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A New Design and Simulation of Smart Sensing for Emergency Vehicle

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ABSTRACT

All emergency vehicles are designed and certified to better respond to emergencies. Also, emergency vehicles have the legal right to violate the highway code to get to a certain area as quickly as possible. The victim's existence is helpless in the event of a stroke of fate or an emergency. Because of the visitors, emergency vehicles also have to give way to get to the scene. This change can also further increase the victim's chance of death. Therefore, to solve the problem, it is crucial to plan and limit travel time so that emergency vehicles use their maximum capacity. Preventive service can be a means for emergency vehicles to reach their intended vacation spot in a much shorter time. So, there is a call to address this emergency vehicle action. This look at strategies is an intelligent detection utility to deal with alarming traffic jams. This mission aims to simulate the intelligent detection of emergency vehicles through simulation software. The purpose of e-Buzz: Simulation of Smart Sensing for Emergency Vehicles is to assist the government that may be responsible for responding to emergencies, including ambulance, police, fire, and many others. The main element to ensure that this simulation works is based on the type of sensor used and its usefulness and responsibility. The sensor can detect the sound of emergency vehicles and respond immediately to them by signalling smaller parallel visitors to change the screen from pink to green or vice versa. Therefore, this flow reduces the travel time required for emergencies.

1. Introduction

Among ASEAN countries, Malaysia has the fourth-highest congestion level with the second-highest carbon dioxide (CO_2) emissions, according to the traffic index by City 2020 Mid-Year [1].

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Traffic congestion is an emerging problem, especially in developing countries like Malaysia. The growth of the middle class and urban population considerably impacts the increase of vehicles, which has a global impact on increasing traffic congestion and delays [2]. There is proof that traffic congestion will eventually cause slow traffic, which will lengthen travel times and make it a major issue in urban areas. Therefore, it is crucial to increase transportation efficiency, especially when using emergency vehicles.

Each emergency vehicle is designed and approved to respond to emergencies [3]. Additionally, the law permits emergency vehicles to break normal traffic rules to reach their destination as soon as possible, such as crossing an intersection at a red traffic light [3]. The victim's life depends on other people’s mercy in an accident or emergency [4]. Traffic delays can cause emergency vehicles to arrive at the scene with delays. This delay can increase the chances of the victim dying. Due to this, it is important to strategically plan the route and minimise travel time to maximise the efficiency of emergency vehicles [5]. Pre-emption (time management) can make it possible for emergency vehicles to reach their destination in a much shorter time. Therefore, the current emergency vehicle situation must be addressed.

This study explores the use of an intelligent sensor application to deal with bad traffic congestion. The goal of this project focuses on the design of e-Buzz and simulating the intelligent sensors for emergency vehicles using simulation software. The e-Buzz: Intelligent Detection Simulation for Emergency Vehicles was created to support responsible authorities in responding to emergencies including ambulances, police, fire brigades, and many others. These vehicles can break the standard traffic rules to save lives in an emergency. Whether this simulation works successfully depends primarily on the sensor type, application, and responsibility. It indicates that the sensor is very sensitive to its environment. This study aims to address the problem statements mentioned earlier.

One of the e-Buzz objectives is to prioritize information from real-time traffic monitoring to provide a faster emergency response. Furthermore, it evaluates the methods using a case study for the efficacy in providing faster emergency response and minimises its delay in traffic. Finally, using the software, e-Buzz develops a complete simulation of smart sensing for emergency vehicles. The sensor’s functionality is to detect the sound of emergency vehicles and respond immediately by signalling the parallel traffic light to change the display from red to green or vice versa. Thus, this action will shorten travel time for emergency vehicles. Although this suggestion may seem contradictory and simple, additional effects impact the sensor’s efficiency and can cause road congestion. Due to the increasing number of vehicles, unstable traffic signal changes and heavy traffic will generate many waves for sensors to detect unnecessary frequencies. Preventing the sensor waves and frequencies is crucial to ensure e-Buzz's success rate. The applicability of sensors (e.g., ultrasonic sensor, colour sensor, light sensor, and microphone sensor) can be tested by predicting the success rate of this project. According to one of the studies, the microphone sensor is chosen for its ability to ignore different waves and frequencies and highly detect emergency vehicle sounds. Therefore, this study requires information from real-time traffic monitoring to provide a faster emergency response without affecting safety. A case study evaluation method of effectiveness is also used in this study to provide faster emergency response and minimise traffic delays. In addition, this study contributes to developing a complete simulation of intelligent sensing for emergency vehicles using SolidWorks and PTV Vissim software.

2. Framework Design

The project scope is bound to the case at Pekan Bukit Pasir, Muar, Johor. Based on the observation, the traffic flow is heavy during rush hours. Hence, this project’s simulation will be conducted during rush hours because there are more vehicles at these times. As a result, the accuracy of the simulation is highly expected to be realistic based on the traffic flow. The information related to the objective is collected to improve the real traffic simulation as this project is still under development according to the statistics. Next, the efficacies of identified sensor detection on frequent ambulance sirens are investigated to provide a faster rate of emergency help and minimise ambulance traffic delays [6]. Evidence on this adoption is important to prove that the e-Buzz project is applicable for lifesaving or rescuing life by ensuring that emergency vehicles, such as ambulances are routed to the shortest path to reach the nearest hospital. To test the applicability of the e-Buzz is performed by using simulation software for designing and simulating the scenario as mentioned earlier. In this study, the SolidWorks version 2020 is used for designing, and PTV Vissim 2022 is used for the case study simulation.

This paper provides advanced insight from prioritizing real-time traffic monitoring to achieve a realistic and faster emergency response. The scopes are bound such as the software used for designing and simulation, the availability of the software licensing, and the sensor type used for e-Buzz. The e-Buzz introduces the real-time testing case study and is exposed to limited time during peak and non-rush hours. Therefore, the case study allows to evaluate the efficacy of providing faster emergency response to reduce traffic delays.

2.1 Traffic Management Smart System

The research gaps that need to be explored in a modern scenario, there is a sane site visitor management system for smart metropolises. The suggested answer is to take an ambulance and find the shortest possible route to its destination. Managing moderate traffic site visitors is an important part of how 4,444 smart site visitors work. There are 4,444 important factors to consider. One of them is the duration and consistency of inexperienced slowly. Some site visitor structures specify a hard and fast medium length and streak that is the most acceptable value for regular and regular site visitors but no longer acceptable for dynamic site visitors. Currently, most countries do not think about ambulances such as ambulances, police cars, and trucks and take various measures, including inexperienced lighting fixtures, to put emergency engines on standby, causing survival and death.

Additionally, multiple engines increase the ambulance's reaction time while the ambulance makes its decision until the ambulance arrives at the ambulance location [7]. Proposed answers to shorten travel times by building short-length and naive lighting series, respectively, are mainly based on dimensional distance with shorter deposition and reaction times. Initially, Integrated Transportation Management Systems (ITMS) is offered considering the fate of site visitors and the unique irony of easy hacking. Every car is based on the Internet in using Wi-Fi generation for the purpose of talking to various people [8]. This involves providing an environmentally friendly VANET-based navigation vehicle for ambulance use. Vehicular ad hoc networks (VANETs) are created using the principles of mobile ad hoc networks (MANETs). This usage involves the problem of determining the shortest route to a vacation destination to avoid sudden congestion in updating travel information and data in real-time.

A dynamic routing engine was proposed by integrating real-time site visitor randomness and international location structure. 4,444 site visitors suggested ingenious techniques for fighting ambulances, striking stolen motors, and managing congestion. This attaches a Radio Frequency Identification (RFID) tag to the vehicle to help remember the range of the engine moving along a given path. Several researchers have designed many methods to suggest a smooth path to the emergency engine after assuming that the emergency engine moves in the same direction. These healthy visitor management elements are currently being evaluated across all work segments for further updates and changes to meet requirements.

2.2 Underlying Concept of Travel Time for Emergency Vehicle

Priority was well-liked in ambulance vehicles before Intelligent Transportation System (ITS) existed. It involves concerns about safety aspects and traffic improvements. Improved technology is being proposed to be incorporated into an ITS strategy for ensuring a safe green space for emergency vehicles while keeping the separation of red lanes [9]. The American Technical Council first introduced additional emergency vehicle operation measures in 1929. This technique integrates priority directions into the original signalling system [9]. Priority Service Request was a new system that 3M implemented in 1979 [10]. It marks the beginning of dispatch priority with the system allowing two emergency vehicles, namely high priority and low priority. The company that introduced this system is Opticom. This travel product uses separate transmitters where required for ambulances and transport vehicles. Since then, infrared transmitters and detectors have replaced strobe lights that flash public lights to pass traffic lights. In 1992, 3M upgraded its infrared transmitter by including an encoder. Therefore, it is crucial in the travel time concept for emergency vehicles that emphasizes the importance of the Internet of Things (IoT) implementation [11-12], the development of radio for traffic light control [13 -17], RFID-based traffic light prioritization [18], and emergency vehicle traffic signal coordination [19-22]. Understanding various basic concepts of travel time for emergency vehicles is important to know the reaction to how and why these various concepts affect the emergency vehicles' travel time. This basic concept was created to distinguish the implementation of technology related to the travel time of emergency vehicles.

3. Methodology

Of all the methods used in this project, the study focuses on software simulation and design adjustments. Any deficiencies in the projects must be identified as quickly as possible. Using SolidWorks and PTV Vissim software, the shapes of the design project are drawn and built-in advance based on measurements. The design and all original components are adapted to the situation. The shape of the sensor is designed with the SolidWorks 2022 software. PTV Vissim 2022 then simulates how the sensor works when emergency vehicles approach. The counting chamber is used to collect data in real-time for 12 hours to know when more cars are on the road.

The final focus of the project completion step is the creation of a Google Form to collect the experiences and thoughts of emergency vehicle drivers. Based on this step, the things that need to be improved by this project can be known, as the challenges it faced to make it happen. The material of this project will be included in this section because it summarizes the amount and cost invested in the project. Finally, the type of sensor used to get the best result. Some designs from previous studies became sample designs for this study that others had done throughout the early design phase, and some fresh concepts were developed. This design also uses the concept of a traffic light with a single signal light beside a sensor to inform the road user. This design has a big dimension to provide a suitable space for other electrical components and make it easy for emergency vehicle drivers to recognize the single light. The device's design is approximately smaller than traffic lights to avoid confusion for other road users. This design also takes the effectiveness of the sensor working principle to increase the volume of the emergency vehicles' siren by implementing the audio amplifier to run on this system. To have the effectiveness of the sensor, the best place for the sensor is outside of the device.

3.1 Materials and Methods

All selection materials have specific roles and functions required for the product to work well. For the device to work well, the material should be chosen and decided to be processed correctly so that the project goal can be achieved and fulfilled. After discussion and research, the next step is determining the suitable material that qualifies the product to operate properly**.** The material chosen for the e-Buzz are as follows: plastic, high-strength low alloy steels, stainless steel, alloy metal, and liquid crystal display (LCD). This project performed a quantitative study by collecting data from the selected locations at Muar, Johor.

3.2 Pole Stress Calculation of the E-Buzz

The pole stress calculation of the e-Buzz is based on the knowledge and application of Solid Mechanics that focuses on bending stress. The calculation finds the maximum stress and efficiency on the pole which holds the e-Buzz. First, the calculation to find the centroid distance, $\bar{y}$ in the y-axis as shown in Eq. (1). The radius of the pole, y is 50 mm. The symbol A represents the area of the pole. All the calculation results are shown in the Table 1.

$$\bar{y} = \frac{Ay}{y} \tag{1}$$

After finding the centroid, the moment of inertia, I is calculated as presented in Eq. (2). As the pole's shape is circular, the inertia formula for the circle shape is applied. The symbol d represents the diameter of the pole.

$$I = \left[\frac{\pi}{4}(y)^4\right] + \left[\frac{\pi}{4}(d)^2 \times (y)^2\right] \tag{2}$$

Then, the value of the maximum stresses of compression and tensile are shown in Eq. (3) and Eq. (4) respectively. M represents the moment, while c stands for the length from the shape of the centroid. The values of maximum compression and tensile stresses are the same.

$$\sigma_{\max\_c} = \frac{Mc_c}{I} \tag{3}$$

$$\sigma_{\max\_t} = \frac{Mc_t}{I} \tag{4}$$

Finally, the efficiency value is calculated using its formula, where the stress is divided by the pole material elasticity as presented in Eq. (5).

$$\varepsilon = \frac{\sigma}{E} \tag{5}$$

Table 1
Pole Stress Result Calculation of the e-Buzz

$\bar{y}$ (mm)	I (mm^4)	M (Nm)	d (mm)	E (MPa)	$\sigma_{\max\_c}$ (MPa)	$\sigma_{\max\_t}$ (MPa)	ε
50 mm	245.43 x 10^5	500	100	190	5.09×10^{-6}	5.09×10^{-6}	2.68×10^{-8}

4. Results and Discussion

The result discusses e-Buzz design fabrication, data collections, engineering analysis of e-Buzz, and analysis of PTV Vissim simulation of the e-Buzz.

4.1 E-Buzz Digital Fabrication

The screws and nuts are included in the total of 13 components that make up the e-Buzz. After consulting with the responsible personnel and supervisor, the screws and nuts are disregarded for 3D printing. It is because the 3D printing phase will take much longer to finish. Using a hot glue gun is an alternative method of assembling the component. The e-Buzz original model's dimensions are more than those of a 3D printer. The scale of the model is then decreased by subtracting 2 from the original to help speed up the printing of the component. The component is printed using a component printing programme known as Ultimaker Cura. The substance used in this study is called polymaker and comes in several colours. Bracket (47 minutes), Display Screen Mount (7 hours 49 minutes), Display Screen (5 hours 39 minutes), Microphone (1 hour 24 minutes), Mount (3 hours 44 minutes), Mount Hook x4 (56 minutes), Pole (2 hours), Rotating Part (21 minutes), Siren Cover (2 hours 4 minutes), and Siren Base make up the component that is printed (2 hours 31 minutes).

4.2 Data Collection

The purpose of data collecting is to determine the applicability of this project. A Google form called “Study on the challenges of carrying out duties as an emergency vehicle driver” is developed to collect data. This Google form is intended for emergency vehicle drivers because they are in emergency scenarios, but they must get there as soon as possible. The emergency vehicle's drivers can all have experience or not. 31 respondents who are the authority drivers completed the survey, where their data will be analysed for this research study.

4.2.1 Age

Figure 1 illustrates the age of authority drivers. According to the figure below, most emergency vehicle drivers are between 31 and 40 years old, with 10 drivers (32.26%). Both between 41 and 50 years old and between 20 to 30 years old are 9 drivers (29.03%). Finally, from 31 drivers, only 3 drivers (9.68%) were aged 51 to 60 years old.

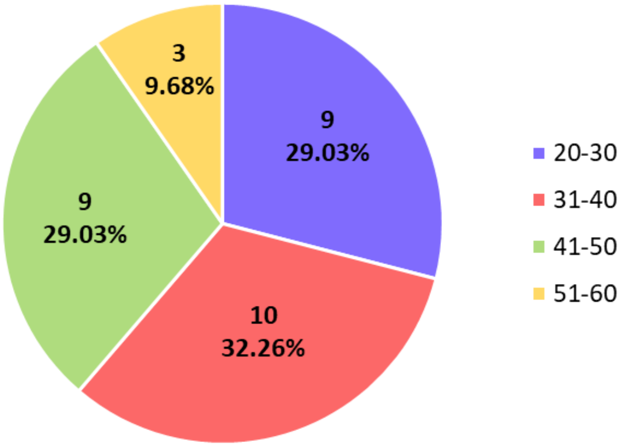

Fig. 1. Age of the authority drivers

4.2.2 Drivers of emergency vehicles of the following authorities

Figure 2 presents the drivers of emergency vehicles of authorities. Based on this figure, the Malaysian Ministry of Health employs most emergency vehicle drivers, with 20 drivers (64.52%). The following are Malaysian Fire and Rescue Department, with a value of 5 drivers (16.13%). With 4 drivers (12.90%), Royal Malaysia Police comes third. Malaysia Civil Defence Department, with a value of 2 drivers (6.45%), has the least number of drivers.

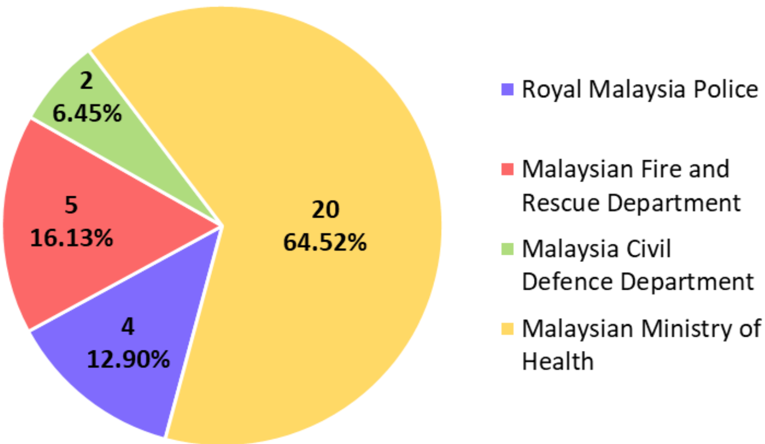

Fig. 2. Drivers of emergency vehicles of the authorities

4.2.3 Will innovation to reduce travel time for emergency vehicles help you?

Figure 3 shows whether the innovation can reduce travel time for emergency vehicles from the respondents' point of view. The driver is questioned on the relevance of this innovation in the Google form. Based on the results, it can be concluded that the inquiry is plausible because most respondents that have 29 drivers (93.55%) tick "YES" to agree with this statement while the remainder, which are 2 drivers (6.45%) tick "NO".

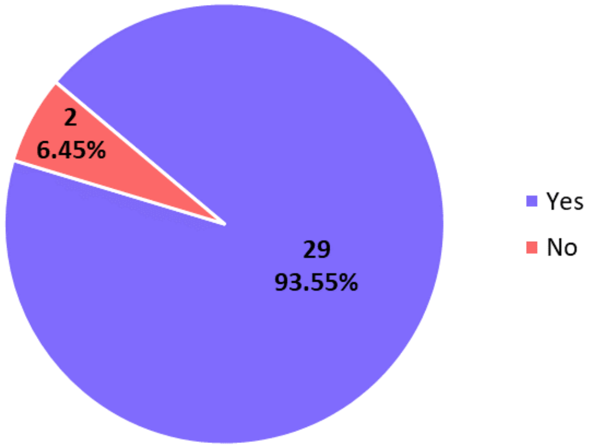

Fig. 3. Respondents' point of view whether innovation can reduce travel time for emergency vehicles

4.2.4 Do you think this study is relevant?

Figure 4 illustrates the study relevance chart with a rating scale measure of 1 (not relevant) to 5 (very relevant) to indicate the relevancy of this study. According to this figure, the scale of 5 (very relevant) has been chosen by the most respondents, which is 23 respondents (74.19%). The other 8 respondents (25.81%) scaled this study as 4 (relevant). Therefore, it can be concluded that all the respondents support this study.

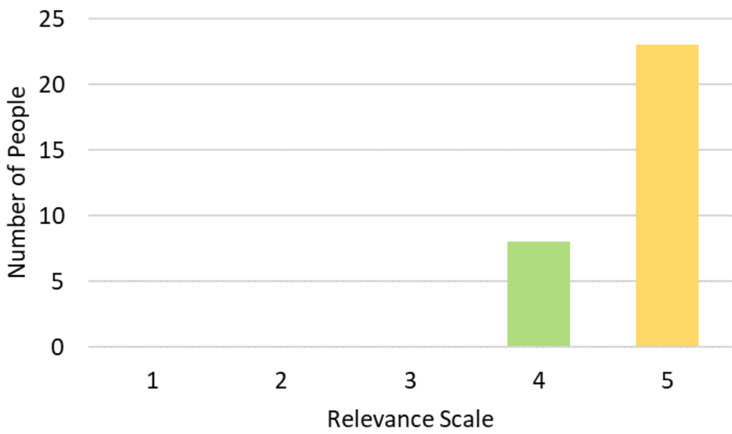

Fig. 4. Study relevance chart

4.3 Engineering Analysis of the e-Buzz

When a body is subjected to a body force or a surface force while in its initial state of equilibrium or undeformed state, it deforms correspondingly until it reaches a new state of mechanical equilibrium or deformed state. The surface forces are applied to the body due to contact with other bodies, whereas a force field, such as gravity, produces the interior body forces. Stress is the relationship between outside forces, whereas strain is the physical deformation of an object. Stress-strain relations are the name for their interaction that shows the body's physical characteristics.

Figure 5 presents the simulation of the e-Buzz device (pressure analysis). In order to distinguish the region that applied forces, the parts are coloured. The centre of the frame plate, where the stress amount was 3.426 MPa, was the highest place to encounter the most stress. It indicates that the device can withstand an external force of 98.1 N.

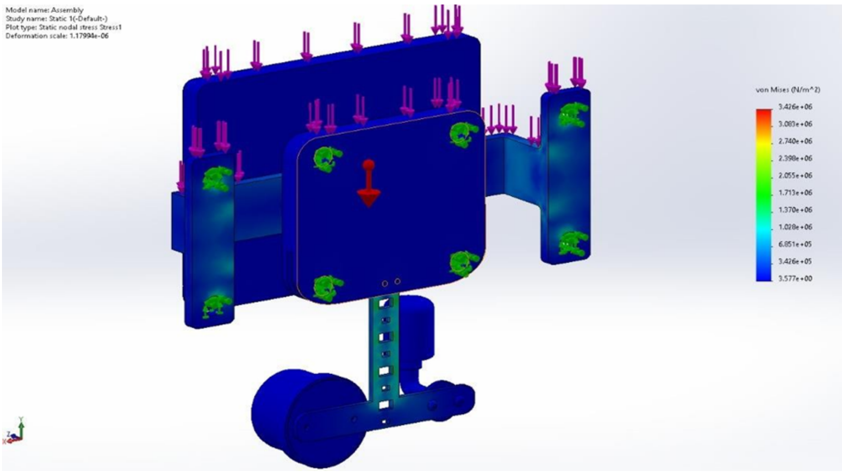

Fig. 5. Simulation of e-Buzz device (pressure analysis)

The e-Buzz Device simulation is depicted as shown in Figure 6. Resultant displacement (URES) refers to the outcome of deformation. The highest area with the greatest amount of URES was 0.001 mm high. The results demonstrate no deformation when an external force is applied. It indicates that the e-Buzz can support the load being applied. Deformation results in a component being moved beyond its elastic limits, resulting in permanent deformation once it is unloaded. Deformation does not indicate material failure.

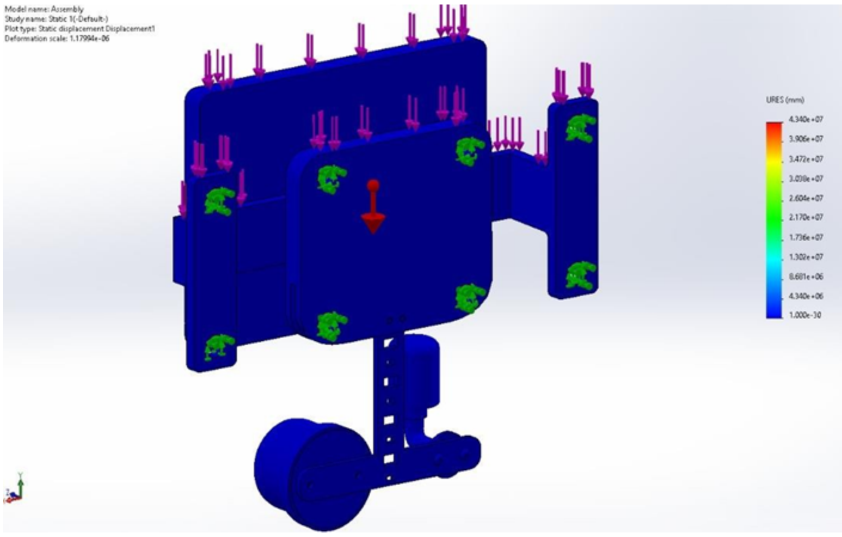

Fig. 6. Simulation of e-Buzz device (displacement analysis)

The outcome of the factor of safety (FOS) analysis is presented in Figure 7. The ratio of allowable stress to actual stress is the safety factor. The minimal FOS value for the entire body structure is 87.39. This device can support itself without additional forces. However, if the safety factor is less than 1, it indicates that the device will fail.

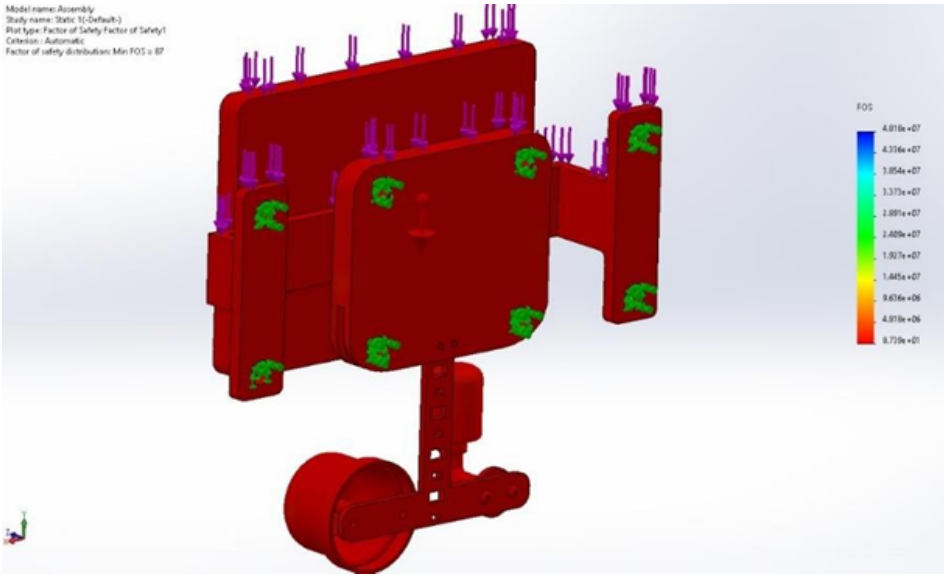

Fig. 7. Simulation of e-Buzz device (FOS analysis)

4.4 Analysis of PTV Vissim Simulation of the e-Buzz

This section will cover the findings related to Bukit Pasir's current street conditions and the simulation model of the e-Buzz gadget concepts used in PTV Vissim. There are now four streets leading from the Bukit Pasir region as shown in Table 2.

Table 2
Street technical specification

No	Streets	Types	Length(m)	Width(m)	Status
1	Jalan Muar to Labis1	2/2 UD	250	7	Provincial
2	Jalan Muar to Labis 2	2/2 UD	250	7	Provincial
3	Jalan Keramat	1/1 UD	150	3.5	Provincial
4	Jalan Jorak to Bukit Pasir	1/1 UD	150	3.5	Provincial

4.4.1 First simulation modelling: data collection results

The first simulation modelling was carried out using a single strategy based on the most recent data traffic flow. The results of the PTV Vissim simulation are shown in the following table.

After doing the first simulation modelling, Table 3 demonstrates the average vehicle speed passing these four streets varies for each street. Aside from acceleration and vehicle, software recorders use additional key parameters to save journey time. For the first simulation, the data traffic obtained through observation in the Bukit Pasir area is used to run the software. In the most recent simulation, this data will be compared in order to see the different statistics obtained after using the e-Buzz gadget concept.

Table 3
Data collection results after first simulation

No	Streets	Acceleration (m/s^2)	Distance (m)	Length (m)	Vehicle	Queue Delay (seconds)	Speed Average (m/s^2)
1	Jalan Muar to Labis 1	0.90	97.76	7.28	59	37.29	28.42
2	Jalan Muar to Labis 2	1.35	115.56	6.11	55	58.39	27.38
3	Jalan Keramat	2.19	51.49	5.61	8	39.61	10.74
4	Jalan Jorak to Bukit Pasir	1.88	72.66	6.40	8	38.78	14.77

4.4.2 Second simulation modelling vehicle time travel result

A single strategy was used to implement the second traffic management simulation modelling. The strategy was to divert traffic away from the four main streets. Following the deployment of this second simulation, the streets' performance may be seen as follows. The statistic was recorded from PTV Vissim programmed for the second simulation, as presented in Table 4. The information was divided into three primary categories: time spent travelling, distance travelled, and the number of vehicles on the road.

Table 4
Vehicle time travel results after second simulation

No	Streets	Travel Time (seconds)	Distance Travel (m)	Vehicle
1	Jalan Muar to Labis1	26.07	70.0	18
2	Jalan Muar to Labis 2	23.79	70.0	17
3	Jalan Keramat	64.64	55.0	2
4	Jalan Jorak to Bukit Pasir	58.05	55.0	3

Figure 8 illustrates the results in charts of vehicle travel time measurement. The measurement is over the time taken.

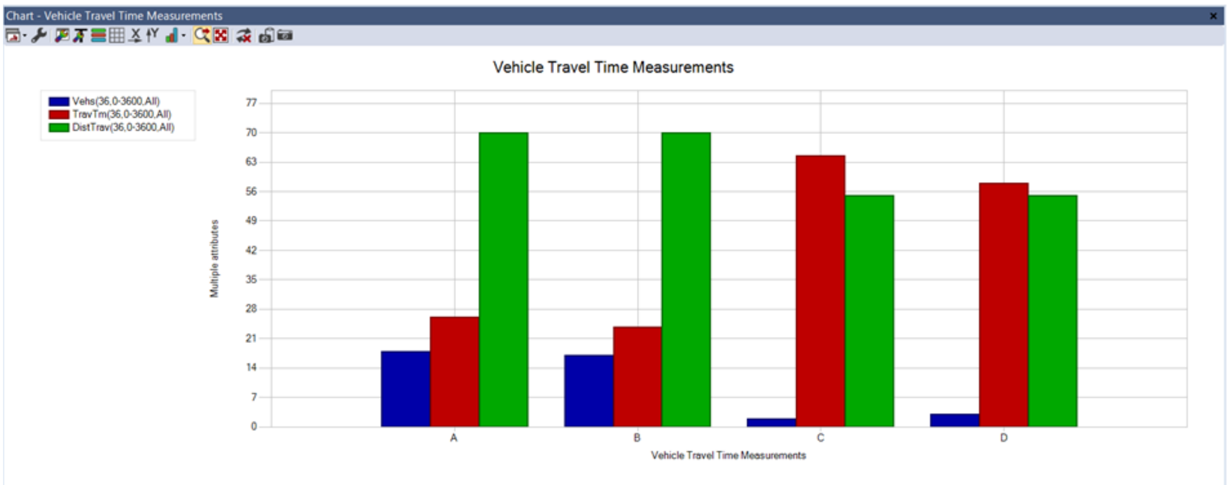

Fig. 8. Chart of vehicle travel time measurements

4.4.3 Third simulation modelling: data collection result after applied e-Buzz concepts

The third traffic control plan was implemented using a single method: installing detectors on the two main streets, Jalan Muar to Labis 1 and Jalan Muar to Labis 2. It is because the e-Buzz gadget concept focuses on the two main roads that are frequently used by emergency vehicles or ambulances. The results of the PTV Vissim simulation are shown in the following table.

Based on Table 5, it is clear that the e-Buzz device principles have led to some improvements in the vehicle speed parameter travelling through these four streets, with average improvements from 16.28 m/s to 29.01 m/s and average queue wait reductions from 37.01s to 57.39s. This demonstrates how the ideas will improve traffic flow on four main roadways.

Table 5
Data collection results after third simulation

No	Streets	Acceleration (m/s^2)	Distance (m)	Length (m)	Vehicle	Queue Delay (seconds)	Speed Average (m/s^2)
1	Jalan Muar to Labis 1	0.96	98.26	7.28	59	37.01	29.01
2	Jalan Muar to Labis 2	1.39	115.84	6.11	55	57.39	27.78
3	Jalan Keramat	2.20	51.47	5.61	8	38.09	10.64
4	Jalan Jorak to Bukit Pasir	2.13	72.90	6.40	8	37.11	16.28

4.4.4 Fourth simulation modelling: vehicle time travel result after applied e-Buzz concept

The third simulation's approach was used to implement the fourth traffic management simulation modelling; however, the outcomes differed. Following the implementation of this fourth simulation, Table 6 shows how the streets performed:

Table 6
Vehicle time travel results after fourth simulation

No	Streets	Travel Time (seconds)	Distance Travel (m)	Vehicle
1	Jalan Muar to Labis 1	25.55	70.0	18
2	Jalan Muar to Labis 2	18.11	70.0	17
3	Jalan Keramat	75.66	55.0	2
4	Jalan Jorak to Bukit Pasir	72.97	55.0	3

Figure 9 presents the chart results of vehicle travel time measurement after the fourth simulation. The measurement is over the time taken.

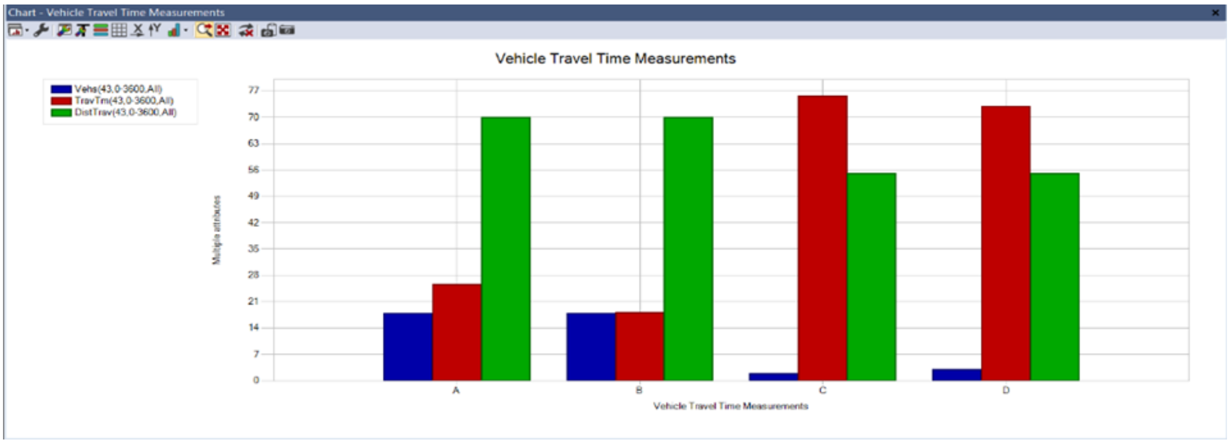

Fig. 9. Chart of vehicle travel time measurements after fourth simulation

5. Discussion

An overview of the research problems and objectives is presented before discussing the e-Buzz: Simulation of Smart Sensing for Emergency Vehicles. Additional discussion of effects, restrictions, suggestions, and contributions. The study's findings and insights lead to conclusions congruent with its intended goal. The subject of this project's discussion and conclusion is the Johor neighbourhood of Pekan Bukit Pasir, Muar. In order to improve the findings of this study, various recommendations have been made to researchers for additional research. One of the limitations is the need for more time, especially in making the 3D printing of the e-Buzz. Some errors are faced during the analysis of the SolidWorks and making the simulation.

This research project will significantly impact how Malaysian drivers react to emergencies. Knowing and locating specialists in the field of study is crucial since it can assist in clarifying and streamlining the project's scope. For a firm understanding of the project's applicability, study the theory. Furthermore, this project's simulation of the PTV Vissim programme is based on a free trial. Therefore, there are certain restrictions and watermarks when using the software. The advice is to apply for a research-based license from the PTV authorities. The evaluation has four testing as shown in Table 6.

Table 6
Table evaluation inventory system with respondent

Item	Testing	Results
1	System efficiency	Not that efficiency because it also can detect the surrounding sound
2	System Interface	Agree the system interface is user friendly and easy to understand
3	System functionality	Agree because the system can read detect the sound of emergency vehicle
4	System difficulties	Disagree because the system design easy to understand for users

5.1 Advantages of the system

The following are the advantages that can be acquired through the development of this system during system testing:

i. Cutting down time travel - Able to reduce time travel of emergency vehicles
ii. Save the victim’s life – If any accident happens, the authorities can arrive at the location faster

5.2 Disadvantages of the System

The following are the disadvantages obtained through the use of the system during the testing:

i. Expensive to produce the e-Buzz
ii. Take a long time to produce the product
iii. Can detect the surrounding sound

5.3 Improvement of the System

The followings are the improvements and suggestions made by the store worker during system testing to ensure that the system developed has no problem:

i. Decrease the cost to produce the product – Do more Research & Development on how the production cost can be reduced.
ii. Find ways to reduce the production of the product – Do more research on where the time in producing the e-Buzz can be cut.
iii. Find a sensor to detect the emergency vehicle's siren – Find a sensor that can only detect the emergency vehicle's sensor.

6. Conclusion

Combining mechanical and civil engineering knowledge, the e-Buzz: Simulation of Smart Sensing for Emergency Vehicle has been successfully finished for the section's conclusion. The e-finished Buzz's design was extensively developed and created using a 3D printer. The e-smart Buzz's sensing simulation has been successfully completed as of now. It is due to the data and outcomes from the simulation before and after the e-Buzz implementation. The findings sufficiently support and address the project's goal, which was to reduce the trip time of emergency vehicles. From the simulation, the project will be feasible for implementation in this case study, situated in Pekan Bukit Pasir, Muar Johor.

Additionally, this initiative has a strong potential for acceptance and implementation in Malaysia. The key factors influencing this project have also been examined in e-Buzz: Simulation of Smart Sensing for Emergency Vehicle. This factor will significantly impact reducing the travel time for emergency vehicles. Overall, the e-Buzz design and simulation approach serves as the foundation for smart traffic management for emergency vehicles. Through the research study, it develops a proactive approach that uses real-time traffic monitoring information to provide a faster emergency response without compromising road safety regulations. Furthermore, it helps develop a sensing system based on siren characteristics to detect sirens from emergency vehicles effectively and can respond immediately. Next, intelligent sensing work can approach the state of emergency vehicles towards traffic lights through complete simulation.

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