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Risk Behavior Analysis in Indonesian Logistic Train Level Crossing

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Abstract: *Background*: At Indonesian level crossings, traversed by logistics trains, there are still frequent cases of accidents. The overall mishaps in 2020 were 199 cases of accidents at level crossings involving road drivers. Mental load factors affect the behavior of drivers on the road; *Methods*: this study, field observations and surveys were carried out using the Driver Behavior Question-naire (DBQ) and NASA TLX to measure mental load; *Results*: The results showed that 62% of drivers had a very high mental load factor. The mental load factors are effort, frustration, and temporal demand. Meanwhile, based on the results of DBQ, the type of behavior that is often carried out is Violation; *Conclusions*: From the results of field observations, it is also known that there is a significant influence between time and type of vehicle on violations. Thus, it was necessary to improve facilities and systems at level crossings to provide convenience and reduce the volume of transportation going through level crossings to reduce the risk of accidents and violations at level crossings.

Keywords: driver behavior questionnaire; level crossing; workload mental; logistic train

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1. Introduction

A level crossing represents an intersection between a highway and a train lane where the train lane is the track with priority over the road. Level crossings are one of the safety means used by trains to be able to warn drivers on the highway to stop and wait for the train to pass [1]. Even so, level crossings are one of the most complex road safety issues due to the increasing volume of vehicles and departures and rail and train infrastructure [2]. Level crossings can cause various problems, including traffic jams and accidents. Congestion at level crossings due to the closing of crossing gates to prioritize train travel, can result in a queue of motorized vehicles. Congestion at level crossings can also be affected by the intersection of the railroad with the highway. The main causes of accidents at level crossings is drivers' behavior, as they are less disciplined, and the number of unofficial level crossings.

Level crossings are one of the critical facilities in Indonesia, where the number of officially guarded level crossings owned by the Indonesia Railways Company is 1290, the officially unguarded amount to 1962, and the number of illegal crossings amount to 1888, in June 2020. From January to September 2020, there were 199 accident cases at level crossings. Most problems are caused by drivers not caring about the existing safety issues [3]. The road drivers have become the main cause of accidents due to various factors, including either negligence, facility or environmental factors, the condition of the driver concerned, or other factors [4]. Despite the improvements in facilities, technology, and security systems, human-error as the main cause of accidents is still high. This amounts to 80% of accidents being due to drivers violating existing rules, and from these accidents, most occur when safety facilities function very well [5].

In Indonesia, research on driver behavior on the highway is often discussed, however it is not specifically focused on level crossings [6]. Although overseas journals about level crossings have been widespread, there has been no research update that specifically discusses the behavior of road users at level crossings in Indonesia. Based on several studies, it is known that the problematic drivers' tendency to obey regulations becomes the real cause of frequent accidents. Several studies have been conducted to reduce the number of accidents at level crossings [7–9]. Based on the results of interviews with gatekeepers at local stations, it was found that the most frequent violation incidents were breaking through the gate, including both the bars that were about to be closed and those that had already been closed, which indicates that the system at level crossings has not been fully accommodated properly. This research takes place at level crossings 398B and 361. Trains that pass at this crossing are trains for transporting goods/logistics. From the results of observations made in November 2020 at the crossing, it was found that the number of violations that occurred reached 4393.

Therefore, based on research on the analysis of motorists in North America using the Driver Behavior Questionnaire (DBQ) method, it is concluded that human error is very influential on the number of violators who break the rules. It is necessary to measure mental load regarding waiting times and congestion caused by level crossings that potentially increase stress on motorists, which can linearly increase the chance of accident risk [10]. The behavior of drivers and the mental load of drivers when crossing level crossings must be analyzed to reduce the accident rate. Researchers want to analyze the behavior of drivers carried out when operating their vehicles. The purpose of this research paper can be summarized as follows:

- To determine the causes of the existing violation factors, both in terms of habits, mental burden factors, and the factors influencing driving time and the type of vehicle.
- To determine a precise improvement analysis to provide useful input for level crossing facilities and regulations in Indonesia and evaluate the crossing system at Indonesia Railways Company.

2. Literature Review

2.1. Level Crossing Context

Collisions at railway level crossings are still a problem for the railway industry, with very little advancements in safety over the previous few decades [11]. One-level railway-road crossings, known as railway crossings, pose an elevated risk to road users and need careful adherence to traffic laws (by car drivers) as well as technical railroad operating rules and instructions for railway crossing operation (by employees of railway transport). The replacement of railway crossings by viaducts (over the railway bed) and overpasses is now a global trend (under the railroad). Construction of two-level interchanges is economically unproductive and perhaps technologically unfeasible in some circumstances due to the extreme length of trains and motor roads, differences in climatic conditions, and low traffic volumes of vehicles in 60% of cases [12]. It should be highlighted that collisions between rolling stock and road vehicles have serious implications, including human deaths and the destruction of railway infrastructure [13]. The avoidance of closed automatic barriers by cars, as well as departures to the crossing at the forbidding traffic light signal, are the most common causes of accidents [12].

Peak hours are periods when transportation networks are busiest, with large amounts of train traffic, cars, and pedestrians sharing level crossing access. The operation of actively protected level crossings during such times can significantly disrupt traffic flow [14], and can create hazardous situations, particularly near railway stations, due to the simultaneous crossing access requirements of trains, motorized vehicles, and pedestrians [15]. In heavily urbanized places such as Florida or Edmonds, Washington, level crossings might be blocked for hours every day during regular operations, causing substantial traffic congestion [14]. With anticipated increases in both road and rail traffic loads, this problem is expected to worsen. In Australia, a similar situation exists around Melbourne [16] as well as Brisbane, where the increased frequency of commuter trains within the metropolitan railway network has resulted in more trains and a higher frequency of boom gate closures during peak periods, reaching a frequency of one train every six minutes in 2014. The quantity and duration of level crossing operations increased as a result. Extended level crossing closures owing to high train traffic volumes might cause road congestion at the crossing [17], as has been witnessed near level crossings on the Brisbane metropolitan rail network when train frequency increased. This has been seen in the United States [18], Canada [17], and Europe [19].

2.2. Behavior

Behavior is a response that reflects the action resulting from external and internal environmental stimuli to individuals [20]. For example, the driver's behavior while going through a railroad crossing also comes from the stimulus that stimulates the actions he takes. It can be in the form of a driver's perspective, emotional, or direct action that is visible by people around, such as not looking right and left before driving on the level crossing. Violations were characterized as "intentional departures from practices deemed required to ensure the safe functioning of a potentially hazardous system". In other words, a violation occurs when a law or socially accepted norm of conduct is violated. For example, speeding and driving are frequent [21]. By contrast, errors were described as "the inability of planned efforts to produce the desired results". Errors are classified as slips/lapses and mistakes, both of which are unintentional deviations from desired behavior [22]. Slips are unintentional actions (e.g., turning on the headlights instead of the wipers). In contrast, lapses are memory-related errors (e.g., forgetting the route one is traveling or locking one's keys in the car). The term "mistakes" refers to errors in judgment or decision-making, such as underestimating the speed of an approaching car [10].

2.3. Safety

Road safety is essential; road safety is a condition of protecting everyone from the risk of accidents during traffic on the highway caused by humans, vehicles, road and/or the environment. A traffic accident is an incident on the highway that is unexpected or intentional, involving a vehicle or without involving other drivers, leading to victims or material losses. Traffic accidents are events that are difficult to predict, especially when it comes to predicting when and where they will occur [23]. In the road traffic accident reporting system, the National Transportation Safety Committee (NTSC), in this case, the sub-committee of investigation of traffic accidents and road transportation, obtains reports or news of accidents from various sources, namely the Department of Transportation, Police, Media, and other related agencies. Accidents occur due to two factors, namely:

1. Human factors lead to accidents. It includes work rules, workers' abilities, slow decision-making, physical unwellness, disability, fatigue, illness, and mental factors.
2. Mechanical and environmental factors, the location of the machine, not being equipped with PPE, and broken work tools. The work environment greatly influences workers' morale [24].

An increasing volume of vehicles, congestion, and inadequate road access all cause a high number of road accidents. Increasingly, complex traffic conditions are indeed hazardous and cause accidents. Besides that, there are still many level crossings that will increase the risk for road users on the highway. Road infrastructure and environment are two of the most important elements influencing road safety results (e.g., road type, geometrical design, traffic control, lighting and weather conditions, etc.) [25]. Risk variables can have a direct impact on the likelihood of an accident occurring, as well as the severity of the crash's effects (severity), or they can have an indirect impact through influencing a Safety Performance Indicator (SPI). In the last several years, SPIs have been used to assess the level of road safety [26]. Speeding, danger perception, discomfort, response time, lane location, and other driving perceptions and behaviors are examples of SPIs. These measures indicate whether or not a driver is driving safely (or dangerously). The SPIs that should be included in the study are those for which there is scientific proof of a link to a higher crash risk. The infrastructure-related crash risk factors have been assessed with the explicit purpose of ranking them based on how detrimental they are to road safety (i.e., crash risk, frequency, and severity). The result shows that there were infrastructure risk factors split into three groups: risky (11 risk factors), probably risky (18 risk factors), and unclear (seven risk factors) [27].

DBQ is a way to evaluate and categorize the driver's behavior under a theoretical framework [28]. It is based on the main difference between errors and violations that have their origin in different psychological factors that require distinct treatment. At the beginning of its use, the DBQ method used 50 question items [29], but along with the development of the level of security on the highway, this allowed the variant of the item to decrease [10]. The variance with a small score will be deleted as its use in factor analysis or regression can seriously affect the results [30]. Therefore, it is necessary to analyze these habits using a *driver behavior questionnaire* (DBQ) to measure compliance with the driver's behavior when passing through a railroad crossing. The drivers are asked to rate the frequency with which drivers make various types of mistakes and violations in driving, especially when passing through a railroad crossing [31].

3. Research Method

3.1. Study Design

This study uses two ways of collecting data. The first is direct observation at level crossings and using a questionnaire. In the direct observation of level crossings, the result of violations obtained is assisted with video recording devices via cellphones to detect missed violators during observation. The cellphones is placed 5 m from the stop bar on the left and right, with a height of 1.5 m so that the stop bar can be seen clearly and vehicles can pass through the bar. The objects which were then selected by the researchers based on recommendations from Indonesia Railways Company officers were 398B and 361 as they had a high intensity of logistics trains passing through the crossing.

This research uses a questionnaire as a data collection tool. Items from the questionnaire used came from the mental load method and the behavioral analysis method used. The questionnaire analyzes whether the data taken is valid and how big the mental burden factor felt by the drivers is. The observation process and the distribution of questionnaires were at level crossings 398B and 361. In addition, questionnaires were distributed to drivers who had passed through the level crossings with the help of Indonesia Railways Company officers.

3.2. Site Profile

The object of direct observation is based on the volume of vehicles and trains passing at crossings 398B and 361. This level crossing connects the inter-city route from Surabaya to Gresik and vice versa. At this intersection, passing vehicles are private and public, and logistics and the like. In addition, the trains that pass through this crossing are also quite congested, namely passenger trains and freight/logistics trains. Logistics trains pass more often than passenger trains. The speed of logistics trains is also higher than passenger trains as they do not stop at the nearest station. Therefore, this becomes one of the greater risks of accidents.

The level crossing observed has two railway lines with the same facilities. Observation time on the object of research is between 08:00–10:00 in the morning and 15:00–17:00 in the afternoon with the consideration of the Indonesian Railways Company as the giver of permission to conduct observations. Based on the results of interviews, in addition to the density of passing vehicles, trains also have a high frequency intensity, which causes traffic congestion. There is limited space on the width of the crossing so that queues occur. This condition is also supported by the factor of road users who tend to commit violations.

3.3. Observation

Data retrieval in the field is conducted by recording data directly for a certain time. The data was collected from November 2020 until February 2021. In addition, the researchers also recorded events that occurred at the crossing, along with the recordings of violations to review to see which violations were not included in the direct recording/observation process. Observations were carried out at four different times, namely weekend mornings and morning weekdays (08:00–10:00) and weekend afternoons and weekday afternoon (15:00–17:00). From the time of data collection, the weather was sunny. The locations where the questionnaire survey was conducted were level crossings 398B and 361. The videography data and questionnaire data was gathered from the same locations. At the time of observation, the condition of the existing vehicles was crowded. The following violations were noted by researchers based on field observations:

1. Road users who continue to drive when the warning signal has sounded;
2. Road users who continue to move when the doorstop begins to move down;
3. Road users who break through the bars when the gates are completely closed and reach the bottom position and before the train arrives;
4. Road users who cross the barrier when stopping;
5. Road users who have started moving when the bars are still completely closed after the last carriage of the train have passed;
6. Road users who have started driving when the bar is not fully opened and the warning signal is still sounding.

The recording at two points is also beneficial to see how well the existing warning system provides reminders and how road users respond to the warning system. Based on the hours of observation and the day, the selection of morning and evening is based on the discussions with Railway Police. Level crossing in the morning and evening tend to have high volume intensity in that area. From the observations, it was found that there were six types of vehicles crossing two crossings, namely as follows:

1. Four-wheeled vehicle;
2. Two-wheeled vehicle;
3. Public transportation;
4. Big vehicle/truck;
5. Pedestrians;
6. Cart/similar.

3.4. Questionnaires

Measurements on the subject of the method are carried out simultaneously to road users who have crossed the level crossings in various regions. The survey conducted on the subject is to determine the behavioral factors that become the drivers' habits. The data generated from this questionnaire is qualitative, then processed statistically to obtain thematic analysis results. In testing the driving habits of passing the crossings, the DBQ method is used to see the type of driver behavior [10]. The questionnaire also generated demographic data of the type of vehicle used, the drivers' age, and gender.

3.5. Participants

Participants obtained in the distribution of the questionnaire this time were 153 respondents. Respondents obtained are road users who pass the level crossings in local stations, in both two-wheeled, four-wheeled, and other large vehicles. The total respondents obtained are 69 males, and 84 other people are female. The average age is between 17–30 years. Table 1 shows the demographics of the respondents who have filled out the DBQ:

Table 1. The demographics data of the respondents.

Criteria	Amount
Gender:	
Male	69
Female	84

Table 1. *Cont.*

Criteria	Amount
Type of vehicle:	
Two-wheeled	126
Four-wheeled	25
More than four wheels	2
Age:	
17–30 Years Old	110
31–40 Years Old	29
More than 40 Years Old	14

3.6. Data Analysis

The data analysis has two main parts. The first is quantitative analysis derived from the data collected through observation. The second part is quantitative data and qualitative analysis derived from the results of the DBQ questionnaire to see the factors of the type of driver behavior. In quantitative data derived from observational data, the factors such as driving time, type of vehicle, and the number of violations were collected. Of the three factors, it is tested whether the time factor and the type of vehicle influence the existing violations. The method used to test the effect of existing factors is multi-nominal logistic regression. The data is then used as a reference to evaluate both the driving factor and the level crossing facility factor in Indonesia.

During the observation, the road user is said to have violated if the signs at the level crossing have been lit. Violating behaviors can be detected when the siren and lights on the doorstop have been lit, indicating the vehicle must stop. The criteria used as a reference for detecting violations are seen from the movement of the doorstop, starting from closing, closing completely, starting to open until fully opening. The signs that are used as a reference to see a violation are the stop line for motorists. Non-compliance events such as parking around level crossings or carrying out activities will be important additional information to be added to the research results.

4. Result and Discussion

4.1. Observations

A road user is said to have committed a violation if he violates the signs at a level crossing. For example, when the siren has sounded and the road user continues to drive, this is called a violation. This calculation is made by calculating the frequency of violations. From the observation results for data collection, there were four violations from all existing observations. It was found that the most violations were from two-wheeled vehicles with violations crossing the stop bar. The volume of vehicles on weekdays is more than on weekends. This result was then processed using a multi-nominal logistic regression test to see opportunities and the effect of time and type of vehicle on violations. Table 2 is the results of observational data based on time for violation.

Table 2. Observational data based on time for violation.

Time	Frequency	Percentage
Weekdays Morning	1299	29.6%
Weekdays Afternoon	1273	29.0%
Weekend Morning	874	19.9%
Weekend Afternoon	947	21.6%
Total	4393	100%

Apart from time classification data, observation data is also taken based on vehicle type classification data. Table 3 is the classification of types of vehicles that violate p = at level crossings.

Table 3. Types of vehicles that violate.

Type of Road User	Frequency	Percentage
Four-wheeled Vehicle Driver	204	4.6%
Two-wheeled vehicle driver	3626	82.5%
Public Transport Driver	123	2.8%
Big Vehicle Driver	44	1.0%
Pedestrian	342	7.8%
Carts & street vendors	54	1.2%
Total	4393	100%

From this data, the violation is classified into several groups, as shown in Table 4 below:

Table 4. Type of violations.

Type of Violation	Frequency	Percentage
Keep Going When the Bell Has Rung	749	17.0%
Keep Going When The Doorstop Starts to Close	682	15.5%
Breaking Through when the Doorstop is Completely Closed Before the Train Passes	979	22.3%
Passing the Stop Limit	477	10.9%
Keep Driving When the Doorstop Closes Perfectly After the Train Passes	532	12.1%
Keep Driving When the Doorstop Is Not Completely Open and the Alarm Sounds	718	16.3%
Contraflow	256	5.8%
Total	4393	100%

Based on Table 4, it is known that of the 4393 violations by road users contained in this study, 17.0% is in the form of drivers keeping going when the bell has rung. The road users that keep going when the doorstop starts to close were responsible for 15.5%, while 22.3% occurred due to breaking through when the doorstop was closed before the train had passed. The road users that kept driving when the doorstop was not fully opened reach 16.3%. The alarm sounding reached 16.3%, and contraflow accounted for 5.8%. This shows that most of the violations by road users in this study were due to drivers breaking through when the doorstop was completely closed before the train passed. Furthermore, 10.9% passed the stop limit, and 12.1% kept driving when the doorstop was perfectly closed.

4.2. Multi-Nomial Logistic Regression

In multi-nominal logistic regression, the variable of vehicle time and type for violations are processed using SPSS data to produce a probability of occurrence of a correlation between the dependent and independent variables. The observation data, when processed, will get results in the form of the goodness of fit, partial test, simultaneous test, and determination test. The results of testing the effect of time and type of road users on violation can be seen from Table 5:

Table 5. The results of testing the effect of time and type of road users on violation.

Violation	Variable	B	Sig.	Odd Ratio
Keep Going When the Bell Has Rung—Contraflow	Intercept	−0.911	0.096	
	Weekdays afternoon—Weekend afternoon	−0.968	0.000	0.380
	Weekend morning—Weekend afternoon	0.363	0.045	1.688
	Four-wheeled vehicle—Carts & Street Vendors	5.869	0.000	3.540
	Two-wheeled vehicle—Carts & Street Vendors	1.889	0.002	6.614
	Public Transport—Carts & Street Vendors	4.891	0.000	1.332
	Big Vehicle—Carts & Street Vendors	3.503	0.004	3.323
	Pedestrian—Carts & Street Vendors	2.808	0.000	1.657
Keep Going When The Doorstop Starts to Close—Contraflow	Intercept	−1.617	0.041	
	Weekdays afternoon—Weekend afternoon	−0.392	0.047	0.676
	Four-wheeled vehicle—Carts & Street Vendors	5.740	0.000	3.111
	Two-wheeled vehicle—Carts & Street Vendors	2.529	0.001	1.254
	Public Transport—Carts & Street Vendors	5.257	0.000	1.919
	Big Vehicle—Carts & Street Vendors	4.085	0.002	5.943
	Pedestrian—Carts & Street Vendors	3.710	0.000	4.874
Breaking Through when the Doorstop is Completely Closed Before the Train Passes—Contraflow	Intercept	0.526	0.065	
	Weekdays afternoon—Weekend afternoon	−0.447	0.019	0.64
	Pedestrian—Carts & Street Vendors	2.743	0.000	1.552
Passing the Stop Limit—Contraflow	Intercept	−0.713	0.132	
	Weekend morning—Weekend afternoon	0.48125	0.012	1.999
	Four-wheeled vehicle—Carts & Street Vendors	2.472	0.039	1.184
	Two-wheeled vehicle—Carts & Street Vendors	1.199	0.023	3.317
	Public Transport—Carts & Street Vendors	2.672	0.023	1.447
	Big Vehicle—Carts & Street Vendors	3.037	0.009	2.084
	Pedestrian—Carts & Street Vendors	1.960	0.007	7.098
Keep Driving When the Doorstop Closes Perfectly After the Train Passes—Contraflow	Intercept	−0.368	0.317	
	Weekend morning—Weekend afternoon	1.305	0.000	3.688
	Pedestrian—Carts & Street Vendors	2.622	0.000	1.3768
Keep Driving When the Doorstop Is Not Completely Open and the Alarm Sounds—Contraflow	Intercept	−18.856	0.000	
	Weekdays morning—Weekend afternoon	0.280	0.065	1.498
	Weekdays afternoon—Weekend afternoon	−0.529	0.008	0.589
	Weekend morning—Weekend afternoon	0.5092	0.005	2.082
	Four-wheeled vehicle—Carts & Street Vendors	2.188	0.000	3.206
	Two-wheeled vehicle—Carts & Street Vendors	1.985	0.000	4.177
	Public Transport—Carts & Street Vendors	2.025	0.000	6.247
	Big Vehicle—Carts & Street Vendors	2.104	0.000	1.374
	Pedestrian—Carts & Street Vendors	2.003	0.000	5.016

In the results of this multi-nominal logistic regression, several variables are not significant, or the α value exceeds 0.05. Thus, they are not included in the logistic regression results. However, from the results, the three highest chances of a violation are four-wheeled vehicles. The violation is to keep driving when the doorstop is not entirely open. First, the alarm sounds with a variable coefficient of four-wheeled vehicles—carts and street vendors of 2.188 with an odds ratio of 3.206, indicating the probability of respondents who use four-wheeled vehicles to commit a violation increased by 3.206 times compared to carts and street vendors. Then, the big-wheeled vehicle, in violation, kept driving when the doorstop was not entirely open. Next, the alarm sounded with a variable coefficient of a Large Vehicle—Cart and Street Vendors of 2.104 with an odds ratio of 1.374, indicating the probability of respondents using large vehicles to commit a violation increased by 1.374 times compared to carts and street vendors. Moreover, the third was on public transport, in which the violation was caused by a driver who kept driving when the doorstop was not entirely open. The alarm sounded with a variable coefficient of Public Transport—Carts and Street Vendors of 2.025 with an odds ratio of 6.247, indicating that the probability of respondents using public transportation to commit a violation increased by 6.247 times compared to carts and street vendors.

The partial test that has been carried out indicates an influence of time and type of vehicle on existing violations with a positive effect on average. When tested for the likelihood ratio test, the time and vehicle type variables have a significance value of 0.000. Table 6 shows the output of the partial test:

Table 6. The output of the partial test.

Likelihood Ratio Test	
Variable	**Sig.**
Intercept	
Type of Road User	0.000
Time	0.000

Besides the partial test, the next is simultaneous, which is used to determine whether time and road users affect violation action. The test criteria state that if the probability is <level of significance (α), there is a significant simultaneous effect of time and type of road users on violation.

Table 7 shows that the significance test generated a value of −2 log-likelihood from the intercept of only 345,696, which decreased on the full model value to 177,892 with a probability of 0.000. Thus, the test results show the probability < *level of significance* (α = 5%). It means that the independent variable can give better results than just the intercept. In addition, there is a result of the coefficient of determination of Nagelkerke R2, which has a value of 0.168 or 16.8% and indicates the contribution of time and type of vehicle to the violation, while the rest are external factors. The external factor, based on Larue's research [7], is a factor in the level of driver frustration that causes driver behavior deviations, namely using DBQ analysis. However, even though the contribution of time and the type of road users is only 16.8% of violations, it must still be considered as one of the proposals worthy of inclusion. Table 8 shows the results of the determination test:

Table 7. The significance test.

	−2 log-likelihood	**Sig.**
Intercept Only	345,696	
Full Model	177,892	0.000

Table 8. The results of the determination test.

Cox & Snell R Square	Nagelkerke R Square
0.149	0.161

4.3. Driver Behaviour Questionnaire (DBQ)

4.3.1. Validation

The distributed questionnaire should have a good level of validity related to the validity of the research results. Therefore, once the questionnaires are distributed, the data will be tested for validity using the CFA (confirmatory factor analysis) method. This CFA method is to see the internal structure of the DBQ method, evaluate the model, and see its validity. *Convergent Validity* is to determine whether the indicator is valid or not in measuring variables. The size of the loading factor indicates the convergent validity of each indicator in measuring the dimensions. An indicator is said to be valid if the *loading factor* is positive and greater than 0.5. The results of the *convergent validity* test are presented in the CFA validation table. Based on the analysis results, it can be seen that all indicators measuring behavioral variables produce a loading factor greater than 0.5. Thus the indicators that measure the behavioral variables are said to be valid. Meanwhile, for DBQ reliability, the Composite Reliability results are 0.774 or greater than 0.7, which indicates that the DBQ method is Reliable.

4.3.2. DBQ Result

In the DBQ method, which is used to determine drivers' behavior, three significant behaviors are often enacted by them. These behaviors include checking the speedometer frequently and driving over the speed limit, being impatient with other drivers and overtaking from the inner lane, flashing the light to the driver in front when driving faster, or blocking speed. These behaviors are habits that are often carried out by drivers in the scope of local stations. However, other behaviors need to be considered so that things that can potentially occur can be overcome. Table 9 shows the results of the DBQ Survey of 153 respondents:

Table 9. The results of the DBQ Survey.

Type of Behavior	Average
L(Lapse)	357.5
E (Errors)	373
V (Violations)	377

Once the behavior is grouped, it can be divided into three types of behavior. They are Lapse or misappropriation, Errors, and Violations. Of the three items, the type of behavior that is frequently carried out in violation means that the driver's awareness of the rules at level crossings has not been appropriately implemented.

Table 9 shows CFA Table Validation. Two of the three drivers' behaviors are types of break-the-rule behavior included in violations. It is also supported by the results of the DBQ calculation, whose results show that the types of behavior that drivers often carry out can be classed as violations. It means that the awareness of drivers about the rules at level crossings has not been appropriately implemented. Table 10 shows that road users cause violations when stuck behind another slow-moving vehicle and wanting to forcefully overtake more often than being impatient with other drivers and overtaking from the inner lane. Meanwhile, lapses have the highest score on Not checking rearview mirror before changing lanes, turning around, crossing unstoppable crossings, etc. Not paying attention when trying to overtake when other vehicles are about turn right, failing to read the signs correctly, thus breaking the signs and not seeing the change of crossing signs or train doorstop signs when changing or turning, and as a result, braking suddenly. For error variable, the highest score was for overtaking a line of stopped or slow-moving vehicles, only to find they were queuing to pass through a gap in the level crossing repair lane, braking too fast on slippery roads/rail crossings, and taking the wrong decision when going to cross the road and almost crashing. Fatigue (tiredness), to the extent that drivers were not aware that the traffic light was changing or were not aware of the situation in front them, also had a high score for violation. Meanwhile, another road user also ignored the 'give way' signs on narrow roads to avoid collisions, and broke through the doorstop that was to be closed. Violating behavior is a form of impatience for drivers in controlling themselves to follow existing signs, so they tend to make mistakes that impact risk when crossing the level crossing [32]. Road users must obey all road signs around the level crossing and reduce speed when passing a level crossing. This rule is something that drivers should do to reduce the risk when passing a level crossing, and the driver must obey it. However, according to observation data carried out in November 2019, 1048 violations still occurred and reinforced the existence of deviant behavior carried out by drivers according to the DBQ method.

Table 10. CFA Table Validation.

Questions	Mean	Violations	Lapse	Error
Being impatient with other drivers and overtaking from the inner lane	3.27	0.520		
Being stuck behind another slow-moving vehicle that you want to force overtaking	3.10	0.598		
Getting the wrong route so that you could not avoid the busy roads	2.69			0.535
Overtaking a line of stopped or slow-moving vehicles, only to find they are queuing to pass through a gap in the level crossing repair lane	2.52			0.832
Hitting something while backing out of being out of sight	2.42			0.683
Braking too fast on slippery roads/rail crossings	2.07			0.828
Taking the wrong decision when going to cross the road and almost crashing	2.22			0.820
Entering the main road without looking in the opposite direction so that you almost get hit by another vehicle	2.48			0.758
Not keeping the distance from other vehicles when the crossing gate is closed so you have to brake suddenly	2.37			0.684
Driving fast and turning on full beam (high light at night) when in level crossing	2.73			0.641
Not seeing the change of crossing signs or train doorstop signs when changing or turning on so that you have to brake suddenly	2.44		0.806	
Sharing focus when driving by doing other activities such as playing cellphones, looking at maps, etc.	2.11		0.696	
Not paying attention when trying to overtake when other vehicles are about turn right	2.10		0.835	
Not checking rearview mirror before changing lanes, turning around, crossing unstoppable crossings, etc.	2.29		0.843	
Being failed to read the signs correctly, thus breaking the signs	2.05		0.811	
Not knowing people walking or getting out from behind other vehicles so that it is too late to brake (crash)	2.42		0.744	
Almost getting hit by a vehicle from the opposite direction due to a miscalculation when overtaking	2.70		0.787	
When entering a railroad crossing, you brake suddenly due to a lack of focus	2.22		0.603	
Turning on the wrong sign light, and as a result, almost being hit by another vehicle	2.33		0.767	
Cutting off the lane of other vehicles so that you almost get hit by the vehicle behind	2.38		0.776	
Forgetting to turn off the full-beam (high light) to get a blink from another vehicle	2.39		0.737	
Intending to turn on the windshield wiper but wrongly pressing another button	2.55		0.591	
Overtaking without checking rearview mirror and getting the horn from the car behind that is ready to overtake	2.00		0.750	
Breaking through the doorstop that has been/to be closed	1.99	0.810		

Table 10. *Cont.*

Questions	Mean	Violations	Lapse	Error
Getting angry with other drivers' behavior, so you chase and scold them	2.48	0.744		
Deliberately ignoring the speed limit	2.63	0.734		
Fatigue (tiredness), so that you are not aware that the traffic light is changing or are not aware of the situation in front of you	2.57	0.844		
Parking in a place where it is not allowed (Around the railroad crossing)	2.24	0.778		
Overtaking the slow-moving vehicles in the inner lane or roadside around level crossings	2.63	0.659		
Cutting lanes around the crossing	2.21	0.726		
Do not give way to other passing vehicles so that they grab each other	2.30	0.783		
Ignoring the 'give way' signs on narrow roads to avoid collisions	2.17	0.838		
Ignoring the red light/doorstop of the train at night when the conditions are quiet	2.13	0.790		
Engaging in illegal racing with other vehicles (Due to speeding)	1.93	0.705		
Racing on narrow roads/crossroads	1.79	0.737		
Trying to drive a car/motorcycle without starting it (pulled, downhill, pushed)	2.33		0.560	
Being locked outside the car and leaving the car keys in the car	1.75		0.633	
Forgetting how far you have traveled due to fatigue/microsleep	2.67		0.699	
Missing the destination so that the journey gets longer	2.71		0.658	
Forgetting your current gear and having to look at the screen	2.64		0.640	
Composite Reliability		0.774		

Violating behavior is the most instrumental in an accident, so that the more violations that occur, the greater the risk of accidents appearing [33]. Therefore, to find a solution in tackling violations, it is necessary to improve the system at a level crossing. The system improvements are useful as a means to positively affect drivers as, with the understanding and comfort of the riders, a reduction in the level of violations can be made. Violations are often caused by human factors, including human psychology, systems, and knowledge of traffic procedures [34]. From the results, it was found that the tendency of drivers after passing a level crossing is to enact a type of violation behavior. In the DBQ method, the driving behaviors resulting from observations are then used as a reference to see what habits underlie some of the existing violations. Respondents were asked to fill in the statements with five rating scales to determine the frequency level in performing a behavior shown by the DBQ. From this DBQ, researchers will analyze and conclude the best suggestions to improve behavior, either through rules, facilities, or others [29].

5. Managerial Implication

The behavioral analysis results that were calculated by the DBQ method yield the conclusion that the level of violation is a habit factor that is often carried out by road users when passing a level crossing lane. It is also supported by research by Davey et al. [35], which explains that a significant factor in the drivers' behavior is the type of violation behavior. In multi-nominal logistic regression, it is known that the probability of a violation occurring at the time and type of vehicle that has been observed has a significant influence.

In level crossing number 398B, the doorstops already use an electric motor as a driving force, widening the road when entering a level crossing and leveling the uphill path when entering the level crossing. The main cause of the length of waiting time is not only the factor of inadequate facilities; it can also be caused by the volume of vehicles and the volume of trains that pass at certain times. It has also been investigated in the journal Larue [16] that driving time affects the number of violations. Despite the different culture and driving habits in Indonesia from other countries, with the same high number of violations, it is also necessary to evaluate the driving time factor and the type of vehicle against the number of violations. In addition, the logistics train in the area of objects used in this study has a fairly high intensity.

From the DBQ method, violations and behavioral factors are a close unit. In general, to reduce accident factors and violating behavior, three factors are the driver, vehicle, and environment [36]. Violating behavior is a form of impatience for drivers to control themselves to follow existing signs, so they tend to make mistakes that lead to risk when crossing the level [32]. From environmental factors, sign facilities that act as information providers to tell drivers to be more careful when crossing level crossings by obeying the existing signs. On the direct crossing, the existing signs have been damaged or even lost, as evidenced by the results of field observations that found there were no warning signs when entering the crossing, and the boundary line for vehicles to stop when crossing was closed. Signs are part of the traffic infrastructure that must exist due to the government's obligation to provide drivers with safety on the highway. Therefore, it is necessary to improve traffic signs so that passing drivers can see and apply the existing signs. From other facilities factors, it turns out that there are still level crossings that are not maintained or without gates. Therefore, Indonesia Railways Company needs to pay attention to provide complete facilities or even close the level crossing. Without a doorstop, they are one of the latest cases of the importance of signs and adequate facilities. With the properly equipped signs and facilities, every driver will be more alert when crossing the direct crossing.

During field observations, pallet loading and unloading activities were found in front of level crossings from the driving factor. It is something the researchers' have noted as, in addition to being risky, illegal parking activities can reduce the flexibility of other drivers in passing level crossings. Furthermore, it can cause congestion, increasing the driver's frustration, which ultimately impacts sign violations. Therefore, it is necessary to frequently conduct sterilization by deploying the special railway police, inspecting level crossing areas that have prohibited activities. From the analysis above, it is expected to bring a significant impact on drivers with regard to eliminating violating behaviors, especially impatience, rushing, and excess speed. In the DBQ results, it is found that external and internal factors of the crossing directly affect the behavior of passing drivers. Therefore, it is necessary to take particular actions to have a deterrent effect on violation and other deviant behaviors in order to reduce risk [37,38]. It is very important to ensure safety on level crossings automatically through remote monitoring, and from this automatic supervision, direct enforcement of violation can be carried out [29].

Every city intersection attempts to increase rider compliance by implementing online ticketing through camera surveillance. If the same thing applies to level crossings, violators who usually ignore signs or who are reckless will be more careful due to the deterrent effect caused by these rules when passing through level crossings. Surveillance cameras already exist in level crossings owned by the department of transportation. However, the same thing has not been implemented in other level crossings, especially those gatekeepers guarding for the Indonesia Railways Company. Thus, it is necessary to synchronize between the Indonesia Railways Company, the Department of Transportation, and the traffic police to realize this. Strengthening relationships between organizations responsible for safety management will have a positive impact in strengthening control activities around proactive risk management and monitoring [39]. Therefore, with the results of the DBQ method concluding that the highest number of behaviors carried out are *Violations*, it is necessary to change the drivers' lane so that it is not on the same level as the crossing. To add insight to road users, socialization for drivers is required in banners, information through the media, or collaboration with the traffic police.

6. Conclusions

6.1. Conclusions

This study explains how the drivers' behavior affects passing through level crossings. Through observational research, the level crossing numbers 398B and 361 have a high level of risk due to the high intensity of logistics trains. The DBQ method was used to analyze the violation. In the DBQ method, the questionnaire was filled out by 153 respondents by distributing 41 questions that had been previously validated. As a result, there are three groups of behavior, namely errors, lapses, and violations.

It was found that environmental factors influence violations. The drivers' behavioral factors have an important role in the resulting risk. The DBQ method found that the type of violation behavior is one of the main causes of frequent violations that occurred during observation. Violating behavior factors also have a critical role in the risks posed to other road users. It is also reinforced from the results of the multi-nominal logistic regression test that the driving time factor and the type of driving influence violations that occurs. In the results of the NASA TLX questionnaire, it was found that effort, frustration, and time requirement were the main causes of high mental workload. Therefore, it is necessary to improve insight for road users, rule enforcement on level crossings, and supporting facilities to apply on all level crossings. With the improvement of the crossing system and the behavior of the drivers, risk factors could be minimalizing.

6.2. Limitations

This study has limitations. This research was only carried out on the local station work area due to the pandemic period. Thus, it could not be widely covered to obtain adequate observation results. In addition, the selection of research objects has been directed by the Indonesia Railways Company as the manager of level crossings so that unofficial crossings are not a priority. This research provides descriptive suggestions as journals or research related to drivers at level crossings in Indonesia is still limited. With references from foreign journals, there can be differences in culture, habits, and technology so that researchers filter each variable that is within the scope of the research. The variables used are quite limited so that this affects the R-squared values, which tend to be low. Hopefully, in the future, the same research regarding the habit of drivers at level crossings can be multiplied to create increased safety and existing facilities at level crossings to provide security and safety for both trains and road users.

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