



Distribution, Severity, and Root Causes of Traffic Accidents in a Logistics Company

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Article Info

Article History:
Submitted December 2025
Accepted April 2026
Published April 2026

Keywords:
Accident; Severity; Logistics
and Transportation;
Root Cause

DOI
<https://doi.org/10.15294/kemas.v21i4.40248>

Abstract

Traffic accidents are the main issue in logistics and transportation, causing health and economic losses, including lowering productivity. The study aimed: 1) to investigate the distribution of accidents, 2) to examine the category and severity of accidents based on operational type, and 3) to evaluate the root cause of accidents in logistics/goods transportation. This quantitative study was conducted in Indonesia using the data from Logistics Corporation from 2022 to 2023. The variable consists of operational type, accident category, severity, and root cause. This study was analysed using descriptive and inferential statistics. The chi-square was used to examine the statistical test, with the alpha set at 5%. The analysis was performed in Stata Ver 13 (College Station, TX, USA). A total of 288 accidents were reported during 2022-2023, with the accidents being highly distributed on Java (50%) and Sumatra (44.79%). The Accident category noted that collisions with objects, hits, and single-vehicle accidents are prevalent. The accident severity is as follows: minor severity (83.33%) and higher minor severity (16.67%). The statistical test also exhibits a significant on accident severity between last mile and long haul (p value < 0.05). According to operational type, long-haul operations have high accident intensity, while last-mile operations have severe accidents. The root cause of the accident is caused by third-party error (32.98%), followed by driver behavior (30.56%), driver competence (13.88%), and driver distraction (6.59%). The company should establish regulations, standard operating procedures (SOPs), work shift schedules, and vehicle maintenance protocols, and ensure their implementation. Additionally, measuring stress levels and work-related fatigue among drivers should be conducted to help prevent accidents.

Introduction

According to the integrated annual report of BPJS Ketenagakerjaan, the number of occupational accidents increased to 182,835 cases in 2019, compared to 173,415 cases reported in 2018. BPJS Ketenagakerjaan reported that the number of transportation accidents in 2019 rose to 116,411 cases, resulting in 25,671 fatalities, 12,475 serious injuries, and 137,342 minor injuries. This represents an increase from 109,215 transportation accident cases recorded in 2018 (BPJS Ketenagakerjaan, 2020). Research by Bekelcho *et al.* (2024) in the Gamo zone, southern Ethiopia, researchers found that the percentage of truck drivers

who reported near-miss traffic events was about 72.5%. Driving on the wrong side of the road (13.5%), speeding (22.6%), and skidding (13.2%) were the highest contributing factors. There were notable correlations found between near-miss incidents and factors such as weekly driving frequency, accident scene location, road conditions, sleep status, and meteorological circumstances (Bekelcho *et al.*, 2024).

Traffic accidents on rural roads and along coastal highways represent a significant global concern, posing substantial risks to road users and complicating public safety initiatives. In Indonesia, 75.08% of traffic accidents happen on rural roads, whereas 23.55% happen on

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national routes. Roads in rural areas are known to have a high accident rate. Consequently, poor road conditions limit access to education, jobs, and other necessities, impede community movement, and interfere with everyday activities, all of which hurt the growth and well-being of rural communities (Sari *et al.*, 2024). Research by Bunn *et al.* (2022) showed that by using initial injury report data, truck drivers, especially those operating light and medium trucks, can receive customized safety training that identifies the most common injury scenarios and vehicle types. For truck drivers who have previously sustained injuries in accidents, road safety regulations emphasizing driver education, collision assessments, and in-vehicle monitoring systems are crucial, particularly for light and medium truck drivers. The primary objective of traffic accident research is to reduce the frequency and severity of such incidents. The criteria used to evaluate accident severity are typically based on the presence of injuries or property damage. While this approach provides insight into the impact on the individuals involved, it does not account for broader effects on overall traffic conditions. A limited number of studies examine injuries sustained by operational type (last mile and long haul). This study refers to the accident location on the last mile and long-haul operations at one of Indonesia's logistics companies during 2022-2023.

The NHTSA report indicates that traffic accidents in 2019 imposed a \$340 billion economic burden on the U.S., with 36,500 fatalities and 4.5 million injuries. Key contributors included high-risk behaviors such as excessive speed, distracted driving, and alcohol impairment. The overall societal harm, including quality-of-life losses, was estimated at approximately \$1.4 trillion, underscoring the need for enhanced preventive strategies (NHTSA Media, 2023). The majority of significant variables were consistently observed across all three vehicle categories, encompassing driver age, alcohol or drug consumption, seatbelt usage, airbag deployment, elevated travel speeds, and vehicle model years post-2010 (Khan *et al.*, 2024). Notably, an increase in driver age was associated with a higher likelihood of variations in injury severity

outcomes for pickup drivers compared to those operating passenger cars and SUVs. Across all vehicle types, seatbelt use substantially reduced injury severity during run-off-road crashes. Passenger cars were particularly associated with increased injury severity at relatively higher travel speeds (exceeding 75 mph), especially when compared to SUVs and pickups traveling at speeds between 61 and 75 mph (Khan *et al.*, 2024). This study examines the category and severity of accidents based on operational type (long haul & last mile). The root cause and severity of accidents were determined through an analysis conducted by HSE analysts based on accident reports from the command center.

Occupational accidents remain a significant public health issue, as they may disrupt productivity and result in human and economic losses. Previous studies have shown that workplace accidents are influenced by multiple factors, including individual characteristics, unsafe behavior, inadequate training, improper use of personal protective equipment, and unsafe working environments. A recent study by Ulfah *et al.* (2023) highlighted that occupational accidents among sugar farmers were closely related to unsafe working practices and inadequate occupational safety management.

A thorough examination of fatal and serious accidents involving delivery drivers is necessary to monitor work-related road safety on a nationwide level (Khan *et al.*, 2024). The local government in Indonesia keeps track of and records traffic accidents; however, they only include instances that victims, offenders, or witnesses report. A logistics company in Indonesia has put in place an autonomous reporting system that is watched over by a command center team. In the case of an incident on roadways, this system notifies stakeholders of the accident. Several factors, including road safety characteristics, driver age, vehicle operating status, and lighting circumstances, significantly affect the severity of heavy truck accidents on urban roads. Road safety features, intersection and section kinds, visibility, vehicle driving state, and inter-vehicle collision types all have a significant impact on the severity of accidents on highways. Road alignment, driver infractions, visibility, and the

sorts of inter-vehicle accidents are all important considerations on motorways (Tian *et al.*, 2024). Casey *et al.* (2024) research on 378 heavy truck drivers at the two Australian truck rest stops in rural New South Wales shows according to the results, although while the majority of truck drivers adhere to the rest regulations regarding driver tiredness, the length of time that drivers spend at rest is influenced by several variables, including the kind of cargo, the driver's shift, the availability of parking spaces, and the amount of time spent on work-related tasks during rest intervals. These elements are likely to increase the risk of violating driver tiredness laws and increase the number of truck drivers involved in fatigue-related collisions. On the other hand, research by Haffer *et al.* (2022) shows that the "last mile" concept for the Bydgoszcz Logistics Hub demonstrates significant potential for the development of logistics services, warehousing, and transshipment activities within the Bydgoszcz-Toruń agglomeration. The establishment of this hub is projected to enhance transport connectivity between the seaports of Gdańsk and Gdynia and major economic centers such as Warsaw, Łódź, and Poznań.

Accident compilation data may not be the most optimal source for calculating accident severity, as it primarily contains information on the severity of injuries sustained by workers or third parties. However, the data is limited in providing estimates of accident-related losses. The primary advantage of analyzing accident compilation data is its inclusion of narrative reports from the first response to incidents, which can provide additional contextual information about the accident. Moreover, the data includes investigations conducted by the HSE team (HSE analyst or HSE officer, based on the severity of the accident), which identify the root causes of the incident, insights that may not be available from other data sources. The study aimed: 1) to investigate the distribution of accidents, 2) to examine the category and severity of accidents based on operational type, and 3) to evaluate the root cause of the accident of logistics/goods transportation.

Method

The applied research design with descriptive and cross-sectional methodology was used in this study. Our study population consisted of truck drivers in one of the private companies in Indonesia. This study employed secondary data of accidents from Corporate X - Indonesia. The corporate command center compiles accident data, which must be reported to the Health, Safety, and Environment (HSE) team within 12 hours after the incident. The HSE team was required to submit an initial report to management within 24 hours of receiving the accident report. An investigation team comprises company management, representatives from the driver management team, the operations team, and the HSE team. The team was responsible for issuing recommendations and corrective and preventive actions based on the investigation findings. The relevant parties must implement these actions within 72 hours for minor to medium accidents and within 168 hours for major accidents, including fatalities. This study included all accident cases reported to the corporate command center and investigated by HSE analysts between 2022 and 2023. Accident severity assessment was based on a severity matrix that emphasized injuries sustained by workers or third parties. Nevertheless, the dataset had limitations, particularly in providing comprehensive estimates of accident-related losses.

The logistics company was a well-known and the biggest transportation and logistics corporation situated in Jakarta, Indonesia, with its headquarters, which offered comprehensive end-to-end logistics solutions, encompassing contract logistics, multimodal transportation, and warehousing services. This logistics operates widely in 26 cities of Indonesia, namely Sumatra, Java, Bali, Kalimantan, Sulawesi, and Lombok. This logistics company has a business scope for long-haul trucking and intercity- last-mile trucking. There are several types of trucks used in this company, including Colt Diesel Double (CDD) trucks, Colt Diesel Engkel (CDE) trucks, FUSO trucks, Light vehicles, trailers, and heavy-duty trucks that operate all around Indonesia.

An analysis of operational categories,

such as long-haul trucking and last-mile trucking, recorded in the accident data compilation was conducted to identify the specific operational type associated with each incident and to obtain a deeper understanding of the contributing factors leading to driver injuries. Operational type classification, confirmed to the logistics company definitions, consists of long-haul and last-mile trucking. The data analyzed in this study consist of several variables, including the type of operation, accident category, severity, and the root cause of the accident. The type of operation refers to logistics transportation activities conducted by the corporation and is classified into last-mile and long-haul operations. Last-mile operation is defined as short-distance goods delivery within a city or local area, whereas long-haul operation refers to long-distance goods delivery across cities, provinces, or islands. Accident category represents the classification of traffic accidents involving company vehicles and includes ejected accidents, hit incidents, single-vehicle accidents, collisions with objects, stolen vehicle accidents, and multi-vehicle collisions.

Accident severity refers to the level of injury severity resulting from a traffic accident involving a vehicle. Accident severity was measured using a severity index and determined through investigations conducted by an HSE officer using the Occupational Health, Safety, and Environment (OHSE) 09.02.03 Traffic Accident Report Form and Traffic Investigation Report. The severity of accidents was classified into five levels: minor, moderate, medium, major, and fatal. Minor accidents include incidents causing minor injuries with or without first aid treatment, mild health disturbances, and no absence from work or impact on work performance. Moderate accidents refer to injuries requiring medical treatment but not resulting in absence from work on the following day. Medium accidents involve injuries requiring medical treatment where the victim is unable to work on the following day but does not require hospitalization. Major accidents include incidents causing permanent disability, fractures, loss of consciousness, or hospitalization lasting more than 24 hours. Fatality refers to accidents resulting in death. The root cause of the accident is defined as

the underlying factor contributing to the occurrence of an accident and was identified through accident investigations using the Traffic Accident Report Form and the Traffic Investigation Report conducted by an HSE officer.

Before performing the analysis, we conducted data cleaning where the following aspect was considered, namely, missing data. There were missing data in the accident variables category (1 missing data point) and root cause (4 missing data points). Then, we excluded the missing data in the analysis. This study was analyzed by descriptive and inferential statistics. The descriptive statistics were conducted to describe the distribution of data, measures of frequency, and percentages. On the other hand, the examination of the hypothesis test was conducted by inferential statistics with the chi-square. The alpha was set at 5% with a confidence interval of 95% ($p\text{-value} < 0.05$; reject the H_0). The inferential statistics were performed in Stata Ver 13 (College Station, TX, USA). This study employed secondary data, for which ethical clearance was not required in this study.

Result and Discussion

During 2022 - 2023, 288 accidents have been recorded, in which the total number of accidents in 2022 and 2023 is 136 accidents (Last mile: 35 and Long haul: 101) and 152 events (Last mile: 29 and Long haul: 123), respectively. The accident distribution during 2022-2023 is presented in Figure 1. As visualized by Figure 1, the serious accident was reported in West Java with 57 events, followed by Central Java (38 events), South Sumatra (37 events), Lampung (31 events), and East Java (23 events).

The category and severity of the accident according to the type of operation visualized in Tables 1 and 2. Based on Tables 1 and 2, the analysis of accident data from 2022 to 2023 reveals differences in accident categories and severity between last-mile and long-haul operations. In 2023, long-haul operations recorded a higher proportion of accidents involving vehicles/trucks being ejected (15.45%) and hit (21.14%) compared to last-mile operations, which reported 10.34% and 6.90%, respectively. Single-vehicle accidents were more prevalent

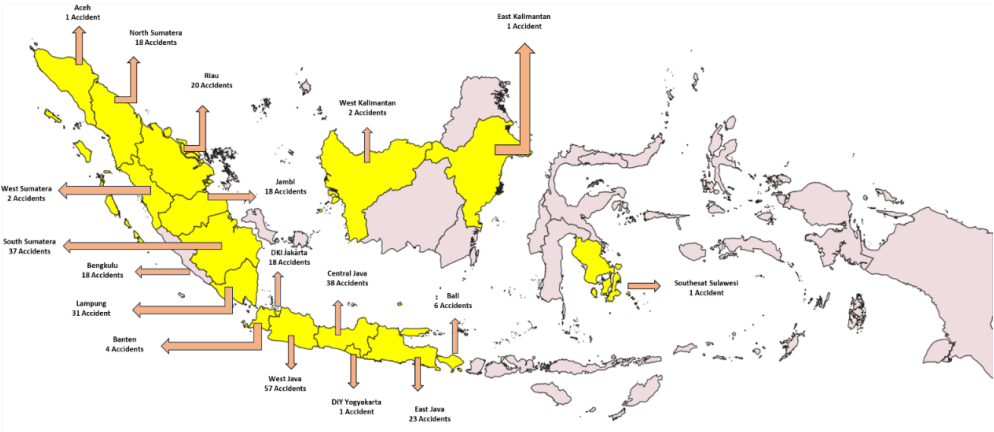


FIGURE 1. The Distribution of Accidents in Indonesia during 2022-2023

TABLE 1. The Category of the Accident by Operational Type

Year	Operational Type	Accident Category												Total n (%)	p-value
		Ejected		Hitted		Single-Vehicle Accident		Collision with an Object		Stolen Vehicle Accident		Multi-Vehicle Collision			
						n	%	N	%	N	%	n	%		
2023	Last mile	3	10.3	2	6.9	5	17.2	16	55.2	2	6.9	1	3.4	29 (100%)	0.120
	Long haul	19	15.4	26	21.1	13	10.5	60	48.8	5	4.0	0	0	123 (100%)	
2022	Last mile	1	2.8	6	17.1	7	20	21	60	0	0	0	0	35 (100%)	0.747
	Long haul	3	3.0	25	25	16	16	56	56	0	0	0	0	100 (100%)	
All year	Last mile	4	6.2	8	12.5	12	18.7	37	57.8	2	3.1	1	1.5	64 (100%)	0.125
	Long haul	22	9.8	52	23.2	29	12.9	116	51.7	5	2.2	0	0.0	224 (100%)	

TABLE 2. The Severity of the Accident by Operational Type

Year	Operational Type	Accident Severity										Total n (%)	p-value
		Minor		Moderate		Medium		Major		Fatality			
		n	%	n	%	n	%	n	%	n	%		
2023	Last mile	21	72.4	1	3.4	1	3.4	4	13.7	2	6.9	29 (100%)	0.036*
	Long haul	111	90.2	5	4.0	1	0.8	5	4	1	0.8	123 (100%)	
2022	Last mile	20	57.1	7	20.0	1	2.8	4	11.4	3	8.5	35 (100%)	0.002*
	Long haul	88	87.1	4	3.9	0	0	5	4.9	4	3.9	101 (100%)	
All year	Last mile	41	64.0	8	12.5	2	3.1	8	12.5	5	7.8	64 (100%)	0.000*
	Long haul	199	88.8	9	4.0	1	0.4	10	4.4	5	2.2	224 (100%)	

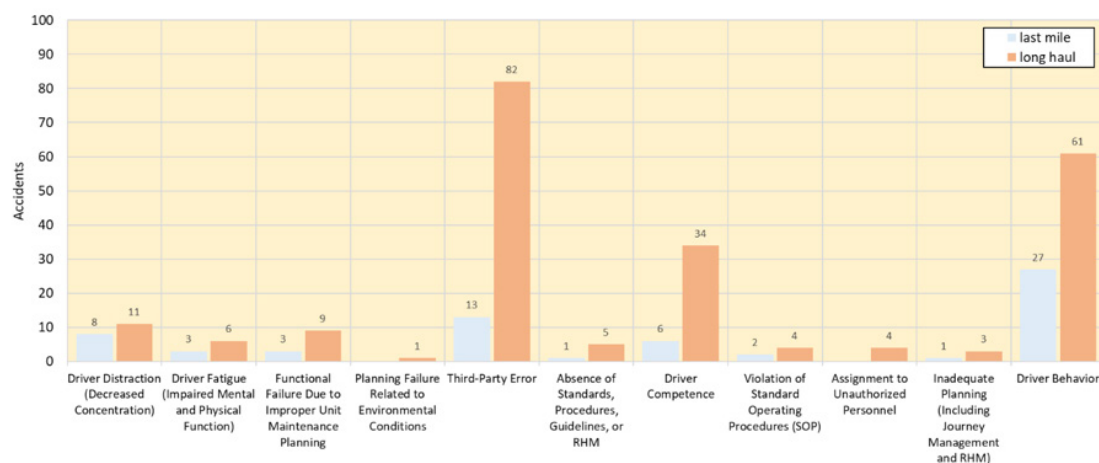
in Last mile operations (17.24%) compared to Long Haul (10.57%). However, collisions with objects were significantly higher in Long Haul operations, accounting for 48.78% of cases, whereas Last Mile operations reported 15.17%. When considering all years, collisions with objects were the most common accident type in Long Haul operations (51.79%), while Last Mile operations had a more even distribution among accident categories. According to the chi-square test, there is no difference in accident category between last mile and long haul (p value 2023: 0.120, p value 2022: 0.747, p value all years: 0.125; p value > 0.05).

As visualized in Table 2, in 2023, 90.24% of accidents in Long Haul operations were classified as minor, compared to 72.41% in Last Mile operations. Moderate and medium-severity accidents were relatively rare, with both operational types reporting less than 5% of cases in these categories in most years. Major accidents were more prominent in Last Mile operations in 2023, reaching 13.79%, compared to only 4.05% in Long Haul. Across all years, Long Haul operations consistently reported a higher proportion of minor accidents (88.84%), while Last Mile operations exhibited slightly higher proportions of moderate (12.50%) and medium-severity accidents (3.13%). According to the chi-square test, there are differences in accident severity between last mile and long haul (p value 2023: 0.036, p value 2022: 0.002, p value all years: 0.000; p value > 0.05).

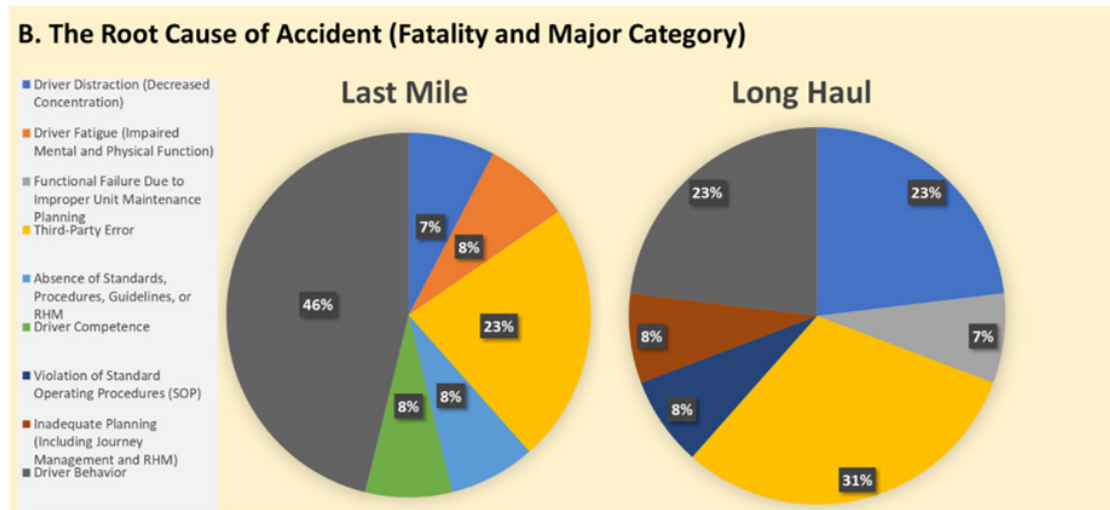
Figure 2 visualizes the accident root cause (all accident severity vs fatality & major severity). Based on Figure 2A, the root causes of accidents differ between Last Mile and Long-Haul operations, with notable variations in frequency and distribution in all accident severities. Across all years, the Third-Party Error was the most common cause, accounting for 95 accidents (long haul: 82 accidents and last mile: 13 accidents). Similarly, Driver Behavior was another major contributing factor, with 88 accidents (long haul: 61 accidents & last miles: 27 accidents). Other significant causes included Driver Competence, which accounted for 40 accidents (Long Haul: 34 accidents and Last Mile: 6 accidents), and Driver Distraction (Decreased Concentration) with 19 accidents (Long Haul: 11 accidents and Last Mile: 8 accidents).

When considering only fatality and major accidents visualized in Figure 2B, Driver Behavior emerged as the leading cause in Last Mile operations (6 accidents), followed by Third-Party Error (3 accidents). On the other hand, the root causes were more distributed in long-haul operations. The Third-Party Error and Driver Distraction each accounted for 4 and 3 fatality or major accidents, respectively. In the modern era, logistics and transportation have become an integral part of human life, as they facilitate the transportation of essential goods across regions. However, the increasing volume of delivery processes, the competency

A. The Root Cause of Accident



(a)



(b)

FIGURE 2. The Accident Root Cause (A: All Accident Severity; B: Fatality and Major Severity)

of drivers, the lack of operational standard procedure, and external factors raise the risk of accidents among workers, particularly the company's drivers, contributing to economic and health loss.

During 2022-2023, 288 accidents of this logistics and transportation were reported in this logistics company, with high distribution on long haul at 77% compared to 33% on last mile operation. In this study, the last mile operation is an intracity transportation, where this operation type is common in the Sumatra area, while the long-haul operation is freight forwarding between provinces and islands in Indonesia. As visualized on Figure 1, it evident the accident was highly distributed on Java (141 accidents), and Sumatra (129 accidents), with the highest events were reported in West Java with 57 events, followed by Central Java (38 events), South Sumatra (37 events), Lampung (31 events), and East Java (23 events). These findings indicate that Java Island has the most prevalent accidents.

According to accident category captured on Table 1, collision with an object is prevalent (all: 53.12%; last mile: 57.81% vs long haul: 51.79%), followed by hit (all: 20.83%; last mile: 12.50% vs long haul: 23.21%) and single-vehicle accident (all: 14.23%; last mile: 18.75% vs long haul: 12.95%) during 2022-2023. Based on the chi-square test, there are no differences

in accident categories between the last mile and long haul ($p\text{-value} > 0.05$). In this study, the collision with an object includes instances of scraping or hitting other vehicles, while a single-vehicle accident refers to an accident involving only one vehicle, without the involvement of other vehicles or individuals. Eboli *et al.* noted that road accidents may differ in severity level due to determining factors, including road condition, environment, and drivers' characteristics.

On accident severity, the high number of accidents is distributed among minor severity (83.33%), followed by major (6.25%), moderate (5.91%), and fatality (3.47%) during 2022-2023. The statistical test also exhibits the significance of accident severity between last mile and long haul ($p\text{-value} < 0.05$), which indicates there are differences in accident severity between last mile and long haul. Based on Table 1, the minor accident severity in last-mile operations is 41 out of 64 accidents (64.06%), with higher accident severity is 35.74% (23 out of 64 accidents). On the other hand, the minor accident severity in long-haul operation is 199 out of 224 accidents (88.84%), where higher accident severity is 11.16% (25 out of 224 accidents). This finding exhibits several points, including that the intensity of accidents is high in long-haul operations, while the last-mile operation has a more severe accident category

than long-haul operations.

It is well-known that accidents can cause major severity and fatality. Major crashes were associated with the distance travelled daily and the number of trips to the distribution hub (Tian *et al.*, 2024). The high severity of accident category on last mile operations may be determined by human error, including the compliance in explaining a company's standard operating procedure for driving. Waskito *et al.* (2024) mentioned that human error plays a vital role in truck accident severity, in which driver violations have the most significant impact on fatalities and multiple-vehicle accidents. Long-haul delivery accidents are often attributed to factors such as driver fatigue, insufficient sleep, poor sleep quality, and heavy traffic, as drivers must adhere to strict schedules for loading and unloading. Additionally, the extended travel distances involved in goods transportation contribute to these risks (Haffer *et al.*, 2022).

As visualized in Figure 2A, the root cause of accidents during 2022-2023 is third-party error (32.98%), followed by driver behavior (30.56%), driver competence (13.88%), and driver distraction (decreased concentration) (6.59%). In addition, the root cause of severe accidents (major and fatality) according to operational type, shown by Figure 2B, in the last mile exhibits the driver behavior and third-party error as the leading cause, while the third-party error and driver distraction are highly distributed in long-haul operations. In this study, fatal accidents were primarily caused by the negligence of other drivers, particularly those lacking concentration, which led to fatal collisions. According to the driver's statement in the accident report, while the driver had stopped to find a location, the truck/unit was rear-ended by a motorcycle, resulting in the motorcycle driver losing consciousness. Another note on the report indicates that the driver's negligent behavior involved attempting to overtake another vehicle, but a motorcycle was coming from the opposite direction, resulting in a collision.

Accidents, particularly road traffic accidents, are primarily caused by a combination of human factors, vehicle-related factors, infrastructure conditions, and environmental factors (Febriati *et al.*, 2021). The

study indicates that human factors, primarily carelessness and excessive speed, along with road and environmental conditions, contribute significantly to accidents (Alhomoud *et al.*, 2022). It was found that age and driving experience have a notable impact on accidents (Lesmini *et al.*, 2018), as these factors influence driving speed, habits, and style. Additionally, research has shown that educational level plays a critical role as a determinant in road accidents (Eboli *et al.*, 2020). One of the primary causes of accidents is driver behavior, with male drivers exhibiting more aggressive and speed-related behaviors than female drivers (Alkaabi, 2023). This aligns with the current study, as the majority of drivers involved in accidents were male, suggesting a higher potential for accidents due to these behaviors.

This research indicates that driver behavior can contribute to fatal accidents. Inappropriate driving behaviors, coupled with poor vehicle handling, constitute actions on the roadway that can lead to dangerous conditions and subsequent road accidents (Waskito *et al.*, 2024). Other studies suggest that promoting positive driving behavior among truck drivers can improve safety, highlighting the importance of driving behavior in minimizing road traffic accidents (Taiwo *et al.*, 2024). Additionally, research shows that driver behavior, which encompasses a driver's unique approach to the road, including preferences for speed, following distance, overtaking habits, and adherence to traffic regulations, plays a critical role in accident prevention (Chen *et al.*, 2015). In Turkey, the high rate of work-related accidents in the logistics sector highlights the importance of occupational health and safety measures (Aksu, 2024). Lyapin *et al.* (2019) noted that incorporating accident response services into intelligent transportation and logistics systems can enhance efficiency and mitigate the impact of an accident. A limitation of this study is that the data were collected over a period of only two years. Additional variables, such as age, severe events, medical check-up results, work-related stress, and workload, should be analyzed to provide a more comprehensive understanding.

Conclusion

A total of 288 accidents were reported in an Indonesian logistics and transportation company during 2022-2023, with the accidents being highly distributed on Java (50%) and Sumatra (44.79%). The accident category noted that collisions with objects, hits, and single-vehicle accidents are prevalent in the last mile and long-haul operations. The accident severity is minor severity (83.33%) and higher minor severity (16.67%), in which the statistical test also exhibits a significant on accident severity between last mile and long haul (p value < 0.05). According to operational type, long-haul operations have high accident intensity, while last-mile operations have severe accidents. The root cause of the accident is caused by third-party error (32.98%), followed by driver behavior (30.56%), driver competence (13.88%), and driver distraction. The company should establish regulations, standard operating procedures (SOPs), work shift schedules, and vehicle maintenance protocols, and ensure their implementation. Additionally, measuring stress levels and work-related fatigue among drivers should be conducted to help prevent accidents.

Acknowledgments

This study was supported by Jenderal Soedirman University.

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