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ANALYSIS OF THE IMPLEMENTATION OF SCHOOL SAFETY ZONES (ZOSS) IN TOMOHON CITY

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Abstract
Tomohon City is city in the province of North Sulawesi, Indonesia, which is enclave from Regency Minahasa with amount sufficient school many. Some schools located on the edge road main, where vehicles passing by with speed very dangerous height for children the school that will cross way to go or when going home from school. Children are often careless and spontaneous, so they have the potential to become victims of traffic accidents. Evaluation of the implementation of the School Safe Zone (ZoSS) needs to be carried out, so that the behavior of pedestrians and drop-off behavior can be known, whether they have behaved safely or not. Then we can draw conclusions whether the School Safe Zone has been effective in its implementation or not. SD Negeri 2 Tomohon and SD Lentera Harapan Tomohon are located on the edge of the main road so they were chosen as research locations because in front of these two schools there is a School Safe Zone (ZoSS) that needs to be evaluated. These two School Safe Zones will be evaluated based on the Decree of the Director General of Land Transportation Number 3582 / AJ.403 / DRDJ / 20018. The research was conducted for 3 days at each location, and was carried out directly including data on the completeness of School Safe Zone (ZoSS) facilities, data on pedestrian behavior and data on drop-off behavior. Speed data and volume data were taken based on references to the 2023 Indonesian Road Capacity Guidelines (PKJI) which will then be processed to obtain the level of service of the road sections studied. From this study, the data on pedestrian and usher behavior in both research locations can be stated as "not yet safe" with Zcount > Ztable. Based on the results of the service level analysis for the Jl. Sam Ratulangi section (SD Negeri 2 Tomohon), the capacity was obtained 3376 smp/hour, the peak hour volume ranged from 374 smp/hour – 788 smp/hour with a service level of service level B during peak hours. While for the Jl. Makmur section (SD Lentera Harapan Tomohon), the capacity was obtained 3440 smp/hour, the peak hour volume ranged from 705 smp/hour – 985 smp/hour with a service level C during peak hours. Therefore, it is necessary for schools to pay attention to educate students about safety in crossing the road, and for the government, especially the Tomohon city transportation agency, to socialize the intent and purpose of implementing the School Safe Zone (ZoSS) for other road users in order to create comfort and safety for road users.

Keywords: School Safe Zone, Speed, Capacity, Road Service Level.

INTRODUCTION
In Indonesia, school children under the age of 14 (elementary school age) often do not understand traffic rules well, so children of this age are very vulnerable to accidents Tomohon became an autonomous region (city) with the enactment of Law Number 10 of 2003 concerning the Establishment of South Minahasa Regency and

Tomohon City in North Sulawesi Province by the Indonesian House of Representatives, but its inauguration was only on August 4, 2003 (Pangestu & Abduh, 2024). Based on data from the Central Statistics Agency of Tomohon City in 2021, the population of Tomohon City in 2020 was 100,587 people, with a density of 683 people/km2, and in mid-2024 it was 103,213 people (Kementrian Pendidikan, Kebudayaan, Riset dan Teknologi, Direktorat Jenderal Pendidikan Anak Usia Dini, 2024). Tomohon City is one of the cities in North Sulawesi Province which is nicknamed the City of Education. There are 54 Kindergartens, 68 Elementary Schools, 24 Middle Schools, and 17 Senior High Schools and Vocational Schools (SMA/SMK) which if all of them are totaled, total 163 schools in Tomohon City (SAID, 2018). Of course, it is the hope of every parent that their children can go to school and return home safely.

There are many factors that can affect the safety of school children when going to and from school (Perumean-Chaney & Sutton, 2013). The large number of schools in Tomohon City located on the edge of the main road where many vehicles travel at high speeds is one of the factors that can increase the occurrence of accidents. With conditions like this, it will be very dangerous for school children when crossing the road. Children who are often not very careful when crossing make them vulnerable to traffic accidents (Indonesia, 2018).

According to AASHTO, 2004, the characteristics of each person's pedestrians are different. Pedestrians at the age of elementary school children, 6 to 12 years old, are still very vulnerable to traffic safety, especially when crossing the road (Official, 2004). In response to this, the Indonesian Government through the Central Department of Transportation has implemented the School Safe Zone (ZoSS) program, in accordance with the Decree of the Director General of Land Transportation Number 3582/AJ.403/DRDJ/2018 concerning Technical Guidelines for Prioritizing Pedestrian Safety and Comfort in School Areas Through the Provision of School Safe Zones implemented throughout Indonesia, including North Sulawesi, especially in Tomohon City.

(Wahyuni, 2015), in his research in Pekanbaru stated that some ZoSS facilities installed were different from the recommended guidelines, such as signs and markings that were installed were not maintained with some signs covered by tree branches or billboards and the paint color of the markings had begun to fade. This can result in reduced effectiveness of ZoSS.

School Safety Zone (ZoSS) is an innovative program in the form of a time-based speed zone that can be used to regulate vehicle speed in school areas (Wahyuni, 2015). In Tomohon City, two School Safety Zones have been installed, namely in front of SD Negeri 2 Tomohon and in front of SD Lentera Harapan Tomohon.

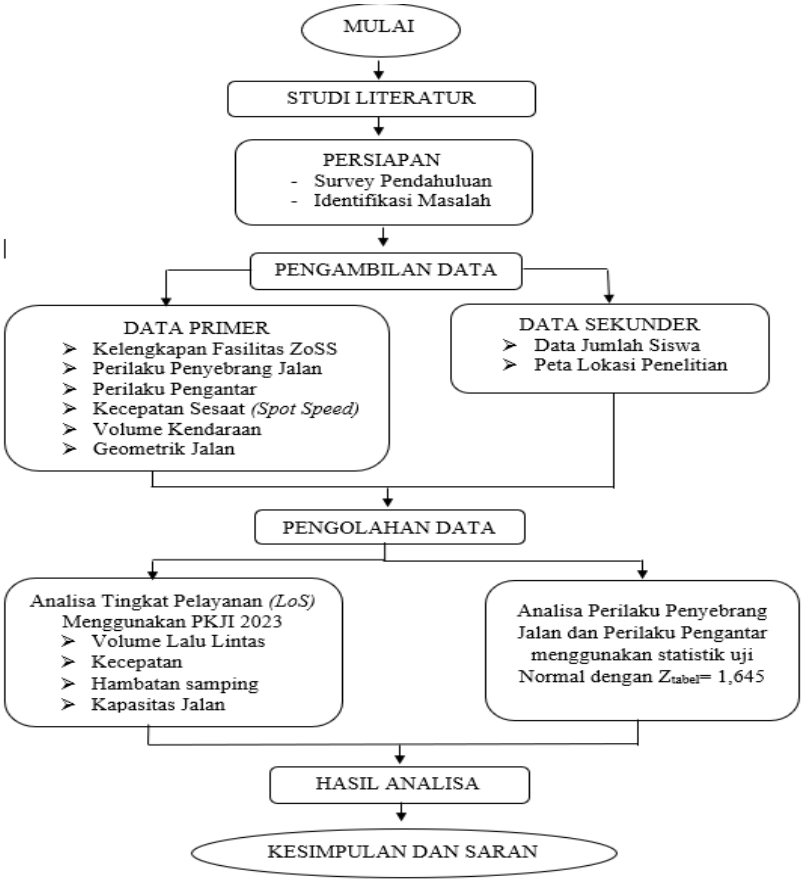
However, in reality the use of School Safe Zones has not been effective. All of this is inseparable from the lack of supporting facilities such as road markings and traffic signs, or the lack of knowledge of road users, namely school children, about the School Safe Zone (ZoSS). Children who cross the road without following standard procedures for how to cross the road properly can increase the potential for accidents. Moreover, school children are often still spontaneous and less careful on the highway (Trifunović, Pešić, Čičević, & Antić, 2017).

Therefore, it is necessary to conduct research to evaluate the implementation of the two School Safety Zones (ZoSS). To find out whether the implementation of the School Safety Zone is according to plan or not.

The purpose of this study that the author wants to achieve is to analyze the implementation of the School Safe Zone that has been implemented in the 2 (two) schools including the behavior of pedestrians and the behavior of ushers (Lee, 2024). Analyze the level of service on the roads around the School Safe Zone that has been implemented in the 2 (two) schools.

This research is expected to be used as a reference material for further research in the future, especially regarding the implementation of the School Safety Zone (ZoSS) in Indonesia, especially in Tomohon City. And hopefully this research can be an evaluation for the Tomohon City government, especially the Tomohon City Transportation Agency regarding the implementation of the School Safety Zone (ZoSS) in several schools in Tomohon City, so that school children can go to school and return home safely, securely and comfortably.

RESEARCH METHOD



Picture 1. Chart Flow Study

This study was conducted for 2 weeks, in two different locations. The first School Safety Zone (ZoSS) is located in front of Tomohon 2 Public Elementary School, precisely on Jl. Sam Ratulangi, Matani Tiga, Tomohon City, which is the access road to Tondano. The study was conducted for 3 days a week, namely on Monday, April 30, Thursday, May 3, and ended on Saturday, May 5, 2024. The second School Safety Zone (ZoSS) is located in front of Tomohon Lentera Harapan Elementary School, precisely on Jl.

Makmur, Paslaten Satu, Tomohon City, which is the access road to Tomohon Beriman Market. The study was conducted for 3 days in two weeks, namely on Monday, May 7, Saturday, May 12, and ended on Thursday, May 17, 2024. The study was conducted at both locations starting at 06.00-18.00 WITA.

Geometric Data

1) The geometry of Sam Ratulangi Street (Tomohon 2 Public Elementary School).

Based on the results of the field survey, the following geometric data was obtained for Jl. Sam Ratulangi:

a. 2 lane 2 way undivided road type (2/2 UD)
b. The road is equipped with sidewalks on the left and right sides of the road, with a road width of 6.6 meters and a left and right shoulder width of 1.8 meters and 0.4 meters respectively.
c. The length of the School Safety Zone (ZoSS) studied was 112.5 meters.
d. The School Safety Zone (ZoSS) type is type 2/2 UD with a speed limit of 30 km/hour.

2) The geometrical features of Makmur Street (Lentera Harapan Elementary School, Tomohon).

Based on the results of the field survey, the following geometric data was obtained for Jl. Makmur:

a. Road type 2 lanes 2 directions undivided (2/2 UD)
b. The road is equipped with sidewalks on the left and right sides of the road, with a road width of 8.15 meters and a left and right shoulder width of 0.5 meters each.
c. The length of the School Safety Zone (ZoSS) studied was 29 meters.
d. The School Safety Zone (ZoSS) type is type 2/2 UD with a speed limit of 20 km/hour.

Data Collection Methods

In this study, the technical implementation was carried out by conducting a field survey. Data collection was carried out to obtain primary data and secondary data. The method of implementing the survey can be explained as follows:

1. Primary Data

Primary data is data obtained through direct surveys.
field, including:

a. Data on Completeness of School Safety Zone Facilities (ZoSS)

In conducting a survey of the completeness of the School Safe Zone (ZoSS) facilities, several facilities in the School Safe Zone (ZoSS) will be directly observed and compared with the existing standards, namely the Decree of the Director General of Land Transportation Number 3582/AJ.403/DRDJ/2018, which includes:

- ZoSS Type
- ZoSS Speed Limit (km/h)
- Speed Limit Plan (km/h)
- ZoSS Length (m)
  - Minimum Requirements
  - ZoSS Marking
  - Zebra Cross
  - Signs Then cross

  Color zig-zag markings yellow

- Guide crossing

- Need Addition
  - Noisy tape

Behavioral Data Pedestrian Crossing

Data collection on pedestrian behavior will be recorded using a camera. and then it will be converted into written data. Selection method The sample to be used is a simple random method with take a sample of 10% of the number of students in one school And what will be seen are the characteristics of the students when they will crossing until finished crossing. There are 4 (four) criteria that will be assessed against the character of students in crossing the road, namely:

- Standard procedures for crossing 4T, which include:
  - T1 – Wait a moment:
  - T2 – Look Right
  - T3 – Look Left
  - T4 – Look Right Again
- How to cross (walk or run)
- Facilities used (with zebra crossing or pedestrian bridge (JPO) or without facilities)
- Status of the crossing (independent or not independent)

The survey will be conducted in the morning, namely during school hours (06.30-08.30) and after school hours (12.00-14.00).

2. Secondary Data

Secondary data will be obtained from the schools that will be studied. Data The secondary school in question is the number of students in the 2 (two) schools. concerned. The number of students from the two schools will be used as Determining the number of samples to be studied in the pedestrian behavior data survey road and introductory behavioral data survey. Surveys for secondary data will also be done by visiting the relevant agencies to request supporting data which is needed in this research process.

RESULTS AND DISCUSSION

The results of the survey that has been conducted, then obtained data on the completeness of facilities from the School Safety Zone at SD Negeri 2 Tomohon and SD Lentera Harapan Tomohon. This survey was conducted by looking at the Decree of the Director General of Land Transportation Number 3582 / AJ.403 / DRDJ / 2018. Data on the completeness of facilities from the School Safety Zone can be seen in the following table:

Table 3. Data on Completeness of School Safe Zone Facilities

School Name	Road Type	Speed Limit in ZoSS (km/h)	ZoSS Type	ZoSS Length (meters)	Minimum Requirements	Additional Requirements
SD Negeri 2 Tomohon	2-lane undivided (2/UD)	30	2UD-30	112.5	ZoSS Markings, zebra cross, traffic signs, zigzag lines (yellow)	Rumbling strips

School Name	Road Type	Speed Limit in ZoSS (km/h)	ZoSS Type	ZoSS Length (meters)	Minimum Requirements	Additional Requirements
SD Lentera Harapan Tomohon	2-lane undivided (2/UD)	20	2UD-20	29	ZoSS Markings, zebra cross, traffic signs	-

Source: Survey, 2024

School Safety Zone (ZoSS) Conditions

1. Tomohon 2nd State Elementary School
   - The condition of the markings in the School Safety Zone (ZoSS), such as the yellow "zig-zig" markings and the "red carpet" are no longer very clear because they have started to peel off.
   - The condition of the signs has been completely installed on the left and right sides of the School Safety Zone (ZoSS) according to their respective locations as seen based on existing standards, namely the Decree of the Director General of Land Transportation Number 1304/AJ.403/DJPD/2014.
2. Tomohon Lantern of Hope Elementary School
   - The condition of the markings in the School Safety Zone (ZoSS), such as the "red carpet" markings, are no longer very clear because they have started to peel off.
   - The condition of the signs has not been completely installed on the left and right sides of the School Safety Zone (ZoSS) in accordance with existing standards, namely the Decree of the Director General of Land Transportation Number 3582/AJ.403/DRDJ/2024. The signs that have not been installed include:
     - o Warning signs in the form of the words "REDUCE SPEED, SCHOOL SAFETY ZONE"
     - o Warning signs for pedestrian crossings.
     - o Speed limit signs maximum .
     - o Speed limit sign maximum

Behavioral Data Analysis Pedestrian Crossing

After the completeness data for the School Safety Zone (ZoSS) is obtained , the next step is... done behavioral data analysis crosser road . Behavioral data analysis crosser road done based on Reference . Behavioral data analysis crosser road done based on Director's Decree reference General Land Transportation Number 3582/AJ.403/DRDJ/2018. The analysis results can be seen in the following table:

Table 4. Recapitulation of Pedestrian Behavior Data

School Name	Z_{calculated}	Z_{table}	Remarks
SD Negeri 2 Tomohon	0.17	1.645	"Not Safe Yet"
SD Lentera Harapan Tomohon	-1.6	1.645	"Not Safe Yet"

Source : Analysis , 2024

From the results comparison Zcount and Ztable obtained Zcount more small than Ztable with mark Zhitung = 0.17. Thus, it can be said that the behavior of pedestrians is "Not Safe".

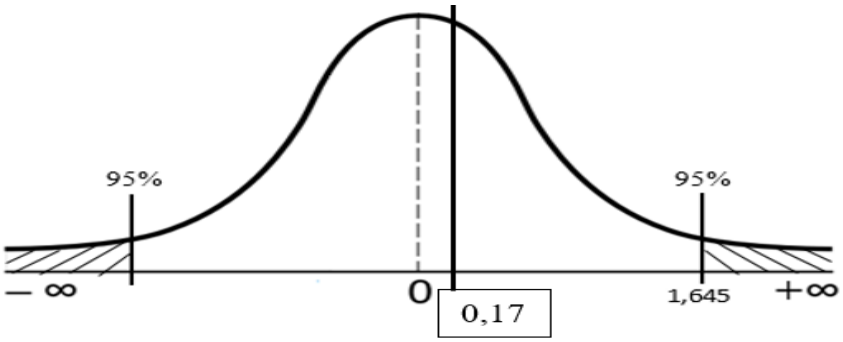


Figure 2. Normal Distribution Curve for Pedestrian Behavior Data at Lentera Harapan Elementary School, Tomohon.

Introductory Behavioral Data Analysis

After the pedestrian behavior data has been obtained, the next step is to analyze the pedestrian behavior data. The analysis of pedestrian behavior data is carried out based on the reference of the Decree of the Director General of Land Transportation Number 3582/AJ.403/DRDJ/2018. The results of the analysis can be seen in the following table:

Table 5. Recapitulation Data Introduction Behavior

School Name	Z_{calculated}	Z_{table}	Remarks
SD Negeri 2 Tomohon	-0.5 / √33	1.645	"Not Safe Yet"
SD Lentera Harapan Tomohon	0.17	1.645	"Not Safe Yet"

Source : Analysis , 2024

From the results analysis , it can be concluded mark Zcount more small than mark Ztable . Thus it can be said that the behavior of pedestrians is "Not yet safe".

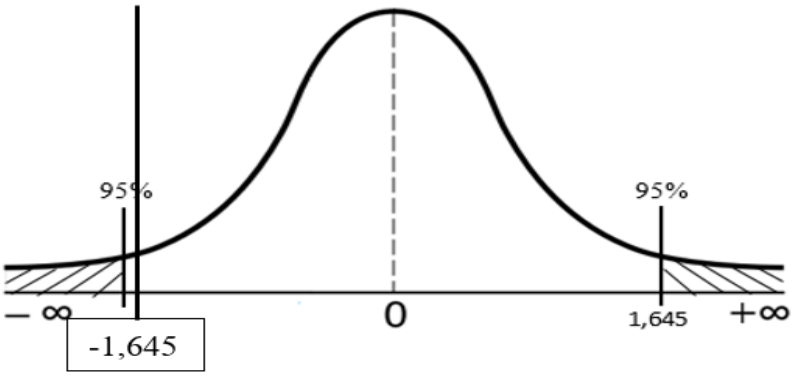


Figure 3. Normal Distribution Curve for Introductory Behavior Data of Elementary School 2 Tomohon

Speed Data Analysis

Speed data analysis is calculated to determine how many vehicles reduce speed when in the School Safe Zone (ZoSS) in percentage form.

The following is a recapitulation of the results of the speed data analysis at the two research locations:

Table 6. Recapitulation of Vehicle Speed Percentage Data

Location	Date	Data Collection Period	Percentage of Vehicles Reducing Speed
SD Negeri 2 Tomohon (Jl. Sam Ratulangi)	Monday, 30 April 2024	School Entry Time	33%
	Thursday, 3 May 2024		50%
	Saturday, 5 May 2024		100%
	Monday, 30 April 2024	School Dismissal Time	58%
	Thursday, 3 May 2024		83%
	Saturday, 5 May 2024		100%
SD Lentera Harapan Tomohon (Jl. Makmur)	Thursday, 17 May 2024	School Entry Time	67%
	Saturday, 12 May 2024		58%
	Monday, 7 May 2024		50%
	Thursday, 17 May 2024	School Dismissal Time	83%
	Saturday, 12 May 2024		92%

Source : Survey And Processing Data, 2024

Volume Data Analysis

Based on survey volume data collection the cross that has been carried out , the data obtained next in the arrangement in form table , then determined peak hours based on the largest volume . The volume data obtained from results survey Still in unit vehicles /hour (vehicles /hour) and must changed into the unit car passengers (smp /hour) with method multiply mark equivalent car passengers (emp) to each type vehicles in accordance with PKJI 2023.

The results of the vehicle survey and traffic volume calculations are divided into 2 different locations. The following are the results of the vehicle volume data analysis on the two road sections studied:

Table 7. Peak Hour Traffic Volume Data Recapitulation

Location	Direction	Date	Time Interval	Peak Hour Volume (smp/hour)
SD Negeri 2 Tomohon (Jl. Sam Ratulangi)	Left Lane (Towards Tondano)	Monday, 30 April 2024	08:15 – 09:15	587.9
		Thursday, 3 May 2024	17:00 – 18:00	384.2
		Saturday, 5 May 2024	10:30 – 11:30	360.5
	Right Lane (Towards Tololiu)	Monday, 30 April 2024	11:00 – 12:00	440.5
		Thursday, 3 May 2024	16:15 – 17:15	341.1
		Saturday, 5 May 2024	11:15 – 12:15	273.6
SD Lentera Harapan Tomohon (Jl. Makmur)	Left Lane (Towards Market)	Monday, 7 May 2024	06:30 – 07:30	639.0
		Saturday, 12 May 2024	07:30 – 08:30	729.7
	Right Lane (Towards City Park)	Monday, 7 May 2024	10:30 – 11:30	830.4
		Thursday, 17 May 2024	08:45 – 09:45	757.5

Source: Survey And Processing Data, 2024

Road Capacity Analysis

Capacity is defined as the maximum flow through a point on a road that can be maintained per unit hour under certain conditions. The following are the capacity parameters on the two road sections that have been studied:

Table 8. Parameter Capacity Road in section Jl. Sam Ratulangi Tomohon (SDN 2 Tomohon)

Parameter	Condition	Value	Remarks
Basic Capacity (C_0)	Dual-lane undivided	2900	Total for two lanes
Effective Lane Width (FCw)	7 meters	1.00	Total for two lanes
Directional Split (FCsp)	2/2 UD with curb	1.00	Medium
Side Friction (FCsf)		0.91	
Population (FCcs)	101,981 people	0.90	Between 0.1 – 0.5 million people

Source: Survey And Processing Data 2024

Table 9. Road Capacity Parameters on Jl. Makmur Tomohon
(Tomohon Lantern of Hope Elementary School)

Parameter	Condition	Value	Remarks
Basic Capacity (C_0)	Dual-lane undivided	2900	Total for two lanes
Effective Lane Width (FCw)	8 meters	1.14	Total for two lanes
Directional Split (FCsp)	2/2 UD with curb	1.00	High
Side Friction (FCsf)		0.82	
Population (FCcs)	101,981 people	0.90	Between 0.1 – 0.5 million people

Source : Survey And Processing Data, 2024

Based on the data that has been obtained above, then capacity the way on both section the path can be counted as follows:

1. Road capacity on Jl. Sam Ratulangi C= C0 × FCW × FCSP × FCSF × FCCS
   C= 2900 × 1.00 × 1.00 × 0.91 × 0.90
   C= 2375.1
2. Road Capacity on Jl. Makmur C= C0 × FCW × FCSP × FCSF × FCCS C= 2900 × 1.14 × 1.00 × 0.82 × 0.90
   C= 2439.8

Degree of Saturation Analysis

The degree of saturation is the comparison of the volume (flow value) of traffic to its capacity (C). The following is a recapitulation of the degree of saturation and level of service (LoS) values on the two road sections at the research location:

Table 10. Degree Values Saturation

Location	Direction	Date	Peak Volume (Q) Per Lane (smp/hour)	Peak Volume (Q) Total Two Lanes (smp/hour)	Capacity (C) (smp/hour)	Degree of Saturation (DS)	Level of Service (LoS)
SD Negeri 2 Tomohon (Jl. Sam Ratulangi)	Left Lane - Right Lane (Towards Tondano and Patung Tololiu)	Monday, 30 April 2024	587.9	1028.4	2375.1	0.432992951	Service Level B

Location	Direction	Date	Peak Volume (Q) Per Lane (smp/hour)	Peak Volume (Q) Total Two Lanes (smp/hour)	Capacity (C) (smp/hour)	Degree of Saturation (DS)	Level of Service (LoS)
SD Lentera Harapan Tomohon (Jl. Makmur)	Left Lane - Right Lane (Towards Market and City Park)	Thursday, 3 May 2024	384.2	725.3	2375.1	0.305376561	Service Level B
		Saturday, 5 May 2024	360.5	634.1	2375.1	0.266978325	Service Level B
		Monday, 7 May 2024	639	1447.7	2439.8	0.591317412	Service Level C
		Thursday, 17 May 2024	729.7	1333.1	2439.8	0.546309751	Service Level C
		Saturday, 12 May 2024	830.4	1587.9	2439.8	0.650824563	Service Level C

Source : (Survey Results and Data Processing 2024)

CONCLUSION

Based on results The analysis that has been done , behavioral data crossers and behavioral data introduction in both schools under review that is as follows:
Tomohon 2 Public Elementary School for behavior crosser obtained Zcount = 0.17 < Ztable = 1.645 then behavior the crosser can be said to be "Not yet saved", and for behavior introduction obtained $Z_{count} = \frac{-0,5}{\sqrt{\frac{0}{33}}}$ (cannot be defined) or can categorized $Z_{count} < Z_{table}$ so behavior The introduction can be said to be "Not yet safe".
Lentera Harapan Elementary School Tomohon For behavior crosser obtained Zcount = -1.6 < $_{Ztable}$ = 1.645 then behavior the crosser can be said to be "Not yet saved", and for behavior introduction obtained Z_{count} = 0.17 < Ztable = 1.645 then behavior introduction can be said to be "Not yet saved". With thus implementation from the two School Safe Zones (ZoSS) were reviewed namely at SD Negeri 2 Tomohon and SD Lentera Harapan Tomohon it can be said to be "Not Yet Effective " in its implementation .

Based on the results of the road service level analysis carried out on the Jl. Sam Ratulangi Tomohon section using the Indonesian Road Capacity Manual (PKJI 2023), the capacity (C) = 3,376 smp/hour was obtained, with the highest degree of saturation occurring on Monday, April 30, 2024 with a degree of saturation (DS) value = 0.4329 with a service level of B. Meanwhile, for the results of the road service level analysis

carried out on the Jl. Makmur Tomohon section using the Indonesian Road Capacity Manual (PKJI 2023), the capacity (C) = 3,440 smp/hour was obtained, with the highest degree of saturation occurring on Saturday, May 12, 2024 with a degree of saturation (DS) value = 0.6508 with a service level of C.

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