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RESEARCH ARTICLE

Digital Human Modeling Tecnomatix Jack To Analyze The Visibility Of Traffic Light

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Abstract

Regulation of the Minister of Transportation of the Republic of Indonesia Number PM 49 of 2014 concerning Traffic Signaling Equipment. The regulation does not regulate the driver's visibility to the traffic light. Too close a distance causes a forced neck position. Researchers conducted a visibility analysis using the Digital Human Modeling Technomatix Jack. Traffic light data in the city of Denpasar, Bali, Indonesia. Anthropometric data from the Indonesian Ergonomics Association, namely data for Indonesian men, 50% percentile, aged 17 to 47 years. Tested motorcyclists, jeeps, and sedans. The result is that the distance from the left traffic light for motorcycles, jeeps, and sedans is an average of 6.75m. and the distance of the top lamp is 11.9m, 7.64m, and 8.74m. Some traffic lights in Denpasar City require auxiliary lights to be placed on the opposite side of the road.

Keywords: DHM, Traffic Light, Tecnomatix. Visibility

Introduction

In all countries of the world, important information about road limitations and conditions is presented to drivers as visual signals, such as traffic signs and traffic lanes. Traffic signs are an important part of road infrastructure to provide information about the current state of the road, restrictions, prohibitions, warnings, and other helpful information for navigation [1][2]. in adverse traffic conditions, the driver may accidentally or deliberately not notice traffic signs [3].

The main factors that can determine a car accident are three: the environment, the vehicle, and the driver. Among these factors, the most relevant is certainly the human one: it is estimated that in 20-40% of fatal accidents the driver's psychophysical conditions are the main cause or a co-factor. Studies on human factors and their interaction with the vehicle may be useful for road safety [4]. The driver's eye height from the ground is one of these variables [5]. This height is one of the parameters needed for the determination of the minimum radius in the vertical crest. Marginally the measurement must be considered in setting the minimum side distance of an obstacle to visibility in horizontal curves [5].

The real-time measurement of traffic queue parameters is required in many traffic situations such as accident and congestion monitoring and adjusting the timings of the traffic lights [6]. To detect and measure queue parameters, two different algorithms have been used. The first algorithm is motion detection and the second is a vehicle detection operation.

Visibility can directly reflect the driver's visual area and blind spot of operation. In Jack software, View Cones simulation starts from the operator's eyes and sets the cone angle as 40 degrees of human physiological characteristic visual angle. Vision Analysis simulation can intuitively reflect the visual area range of the human eye's visual angle and judge the rationality of design through area coverage [7].

In Indonesia, regulations regarding traffic lights are regulated in the Regulation of the Minister of Transportation of the Republic of Indonesia Number PM 49 of 2014 concerning Traffic Signaling Devices [8]. The regulation does not regulate the minimum distance between the driver's stop and the traffic light. So in this research, the distance is simulated using a simulator.

Materials and Methods

A. Tecnomatix Jack

Jack is the stand-alone offering from Siemens PLM Software for Human Factors and Ergonomic Analysis. Jack has several add-on modules which will be covered in this paragraph and have separate training that is available. The first, 3D Body Scan can be used to create humans using existing body scans (such as the SAE CAESAR Scans). The second module, the Occupant Packaging Toolkit (OPT) can be used to maximize vehicle design for the occupant or user. The third is the Task Analysis Toolkit (TAT), which is used in the manufacturing communities to design better workplaces and maximize the safety of workers. Finally, the MoCap module, which adds the ability to connect to a wide variety of virtual reality hardware for immersive studies. Both the OPT and TAT have separate training manuals which explain the capabilities of the modules in greater detail [9].

Jack 9.0 is available as a 64-bit application that runs on 64 bit Windows workstations. A minimum reasonable system requirement is shown in the configuration table below. However, configuration requirements may increase if higher performance is desired. For example, if you will be working with large geometry sets or using motion capture, a faster machine with more memory will likely be required. Version 9.0 has a DirectModel rendering engine that supports JT file versions through v10. This new version of DirectModel is designed to work with graphics cards using OpenGL 3.0 or higher. Certain features, such as reflections (mirrors), may not work on older graphics cards. The required hardware is shown in table 1.

Windows 7, Windows 10		
	Minimum	Recommended
Processor	1 GHz	2 GHz
Memory	2 GB	4 GB
Free disk	400 Mb	600 Mb
Graphics:		
OpenGL Support	3	3 or higher
Maximum Screen Resolution	1280x1024	1920x1200

Table 1: Jack 9.0 Minimum Recommended Configuration

B. Regulation Of The Minister Of Transportation Of The Republic Of Indonesia Number Pm 49 Of 2014

Regulation of the minister of the Republic of Indonesia number 49 of 2014 regulates Traffic Signaling Equipment [8]. A traffic signaling device is an electronic device that uses light signals which can be equipped with sound signals to regulate the traffic of people and/or vehicles at intersections or on roads. The Traffic Signaling Tool serves to regulate the traffic of people and/or vehicles at intersections or on roads. Traffic signaling tools consist of three-color lights, two-color lights, and one-color lights. Traffic Signaling Devices with three-color lights are used to regulate Vehicles. Three-color lights consist of red, yellow, and green lights. Three-color lights are arranged vertically in sequence from top to bottom in the form of red, yellow, and green lights or horizontally sequentially from the perspective of Road Users from right to left in the form of red, yellow, and green lights. The main components consist of Luminaires, support poles, foundation construction buildings, control devices, and installation cables. The tricolor lights are placed at a distance of at least sixty centimeters measured from the outermost part of the armature to the outermost edge of the road shoulder and placed at a distance of at least thirty centimeters measured from the outermost part of the armature to the outermost left and right edges of the lane divider or median. The size and shape of the three-color lights are shown in Figure 1 for Straight Pole Traffic Signaling Devices, Figure 2 for Curved Pole Traffic Signaling Devices, Figure 3 for Elbow Pole Traffic Signaling Devices, and Figure 4 for Pole Traffic Signaling Devices Goal. This study does not discuss two-color lamps and one-color lamps.

Figure 1: Straight Pole Traffic Signaling Devices [8]

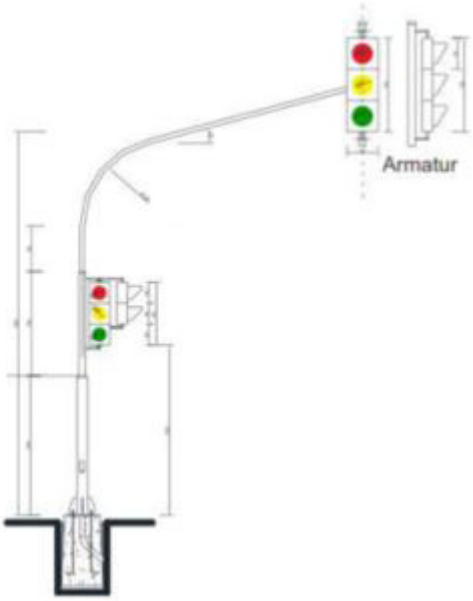

Figure 2: Curved Pole Traffic Signaling Devices [8]

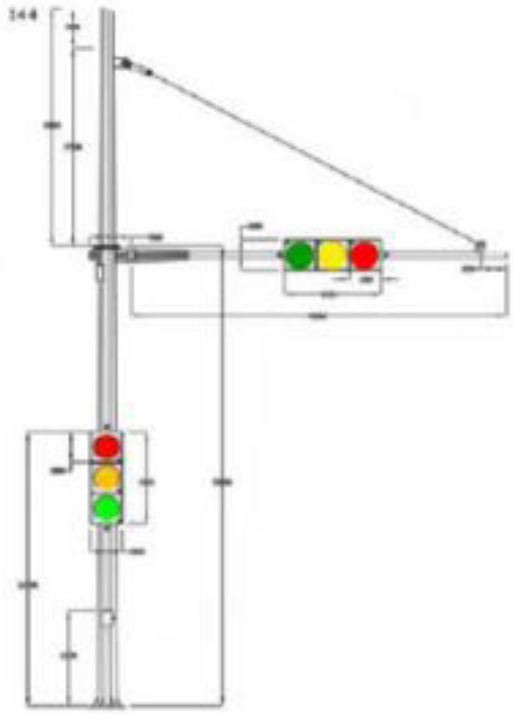

Figure 3: Elbow Pole Traffic Signaling Devices [8]

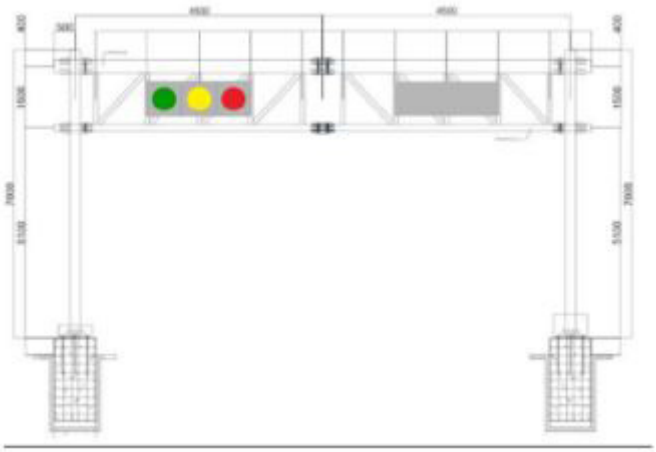

Figure 4: Traffic Signaling Devices Goal

C. Methods

A sampling of a traffic light was carried out in Denpasar City. The sample is used to see the existing traffic light conditions. Making simulations using Tecnomatix Jack software version 9 with anthropometry using anthropometry Indonesian men 50% percentile aged 17 to 38 years obtained from the Indonesian Ergonomics Association web site [10]. Anthropometric data is adjusted to the table in the Jack software. There are 3 vehicles used, namely motorbikes, jeeps, and sedans. Data = data on the height of the traffic light using data from the Regulation of the Minister of Transportation No. 49 of 2014. From the simulation, the normal visibility was analyzed for the traffic light on the left and the traffic light on the top. The type of traffic light used is a curved pole type. rice.

Result and Discussion

The surveyor surveyed several traffic lights in the city of Denpasar. The data collected is shown in Figure 5, including the height of the top traffic light (marked 1), the left side traffic light (marked 2), and the additional traffic light at the farthest point marked 3). The position of the lamp on the left and the closest part of the data obtained is 3.6 m while the distance of the farthest traffic light obtained is 30.7 m from the driver. for the farthest distance using an auxiliary lamp which is added at a certain distance. In Indonesia, the front queue is used for motorbikes, while cars are in the queue after motorbikes. For some traffic lights in Denpasar City, motorbikes require a rather forced head position to be able to see the traffic light.

Figure 5: Traffic light example

No	Lokasi	Link Lokasi
1	Jl. Sidakarya, Sesetan, Denpasar Selatan,	https://goo.gl/maps/YWxT17xp6DkcfUzN7
2	Jl. Tukad Yeh Aya, Panjer, Denpasar Selatan,	https://goo.gl/maps/AE3d5AiSKcpMFroSA
3	Jl. Tukad Batanghari Panjer, Denpasar Selatan,	https://goo.gl/maps/AE3d5AiSKcpMFroSA
4	Jl. Tukad Musi , Panjer, Denpasar Selatan	https://goo.gl/maps/AE3d5AiSKcpMFroSA
5	Jl. Subita, Sumerta, Denpasar Timur,	https://goo.gl/maps/R81y8Loz9hwdbWhD8
6	Jl. WR Supratman , Sumerta, Denpasar Timur,	https://goo.gl/maps/R81y8Loz9hwdbWhD8
7	Jl. WR Supratman Barat, Sumerta, Denpasar Timur	https://goo.gl/maps/R81y8Loz9hwdbWhD8
8	Jl. Surabi, Kesiman, Denpasar Timur	https://goo.gl/maps/heJHRSgKBZuZBvch9
9	Jl. Sokasati, Kesiman, Denpasar Timur	https://goo.gl/maps/heJHRSgKBZuZBvch9
10	Jl. WR Supratman Tengah , Kesiman, Denpasar Timur,	https://goo.gl/maps/heJHRSgKBZuZBvch9
11	Jl. Waribang, Kesiman Petilan, Denpasar Timur	https://goo.gl/maps/1XtxkpYKQydMxim59
12	Jl. Sulatri, Kesiman Petilan, Denpasar Timur	https://goo.gl/maps/1XtxkpYKQydMxim59
13	Jl. Hasanuddin, Pemecutan, Denpasar Barat,	https://goo.gl/maps/dnitTm8MBBuQy88Z7
14	Jl. Imam Bonjol Utara, Pemecutan, Denpasar Barat	https://goo.gl/maps/dnitTm8MBBuQy88Z7
15	Jl. Imam Bonjol , Pemecutan Klod, Denpasar Barat	https://goo.gl/maps/BSLmQnKw4o3bew4E8
16	Jl. Pulau Biak, Pemecutan Klod, Denpasar Barat	https://goo.gl/maps/BSLmQnKw4o3bew4E8
17	Jl. Imam Bonjol , Pemecutan Klod, Denpasar Barat	https://goo.gl/maps/BSLmQnKw4o3bew4E8
18	Jl. Gunung Karang , Pemecutan Klod, Denpasar Barat	https://goo.gl/maps/BSLmQnKw4o3bew4E8
19	Jl. Pulau Misol, Dauh Puri Kauh, Denpasar Barat	https://goo.gl/maps/o8geCUFWPSvfJtow8
20	Jl. Teuku Umar , Dauh Puri Kauh, Denpasar Barat	https://goo.gl/maps/o8geCUFWPSvfJtow8

Table 2: Traffic Light Location With Google Map

Indonesia Antropometri
THE LARGEST ANTHROPOMETRY DATA IN INDONESIA

YOU ARE HERE Kompilasi Data → Data Antropometri

Data Antropometri

Rekap Data Antropometri Indonesia

Suku - **Semua Suku** , Jenis Kelamin - **Semua Jenis Kelamin**, Tahun - **2018** s/d **2018** , Usia - **17** s/d **47**

Dimensi	Keterangan	5th	50th	95th	SD
D1	Tinggi tubuh	149.67	164.95	180.24	9.29
D2	Tinggi mata	138.25	153.62	168.98	9.34
D3	Tinggi bahu	119.03	137.1	155.16	10.98
D4	Tinggi siku	86.29	103.93	121.56	10.72
D5	Tinggi pinggul	86.34	96.01	105.67	5.88
D6	Tinggi tulang ruas	60.83	74.18	87.54	8.12
D7	Tinggi ujung jari	53.69	61.08	68.46	4.49
D8	Tinggi dalam posisi duduk	66.85	86.86	106.87	12.16
D9	Tinggi mata dalam posisi duduk	60.77	76.49	92.2	9.55
D10	Tinggi bahu dalam posisi duduk	47.21	61.02	74.83	8.39
D11	Tinggi siku dalam posisi duduk	10.2	24.44	38.69	8.66
D12	Tebal paha	8.25	16.38	24.51	4.94
D13	Panjang lutut	51.61	59.04	66.46	4.52
D14	Panjang popliteal	41.33	48.56	55.8	4.4
D15	Tinggi lutut	44.84	52.68	60.53	4.77
D16	Tinggi popliteal	35.44	41.21	46.99	3.51
D17	Lebar sisi bahu	32.97	41.88	50.79	5.42
D18	Lebar bahu bagian atas	25.37	34.28	43.2	5.42
D19	Lebar pinggul	25.62	36.11	46.59	6.37
D20	Tebal dada	-12.11	23.3	58.72	21.53
D21	Tebal perut	14.4	22.49	30.59	4.92
D22	Panjang lengan atas	22.13	37.17	52.21	9.14
D23	Panjang lengan bawah	34.03	42.81	51.6	5.34
D24	Panjang rentang tangan ke depan	62.79	76.77	90.74	8.49
D25	Panjang bahu-genggaman tangan ke depan	52.09	64.57	77.05	7.59
D26	Panjang kepala	15.87	19.02	22.17	1.92
D27	Lebar kepala	13.06	15.79	18.53	1.66

Figure 6: Anthropometric data of Indonesians 17-47 years old

Anthropometry data retrieval due to the Covid-19 Pandemic conditions used data obtained from the website of the Indonesian Ergonomics Association. Using 50% percentile male data aged 17-47 years. Anthropometric data is shown in Figure 6. Anthropometric data is inputted into the Tecnomatix Jack software by customizing human anthropometry. The results are shown in Figure 7.

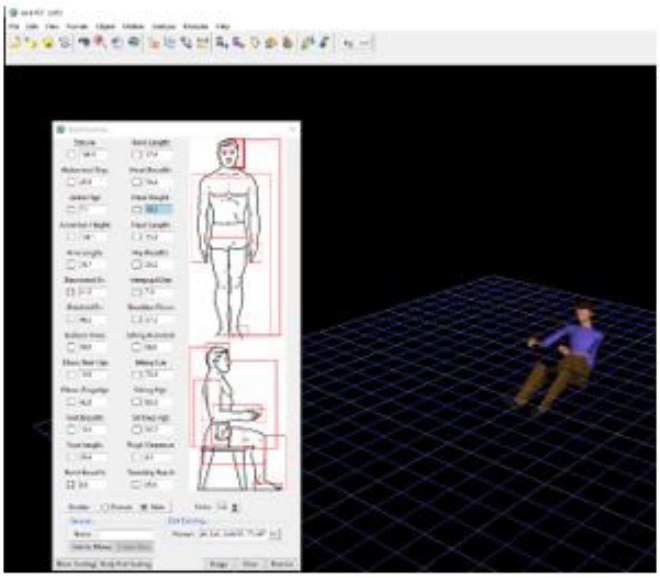

Figure 7: Anthropometric data on the Tecnomatix jack simulator

Figure 8: Joint position of the human body in a motorcyclist simulation

The next stage is making a vehicle queue simulation at the traffic light on the Tecnomatix Jack simulator. In the simulation, there are 3 vehicles used by the driver, namely motorcycles, jeeps, and sedans. The assumption made in this simulation is that the driver is in the leading position in the traffic light. For simulating a rider using a motorcycle, the joint conditions on the body are shown in Figure 8. Simulation results of motorcycle riders in line at the traffic light are shown in Figure 9 for the minimum distance of view towards the left side of the traffic light with the minimum distance from the vehicle to the traffic light is 6.57m and Figure 10 shows the minimum distance from the vehicle to the top traffic light is 11,9 m. Traffic light in the city of Denpasar, placing a queue of motorcycles in the front position. This causes some traffic lights to require additional lights across the road to make it easier for motorists to see the traffic lights. There are several traffic lights in the city of Denpasar that do not meet this requirement.

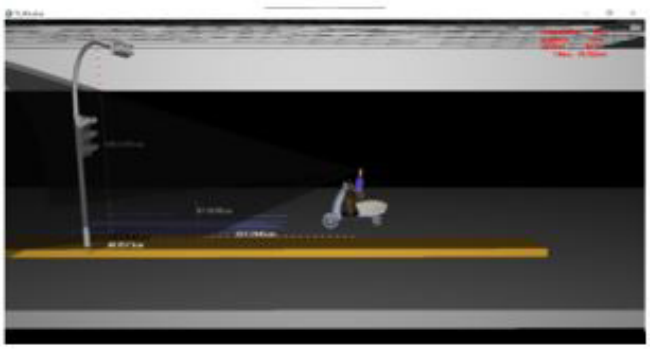

Figure 9: The distance for motorcyclists to the left side of the traffic light

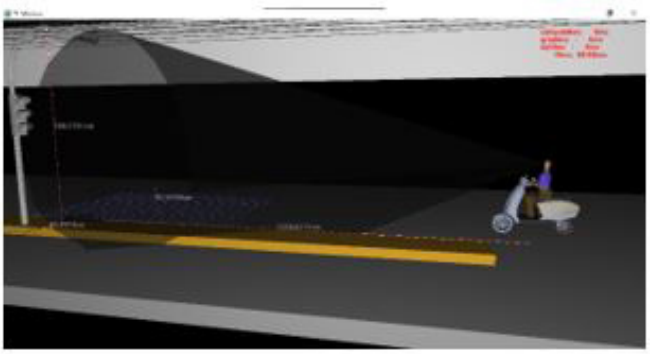

Figure 10: The distance of the motorcyclist to the top traffic light

Figure 11: Joint position of the human body in jeep car driving simulation

Car drivers in line at traffic lights in Indonesia are usually after motorcycles. The simulation of the queue at the traffic light using a car is displayed in two vehicles, namely a jeep and a sedan. The two cars in the main simulation differ in the seat height from the ground. Another different thing is the position of the driver in the vehicle. The position of the joint of the human body on the jeep is shown in figure 11. while the position of the joint of the human body on the sedan is shown in figure 12. The type of traffic light used in the simulation is the same as when the simulation uses a motorcycle. The traffic light height data uses data from the regulation of the Minister of Transportation of the Republic of Indonesia No. 49. The simulation results of the jeep's minimum distance to the traffic light are shown in Figure 13 for the position of the left traffic light and Figure 14 for the position of the top traffic light. Each gets a distance of 6.77m and 7.64m for the distance to the left traffic light and the top traffic light.

Figure 12: Joint position of the human body in sedan car driving simulation

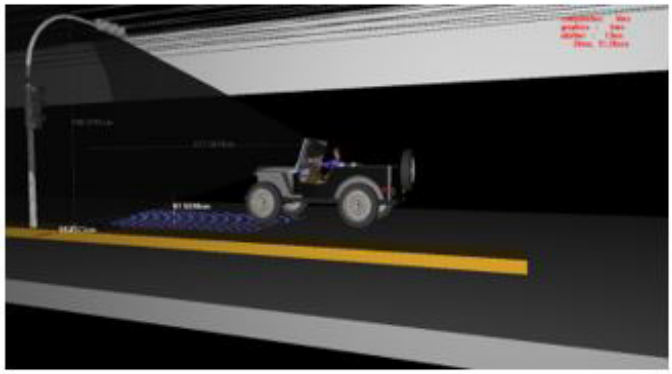

Figure 13: The distance of the jeep driver to the left side of the traffic light

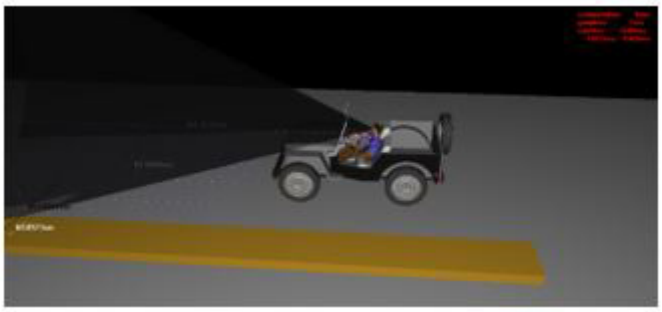

Figure 14: The distance of the jeep driver to the top of the traffic light

The simulation results of the minimum distance for a sedan car driver to the traffic light are shown in Figure 15 for the distance from the driver to the left traffic light and Figure 16 for the distance from the driver to the top traffic light. From the simulation results, each distance is 6.92m for the distance from the driver to the left traffic light and 8.74m for the distance from the driver to the top traffic light. When compared to a jeep, the distance obtained in a sedan is relatively longer. This is caused by the seat height from the ground level is higher for a jeep. Similarly, when compared to a motorcycle, the visibility will be further due to the lower seat height on the motorcycle. From the simulation results, it can be seen that the higher the driver's seat from the ground, the closer the visibility to the traffic light. Because there are various kinds of vehicles available, it can be recommended that the vehicle that has the lowest seat height be used as a benchmark. Vehicles that have relatively lower seats are motorbikes and motorbikes in Indonesia are placed at the front of the queue. Motorcycles can be used as a standard for determining the distance of the vehicle queue to the traffic light. This is necessary to provide comfort for motorists in queuing at traffic lights.

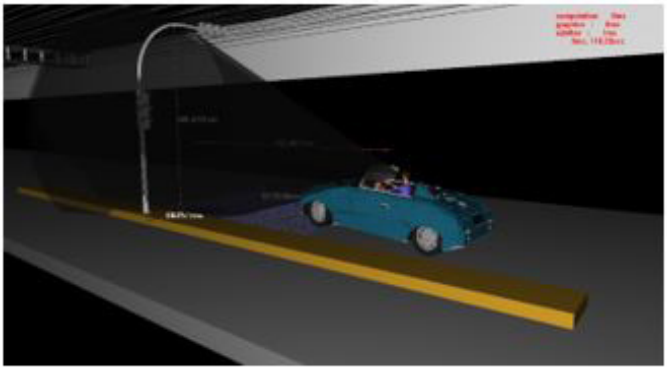

Figure 15: The distance of the sedan driver to the left side of the traffic light

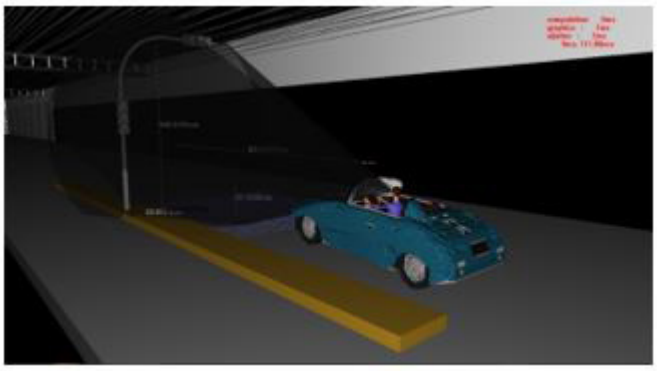

Figure 16: The distance of the sedan driver to the top of the traffic light

No	Transportation type	Distance to left traffic light (m)	Distance to top traffic light (m)
1	Motorists	6,57	11,90
2	jeep car driver	6,77	7,64
3	sedan driver	6,92	8,74

Table 3: Comparison of Waiting Distance at The Traffic Light

Table 3 shows that there is no significant difference in the views of motorcyclists, jeeps, and sedans at the traffic light on the left, while at the top traffic light there is a significant difference. From the results of a survey conducted on traffic lights in Denpasar City, on average for motorcycle riders whose position is at the front, the distance from the traffic light to the vehicle is too close. To overcome this condition, the existing traffic light has been provided on the opposite side of the road in front of an additional traffic light to make it easier for motorists to see. However, it is also necessary to pay attention to the size of the traffic light that is used if the distance is too far.

Conclusion

1. The digital human modeling Tecnomatix jack can be used to estimate the visibility distance from traffic lights to motorists.
2. From the testing of the three vehicles tested, namely motorcycles, jeeps and sedans, the distance from the traffic light to the driver for the left-hand traffic light is an average of 6.75m while to the top traffic light, respectively 11.9m, 7.64m, and 8.74m for motorbikes, jeeps and sedans
3. The distance of the waiting area at the traffic light is largely determined by the height of the driver's seat.
4. If a comfortable distance from the traffic light to the driver cannot be achieved due to insufficient space, this can be circumvented by placing a traffic light across the road while paying attention to the distance of the lamp placement and the size of the lamp.

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