this section, the researcher will discuss the effectiveness of implementing a traffic signal system in enhancing the safety of the Padang-Pariaman railway line. Effectiveness is closely related to the achievement of predetermined goals, as it provides an overview of an organisation's success in achieving planned goals or targets. Effectiveness can be observed or measured using several indicators, depending on the researcher's perspective and the aspect being studied. To assess the efficacy of implementing a traffic signal system in enhancing the safety of the Padang-Pariaman railway line, the researcher will apply the theory proposed by Budiani [35], which focuses on the indicators of effectiveness, including the accuracy of policy targets, policy socialisation, policy objectives, and policy monitoring.

In terms of the accuracy of policy targets, the extent to which policy participants are aligned with previously determined targets. Based on the research findings, a traffic signal system is a traffic signaling device that works with warning lights. The purpose is to ensure the safety of the railway line and to raise awareness among road users. When the sensor sounds or lights up, it is a sign that a train will soon cross, and the public should exercise caution. Furthermore, the implementation of the traffic signal system remains safe and effective. Still, it operates fairly well in terms of operational effectiveness, as some systems were not functioning properly and have been temporarily repaired by the manager. The implementation of the traffic signal system, based on data from research informants, is appropriate because it has been well-planned and executed.

The installation of a traffic signal system is carried out based on data collected not only at several points along each end but also on a history of accident rates, considerations of location, and traffic volume on the route. According to the study's findings, the accuracy of the target for the traffic signal system implementation policy in terms of railway line safety is right on target.

The target is to ensure the safety of the railway line and road users to reduce the accident rate; meanwhile, in the socialisation of the implementation of the traffic signal system, namely the ability of the implementer to carry out socialisation so that information regarding the implementation of the traffic signal system can be conveyed to the public in general. Based on the study's findings, it can be explained that socialisation was carried out among the public and other stakeholders at the level crossing of the railway line from Padang City to Pariaman City. Socialisation was conducted at several level-crossing points on the railway line using several available information media. The research findings indicate that the socialisation of the traffic signal system implementation policy for the safety of this railway line has been ongoing for a long time. This socialisation was facilitated through the community, utilising the railway line and local government to ensure safety around the railway tracks.

Furthermore, the monitoring aspect of the policy is an activity carried out after the policy is implemented as a form of attention to policy participants. Based on the research findings, it can be explained that the partner service provider monitors the implementation of the traffic signal system. Repairing the traffic signal system in the event of damage is also carried out by the partner, who provides a report to us once the repair is complete. Routine monitoring is conducted by officers from the Railway Engineering Center every week, typically once or twice a week. Monitoring is carried out by the partner service provider and the railway centre in terms of safety. Monitoring and supervision carried out so far have been running well on the traffic signal system applied at level railroad crossings. Monitoring and supervision carried out so far have been successful in the operation of the traffic signal system applied at level railroad crossings. They are considered quite effective because they will reduce accidents at level crossings. Based on the description of the research findings previously explained, the researcher would like to further elaborate on the results obtained in the field about the theory employed. The comparison is to determine whether implementing the traffic signal system for the safety of the Padang-Pariaman railway line is adequate. The researchers AM and Yuliani [34] explain that effectiveness in organisational activities can be formulated as the level of target realisation that shows the extent to which the target has been achieved. Measuring effectiveness is not easy; it requires appropriate indicators and depends on who is assessing it. In this case, the expert Budiani [35] explains that there are several indicators to regulate effectiveness, namely:

4.2 Target accuracy

In this case, the purpose of implementing the traffic signal system is to ensure the safety of the Padang-Pariaman railway line. Based on the findings obtained by researchers in the field, the primary purpose of the target accuracy of implementing the traffic signal system for the safety of this railway line is compelling. This is because the target accuracy protects railway lines, road users, and pedestrians, thereby reducing the accident rate. However, there are a few obstacles to achieving this target accuracy, namely the lack of awareness within the community, such as breaking through doors or crossing signs, which can result in accidents.

4.3 Policy socialization

In this case, the purpose of implementing the traffic signal system is to ensure the safety of the Padang-Pariaman railway line. Based on the findings obtained by researchers in the field, the main objective of socialising the policy implementation of the traffic signal system for the safety of this railway line

remains largely ineffective. This is because railway officers have carried out socialisation within the railway community, and many people have noted that socialisation has been conducted both directly and digitally. However, some people still do not know this information because officers have not maximised socialisation with the railway community on the Padang-Pariaman line.

4.4 Policy objectives

In this case, the objective is to implement the traffic signal system for the safety of the Padang-Pariaman railway line. Based on the findings obtained by researchers in the field, the policy objective of implementing the traffic signal system for the safety of this railway line has been practical. This is because it aims to achieve the goals of the traffic signal system, ensuring safety and anticipating a reduction in the number of accidents that occur on railway lines and road users. In this case, the post guard already knows the policy's purpose, and the community is also aware of it, working together to inform those who are not so that the accident rate decreases and the policy's goals are achieved.

4.5 Policy monitoring

In this case, the purpose of implementing the traffic signal system is to ensure the safety of the Padang-Pariaman railway line. Based on the findings obtained by researchers in the field, the primary purpose of policy monitoring, from the implementation of the traffic signal system to the safety of this railway line, has been practical. This is because most guards and monitoring are typically conducted once a week or every other week, based on the needs. The monitoring schedule already exists, and it has been carried out optimally. This monitoring is conducted by the Track Guard Officer, who is responsible for the railway office's public relations regarding safety. So far, monitoring for the traffic signal system implemented at the railway crossing has been going well. This supervision has been quite adequate for the Padang-Pariaman railway crossing guard officers.

Based on data from the Indonesian Railway Company, Reg. Div II, the rate of train accidents in West Sumatra is high nationally, despite the short distance of the tracks and rails, which is unusual. One trigger is the large number of illegal level crossings. The length of the track from Padang to Pariaman is approximately 60-70 km, while the number of illicit level crossings exceeds 200 points.

In addition to the numerous illegal level crossings, the high rate of train accidents in West Sumatra is also attributed to a lack of public awareness when crossing the tracks. In fact, at official and guarded level crossings, sometimes there are still residents who break through when the train passes. Therefore, increasing safety awareness when crossing levels is crucial. In addition, the Railway Engineering Center is also undertaking various initiatives, including closing hundreds of illegal level crossings, inspecting roads, installing sterilisation markers, building crossing gates, and implementing an early warning system.

Based on information from the West Sumatra Railway Engineering Center, safety improvements have been implemented at level crossings, including the closure of 245 unauthorised level crossings, the construction of 7 km of inspection roads around the tracks, and the installation of 27 level-crossing gates. Furthermore, a 10 km sterilisation fence and a 3.5 km ornamental fence were also built, and an early warning system was installed at 38 level crossing points.

Data from the West Sumatra Provincial Transportation Agency explains that the risk of accidents at level crossings is indeed high. The Agency noted that there were 338 level crossing points in three districts/cities, namely Padang, Padang Pariaman, and Pariaman. Of the 338 points, 288 were unregistered or illegal level crossings.

Based on the explanation above, it can be said that the effectiveness of using the traffic signal system in ensuring the safety of the Padang-Pariaman railway route has not been optimally achieved, as there are still many illegal level crossings. The factor of public awareness, which is still lacking in increasing vigilance when crossing railway lines, also causes serious accidents.

5. CONCLUSIONS

Based on the study's findings on the effectiveness of implementing a traffic signal system for the safety of the Padang-Pariaman railway line, it was concluded that the implementation of the traffic signal system was compelling in ensuring the safety of the Padang-Pariaman railway line. First, the accuracy of the target is an indicator of the effective implementation of the traffic signal system, especially on railway lines, which ensures the safety of road users and pedestrians. Second, the socialisation of this policy has been carried out by the Railway Engineering Center, the Transportation Service, and the post guard officers to the public, introducing the EWS traffic signalling device so that it is maintained and serves as a warning for the public to cross level crossings. Third, the objective of the traffic signal system implementation policy, which is to ensure safety and anticipate a reduction in the number of accidents on the railway line and for road users, has been achieved. Fourth, this policy is monitored by the post guards and the traffic signal system, typically once a week or every other week, as needed. The monitoring schedule already exists and has been carried out optimally. This monitoring is conducted by the Track Guard Officer, the railway centre's public relations representative, regarding safety. So far, tracking the traffic signal system implemented at the railway crossing has been going well. This supervision has been quite adequate for the Padang-Pariaman railway crossing guard officers.

Based on the results of the research that has been conducted, there are several recommendations from researchers to optimise further the effectiveness of the implementation of the traffic signal system for the safety of the Padang-Pariaman railway line, namely: first, in the process of achieving the objectives, monitoring, and supervision by Indonesian Railway Company, the Railway Engineering Center, and the Post Guard Officers should be further improved. Second, it is recommended that monitoring be designed to specialise in the traffic signal system so that no damage occurs in the field. Third, there is a need for an approach from the Railway Engineering Center to the community regarding the development of the traffic signal system to increase public compliance and support for railway traffic regulations, as well as the implementation of the traffic signal system.

For this, policy synergy is necessary among the central government, provinces, and local governments, including district or city governments. The reactivation of the railway line in West Sumatra has begun to show positive results. Residents have started to feel that the presence of the train can

contribute to the smoothness and effectiveness of their daily travel. With the allocation of funds from the central government, hundreds of illegal level crossings have been closed by building inspection roads on both sides of the railway tracks. These efforts are already underway. The region is building safety facilities, such as signs and markings, as early warnings.

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