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Comparative analysis of spark ignition engine performance using RON 95 and RON 100 gasoline fuels

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ABSTRACT

Most of the vehicles used by Malaysians have engines that only require petrol RON 95 to power the engine. However, many people claimed that utilising RON 100 instead of RON 95 for their vehicles will improve engine performance. Furthermore, many people speculate that using oil with a low octane level in an engine with low performance will affect the engine's performance. The goal of this research is to analyse and compare the engine performance and emissions on a spark ignition engine using gasoline RON 95 and RON 100. In this study, a single-cylinder four-stroke engine running with RON 95 and RON 100 has been tested on an engine dynamometer to evaluate the brake power, torque, specific fuel consumption, and exhaust emissions. The emissions from the engines have been determined using a gas emissions analyser. The outcomes of the experiment have been analysed based on engine torque, braking power, and exhaust emissions. Based on the analysis, torque, brake power, and emissions data obtained from the dynamometer engine, RON 100 has a higher and smoother performance than RON 95.

1. INTRODUCTION

Historically, the Research Octane Number (RON), which describes anti-knock performance in a variety of scenarios, has been used to track gasoline combustion. The higher the octane level, the greater the amount of compression the gasoline can withstand before exploding. The octane rating is more closely related to

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the fuel's resistance to compression than its power output or energy content per unit mass or volume [1]. Therefore, great fuel compressibility is crucial for gasoline engines in particular. If the user utilise gasoline with a lower octane rating (pre-ignition), engine knocking might happen [2]. Although all European gasoline cars must be capable of running on RON 95 fuel, some vehicles are calibrated to take advantage of higher-octane fuels available on the market, usually by advancing spark timing or increasing boost pressure, which results in more brake power and possibly better fuel consumption [3-4]. Vehicles with increased or variable compression ratios that can fully utilise higher octane may become commercially accessible in the future, but they are not presently available. Increasing RON, on the other hand, appears to provide more benefit to engine brake power and speed for the same octane number change [5-6]. It has also been suggested that specially modified engines, such as those with higher compression ratios and a high RON 100, could boost fuel efficiency. Others have suggested creating an octane index that takes into account both RON and octane quality. The real octane number is the simple average of two separate octane rating techniques, RON and motor octane rating (MOR), which differ mainly in the particulars of the operating circumstances [6].

RON 95 is roughly equivalent to 91-octane on the anti-knock index currently in use in the United States (US). Every automobile has a minimum compression ratio. Thus, the simplest way to determine which gasoline type to use is to look up the vehicle's minimum octane rating in the service manual or on the fuel lid cover [7]. High-compression engines, which provide more power, often utilise fuels with a higher octane rating, such as RON97. Contrary to common opinion, a higher RON or grade does not automatically indicate superior quality but rather the capacity to postpone auto ignition. Another common misconception is the idea that using fuel with a higher octane rating than the engine manufacturer suggests can increase fuel economy or power output.

The process of combustion is another factor that is connected to the energy capacity of the fuel and the discharge. Consequently, the quantity of power generated by the fuel often has little impact on such an event [8-9]. High RON levels enable the production of shutter engines with high compression ratios and timing of the ignition. High compression ratios, on the other hand, frequently result in explosively small quantities of combustion. The advantages of employing the RON 100, particularly for premium engines, are that the weight of the load will permit the use of high-compression engines that generate a lot of power (output).

Based on the findings, it must be proved in this research either RON 95 or RON 100 is better for ignition engines. Engine efficiencies were measured using a test engine coupled to an engine dynamometer using RON 95 and RON 100 gasolines. A dynamometer is a device that uses a load to stimulate varying speed and torque requirements. This data can be used to compute power. A dynamometer is a load device used to measure an engine's torque and speed. It would keep track of fuel consumption, pollutants, and other data. A dynamometer can also be used to control the engine's speed by varying the load it is subjected to. The use of dynos to assess different engine designs at the same load characteristics is common. We want to test the engine in conditions that are similar to those seen in the field, such as speed and torque, or even use the dynamometer to simulate a real driving cycle.

In Malaysia, gasoline fuels come in three different fuel grades, which are RON 95, RON 97, and RON 100. The diversity of the fuel grade in the Malaysian market is to meet the requirements that are recommended by vehicle manufacturers [10]. However, many users of vehicles with lower RON requirements have claimed the improve in engine performance if using higher RON petrol. Therefore, this project is aimed to analyse spark ignition engine performance and emissions using RON 95 and RON 100 gasoline fuels.

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2. METHODOLOGY

This project used the dynamometer engine to test RON 95 and RON 100 and record the results, such as torque, brake power, and specific fuel consumption. The dynamometer needed for this project can be found in the UITM Permatang Pauh Thermodynamic Laboratory. The dynamometer will be connected to four-stroke engine. The engine is a single-cylinder petrol engine. The variable load will be water, which will be gradually increased until it reaches 8 ml in order to obtain engine brake power. The results for torque, brake power, and specific fuel consumption could be acquired by starting the test on both RONs.

2.1 Material purchase and storage

The RON 95 and RON 100 have been purchased from a nearby Shell gas station. Gasoline must be stored in a DOT-approved tank or container. Keep gasoline canisters tightly closed and handled gently to minimise spilling. Because gasoline is flammable, it should be stored at room temperature, away from heat sources such as the sun, hot water heaters, space heaters, and furnaces, and at least 50 feet away from ignition sources such as pilot lights. Gasoline vapors can travel down the floor to ignition sources because they are heavier than air. In places where gasoline is handled or stored, smoking is prohibited.

2.2 Engine dynamometer testing

The engine has been used in the experiments was a 4-stroke. single cylinder TD113 MKII. Engine specifications are listed in Table 1. The experimental schematic diagram for the SI engine and Hydraulic dynamometer are shown in Fig 1. A hydraulic dynamometer TD113 was used to measure the performance of the engine. The hub of the hydraulic dynamometer was directly connected to the instrumentation unit TD114 to perform this test, as shown in Fig 2.

Table 1. Engine Specifications

Specification	Description
Engine type	4 – Stroke
Engine power range	2.5 kW – 7.5 kW
Maximum torque	15 Nm
Maximum speed	6000 rev/min

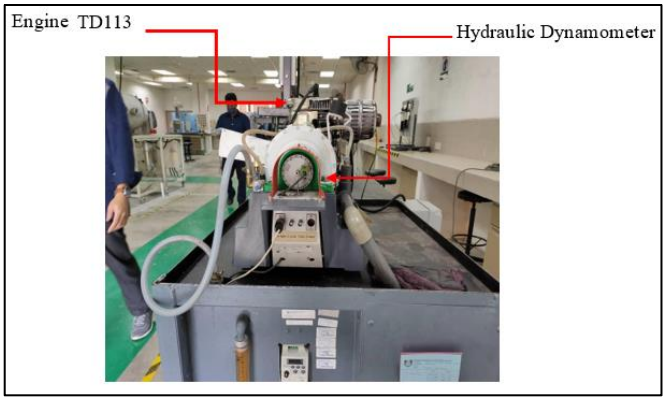

Fig. 1. SI engine and Hydraulic dynamometer

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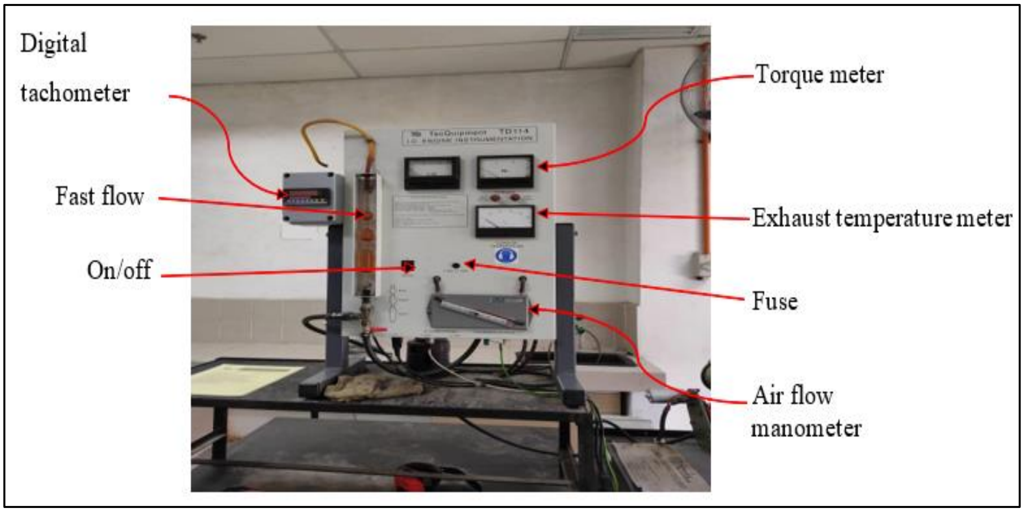

Fig. 2. Instrumentation unit TD114

2.3 Data analysis

After data has been secured from the hydraulic dynamometer, it is transferred to an Excel spreadsheet. While the instrumentation unit does have the capability of performing the data analysis, the decision was made to perform these tasks in Excel for the ease of data manipulation that has been provided. Once the data is transferred, a set of custom macros created using Excel's macro recording feature are applied to the data files.

The data for engine performances has been performed in an Excel spreadsheet shown in Table 2. The graphs that will be constructed are torque, brake power, exhaust temperature, and specific fuel consumption versus load. The torque, brake power, exhaust temperature, and specific fuel consumption data will be marked on the y-axis, and the load data will be marked on the x-axis. The purpose of these graphs is to understand the exact or minimum that is needed from the engine using RON 95 and RON 100 to make an accurate assessment for this project. The graphs also give maximum torque, brake power, exhaust temperature, and specific fuel consumption the engine can produce, and speed corresponding to these data**.**

Table 2. Engine performance results

Load (kg)	Speed (rpm)	time		Torque		Brake Power		Fuel Consumption		Exhaust Temperature	
		RON 95	RON 100	RON 95	RON 100	RON 95	RON 100	RON 95	RON 100	RON 95	RON 100
0	4000	31.62	34.75	0	0	0	0	0	0	179.7	120
0.5	3200	37.84	37.77	0.5	1.3	0.167	0.502	3.37	1.41	194.5	167
1	3150	39.53	38.75	1	1.7	0.33	0.56	1.64	0.98	191.5	168
1.5	2700	43.92	41.71	2.5	2.7	0.71	0.76	0.71	0.67	192	155
2	2150	46.25	49.69	4.25	3.95	0.96	0.9	0.48	0.48	169.5	153
2.5	1650	61.775	47.63	6	6.75	1.036	1.209	0.33	0.39	165.4	140

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3. RESULTS AND DISCUSSION

3.1 Exhaust Temperature

Under various loads ranging from 0 kg to 2.5 kg, the exhaust temperature in response to gasoline RON 95 and RON 100 was tested. RON 95 produced more heat than RON 100 did during the experiment. In comparison to RON 95, RON 100 typically brings out less heat. The graph in Fig. 3 illustrates the findings. In general, exhaust temperature decreases when load increases in a low compression ratio engine. This has to do with the combustion process, which takes time for the engine to burn all of the fuel and air mixture [11]. Due to the engine's low compression ratio, RON 100 takes longer to ignite than RON 95 gasoline fuels.

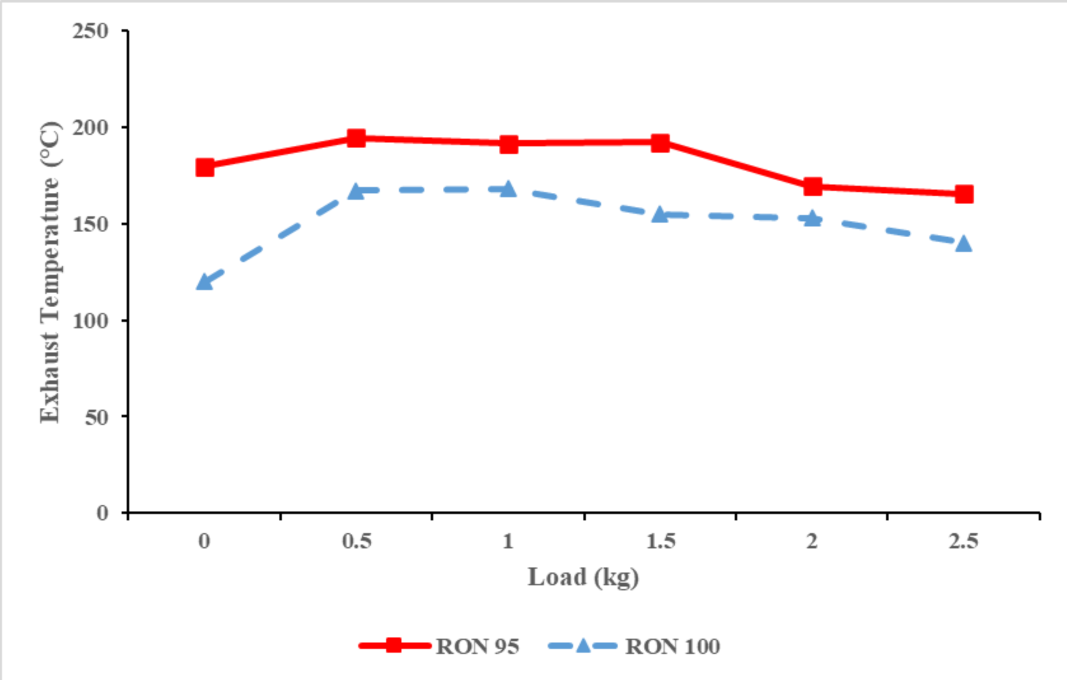

Fig. 3. The experimental results of exhaust temperature versus load

3.2 Torque

Fig. 4 shows that, with the exception of the load range between 1.5 kg and 2 kg, RON 100 produced more torque than RON 95 did. With RON 95, torque was greater at that load. A different trend in the parameter was discovered, with RON 95 producing higher torque than RON 100 from 1.5 kg to 2 kg. RON100 produces higher torque than RON 95 with a load of 2.5 kg. In general, RON 100 generates higher torque than RON95. The graph showing the findings shows that the torque in RON 100 was high. For RON100, the torque decreases mostly due to intake and exhaust flow restrictions in the load range of 1.5 kg to 2 kg. Because the engine could not breathe much quicker and needed time to rest, volumetric efficiency decreased [11]. The fuel cannot burn entirely as the piston's load increases until it reaches 2 kg. As a result, torque is reduced.

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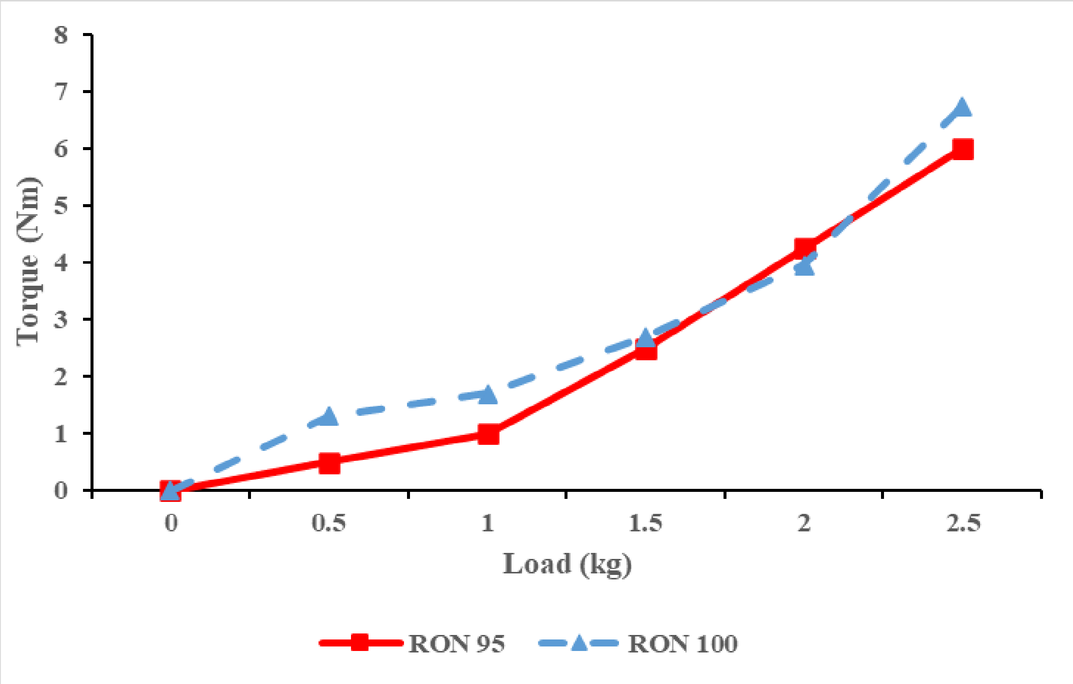

Fig. 4. The experimental results of torque versus load

3.3 Brake power

According to Fig. 5, the engine running on RON 100 obtained its best performance with a load of 2.5 kg and a braking power of 1.209 kW. RON 95 offers more brake power than RON 100 at range loads of 1.5 kg to 2 kg. RON 100 produces higher brake power than RON 95 with a weight of 2.5 kg. On average, RON 100 generates more stopping power than RON 95. Following that, the braking power began to decrease until it eventually zeroed out. For RON 100, the engine did not receive the right amount of air and fuel into the cylinder or burn it at the right rate when the load range was 1.5 kg to 2 kg. It is because there is less time for compression, burning, and blowout the faster the engine is running [12-13]. As a result, the engine's ignition timing is affected, which causes the burn process to begin earlier. Therefore, the flame extinguishes just before the exhaust valve opens.

3.4 Specific fuel consumption

From Fig. 6, the specific fuel consumption increased when the speed increased until it reached 3200 rpm. At high speeds, specific fuel consumption increases because more power is required to achieve the higher speed, and this power comes from the engine. In the engine, when the vehicle moves at high speed, the piston will also reciprocate at a very high speed, which ultimately consumes more fuel. At 3200 rpm, RON 95 produced more specific fuel consumption than RON 100. This is because lower octane numbers burned the fuel faster than high octane number fuels [14-15]. The specific fuel consumption decreased rapidly at 3200 rpm because the engine had reached its maximum efficiency to fully consume the fuel.

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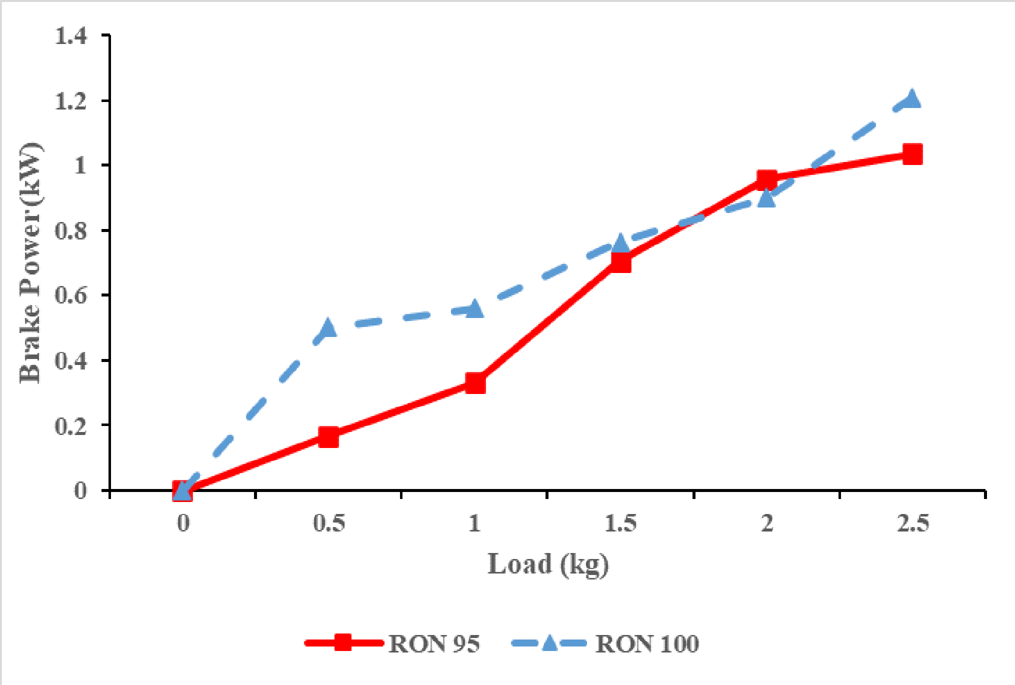

Fig. 5. The experimental results of brake power versus load

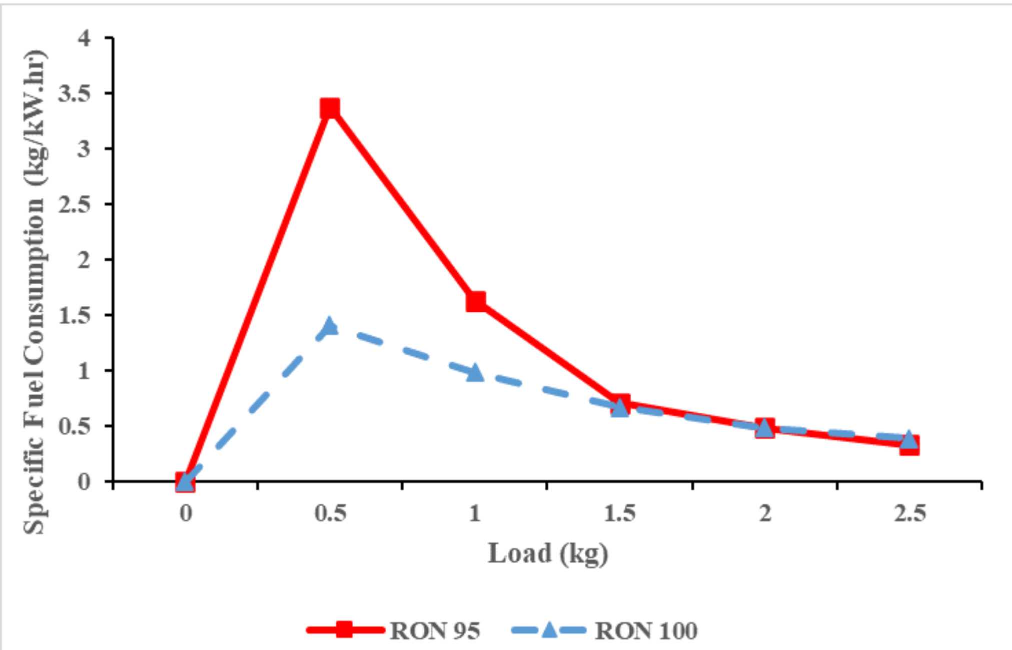

Fig. 6. The experimental results of specific fuel consumption versus load

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4. CONCLUSION

The main goal of this research is to identify the effect of RON number on single-cylinder 4-stroke engines. By analysing the engine performance for RON 95 and RON 100 gasoline fuels, the research findings was compiled and recorded. The main conclusions that can be drawn from this experimental research are as follows:

(i) The braking power increases as the torque increases for both fuel grades. As for all, RON 100 gasoline fuel has the highest calculated brake power, in contrast to RON 95.

(ii) The highest brake power and torque was indicated by RON 100 gasoline fuels at a load of 2.5 kg for 1.209 kW and 6.75 Nm.

(iii) For the specific fuel consumption, RON 95 generally consumes more fuel than RON 100.

(iv) Regarding exhaust temperature, RON 95 produces more heat than RON 100.

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6. CONFLICT OF INTEREST STATEMENT

We declare that there is no conflict of interest regarding the publication of this paper.

7. AUTHORS' CONTRIBUTIONS

Hazim Sharudin: Conceptualisation, data curation, formal analysis and writing original draft; **Sharzali Che Mat**: Conceptualization, supervision, editing and validation; **Ahmad Hadri Azizuddin**: Conceptualisation, methodology, formal analysis; **Muhammad Arif Ab Hamid Pahmi**; Conceptualisation, writing review and format editing; **Azmi Husin**; Conceptualisation, formal analysis and validation; **Noor Iswadi Ismail**; Formal analysis, and validation; **Mahamad Hisyam Mahamad Basri**; Writing review and format editing.

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