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Implementation of Traffic Safety Management on Road Sections with Non-Standard Grades

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A B S T R A C T

The majority of traffic accidents were caused by the negligence of drivers and road users, followed by vehicle factors, and road conditions as the following variable. The focus of this research is on traffic safety managementcaused by the level of incline and descent on the Sofi-Wayabula road, Morotai Regency. This quantitative descriptive research involved traffic management, maintenance, and patrol supervisors. The research instrument applied consisting observation sheets, interview, and documentation research sheets. The grade or road slope outside the standard requires the mitigation of traffic sign engineering. This study proposes it through the implementation of the Building Information Modeling or BIM method supported by the optimization of 3D animation of traffic signs, especially in North Maluku. The research findings indicated that a number of drivers were assisted by the implementation of 3D animation engineering of traffic signs at a number of accident-prone points along the 10.9 km on the Sofi-Wayabula road, Morotai Regency, North Maluku Province. The research targets agreed by the researcher were effective with traffic safety governance supported by renewable technology methods and engineering.

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INTRODUCTION

Traffic accidents are one of the ongoing problems that require simultaneous and integrated handling of the overall variables of traffic safety management. Law of the Republic of Indonesia Number 22 of 2009 concerning Road Traffic and Transportation describes that a traffic accident is an event that occurs on the road and arises accidentally, involves vehicles and other road users that effected property losses and human casualties. Traffic accidents occurred throughout the road network unexpectedly. Road facilities strongly consider safety aspects in the study of traffic accidents to reduce the fatality rate due to traffic accidents occurred (International Organization for Standardization, 2012). The implementation of the Building Information Modelling or BIM method in road traffic management and governance has not been fully utilized.

Therefore, this study proposes the optimization of traffic sign engineering through 3D animation that is targeted to ultimately reduce the increase in traffic accidents on the 10.9 Km road section on the Sofi-Wayabula road section of Morotai North Maluku Province. The activity of calculating the volume of road traffic density is an initial activity as an effort to survey the initial research to identify comorbidities in the emergence of traffic accidents that occur at a number of points in the research locus determined by the researcher. The Building Information Modeling or BIM method is supported by the Autodesk Revit Architecture auxiliary program as an optimization in identifying the efficiency of traffic signs whose designation has not been maximized with indicators of the under creasing accident rate on the road section that is the research location.

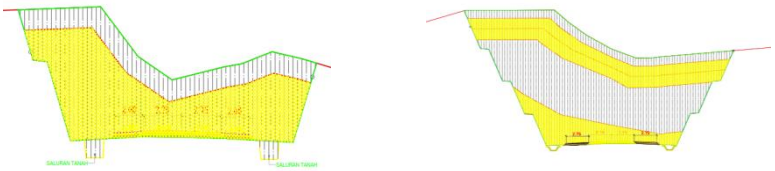

Figure 1. The Under Creasing Accident Rate on the Road Section that is the Research Location

The basis for conducting this series of studies includes traffic safety problems on roads along 10.9 km on the Sofi-Wayabula road section, Morotai Regency, North Maluku Province, which must be moved by the effectiveness of its handlers. The fulfillment of the research target, that is the optimization of 3D animation of traffic signs, especially in a number of traffic-prone points through the implementation of the Building Information Modeling or BIM method, is the expected and practical benefit of research faced by every road users.

THEORETICAL REVIEW

The grade or road slope outside the standard requires the mitigation of traffic sign engineering. This study proposes it through the implementation of the Building Information Modeling or BIM method supported by the

optimization of 3D animation of traffic signs, especially in North Maluku. The research findings indicated that a number of drivers were assisted by the implementation of 3D animation engineering of traffic signs at a number of accident-prone points along the 10.9 km on the Sofi-Wayabula road, Morotai Regency, North Maluku Province. The research targets agreed by the researcher were effective with traffic safety governance supported by renewable technology methods and engineering.

METHODOLOGY

This research is an effort to optimize traffic engineering by utilizing the Building Information Modelling or BIM method in the form of 3D animations of traffic signs. The targets are to enlighten the road users to read and translate the signs. Thus, the accident mitigation can be identified. The locus of the study is located along 10.9 km on the Sofi-Wayabula road section of Morotai Regency, North Maluku Province. Sased on data obtained from the North Maluku Police, it showed that the significance of the accident rate caused by road conditions and the ineffectiveness of traffic signs. On May-August 2022, there was a series of phased research by researcher and involved a number of research informants who provided accurate information regarding the level of road insecurity and are used as the basis for secondary data information and field research that support the result and discussion of this research.

Meanwhile, the data acquisition technique applied were interview techniques, observation, documents studied and accident rate data released from the North Maluku Police. The presentation of research data was explained through identifying the degree of conformity of a number of discussions with established standards. The conformity level scale consisted of corresponding, non-linear and non-existent, then multiplied by 100% and divided by a total of 80 indicator points. The final of the percentage of the degree of conformity of each indicator is the basis for drawing analytical conclusions and described through the stages of research discussion.

RESULTS AND DISCUSSIONS

This study analyzes the implementation of the concept of Building Information Modeling or BIM as a method by designing 3D animated traffic signs according to structural design supported by revit software to obtain the validity of research findings with the final target reducing the number of traffic accidents on roads along 10.9 km on the Sofi-Wayabula road section, Morotai Regency, North Maluku Province so as to increase effectiveness and added value to road users.

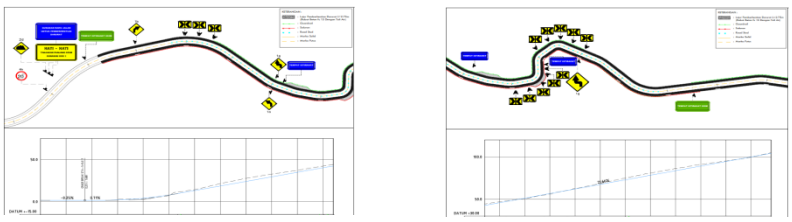

Figure 2. To Increase Effectiveness and Added Value to Road Users

The implementation of the Building Information Modelling Method or BIM, that is supported by Revit Software through Microsoft Excel as supporting software, is considered in accordance with the geographical conditions of the slope of the incline and descent at the research locus. The research site is part of a project that stretches along a Provincial road with a Public Works Department associate in charge. The road section is still in the stage of continuous maintenance so that there are still minimum service standards or SPM that have not met the established standards including a number of road segments, especially uphill and downhill sections.

Since its inception until now, the 10.9 km long road on the Sofi-Wayabula road section of Morotai Regency, North Maluku Province has taken a lot of casualties due to the ineffective function and use of traffic signs placed on several road segments and not enough to help drivers in anticipating the danger of accidents, especially in a number of standard non-grade climbs. Regarding the implementation of the Building Information Modeling or BIM method in 3D animation engineering, traffic signs are shown in several main menu simulations which are pages containing navigation to other pages or application sub-systems, including warning signs, instruction signs, prohibition signs, command signs and simulations. The following is the main menu page looks like described in the image.

Figure 3. The Main Menu Page looks like Described in the Image

The warning page contains a number of buttons with the warning signs logo and at the bottom of the stage there is a description of the function of each of the warning signs and the following is what the warning signs look like.

Figure 4. The Function of each of the Warning Signs and the Following is What the Warning Signs Look Like

The warning page contains a number of buttons with the command signs logo and at the bottom of the stage there is an explanation of the functions of each command sign and the following is what the command signs page looks like. The warning page contains a number of buttons with the prohibition signs logo and at the bottom of the stage there is an explanation of the function of

each prohibition sign and the following is the appearance of the prohibition signs page.

Figure 5. The Function of each Prohibition Sign and the Following is the Appearance of the Prohibition Signs Page

The Instruction Signs page contains a number of buttons with the sign logo and at the bottom of the stage there is an explanation of the function of each instructional sign and the following is the appearance of the instruction sign page. The Simulation page contains an animated video explaining the traffic signs and the following is what the simulation page looks like. The About page contains application designer profile information and application version information of traffic signs and the following view of the about page is described in the following image. This application is equipped with a description feature of each traffic sign and application data obtained from the North Maluku Police so that the validity of the data can be tested proportionally. This application has an animated video page that can add to the user's appeal. Based on research findings when linked to relevant theories and research, it indicates that 3D animated traffic signs are very helpful for road users. The following is data from the North Maluku region traffic accident report which describes the fluctuations in the incidence of traffic accidents.

Table 1. The North Maluku Region Traffic Accident Report which Describes the Fluctuations in the Incidence of Traffic Accidents

No	Description	Unit	01-01-2021 to 31-12-2021	01-01-2022 to 25-07-2022	Total	Per cent	Information
	Based on Road Surface Conditions						
a	GOOD	CASE	200	135	-65	-32.50	Go Down
b	PERFORATED	CASE	3	3	-	-	Same
c	CHOPPY	CASE	3	1	-2	-66.67	Go Down
d	CURLY	CASE	0	1	1	100.00	Climb
e	GROOVED	CASE	0	0	-	-	Same
f	SMOOTH	CASE	2	1	-1	-50.00	Go Down
g	DUSTY /		0	1			Climb

	SANDY	CASE			1	100.00	
h	FLOOD	CASE	0	0	-	-	Same
i	WET	CASE	6	3	-3	-50.00	Go Down
j	UNKNOWN DATA	CASE	3	0	-3	-100.00	Go Down
	SUM	**CASE**	**217**	**145**	**-72**	**-33.18**	Go Down
	BASE GEOMETRIC ROAD						
a	STRAIGHT	CASE	138	106	-32	-23.19	Go Down
b	CORNERING	CASE	57	31	-26	-45.61	Go Down
c	CLIMBS / DESCENTS	CASE	12	19	7	58.33	Climb
d	TUNNEL	CASE	0	0	-	-	Same
e	BRIDGE	CASE	3	1	-2	-66.67	Go Down
f	SHARP BENDS / FRACTURES	CASE	2	0	-2	-100.00	Go Down
g	INTERCHANGE (Y)	CASE	2	3	1	50.00	Climb
h	ROUNDABOUT (O)	CASE	1	0	-1	-100.00	Go Down
i	INTERSECTION FOUR (x / +)	CASE	8	0	-8	-100.00	Go Down
j	INTERCHANGE (T)	CASE	5	3	-2	-40.00	Go Down
k	MISALIGNED INTERSECTION FOUR (-L)	CASE	0	0	-	-	Same
l	MULTI	CASE	0	0	-	-	Same
m	UNKNOWN DATA	CASE	1	1	-	-	Same
	SUM	**CASE**	**229**	**164**	**-65**	**-28.38**	**Go Down**

As stated by Widowati (2017), risk management is a series of processes for identifying, measuring and determining risks as well as developing strategies to prevent traffic accidents and events that cause losses. While the discussion related to road safety risk management, a risk management system developed based on a risk analysis process that includes risk aspects, risk triggers and related descriptive variables; efforts to reduce the uncertainty of

risk analysis methods, periodic timing, duration and surveys should be in accordance with contextual needs; and the development of an integrated traffic accident risk management scheme on all related variables, should, be linear local conditions in a proportionate and comprehensive manner. The success rate of traffic accident risk management depends on the achievement of each supporting performance system indicator (da Costa et al., 2016). Road safety management and control has the main task of assessing the risk of traffic accidents based on case studies in order to improve the control of the risk of high traffic accidents in traffic (Sun et al., 2020).

Road Traffic and Transport Safety Management or KLLAJ Management, according to the Government Regulation of the Republic of Indonesia Number 37 of 2017 concerning Road Traffic and Transportation Safety is the entire effort of policyholders who are organized and integrated to realize traffic and road transport safety as stipulated in the National General Plan for Road Traffic and Transportation Safety (RUNK KLLAJ). Meanwhile, the implementation of traffic safety management is in accordance with ISO 39001: 2012, the system framework includes the scope and context of the organization; leadership; planning; implementation; monitoring and evaluations; and continual Improvement in reducing mortality and serious injury in the incidence of traffic accidents (International Organization for Standardization, 2012).

A component of Traffic Safety Management, called planning related to indicators of identification of the risk of traffic accidents on the road, has not been carried out a risk assessment. Thus, the process of analyzing the risk of traffic accidents has not been documented in detail. Data collection is carried out only on the aspects of the causes of traffic accidents and has not been carried out a risk assessment to determine the priority of the problems handled. This condition is supported by the interview process conducted and explained that the implementation of the safety management system is in the process of improvement considering that the road isincluded in the category of newly operating roads and in the process of maintenance. Traffic safety management has a role in supporting the reduction of traffic accident rates and providing safety and comfort guarantees for road users (Varhelyi, 2016).

The term Building Information Modeling or BIM first appeared in 1992 pioneered by G.A. van Nederveen and F.P. Tolman, but the Building Information Modeling method was known in 2002 when Autodesk released an article entitled Building Information Modeling (van Nederveen and Tolman, 1992). The use of BIM technology in the form of an accurate virtual model that can be implemented digitally. Application models designed in computerized systems are able to store the geometry and data needed in building, fabrication, and other activities to realize buildings (Eastman, Teicholz, Sacks, and Liston, 2011). The Building Information Modelling method is supported by an integrated design and construction process facility to obtain better results, the expenditure and duration of a project work is reduced and controlled. Autodesk released BIM-based software called Revit. Revit integrates interdisciplinary architecture, structure, mechanical, electrical, and plumbing or MEP.

The originality of this study is compared linearly with previous similar studies by Bambang Haryadi, et al in 2014, Amelia Makmur and Ranto P. Rajagukguk in 2015, and Deni Setiawan and Mayani Asima in 2019. The difference between this research and a number of previous studies is in the analysis stage of the implementation of traffic safety management which has never been carried out before focusing on novelty problems. A number of parties responsible for traffic safety are BPJT. Meanwhile, the vision and mission were not included in cooperation between parties in organizing traffic safety. Consequently, the relevant managers could not be able to distinguish in depth about traffic safety. Due to the uncertainty in the commitment, it will hinder the implementation of traffic safety efforts. Meanwhile, in determining actions and strategies in ensuring traffic safety, the commitment of decision makers is needed because without the commitment of top management, these efforts will not be realized (Varhelyi, 2016). The commitment is manifested in the form of a traffic safety management policy that is written, signed and clearly states the purpose of traffic safety and is communicated to all interested parties. However, the process of socializing road safety policies has not been effective. This condition is due to the absence of special program scheduling related to the communication process of policy implementation. The existence of this policy helps limit the behavior of road users (Arindita et al., 2019).

Risk mapping has not been accompanied by an assessment of the risk level of traffic accidents so it has not been assessed quantitatively. Risk assessment arising from failure and negligence is categorized based on risk matrix measuring parameters to determine the risk category to be said to be low, medium, high or extreme (Setiawan & Asima, 2019). Based on the opinion of Widowati (2017) the risk assessment process is carried out starting from risk identification, risk analysis, and risk evaluation. On this section of the road, there are several road conditions that are not in accordance with applicable standards. On the main line there are still potholes, ruttings, and cracks at some points. Meanwhile, the anti-glare segment has only been installed 90%. Linear with the research of Santosa, Mahyuddin, & Sunoto (2017) damaged and potholes affect the occurrence of traffic accidents. The quality and completeness of road components also trigger the occurrence of traffic accidents (Touahmia, 2018). The use of traffic signs provide extraordinary benefits to motorists if they are applied according to the functions for road users. The aspect of the usefulness of traffic signs can be achieved if road users are able to read the signs well. Renewable methods supported by appropriate technology are needed to accomplish these targets and 3D animation of traffic signs is implemented in this study to obtain the final target of the study, those are reducing accident rates and proportional traffic governance and management.

CONCLUSIONS AND RECOMMENDATIONS

Based on the research findings and discussion, it can be concluded that the realization of the Building Information Modelling or BIM method in engineering 3D animated traffic signs along 10.9 km of roads on the Sofi-Wayabula road section, Morotai Regency, North Maluku Province, is able to

provide comprehension and reduce accident rates. The suggestions proposed by the researchers include ongoing socialization and training related to traffic safety and road safety policies. Besides, regulations that are needed to increase road users' awareness of the importance of mitigating traffic accidents by heeding the road order equipment provided.

FURTHER STUDY

Therefore, this study proposes the optimization of traffic sign engineering through 3D animation that is targeted to ultimately reduce the increase in traffic accidents on the 10.9 Km road section on the Sofi-Wayabula road section of Morotai North Maluku Province. The activity of calculating the volume of road traffic density is an initial activity as an effort to survey the initial research to identify comorbidities in the emergence of traffic accidents that occur at a number of points in the research locus determined by the researcher. This application is equipped with a description feature of each traffic sign and application data obtained from the North Maluku Police so that the validity of the data can be tested proportionally. This application has an animated video page that can add to the user's appeal. Based on research findings when linked to relevant theories and research, it indicates that 3D animated traffic signs are very helpful for road users. The following is data from the North Maluku region traffic accident report which describes the fluctuations in the incidence of traffic accidents.

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