Assessment Of Road Accidents: A Black Spot Investigation in East Mega Dike Access Road, Pampanga

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Abstract: - The East Mega Dike Access Road in Pampanga is one of the successful projects accomplished by the Philippine government for emergency engineering intervention. From the time of its construction up until now, the road was still accessible to users, causing the outgrowing number of vehicular accidents each year in East Mega Dike to show a crucial concern to people that utilize the roadway on a daily basis. The physical factors present on the road influence the overall experience and safety of the road user. The research's purpose is to recognize the most hazardous portion of the roadway and assess its overall safety by inspecting the physical road factors. In addition, this research used the accident data records within the years 2019–2021, which evaluated the characteristics of accident rate, severity index, and critical value. Using the Rate Quality Control Method, it was found that the span K006–K007 was the black spot area. A field study was then conducted in the span K006–K007 using the Road Safety Audit checklist, and the results showed numerous factors affecting road safety. The researchers recommended solutions based on the DPWH Road Safety Manuals to keep the road safe and convenient for all.

Key Words: — ***Rate Quality Control Method, Road Safety Audit.***

I. INTRODUCTION

A road is any course of direction or route that is mostly built from a mixture of cement, gravel, sand, and even a chemical solution to make it durable and more stable in any situation. Its primary function is to give people access to travel from point A to point B by means of the ground and water layers (Road | Definition in the Cambridge English Dictionary, n.d.). In the road industry, the development of a certain pathway needs an engineer full of expertise in the field and designers with a deeper and wider range of imagination (Road Engineers: A Look at Road and Highway Design | Ohio University, n.d.). On the other hand, an accident is a phenomenon wherein someone is hurt, damaged, or dies unintentionally (ACCIDENT | Definition in the Cambridge English Dictionary, n.d.). It cannot be completely removed, but it can be avoided and controlled with proper awareness of people and appropriate safety measures (Accident | Event | Britannica, n.d.). Thus, a road accident occurs when a vehicle moves along the motorway, involving the vehicle and causing death or injury to people or unexpected damage to vehicles or structures. Accidents occur when there are numerous vehicles passing around the vicinity, along with the presence of abundant people and animal vagrants present in the streets, buildings within the grounds, and infrastructure along the road. Hence, accidents cannot be entirely avoided; however, accident rates can be decreased with the right traffic management. It requires a systematic study of road accidents, and a proper assessment of an accident's cause

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will help in the recommendation of control and design precautions.

1.2 Study Area

The researchers selected the East Mega Dike Access Road for assessment to determine how to improve and mitigate the massive number of accidents that occur in the area. It is crucial to highlight that the road has been the site of a considerable number of accidents each year. The researchers aim to prioritize the following road factors based on the initial field inspection.

1.2.1 Road Factors Influencing the Road Safety

Road Signs:

Road signs are needed to give information and warn drivers. Road users should be able to see them. One problem that the researchers noticed on the East Mega Dike Access Road was the road signs. Due to their poor condition and the surrounding plants, some signs could not be seen.

In addition, certain signs, such as the hump on the road signs, were situated directly above the hump. Road signs should be placed in advance to give drivers time to respond to the warning.

Road Lightings:

Road lighting provides users with visibility and access at night. The lights must be placed properly to make the road more visible, accessible, and safe for road users. The researcher identified the absence of street lamps as one of the issues in the area.

Moreover, this issue may affect overall safety since road users have no accurate vision of the road ahead, especially when moving in a curvature segment of the roadway.

Road Barriers:

Road safety barriers were employed to stop cars from skidding or swerving off the road. However, based on the preliminary field inspection conducted by the researchers, the road barriers were inconsistent in size and height, which was acceptable, yet there were some segments on the road that had no safety barriers at all. This was a major concern because the road has sloping terrain outside the road space.

For such roads that have curving sections, the road must be clear. To avoid an accident, drivers must have a clear view of any approaching vehicles. As observed by the researchers, tall grass and tree branches blocked the drivers' vision of the entire road. In addition, road humps were also noticed as they lacked visible paint.

II. METHODS

This chapter will present the research method used by the researchers, which covers the research design, identifying the area or place of study, data collection, field inspection, analysis of the data, and conclusion with recommendation.

2.1 Research design

The researchers conducted this study utilizing a quantitative research method since their primary goal was to assess the safety of the East Mega Dike, Access Road, Pampanga. They evaluated the road accidents using the recent reports gathered from the police stations in Bacolor and Porac, Pampanga. The accident rate, accident frequency, severity index, and critical value were calculated from the obtained data in order to locate the black spot. The researchers will identify the factors affecting the overall safety of the road by integrating field inspections using the Road Safety Audit Checklist. The researchers used the results to recommend a solution to assess road accidents and the overall safety of the road.

2.2 Methodology

2.2.1 Data Collection

Administrative Data Collection:

After identifying the area, the researchers worked on administrative data collection at the police stations in Bacolor and Porac and requested some information and data regarding road accidents that occurred in East Mega Dike, Access Road, Pampanga. The request was made through a request letter prepared by the researchers and signed by the C.E. Chairperson, Thesis Adviser, Research Coordinator, and Group Leader. The gathered data served as the primary source used for identifying the black spot, where the accident rate, accident frequency, and severity index were identified and analyzed.

Identifying the Black Spot:

Identification of Accident Rate, Accident Frequency, Severity Index and Critical Value

The accident rate, accident frequency, severity index, and critical value formulas were used to determine the black spot area of the East Mega Dike Access Road.

Accident Rate

$$R_{se} = \frac{(A)(1{,}000{,}000)}{(AADT)(365)(MI)(YRS.)} \quad (Eq.1)$$

Wherein:

R_{se} = Accident rate of the section in accidents per million vehicle miles of travel,

A = Number of accidents for the study period,
AADT = Average Annual Daily Traffic (AADT) during the study period,
MI = Length of the section (in miles),
YRS. =Period of study (years or fraction of years).

Accident Frequency

$$F_{ave} = \frac{total\ number\ of\ accidents}{Length\ of\ study\ area} \quad (Eq.2)$$

$$Ac = F_{ave} + k_a\sqrt{\frac{F_{ave}}{L_j}} - \frac{0.5}{L_j} \quad (Eq.3)$$

Wherein:
Ac = Ac is the critical value for accident frequency (number of accidents)
F_{ave} = the average accident frequency for all road sections
L_j = the length of the road section. Here, Lj is assumed to be 1 km.
k_a = probability factor determined by the level of statistical significance desired for the equation.

$$\alpha = 0{,}1\%\ gives\ k\alpha = 2.576$$
$$\alpha = 5\%\ gives\ k\alpha = 1.645$$
$$\alpha = 10\%\ gives\ k\alpha = 1.282$$

The Black Spot Manual suggested that the use of the RQC Method to choose 5% as the confidence level can be subject to debate. Some experts argued for a higher confidence level, such as 10%, to better balance the risk of including false black spots while identifying more genuine ones. Therefore, it was preferable to use a 10% confidence level instead of a 5% level.

Severity Index

$$Qj = \frac{If\ (9)+Ib\ (3)+Id\ (1)}{A} \quad (Eq.\ 4)$$

Wherein:
Qj = relative severity value
If = number of fatalities
Ib = number of injured persons
Id = number of damaged vehicles
A = Number of accidents for the study period

Critical Value

$$CR = \frac{R_{se}}{V} \quad (Eq.5)$$

Wherein:
CR = Critical Rate
R_{se} = Accident Rate
V = Traffic Volume (AADT) / Length of the road in meters)

2.3 Identify the Black Spot

One of the researchers' goals was to identify the potential black-spot area. The rate quality control method was used to identify the black spot, which involved evaluating three parameters: accident rate, accident frequency, and severity index. The critical value was used as a reference point to compare these parameters; at least one must be greater to be considered a black spot.

The researchers considered one kilometer for the road section and used three years of data from 2019 to 2021. After calculating and comparing the three parameters and the critical value, it was found that the whole road is considered a black spot. The researchers then ranked the critical value from highest to lowest, and the first item on the list will undergo a field inspection using a checklist.

2.4 Field Inspection and Analysis of Checklist

2.4.1 Conduct a field study using the Road Safety Audit Checklist

The checklist used by the researchers in the field inspection is the Road Safety Audit Checklist by Austroads. The checklist is used for road safety inspections. Austroads helps Australia's and the New Zealand's transportation agencies in finding solutions to transport problems. They produce a practical instruction on the design, management, and operation of road transport networks (Austroads, n.d.). The Department of Public Works and Highways used Austroads as one of their references in their manuals. The checklist can be downloaded on their website.

2.4.2 Analysis of the Checklist and Road Safety Audit Report

The checklist was the basis for assessing the factors influencing the overall safety of the road. After analyzing the checklist, a Road Safety Audit Report was made.

2.5.3 Consultation and Validation of Road Safety Audit Checklist and Report

In order to conduct the study properly, the researchers enlisted the assistance of an engineer. The engineer carefully examined the RSA checklist created by the researchers and ensured its accuracy. Additionally, the engineer endorsed the letter and report by signing and stamping them, verifying that the checklist and report have been authenticated.

2.5.4 Recommendation of Solutions Based on the DPWH Road Safety Manual

After analyzing all the data gathered, the researchers concluded that the factors that influenced the overall safety of the East Mega Dike Access Road in Pampanga. The researchers used the results to recommend a solution to minimize accident rates and reduce the hazards of safety concerns. The researchers utilized the checklist from the Road Safety Audit to evaluate the precautionary standards that the road must meet. In light of this, as the research went on, the researchers kept looking for a solution to the issue.

III. RESULTS AND DISCUSSION

This chapter features a synopsis of the results from the statistical analysis of the collected information for this study. There are two stations where the dataset has been extracted. The first data set was from the Bacolor Police Station, which includes detailed data from the East Mega Dike-Bacolor segment. The second data set was from the Porac Police Station, which also includes the detailed data from the East Mega Dike-Porac segment. A tabular table below contains a summary of the two data sets.

3.1 Rate Quality Control Method

3.1.1 Tabulated Result of Black spot Investigation in Year 2019

Kilometer	Number of Accidents	Accident Rate	Accident Frequency	Severity Index	Critical Value	Rank by Critical Value	Priority Rank
K000-K001	2	0.272	1.504	5.769	0.131	2	2
K001-K002	1	0.136	1.504	5.769	0.066	3	3
K002-K003	2	0.272	1.504	5.769	0.131	2	2
K003-K004	1	0.136	1.504	5.769	0.066	3	3
K004-K005	1	0.136	1.504	5.769	0.066	3	3
K005-K006	0	0	1.504	5.769	0	4	4
K006-K007	3	0.408	1.504	5.769	0.197	1	1
K007-K008	0	0	1.504	5.769	0	4	4
K008-K009	0	0	1.504	5.769	0	4	4
K009-K010	1	0.136	1.504	5.769	0.066	3	3
K010-K011	0	0	1.504	5.769	0	4	4
K011-K012	0	0	1.504	5.769	0	4	4
K012-K013	0	0	1.504	5.769	0	4	4
K013-K014	1	0.136	1.504	5.769	0.066	3	3
K014-K015	1	0.136	1.504	5.769	0.066	3	3
K015-K015.6	0	0	1.511	5.769	0	4	4
Total	13						

Based on the presented table above, the data was extracted from the year 2019. It was found that the number of accidents from K001 to K002, K003 up until K005, K009 to K010, and K013 to K015 totals only one accident within that area, which results in it being the third priority in the black spot identification. Meanwhile, K005–K006, K007–K009, K010–K013, and K015–K015.6 counts as zero and puts it in the 4th priority spot. Furthermore, the succeeding kilometer, K006–K007, records a value of three occurrences within that area, which places it at the highest priority in the black spot identification. In addition, kilometers K000–K001 and K002–K003 were found to have two accidents that ranked second in black spot identification. Therefore, it was revealed that K006–K007 had the highest number of accidents in the year 2019. It has an accident rate value of 0.408 and a critical value of 0.197, which makes the segment a black spot zone.

3.1.2 Tabulated Result of Black spot Investigation in Year 2020

Kilometer	Number of Accidents	Accident Rate	Accident Frequency	Severity Index	Critical Value	Rank by Critical Value	Priority Rank

K000-K001	4	0.433	2.917	5.667	0.165	3	3
K001-K002	6	0.649	2.917	5.667	0.248	2	2
K002-K003	0	0	2.917	5.667	0	6	6
K003-K004	2	0.216	2.917	5.667	0.083	5	5
K004-K005	0	0	2.917	5.667	0	6	6
K005-K006	2	0.216	2.917	5.667	0.083	5	5
K006-K007	10	1.081	2.917	5.667	0.413	1	1
K007-K008	3	0.324	2.917	5.667	0.124	4	4
K008-K009	0	0	2.917	5.667	0	6	6
K009-K010	0	0	2.917	5.667	0	6	6
K010-K011	0	0	2.917	5.667	0	6	6
K011-K012	0	0	2.917	5.667	0	6	6
K012-K013	0	0	2.917	5.667	0	6	6
K013-K014	0	0	2.917	5.667	0	6	6
K014-K015	0	0	2.917	5.667	0	6	6
K015-K015.6	0	0	3.075	5.667	0	6	6
Total	27						

This table contains the results of the black spot investigation for the year 2020. It was found that K002–K003, K004-K005, and K008 up until K015.6 has no record of accidents, and K003–K004 and K005–K006 have only two records of accidents. Furthermore, the 4th priority in identifying black spots is the K007-K008 tallies with three numbers of accidents. For K000–K001, four accidents happened, while in K001–K002, there were a total of six accidents. As a result, K000–K001 was the 3rd priority, and K001–K002 was the 2nd priority in the black spot investigation. Meanwhile, most accidents were shown to occur within kilometer posts K006–K007. The area experienced extremely high accident rates, with 10 translating to an accident frequency of 2.917 and a critical value of 0.413. For the priority listing in K006–K007, it was present at the 1st spot in the rank by accident, by crucial value, and in priority rank.

Hence, K006–K007 is where the accident-prone road's black spot is located. Numerous accidents occur in areas where there are a lot of data black spots.

3.1.3 Tabulated Result of Black spot Investigation in Year 2021

Kilometer	Number of Accidents	Accident Rate	Accident Frequency	Severity Index	Critical Value	Rank by Critical Value	Priority Rank
K000-K001	3	0.375	3.846	4.432	0.166	3	3
K001-K002	2	0.250	3.846	4.432	0.111	4	4
K002-K003	13	1.625	3.846	4.432	0.718	1	1
K003-K004	3	0.375	3.846	4.432	0.166	3	3
K004-K005	0	0	3.846	4.432	0	6	6
K005-K006	1	0.125	3.846	4.432	0.055	5	5
K006-K007	4	0.500	3.846	4.432	0.221	2	2
K007-K008	3	0.375	3.846	4.432	0.166	3	3
K008-K009	2	0.250	3.846	4.432	0.111	4	4
K009-K010	1	0.125	3.846	4.432	0.055	5	5
K010-K011	2	0.250	3.846	4.432	0.111	4	4
K011-K012	1	0.125	3.846	4.432	0.055	5	5
K012-K013	0	0	3.846	4.432	0	6	6
K013-K014	2	0.250	3.846	4.432	0.111	4	4
K014-K015	0	0	3.846	4.432	0	6	6
K015-K015.6	0	0	4.087	4.432	0	6	6

Total	37

Based on the table presented above, the data was extracted from the year 2021. It was found that the number of accidents from K000 to K001, K003 to K004, and K007 to K008 totals three accidents within that area, which results in it being the third priority in black spot identification. Meanwhile, K001–K002, K008–K009, K010–K011, and K013–K014 have a total of two accidents, which puts them at the 4th priority spot. Furthermore, post-K002–K003 records a value of 13 occurrences within that area, which places it at the top of the priority list for black spot identification. In addition, K004-K005, K012-K013; K014-K015; and K015-K015.6 records nothing, and kilometers K006–K007 were found to have four accidents, which ranked second in black spot identification.

Therefore, it was checked that K002–K003 had the highest number of accidents in the year 2021. It has an accident rate value of 1.625 and a critical value of 0.718, which makes the segment a black-spot zone.

3.1.3.1 Findings on Kilometer 002-003

Kilometers 2–3 were the most critical road sections in 2021. Within the road section, there is a blind corner that is obstructed by trees and grasses that could cause a road collision. The findings in this section are the lack of signs near the corner road and lighting, especially at night. The researchers recommend installing warning signs to alert drivers and posting lights to lighten the road.

3.1.4 Black spot Investigation Final Priority

	Priority Rank		
Kilometer	**2019**	**2020**	**2021**
K000-K001	2	3	3
K001-K002	3	2	4
K002-K003	2	6	1
K003-K004	3	5	3
K004-K005	3	6	6
K005-K006	4	5	5
K006-K007	1	1	2
K007-K008	4	4	3
K008-K009	4	6	4
K009-K010	3	6	5
K010-K011	4	6	4
K011-K012	4	6	5
K012-K013	4	6	6
K013-K014	3	6	4
K014-K015	3	6	6
K015-K015.6	4	6	6

Based on the tallies in Table 3.1.4, span K006-K007 is a black spot area as it appears to have alarming values in its number of accidents, accident rate, and critical rate factor with consistency in the span of three years. Behind the top priority come the K000-K001 and K001-K002 as they display a bit lower but still dangerous values. As span K006-K007 is a black spot zone, the road portion will undergo a checklist assessment with the official road safety audit. Using the Road Safety Audit checklist, the researchers plan to examine the high-risk area.

3.2 Road Safety Audit Checklist

3.2.1 RSA Findings for K006 – K007

Road Alignment and Cross Section: The findings for the black spots K006–K007 for road alignment and road section are: first, even though there are road signs installed throughout the road, some signs are in poor condition and some are not placed in advance. Road safety is significantly influenced by the state and location of traffic signs. They must be clear and visible to drivers and should be placed in advance to give drivers time to respond to the information or warnings. Second, there are plants and trees within the road alignment that may confuse drivers, especially at night. Third, the road width is inadequate because of the increasing number of road users, and there's no place to park or stop when a car breaks down. The researchers recommend installing new signs that are clear and visible during the day and night and putting them up in advance. The government should maintain the surrounding area of the road—cut the grass or trees around it—and also, if possible, build an emergency parking lot to avoid causing traffic or any accidents.

Auxiliary Lanes: All signs and line markings have been placed following the relevant guidelines and regulations; however, some signage was in poor condition and not installed properly. This poor condition of the signage caused a problem for the road users, as it was not clear and conspicuous. Furthermore, no signs gave advance notice of approaching auxiliary lanes and turn lanes, which could have alerted drivers ahead of time and avoided potential accidents. To address these issues, the researchers recommend establishing a suitable schedule for inspection, cleaning, and replacement of signs to assure adequate maintenance. Additionally, there should be tapers at the start and end of auxiliary lanes to provide for the lateral movement and merging of traffic.

Intersections: The intersection of the roads presents multiple safety concerns. Firstly, all conflict points between vehicles are not being safely managed, potentially leading to accidents or collisions. Additionally, the alignment of medians is not clear

and appropriate, which could create confusion for drivers and further increase safety risks. Furthermore, only vehicles with a vertical clearance under 2.7m can be accommodated, potentially limiting access to the road for larger vehicles or causing problems for those who attempt to use it despite the height restriction. Lastly, the layout of the intersection is only evident in the morning, which may create confusion or danger for drivers who are not familiar with the road. The researchers recommend providing traffic control devices that are understandable and noticeable to drivers from a distance and that will allow them to initiate quickly and to halt if necessary. Additionally, all road junctions should have suitable pavement markings to guarantee vehicles to stop in a logical and proper position and to also assist in defining the intersection area.

Signs and Lightings: Numerous factors were found to cause the span of K006–K007 to be a black spot zone. Poor lighting throughout the entire road is the main problem for users at night. Regulation, warning, and direction signage is not visible and clear throughout the day due to its disrepair. Some were broken and should be placed in a more advanced position to warn the users. These problems with signage get even worse at night as messages and symbols go unnoticed, putting the safety of road users in danger. Lighting poles are another stationary highway danger. The researchers propose the utilization of reflective materials on signage as a cost-effective alternative that requires minimal lighting. Additionally, they suggest the installation of lighting poles equipped with metal halide lamps, ensuring they are strategically positioned to avoid posing a hazard to vehicles that may veer off the road. It is also advisable to design these poles to be sturdy and resistant to damage.

Markings and Delineation: The black spot zone has efficient markings and delineation. At night, when the lighting is inadequate, problems with road delineation occur. Some markings are not visible at night. The researchers recommend the use of road studs to guide the drivers as they approach curves, both uphill and downhill, to avoid leaving each lane. Curved warning signage should also be enlarged to help spot them easily. The application of light posts will positively eliminate every problem the road has.

Crash Barriers and Clear Zones: Based on findings on the checklist, it was found that clear zone widths are not traversable and that no signs of power poles, trees, or rigid fixtures are present in the width of clear zones. Proper treatment or protective measures are implemented for any objects within the clear zone to ensure safety. Additionally, crash barriers and end treatments are correctly installed at required locations, adhering to applicable guidelines and suitability for their intended purpose. However, some barriers are not in good condition, which can result in certain road problems. The length of the crash barriers at each installation is not adequate, and the barriers are small and difficult to see. In addition, the available space between the barrier and the edge line is inadequate to accommodate an emergency vehicle.

Hence, the researchers strongly advise installing protective barriers consistently and with a clear zone free of non-fragile hazards and a minimum of three meters wide from the boundary of the road.

Traffic Signals: According to the findings, there are no traffic signals that could prevent traffic congestion, accidents, or deaths. Without clear instructions on when to stop, go, or yield, drivers may make unsafe decisions that can result in accidents or collisions. Furthermore, the results revealed that there is no visibility of traffic signals or signage, as well as no adequate stopping distance, which could lead to drivers not being able to stop in time to avoid a collision if a hazard appears suddenly. This is especially dangerous if the road is wet or slippery.

In order to address these concerns, the researchers suggest re-installing traffic control devices with clear signage and road markings that tend to assist drivers and pedestrians in safely navigating the area. This can include speed limit signs, crosswalks, and stop signs.

Pedestrian and Cyclist: Based on the field inspection and upon looking at the checklist, K006–K007 has a lack of pedestrian lanes. Since the road is a bypass road, pedestrian lanes are not really necessary in the road segment. However, it is still required to place a pedestrian lane at the junction where the intersection road takes place, as this will help some people to cross easily and to warn drivers to stop in front of the pedestrian crossing to minimize over speeding and overtaking, which can result in an accident. Moreover, the absence of bike lanes or motorcycle lanes has been noted upon checking it on the checklist. Bike lanes intentionally separate small vehicles from regular and oversized vehicles, which can improve the quality of traffic flow and safety. Furthermore, through investigating the area, the checklist revealed that the road has no public utility stops.

Therefore, the researchers strongly recommend placing pedestrian lanes or pedestrianized areas in which emergency vehicles have access on the road, especially at intersections, and placing bike lanes, as this will help to improve the road user's experience and reduce some road-related problems. In addition, installing PUV stops is not totally required since the road is a bypass road.

Pavement and Parking: The results of the checklist revealed that the road had adequate skid resistance. However, to ensure safety, especially during the rainy season, the researchers recommend conducting skid resistance tests, particularly on curves, steep grades, and approaches to intersections.

Moreover, considering the results on the checklist, it was found that parking issues are not applicable since the road is an expressway. Perhaps the researchers recommend installing shoulders to provide spaces for emergency parking. Furthermore, it helps to lessen obstruction due to its narrow area.

3.3 Road Safety Audit Report

3.3.1 Poor Condition, Lack of Visibility and Inadequate of Advance Warning Signs

Road signs must be clear and visible during the day and night. The poor condition of signs, such as those that have been vandalized or dented, needs to be replaced with new ones. Road users should be able to see the road signs to prevent any accidents. Any obstruction around the road signs, like tall grass or trees, that results in not being noticed by the road users should be cleared. Road signs must also be in place in advance to give drivers time to respond to the warning. Without proper advancement of the road signs, it could lead to an accident, especially for road users who are not familiar with the road.

3.3.2 Inadequate traffic signals and markings

Since the road is considered an expressway, road users tend to increase their speed and cease to remember the traffic signals installed in the roadway. However, only a few traffic signals are present at this junction.

Traffic markings also affect the overall safety of the roadway since they warn and inform road users of upcoming hazards. At this road segment, traffic markings like rumble strips and solid white shoulder lines are a bit discolored and difficult to notice, especially at night.

Hence, a properly and consistently installed traffic signal with an adequate size or adopting the above minimum size will let the road users be informed and notified in advance and could positively enhance the road safety in the road segment. Thus, one great proposal is to have a satisfactory traffic light within the intersection. This will give the road users time to respond and stop, if necessary. Consequently, adding or placing a luminous road marking will be favorable to road users during the day and night.

3.3.3 Insufficient lighting particularly at night

Insufficient lighting throughout the entire road is a significant issue, especially for road users who travel at night. This problem gets even worse with unnoticeable signage and symbols at night, which can endanger road users. If drivers cannot perceive and comprehend the road signs and symbols, they may fail to take the necessary precautions, such as slowing down or changing lanes, leading to potential accidents and collisions. Furthermore, issues with road delineation occur solely at night when lighting is inadequate, resulting in certain markings becoming invisible. When drivers are unable to see the markings clearly, they might not be able to follow the designated path or take appropriate precautions, increasing the likelihood of accidents.

Therefore, it is crucial to ensure that the road markings and signage are visible and clear, even in low-light conditions, to maintain road safety. This can be achieved by improving the lighting conditions on the road and using reflective materials on the markings and signage to make them more visible at night.

3.3.4 Inadequate and Damaged Crash Barriers

The poor condition of certain barriers can potentially cause road-related issues. Specifically, the length of the crash barriers at each installation is inadequate, as some of them are small and not easily noticeable. Moreover, there is not enough space between the barrier and the edge line to accommodate emergency vehicles, which could lead to delays in response time during emergencies. This combination of factors could contribute to increased risks for drivers and passengers on the road, and may require attention and improvement measures to be implemented. Therefore, it is strongly recommended to install protective barriers consistently and with a clear zone free of non-frangible hazards and a minimum of three meters wide from the boundary of the road.

IV. SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATION

4.1 Summary of Findings

Based on the data gathered from Bacolor and Porac Police Stations, for three consecutive years, the number of accidents increased, from 13 in 2019 to 27 in 2020 and 37 in 2021. Researchers also did a preliminary investigation in order to identify the factors affecting the overall safety of the road. As a result, an assessment of the road accident-black spot investigation, and field inspections on East Mega Dike Access Road have been conducted.

According to the black spot investigation done by the researchers, Kilometer 006–007 was found to be the black spot in 2019 and 2020, with several accidents of 3 and 10 and a critical value of 0.197 and 0.413, respectively. In 2021, the

black spot was Kilometer 002–003, with a number of accidents of 13 and a critical value of 0.718.

For investigating the East Mega Dike Access Road, a road safety audit checklist was used to determine the factors influencing the safety of the study area. The checklist that the researchers answered was checked and professionally signed. The main part of the checklist contains Road Alignment and Cross-Section, Auxiliary Lanes, Intersections, Signs and Lighting, Markings, and Delineation, Crash Barriers and Clear Zones, Traffic Signals, Pedestrians and Cyclists, Pavement, and Parking.

4.1.1 Findings based on the RSA Checklist

Traffic signs are in bad condition, not placed in advance, and not visible, particularly at night. One of the major issues on the road is lighting. There are few lighting devices that could lighten the road and make the traffic signs and markings visible to the drivers. The road alignment is also not visible due to the tall grass growing around it. The existing roadside barriers are inadequate and damaged. The road is inadequate due to the increasing number of road users. There is no clear zone or emergency parking where the drivers can safely park when there is an emergency.

4.2 Conclusion

East Mega Dike Access Road is a bypass road that serves as an alternative route for motorists coming from Porac to Bacolor to San Fernando and vice versa. The analysis has shown that the most dangerous part of the entire route was Kilometer 006-007. It is safe to infer from the preliminary site investigation performed by the researchers that a number of factors influence the general safety of the road, as follows:

- Poor condition, lack of visibility, and inadequate advance warning signs
- Inadequate traffic signals and markings
- Insufficient lighting, particularly at night
- Inadequate and damaged crash barriers
- Inadequate lanes and no clear zone for emergency parking

The researchers recommend countermeasures to address the factors governing the black spot area, and these solutions are as follows:

- Replacing signs that are in poor condition.
- Installing road signs and traffic signals in advance
- Using luminous paint for road markings
- Placing road studs or street lights
- Replacing damaged crash barriers and
- Add extra lanes and emergency parking.

Overall, the study offers crucial information about how to increase traffic safety. As "Prevention is better than cure" is the guiding premise of the DPWH Road Safety Audit, it is simpler to prevent accidents from happening than to fix the damage after it happens.

4.3 Recommendation

In the future, researchers conducting a similar study may benefit from expanding the scope of their research to gain a more comprehensive understanding of the underlying causes of road accidents on the East Mega Dike Access Road by:

- including qualitative research that explores the behavioral aspects and characteristics of drivers.
- including a qualitative investigation of the influence of weather conditions and vehicle conditions on road accidents.
- considering the feasibility and practicality of proposed solutions to address the causes of road accidents in the area
- exploring potential interventions that address the causes of road accidents in the area.

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