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Lina Gozali; Frans Jusuf Daywin; Jessica Novelia Sagitta; Carla Olyvia Doaly

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The improvement of facility layout at PT. FNP using pairwise exchange method for food powder production 

Lina Gozali; Lamto Widodo; Graziella Michele Kustandi; Frans Jusuf Daywin; Carla Olyvia Doaly

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[Ellisa; M. Florencia; R. Trisno](#)

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Hugeng Hugeng; A. M. Rivaldo; H. S. Utama

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H. S. Utama; W. Wahab; H. Budiono

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Lamto Widodo; I. Wayan Sukania; Gerry Williekumaro

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Stanley Reinaldo; Desi Arisandi; Tri Sutrisno

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Designing mathematics, science, and reading competency dashboard using business intelligence algorithm

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Designing an android-based green school program application with the fuzzy logic weather forecast method: A case study of school students participating in a school greening program ☰

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Design of supply chain performance measurement model using supply chain operation reference (SCOR) in general trading and service company

Adnan Salim; Wilson Kosasih; Lithrone Laricha Salomon; Moses L. Singgih

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Vilia Vianti Halim; Wilson Kosasih; Lina Gozali; Frans Jusuf Daywin

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Sarah Clarisa Raroeng; Wilson Kosasih; Frans Jusuf Daywin; Lina Gozali; Lithrone Laricha Salomon; Calvin Santoso

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Application of six sigma in the car seat production process: A case study

Gabby Florencia; Wilson Kosasih; Lina Gozali; Agustinus Purna Irawan; Didi Widya Utama

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Yenita

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Supply chain management performance measurement using supply chain operation reference (SCOR) approach: Case study of IF Ltd.

Andrew Liauw; Helena Juliana Kristina; Wilson Kosasih

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Utilizing IoT to design innovations based on human behavior in the education sector within COVID-19 pandemic

Feby Artwodini Muqtadiroh; Diana Purwitasari; Eko Mulyanto Yuniarno; Supeno Mardi Susiki Nugroho; Mauridhi Hery Purnomo

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Flexural strength of bamboo fiber composite material as an alternative material for making car spoiler products

Agustinus Purna Irawan; I. Wayan Sukania; Paula Tjatoerwidya Anggarina

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Aerodynamic simulation of car bumper products made of rattan fiber composite material

Agustinus Purna Irawan; Didi W. Utama; Paula T. Anggarina; Najid

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Condition Evaluation of Length Jenderal Sudirman Road Jakarta Using IRAP Method to Achieve Star Rating 4

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Abstract. The traffic collision is an unforeseen occurrence resulting in casualties, property damage as well as financial costs to both society and the individuals involved. In Indonesia, the accident count is still rising every year. The number of accidents is in line with the number of vehicles produced and sold. Various attempts have been made to improve road safety, especially by adopting the IRAP model. IRAP is a persuasive handling activity before the occurrence of an accident. Traffic condition will be the determining factor for SRS calculation. Hereby the base score of 4 varieties according to SRS calculation on long Jenderal Sudirman Street, 4.1 (Vehicle Occupant), 4.2 (Motorcyclist), 3 (Bicyclist), and 2.8 (Pedestrian). Star rating growth can be achieved by improving some substantial attributes such as a pedestrian fence, cycling sign, 40 Km/h speed limit sign, and intersection sign. The result of the BCR calculation shows a value of > 1 which signifies that it is worth doing by improving the 4 attributes. Final star rating after being handled yield a significant score of 4.6 (Vehicle Occupant), 4.2 (Motorcyclist), 3 (Bicyclist) dan 5 (Pedestrian).

1. INTRODUCTION

According to the Global Status Report on Road Safety, 1.35 million victims die every year worldwide and 20-50 million people are injured due to traffic accidents [1]. Serious accidents will still occur if we don't solve the problem of unsafe road conditions for users [2]. In Indonesia, traffic accidents continue to increase every year, the number of accidents is in line with the increase of motorized vehicles produced and sold. The description of the composition of accident characteristics from data processing is known that based on the type of road traffic accidents, collisions are the most common types of accidents at 65.6% [3]. The area with the most accidents is Java Island at 70.35%. Traffic accidents eliminate more than 1.2 million lives annually which have a major impact on a country's progress as they cost 2.7% of government GDP in high-income countries and 2.2% of GDP in low- and middle-income countries [4].

The government has made many efforts to press the number of accidents and improve road safety in Indonesia, one of which is the Government Regulation No. 37 of 2017 concerning Road Traffic and Transportation Safety. The regulation contains a National General Plan for Safety (RUNK) which includes the preparation of a national program for safety activities, provision and maintenance of facilities and equipment, problem assessment, and safety management planning. Various solutions to improve road safety in Indonesia, one of which is by adopting the IRAP model. The International Road Assessment Program (IRAP) is a road assessment program developed by an international organization in the field of road safety that has succeeded in developing ways of assessing road safety for road users through determining the value or risk score that may occur due to road infrastructure elements. [5]

Based on this description, this research is to conduct a study of road safety evaluation that has been carried out on the main road of Jakarta, namely Jalan Jenderal Sudirman, using the IRAP method to achieve Star Rating 4 by examining the existing along with road Star Rating. The examination of the roads was done to provide input on improving problematic roads. This research has the following objectives:

- To find out the Safer Road Investment Plan (SRIP) and calculate the existing star rating of Jenderal Sudirman road using the IRAP method.
- To find out how to reach Star Rating 4 for Jenderal Sudirman road using the IRAP method.
- To determine the advantages of the IRAP method through the handling and calculation of the Benefit-Cost Ratio (BCR).

The benefit of this research is to provide an evaluation of the IRAP method that will soon be implemented in Indonesia, as well as to provide recommendations for how to repair Jalan Jenderal Sudirman that will be carried out.

2. LITERATURE REVIEW

Traffic safety is a form of effort/method to prevent accidents in the form of security, comfort, and economy in moving cargo (people or goods/animals) by using certain means of transportation through certain media or routes from the location/place of origin to the location/place of destination. [6]

Traffic accidents are a negative event of road infrastructure and accidents also pose a risk to the safety of road users which also results in damage to vehicles and goods so that they become material losses. [7]

The International Road Assessment Program (IRAP) is a road assessment program developed by an international organization in the field of road safety that has succeeded in developing ways of assessing road safety for road users through determining the value or risk score that may occur due to road infrastructure elements [5]. There are 4 protocols in IRAP:

1. Risk mappings, which is road risk mapping using detailed accident data to describe the actual number of deaths and injuries on a road segment.
2. Star Rating, which is the performance shown by a road segment to be classified. In a road segment, 4 modes will be assessed for their star rating, namely passenger vehicles, motorbikes, bicycles, and pedestrians.
3. A safer road investment plan, which is the preparation of a star rating plan for a road segment. To increase the star rating on a road segment, eligible costs (affordable, eligible) will be needed so that one alternative will be chosen from the best planning.
4. Performance tracking, tracking of a road segment that is repeated continuously and re-evaluated.

Road Attribute is an element in a road segment such as markings, signs, geometric, road sections, road complementary buildings, road equipment. Star Ratings are based on road inspection data and provide simple and objective measures of road elements installed for passenger vehicles, motorcyclists, cyclists, and pedestrians. Roads with a five-star rating are the safest while roads with a one-star rating are the least secure. Coding the path attribute is at the heart of the IRAP method. The purpose of coding road attributes is to use images from the geometric reference of the road collected during the survey and record the road attributes of each 100m segment. Risk factors or crash modification factors (CMF), are used in the IRAP method to relate road attributes and accident rates. CMF is a multiplier factor to estimate the number of accidents after

a countermeasure is applied to a certain place. A total of 94 precautions/countermeasures can be used in the IRAP method.

3. RESEARCH METHODOLOGY

Survey method

The survey method is direct observation at the location to be reviewed. This method is the primary method of this research which covers many aspects including geometric, road sections, road markings and signs, road complementary buildings, and road equipment, namely on Jalan Jenderal Sudirman. To get these results, researchers will use Google Street View and Google Earth, then the results of these observations will be analyzed. In this study, the IRAP method is used to determine and analyze the star rating of the existing roads. In the initial stage, coding is carried out every 100m of roads following the Road Attribute form. The attributes reviewed were 78 elements (66 technical and 12 non-technical).

Crash Type Scores =

$$\text{Likelihood} \times \text{Severity} \times \text{Operating speed} \times \text{External flow influence} \times \text{Median traversability} \quad (1)$$

Likelihood refers to the risk factors for the road attribute which take into account the possibility of accidents occurring. Severity refers to the road attribute risk factors that explain the severity of the accident. Operating Speed refers to the factors that describe the extent to which risk changes with speed. External flow influence factors explain the extent to which a person's risk is involved in an accident which is a function of road use. Median traversability factors take into account the potential for a wrong vehicle to cross the median (only applies to collisions of one vehicle and direct collisions of passenger vehicles and motorcyclists).

$$\text{SRS} = \sum \text{Crash Type Scores} \quad (2)$$

The SRS represents the relative risk of death and serious injury for individual road users. The SRS value will be compared with the Star Rating Band table to obtain the Star Rating results, as in Table 1

Table 1. Star rating band [8]

Star Rating	Star Rating Score		
	Vehicle occupants and motorcyclists	Bicyclists	Pedestrians
		Total	
5	0 to < 2.5	0 to < 5	0 to < 5
4	2.5 to < 5	5 to < 10	5 to < 15
3	5 to < 12.5	10 to < 30	15 to < 40
2	12.5 to < 22.5	30 to < 60	40 to < 90
1	22.5+	60+	90+

Each color represents a star rating as follows: black in sections represents Star Rating 1, red in sections represents Star Rating 2, orange in sections represents Star Rating 3, yellow in sections represents Star Rating 4, and green in sections represents Star Rating 5. Calibration of accident victims is carried out to relate the amount of traffic flow to the types of accidents that may occur on these roads within 1 year.

$$F_{VO-ROD} = \frac{\text{the real number of victims dying in a single accident on a road segment}}{\sum_{t=1}^n (SRSvo \times a(AADT))^b \times AADT \text{ without MC} \times \text{Fatality growth}} \quad (3)$$

With CF VO RO-D = calibration factor for vehicles with a single passenger accident (driver's side), n = number of segments per 100 meters, SRS VO = Star Rating Score for passenger vehicles, a = AADT multiplier = 1, AADT = average daily traffic average, b = AADT power = 1, Fatality growth = 1.

$$VO_f = VO_{rod} + VO_{rop} + VO_{holoc} + VO_{hoo} + VO_{int} + VO_{pa} \quad (4)$$

$$SI = F \times \frac{\text{the real number of victims who injured in the network / area}}{\text{the real number of victims who died in the network / area}} \quad (5)$$

With FSI_{total} = total number of deaths and serious injuries. Calculation of BCR to see the treatment is feasible (BCR value > 1 = feasible).

$$\text{Benefit} = FSI_{Saved} \times GDP \text{ per capita} \quad (6)$$

With FSI Saved = the number of victims who died and serious injuries were spared after treatment, GDP per capita = gross domestic product per capita.

4. ANALYSIS AND DISCUSSION

The results of CCTV observations at several points are shown in Table 2.

Table 2. Jenderal Sudirman Road CCTV observation of average daily traffic

Object	Description
Car and motorcycle	2662 vehicle/hour
Motorcycle (%)	(40%) 1063 vehicle
Intersection	230 vehicle
Pedestrian	194 people
Cyclist	27 cyclist
Average speed	40 km/hour

Data on Monday at 07.00-09.00 WIB has more traffic Observation flow than Saturday at 17.00-19.00 WIB. The results of the existing initial score average are vehicle with passengers 4.1, motorcycle 4.2, cyclist 3, and pedestrian 2.8. The Star Rating Score has not reached the Star Rating target. The counter measurement by trial and error using Pedestrian fencing, Bicycle signs 40 km/h speed limit, and Signs at the intersection. Trial and error are carried out according to deficiencies in the problematic segment. The trial and error have an impact shown in Table 3

Table 3. Results of trial and error 1

Subject/Segment	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Average
Vehicle with passengers	5	5	3	5	5	5	5	5	5	3	4.6
Pedestrian	5	5	5	5	5	5	5	5	5	5	5

The economic value of the treatment that will be applied to roads is calculated to see whether the treatment is feasible. The following is the calculation result of the BCR value for each treatment in Trial and error 1, shown in Table 4

Table 4. Results of BCR trial analysis and error 1

Countermeasure	BCR	Treatment properness
Pedestrian fence	37.34	> 1 = Proper
Bicycle signs	523.23	> 1 = Proper
Signs speed limit 40 km / h	693.43	> 1 = Proper
Signs at the intersection	563.83	> 1 = Proper

Based on the results of the analysis of the Star Rating Score in the IRAP method which was carried out on Jalan Jenderal Sudirman which stretches along the segment, the following points will be discussed:

1. The existing initial Star Rating on Jalan Jenderal Sudirman is 4.1 for passenger vehicles, 4.2 for motorbikes, 3 for cyclists, and 2.8 for pedestrians. In the mode of passenger vehicles and motorbikes, it appears that they have reached the destination Star Rating according to the coding, where the facilities and road attributes for the two related modes are adequate. Having 4 lanes which are quite wide. Meanwhile, for cyclists, the absence of a separate lane makes the Star Rating score sufficient at number 3. For pedestrians, having a sidewalk alone is not enough to reach the destination Star Rating because the susceptibility to accidents is still large, seen because there are no protective facilities for pedestrians such as fencing/pedestrian fence.
2. Trial and error were chosen because it is the most suitable, logical, and increased treatment combination. most significant. The treatment combination has also been processed to see whether the treatment is suitable for application based on the benefit and expense ratio (BCR). Based on the results of the BCR analysis, all treatments available in trial and error 1 have exceeded number 1 which is feasible to do, shown in Table 5.
3. Based on the results of trial-and-error analysis, treatment for the cyclist mode can only be done by providing bicycle signs. The 94 countermeasures on the IRAP provide a separate bicycle lane with a minimum width of 1.5m, where the total lane width on Jalan Jenderal Sudirman is not sufficient if it has to be reduced to create a special bicycle lane. Therefore, it is recommended to add bicycle signs in the hope that other traffic users will be more careful about passing bicycles.

Table 5. Star rating results after treatment

Mode	Star rating before	Star rating after
Vehicle with passengers	4.1	4.6
Pedestrian	2.8	5

5. CONCLUSION

Based on the results of the analysis of the Star Rating Score in the IRAP method carried out on Jalan Jenderal Sudirman which stretches 1 km, the following conclusions can be drawn:

1. Based on the results of data analysis, the existing initial Star Rating on Jalan Jenderal Sudirman is 4.1 for passenger vehicles, 4.2 for motorbikes, 3 for cyclists, and 2.8 for pedestrians. For pedestrians and bicycle, the problems are in the long segment in Jalan Sudirman
2. Based on the results of trial and error is the most suitable and logical combination of treatments to be carried out, namely providing pedestrian fences, 40 km/hour speed limit signs, crossing signs at intersections, and bicycle signs. After the treatment has been applied, there is an increase in Star Rating in the Pedestrian mode from 2.8 to 5.
3. The advantage of the IRAP method is that uses a mathematical system in which the Initial Existing

Score and handling/treatment are measured quantitatively. The results of handling and costs can be directly evaluated and calculated to be subsequently compared to BCR.

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