Assessment of the air quality parameter at Melaka: Jonker Walk and Surrounding Area

Nurul Ashraf Razali1,2,*, Wan Nurdiyana Wan Mansor1,2 Samsuri Abdullah1,2 Aliashim Albani1,2 Mohammad Fakhratul Ridwan Zulkifli1,2 and Mohd Sabri Mohd Ghazali2,3

1Faculty of Ocean Engineering Technology and Informatics, Universiti Malaysia Terengganu, Terengganu, Malaysia
2Air Quality and Environment Research Group, University Malaysia Terengganu, 21030 Nerus, Terengganu, Malaysia
3Faculty of Science and Marine Environment, Universiti Malaysia Terengganu, Terengganu, Malaysia

Corresponding e-mail: nrazali@umt.edu.my

Abstract. Melaka has been ruled by Portuguese, Dutch and British and well known with its historical background. Melaka also becomes an attraction for tourism; thus give positive impacts to local economies. Tourist, bus driver and the traders working along the main roads are amongst the people who affected with air pollution. In this study, data was collected at the Jonker Walk and surrounding area using VelociCalc/Q-trak 7575 by TSI. The measurement was taken at every 1-minute data for an interval of 60-minutes along the route. Data for carbon monoxide (CO) were measured using electrochemical method, while carbon dioxide (CO2) were measured using non-dispersive infrared (NDIR) technique. Other data such as temperature and relative humidity were also measured using the same instrument. Findings showed that the concentration of CO2 was the highest from 6.00 pm to 7.00 pm with a concentration of 934 ppm. The maximum median was found from 7.00 to 8.00 pm with 350 ppm, which was in the range of the ASHRAE limit. The highest value of CO was observed from 7.00 to 8.00 pm at 8.6 ppm with a median of 1.25 ppm. The 1-hour averaging time showed low concentration for CO level at 1.953 ppm which was below the acceptable limit of 35 ppm. Statistical analysis showed that there is no correlation between CO2 and CO. Moderate relationship exists between CO2 and temperature, CO and temperature and CO and humidity. These findings provide useful information for the tourists during their Melaka visit.

1. Introduction
Tourism is one of the largest-growing economic sectors in Malaysia; where it contributes to the economic and social development of a country. The impact of environmental factors, travel experiences and tourist aesthetic judgment are affecting the tourist destination choices [1]. However, the tourism industry is largely dependent on the climate and weather of a location/destination [2]. Air pollution that exceeds the New Malaysian Air Quality Standards (NMAQS) and American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) can trigger health problems, comforts and lead to a major health problem where 4.2 million deaths are reported every year are linked to outdoor air pollution exposure [1]. Carbon monoxides (CO), nitrogen dioxides (NO2), sulfur dioxides (SO2),...
ozone (O₃) and particulate matter 10 micrometers or less in diameter (PM₁₀) are the example of hazardous gases which are affecting the air quality and also harmful for human health [3]. Approximately 16.28 million tourists had visited Melaka in 2016 [4]. In 2019, the Government of Melaka has decided to launch Tahun Melawat Melaka with the theme of The Gateway to Historic Melaka. Bus drivers and traders working along the main roads are also affected by air pollution.

This data was collected at Jonker Walk from 6.00 pm to 10.00 pm; where it is one of the tourist attraction in Melaka. Melaka has a great street market along Jonker Walk and the business started at 6.00 pm. This aim of this study is to evaluate the CO and CO₂ level at Jonker Walk, Melaka. Both chemical and physical parameters such as CO₂ and CO concentration, temperature and humidity at Jonker Walk and surrounding area were recorded.

2. Experimental design and method
This study focused on the sample points selected at Jonker Walk and its surrounding area. The location covers Melaka Tourism Information Centre, Chen Hoon Teng Temple, Baba & Nyonya Heritage Museum, Dri Poyyatha Vinayagar Temple, Kampung Kling Mosque as shown in Figure 1. The data was collected for 3 hours from 6.00 pm to 10.00 pm. The reading was taken every 60-seconds for an interval of 60 minutes. VelociCalc/Q-trak 7575 was used to measure physical and chemical parameters such as the CO₂ and CO concentration, temperature and humidity. The ASHRAE and NMAQS were used as the guideline.

The Q-trak 7575 measures CO using electro-chemical gas sensors at a range of 0-500ppm while CO₂ is monitored using NDIR method at a range of 0-5000 ppm. The data collected were then tabulated using Microsoft Excel spreadsheet 2013 and processed using the Minitab software. The normality test was performed using the Shapiro-Wilk test [5]. The test rejects the hypothesis of normality when the p-value is less than or equal to 0.05. While for the homogeneity of variances, the Levene’s test was used. This test checks for the variance equality between two sets of data and rejects the hypothesis of homogeneity when the p-value is less or equal to 0.05.

Figure 1: Sampling location
3. Results and discussion

Tourism industries significantly contributed to the economic sectors; however, Saputra in his research reported that the CO₂ produced the tourism activities are high and lead to climate change [6]. Trains, cars and buses have contributed to the increment of CO₂ level in the atmosphere. Other sources of CO₂ in outdoor spaces is from the respiration process. In this study, all data were normally distributed according to the Shapiro-Wilk test with p-value > 0.05. However, data showed variances between groups with p-value <0.05 using Levene’s test. Hence, the median is used as a representative instead of the mean.

Figure 2 shows the variation of the parameters at different times. It was observed that the CO₂ level was the highest from 6.00 to 7.00 pm at 934 ppm as shown in Table 1. The highest median of CO₂ was measured from 7.00 to 8.00 pm with a value of 350.5 ppm. This was probably due to the increment of transportation due to after office hours and food hunting in the sampling area. This could also be due to the closeness of the instrument to the road. Most of the road in the area is very narrow and very close to the pedestrian walk. Other than that, accommodation and restaurants also one of the main contributors to the rising of CO₂ level at the tourism area [7]. The CO₂ data was compared with ASHRAE limit because the NMAQS requires at least 8 hours of sampling time. The concentration of CO₂ for outdoor environment is suggested to be in the range of 300-500 ppm [8]. Table 2 shows the descriptive analysis of CO concentrations. The CO level was the highest at 7.00 to 8.00 pm at 8.6 ppm. Incomplete combustion of carbonaceous fuels produces CO as the by-product [9]. CO was present at moderately low concentration at mean value close to 2.00 ppm for 1-hour averaging time and below the new ambient air quality standard of 35 mg/m³ (~35 ppm) at 1-hour averaging time [10]. Overall, all the measurement data were below the ASHRAE and NMAQS limit as shown in Figure 3.

(a) Boxplot of CO₂ (ppm)  (b) Boxplot of CO (ppm)
Figure 2: Variations of air quality parameter (a) CO₂, (b) CO, (c) temperature and (d) relative humidity.

Table 1: A descriptive analysis of CO₂ concentrations

| Variable | Time   | N  | Mean  | SE Mean | StDev  | Minimum | Q1    | Median | Q3    | Maximum |
|----------|--------|----|-------|---------|--------|---------|-------|--------|-------|---------|
| CO₂ (ppm)| 6.00pm | 60 | 352.8 | 13.8    | 103.3  | 285.0   | 310.5 | 327.0  | 352.0 | 934.0   |
|          | 7.00pm | 60 | 360.90| *       | 5.19   | 39.52   | 315.00| 333.50| 350.50| 509.00  |
|          | 8.00pm | 60 | 317.44| 7.55    | 58.02  | 268.00  | 275.00| 287.00| 351.00| 517.00  |
|          | 9.00pm | 60 | 302.0 | 11.4    | 93.70  | 265.0   | 268.0 | 274.0 | 275.0 | 807.0   |

*Highest values

Table 2: A descriptive analysis of CO concentrations

| Variable | Time   | N  | Mean  | SE Mean | StDev  | Minimum | Q1    | Median | Q3    | Maximum |
|----------|--------|----|-------|---------|--------|---------|-------|--------|-------|---------|
| CO (ppm) | 6.00pm | 60 | 0.948 | 0.134   | 1.003  | 0.100   | 0.300 | 0.500  | 1.175 | 4.700   |
|          | 7.00pm | 60 | 1.953 | *       | 0.263  | 2.006   | 0.100 | 0.400  | 1.250 | 8.600   |
|          | 8.00pm | 60 | 0.4695| 0.0419  | 0.3218 | 0.1000  | 0.3000| 0.4000 | 0.6000| 1.7000  |
|          | 9.00pm | 60 | 0.4618| 0.0265  | 0.2168 | 0.1000  | 0.3000| 0.4000 | 0.5000| 1.2000  |

*Highest values
Figure 3: Gaseous pollutants concentrations during the assessment.

Table 3: Pearson’s correlation coefficient (r) between air quality parameters

|          | CO₂      | Temperature | Humidity |
|----------|----------|-------------|----------|
| Temperature | 0.348\(^b\) | -0.248      | -0.926\(^a\) |
| Humidity  | -0.248   | -0.926\(^a\) | -0.431\(^b\) |
| CO        | 0.156    | 0.487\(^b\) | -0.431\(^b\) |

\(^a\) strong correlation
\(^b\) moderate correlation

Table 3 shows the Pearson’s correlation coefficient (r) among CO₂, CO, temperature and relative humidity. There exists a strong relationship between humidity and the temperature (r = -0.926) and moderate relationship between CO₂ and temperature (r = 0.348), CO and temperature (r = 0.487) and CO and humidity (r = -0.431). Results also showed that there is a weak correlation between CO₂ with humidity (r = -0.248) and CO (r = 0.156).

4. Conclusion
There exists a medium correlation between CO₂ level and the temperature; however, the correlation of other factors was weak. A long term of monitoring is necessary to understand the trend of CO₂ and CO level at Jonker Walk and the surrounding area. The government should promote the use of green transportation such as bicycle and hybrid vehicles in order to control air pollution. Also, routes for pedestrian and cycle walkway should be increased and improved. On the other hand, reducing the air-conditioning system and artificial lighting energy consumption by optimising the natural ventilation is able to reduce the CO₂ emission.

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