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A Comparison of Sound Level Monitoring Using Android-Based Smartphone Applications with The Actual Sound Level Meter

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Abstract: This study compares the performance of the sound level meter applications in the Android smartphone with the actual device and examines the capability of the SLM applications in a smartphone as a replacement of the actual sound level meter. The sound level is tested by a minimum of 5 applications to identify the application that shows the nearest decibel value to an actual device. The sources of sound are generated by dropping a marble onto a steel plate and a sound produced by a car engine. Based on the experiment of dropping marble, the result shows that the SLM application 3 is approximate to the actual device with the difference average decibel value (dB) obtained is 0.5 dB. While for the measuring sound produced by a car engine experiment, the decibel value of SLM application 4 is the nearest to the actual device where the difference of average decibel value with the actual device is 1.1 dB. The study found that there are no smartphone SLM applications that fulfill the IEC or ANSI standards, and they are not ready to replace the professional device as Sound Analyzer (TES-1358). It is preferable to put the smartphone in flight mode when testing the application because it can be used offline to minimize disruptions while obtaining readings. Both the smartphone and the actual SLM should be set on a sturdy tripod with resilient blocks to isolate the device from vibration and the resulting inaccurate readings.

Keywords: Sound Level Meter, SLM Applications, Sound Analyzer

1. Introduction

Sound is essential to human life. It is one of the core parts of communication between people. A sound that caused disturbance to others is known as noise. Too much noise can disrupt one's life enjoyment that leads to ill health effects. Sound is generally defined in terms of loudness (amplitude) and frequency (pitch). The basic unit of sound is called the decibel (dB), while the device to measure the sound is called a sound level meter (SLM). In a portable case, the SLM consists of a microphone,

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amplifiers, an indicator, and some peripheral electronic networks, all of which could affect an SLM's performance.

The sound level meter will be monitored from Android-based smartphone applications and compare the reading of the decibel value to an actual device. Smartphones have developed into powerful computing devices that compete with the strength of personal computers. Almost every smartphone can be turned into a sound measuring device due to the device's built-in microphone. The widespread availability of those instruments enables noise measurement applications to increase individuals who monitor noise. Smartphone applications illustrate the noise approach, including implementing a sound level meter, often combined with other environmental factors, such as air quality. There are several sound monitoring applications available on the market for different mobile devices. However, only a part of those applications achieves sufficient sensitivity to monitor noise levels, including replacing professional sound level measurement instruments.

2. Methodology

This experimental study was carried out by selecting five different sound level meter applications and the decibel values were compared with the actual device. The data were evaluated by monitoring the sound generated by dropping marble and sound produced by a car engine to determine which SLM application produced the decibel value are closest to the actual device.

2.1 Equipment

The main equipment used in this study is the Android smartphone. The model of the smartphone used is Samsung A50. This smartphone is used to download all the sound level meter applications via Google Play Store. According to Kardous and Shaw [1], this android smartphone model has the ability to report A-weighted and unweighted sound levels as well as a slow or fast response time setting. This smartphone is also able to display both equivalent continuous average sound levels. Samsung A50 model smartphone is equipped with the Micro Electrical-Mechanical System (MEMS) type of microphone. This microphone requires very little power to function. Furthermore, the microphone is engraved into a silicon wafer or "chip" using MEMS technology, which fits nicely within the regular smartphone's circuitry. MEMS microphones were found to meet the frequency response tolerances for type-1 working standard microphones specified by IEC 61094-4 [2].

Besides, the actual device used in this study is the Sound Analyzer (TES-1358). This device is able to analyze the real-time digital 1/1-octave and 1/3-octave band. Five measured parameters can be done by using this device such as SPL (Sound Pressure Level), L_{eq} (Equivalent Continuous Sound Pressure Level), LE (Sound Exposure Level), L_{max} (Maximum Sound Pressure Level), L_{min} (Minimum Sound Pressure Level). This SLM is suitable for measuring both occupational and environmental noise [3]. The reading data can be downloaded by using SLMeter software.

Furthermore, another type of equipment that is used is a stainless steel plate 304. This stainless steel plat is used as a flat surface for dropping a glass marble which is selected with a thickness of 8mm and 100mm x 200mm in size. While a glass marble is used to generate the sound where it is selected based on the standard size available in the market, which is 16 mm, with a weight estimation is 5.5g. In addition, the measuring tape is also one of the equipments used in this study. It is to measure the position and the distance during the experiment.

2.2 Methods

The experiment of sound levels monitoring is generated by dropping a marble and a sound produced by a car described in this section. The experiment then will be analyzed to determine the application that shows the nearest result with the actual device.

2.2.1 Procedures: Dropping Marble

The study of sound level monitoring by dropping a marble is carried out by downloading 5 sound level meter (SLM) applications into the Samsung A50 smartphone via Google Play Store. The experiment is conducted on the table. When all the applications are ready to be used, the smartphone is mounted on the tripod at a distance and height of 200mm from the stainless steel plate 304 which is placed on the table. The SLM application is tested one after another to monitor the sound generated by dropping a marble on a stainless steel plate from a height of 200mm. The reading of the sound level is monitored for five trials for each application. The experiment is repeated until all the SLM applications are tested.

Next, the experiment is continued by monitoring the sound level using the actual device which is the Sound Analyzer (TES-1358). This device is also mounted on the tripod and placed at the same height and distance as the smartphone as in Figure 1. The reading of the decibel value is taken repeatedly in five times of trial. Consequently, all the readings of the decibel values are analyzed to indicate the application that shows the nearest value to the actual device.

(a) (b)

Figure 1: Sound Monitoring using: (a) SLM Applications (b) Sound Analyzer (TES-1358)

2.2.2 Procedures: Car Engine

In this study, the car is started up and let the engine running until 5 minutes. Then, the smartphone is placed for sound monitoring, as shown in the Figure 2. This experiment will be using the selected SLM applications selected based on the previous experiment where the applications show the nearest decibel value with the actual device. When the SLM applications have been tested, the experiment will continue with the actual device, Sound Analyzer (TES-1358). The sound analyzer also will be placed in the same position as the smartphone so that it is consistent.

(a) (b)

Figure 2: Sound Monitoring on Car Engine Bay using: (a) Smartphone (b) Sound Analyzer (TES-1358)

3. Results and Discussion

The data obtained from sound level meter applications and the actual device are compared to determine the application that shows the nearest value with the actual device. There are 5 different applications used in this study. All of them have the capability to measure the sound level in the form of a time-domain graph with different limitations. When all the applications have been tested, the Sound

Analyzer (TES-1358) is used to monitor the sound. The result then will be analyzed. This study will be measured two sound sources: a sound source by dropping a marble and a sound produced by a car engine. The devices will be kept in the same position for each sound source.

3.1 Results

The experiment results generated by dropping a marble and a sound produced by a car engine were analyzed by taking the maximum decibel values obtained. The data is then compared so that the nearest decibel value can be identified.

3.1.1 Experiment by Dropping Marble

Table 1: Data of Sample Reading of Decibel Value using Smartphone and Actual Device: Dropping Marble

No. of Trial	SLM Apps 1 (dB)	SLM Apps 2 (dB)	SLM Apps 3 (dB)	SLM Apps 4 (dB)	SLM Apps 5 (dB)	Sound Analyzer (TES-1358) (dB)
1	60.0	62.0	76.0	80.8	88.8	77.7
2	63.0	61.0	79.2	80.8	90.0	79.0
3	60.0	62.0	79.4	80.8	90.0	78.7
4	59.0	62.0	77.9	80.8	90.0	78.6
5	60.0	61.0	77.2	80.8	90.0	78.0

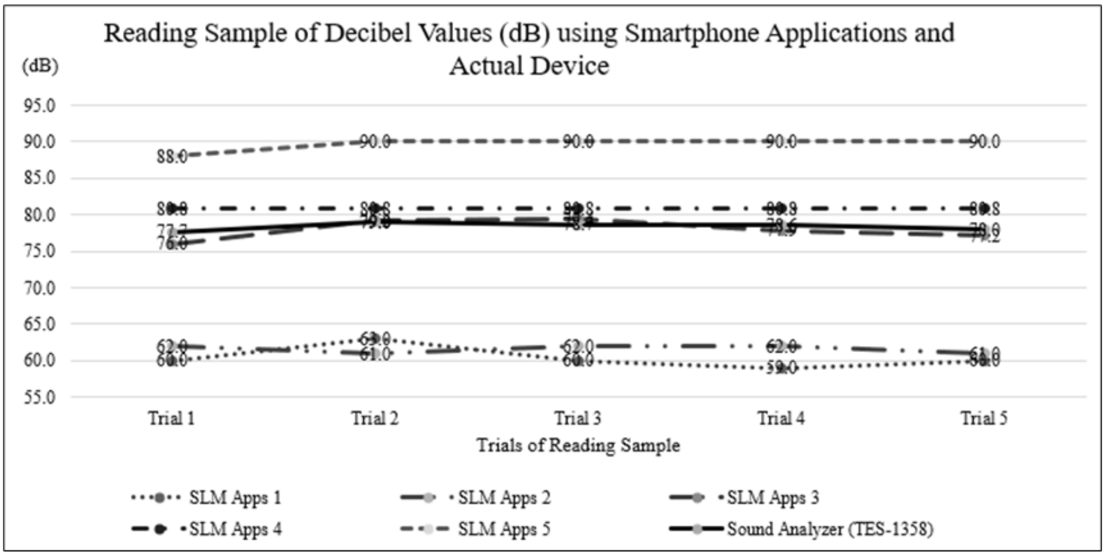

Figure 3: Graph of Reading of Decibel Values using Smartphone Applications and Actual Device: Dropping Marble

Based on the graph shown in Figure 3, the SLM applications 1 and 2 shows the reading of decibel values from 59.0 dB to 63 dB, where the value is much lower than the actual device, Sound Analyzer (TES-1358). For the reading of decibel value for SLM applications 3 and 4, the decibel values obtained are likely almost near the actual device, where the reading value is 76.0 dB to 80.8 dB. In addition, the reading of decibel value at SLM application 4 shows the constant value for all the trials made. SLM application 5 shows that the application performs poorly when it is obtained with a very high reading value compared to the actual device.

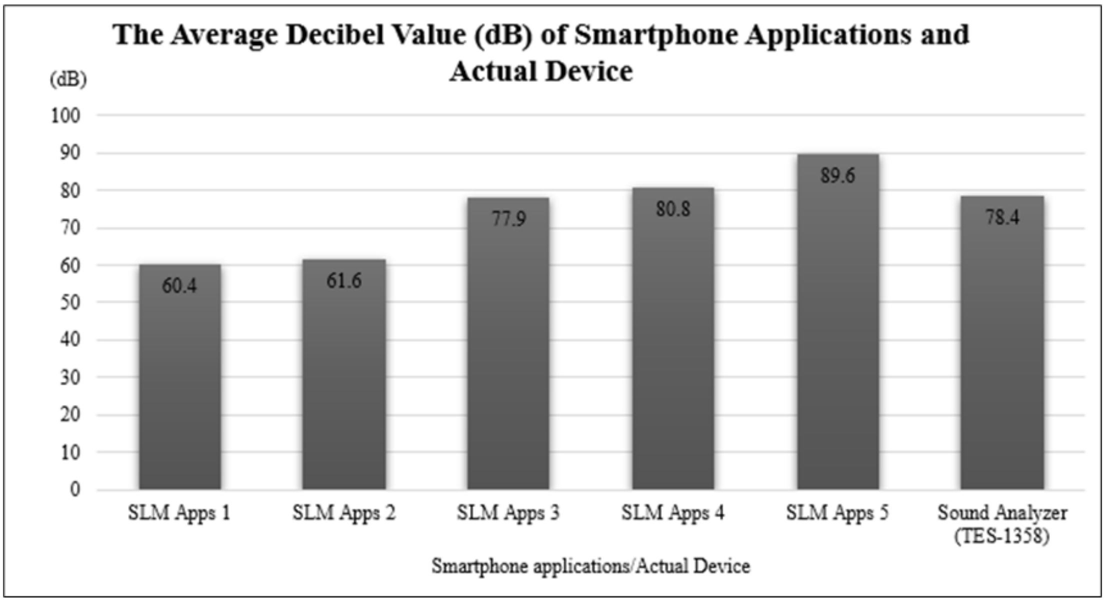

Figure 4: The Average Decibel Value (dB) of Smartphone Applications and Actual Device: Dropping Marble

Consequently, SLM application 3 approximates the actual device since some of the decibel values detected are identical with the value obtained from the actual device. Figure 4 shows that the difference of average decibel value (dB) between SLM application 3 and the Sound Analyzer (TES-1358) is about 0.5 dB.

3.1.2 Experiment of Sound Produced by Car Engine

Table 2: Data of Sample Reading of Decibel Value using Smartphone and Actual Device: Car Engine

No.of Trial	SLM Apps 3 (dB)	SLM Apps 4 (dB)	Sound Analyzer (TES-1358
1	67.7	69.8	71.2
2	67.8	69.2	70.7
3	67.3	69.9	70.8
4	67.4	70.0	70.8
5	67.5	70.0	71.0

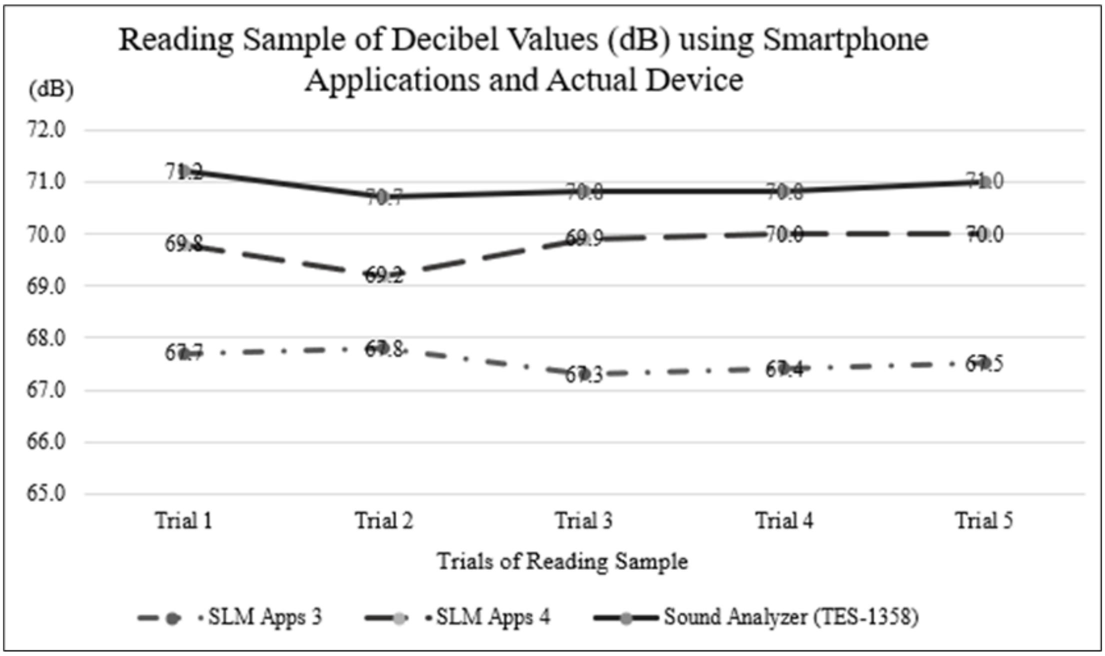

Figure 5: Graph of Reading of Decibel Values using Smartphone Application and Actual Device: Car Engine

In reference to the graph shown in Figure 5, the sound measured using SLM application 3 demonstrates that the decibel value obtained is much lower than the actual device where the readings of the decibel value taken using the Sound Analyzer (TES-1358) are all above 70 dB. For SLM application 4, the reading values are quite close to the reading captured using the actual device where the decibel values for all the trials made are 69.8 dB to 69.2 dB to 69.9 dB to 70.0 dB for the fourth and final trials. Figure 6 shows the average decibel value (dB) taken using smartphone applications and the actual device, Sound Analyzer (TES-1358). The difference average decibel value obtained between SLM applications 4 and the actual device is 1.1 dB.

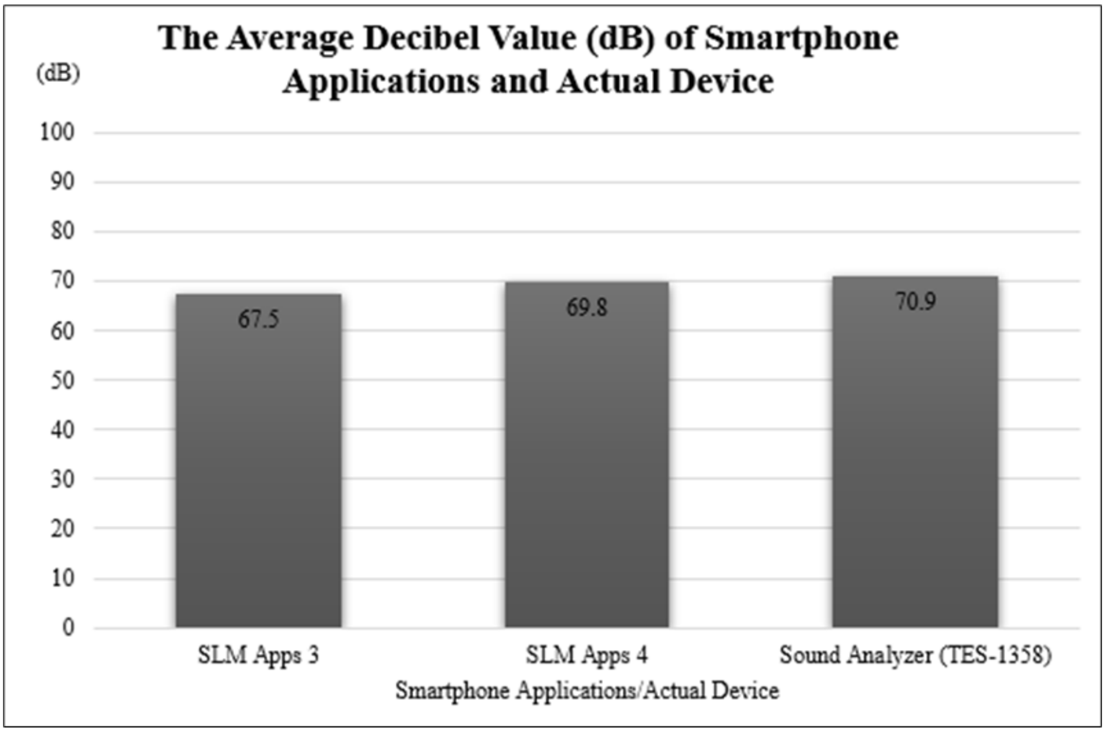

Figure 6: The Average Decibel Value (dB) of Smartphone Applications and Actual Device: Car Engine

3.2 Discussions

There are some reasons as to why the readings are much different for every application. This is because not all the applications are ready to use; some need to be calibrated to read the exact data. Besides, other software may be running in the background, whether visible or not, with the potential to disrupt background operations.

Based on the analysis, the smartphone applications' sound readings are not even adequate to substitute the actual devices for industrial usage. There are some limitations for the built-in MEMS microphone in the smartphone due to its small size and circuit board location, MEMS microphones continue to have limitations in terms of dynamic range and signal-to-noise ratio responsiveness. Another significant limitation imposed by built-in microphones is the inability to undertake periodic or pre-measurement calibration [4].

Moreover, a smartphone or a sound analyzer was positioned in an impractical area for accurate acoustical measurement. The environmental noise and the vibration during the experiment also play an important role throughout doing this experiment. This leads to the readings are different and unacceptably inaccurate.

3.2.1 Analysis Based on Standard Regulations

Occupational noise-related hearing disorders (ONRHD) are the most often reported illness in Malaysia [5]. Therefore, it is important to determine if the sound levels comply with the standard code of Occupational Safety and Health (Noise Exposure) Regulations 2019. This is to ensure that everyone will be aware of excessive noise exposure because hearing damage may occur when exposed to constant background noise.

In this project, the experiment of dropping a marble represents the illustration of capturing the impact noise where loud noise is unusually loud compared to the regular noise levels. Based on the experiment, the highest readings of decibel value obtained are at 80.8 dB, and the daily exposure duration limit for the decibel value at 82 dB and below should be in 16 hours, according to the Department of Safety and Health Malaysia (DOSH).

By referring to the data of sound monitoring generated by dropping a marble and the sound produced by a car engine, all the maximum decibel values taken with the selected applications and the actual device are also below 85 dB(A), which the value is lower than the minimum daily dose noise exposure level as stated in Regulation 6 of the Occupational Safety and Health (Noise Exposure) Regulations 2019 [6] and it is generally considered safe.

4. Conclusion

The performance of the sound level meter (SLM) applications in the Android-based smartphone has been identified as not all the applications can measure the sound as the actual device. From the five chosen applications, there are only two applications that show the nearest reading value during monitoring the sound source by dropping a marble which is SLM applications 3 and 4. It is found that the SLM application 3 is the most approximate to the actual device compared to the SLM application 4 where the difference of average decibel value obtained is about 0.5 dB while the average decibel value for SLM application 4 is 2.4 dB. The comparison of the average decibel value made by monitoring the sound source produced by the car engine with the two SLM applications found that SLM application 4 is the nearest to the actual SLM, with the difference value obtained is 1.1 dB.

Taking everything into account, some of the applications need to be calibrated at first, and the calibrator in the applications is also unable to set the needed value. The non-calibration SLM applications in the smartphone lead to high inaccuracies towards the reading of decibel values. Besides, the MEMS type of microphone installed in the smartphone is another reason for the inaccuracy towards the readings of decibel value. The study indicates that there are no smartphone sound level meter applications that fulfill the IEC or ANSI standards, and they are not ready to replace the professional device as Sound Analyzer (TES-1358).

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