Progress in Engineering Application and Technology Vol. 3 No. 1 (2022) 112-121

PEAT

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/peat
e-ISSN : 2773-5303

A Study on The Water Quality Assessment of The Renchong River at Muar, Johor

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DOI: https://doi.org/10.30880/peat.2022.03.01.013
Received 17 January 2022; Accepted 11 April 2022; Available online 25 June 2022

Abstract: This study is carried out to determine the water quality of the Renchong River based on the WQI parameters. The land activities near the Renchong River were determined through Google Earth Pro and site visit. A total of 4 sampling stations are selected along the Renchong River, namely Station 1 or known as the *Kundang Ulu* Jetty Station, Station 2 or known as *Pasar Gersik* Station, Station 3 or known as *Sungai Renchong* Jetty Station and Station 4 or also known as *Paya Limpah* Station. The water sampling was carried out once a week for one month during both dry and rainy days. The samples were tested for the WQI parameters namely: i) Biochemical Oxygen Demand (BOD), ii) Chemical Oxygen Demand (COD), iii) Dissolved Oxygen (DO), iv) pH, v) Ammoniacal Nitrogen (NH_3-N), and xi) Total Suspended Solid (TSS). Subsequently, the WQI index was calculated for all the four stations. In general, in terms of the WQI parameters, it can be said that with the exception of NH_3-N, the water quality in all 4 stations were in the acceptable range for freshwater aquaculture. Lastly, the WQI results showed that the Station 3 which is the Sungai Renchong Jetty is the cleanest compared to other stations with water quality range between Class I and Class II.

Keywords: WQI Parameters, WQI Index, River Water Quality

1. Introduction

The agricultural sector in Malaysia is one of the most promising sectors as it provides food, creates jobs for rural residents, and promotes the country's economic development [1]. It provides significant employment opportunities for people, especially in the rural areas. Malaysia's land area is approximately 32.98 million hectares, and the agricultural sector has already contributed about 20% of the total land area, or about 6.6 million hectares [2]. In a nutshell, it can be summarized that the agricultural sector plays a vital role in Malaysia's economic growth. Unfortunately, agricultural activities have been identified as one of the primary sources that contribute to negative impact on the environment. Firstly, as the agricultural sector expands, deforestation and overgrazing also increases, resulting in the loss of animals and plants species. Besides that, the excessive use of pesticides leads to biodiversity loss seeing that the birds and aquatic organisms are highly exposed to it and will lead to

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health hazards [3]. Last but not least, agricultural activities also caused air and water pollution. The decomposition of manure and combustion resulted in emissions of methane, nitrogen oxide and carbon monoxide and effluents from the agricultural activities which discharge into the river result in affecting river water quality [4].

Over the years, many research works have been conducted around the world on the agricultural and human activities in relation to water quality [5]. In 2017, a study on the water quality assessment of the Yamuna River, India, revealed that the river is polluted and not save to be used for domestic purposes [6]. Other studies revealed that human activities such as livestock husbandry and agriculture play a significant role in polluting the river. In addition, the use of pesticides in farming activities also influenced the river water quality, in which pesticides can reach and contaminate surface water through runoff from plants and soil quickly [7].

In 2018 in Malaysia, 161 rivers were added to the national river water quality monitoring program. The river water quality was assessed based on a total of 8118 samples taken from a total of 638 rivers. Out of 638 rivers monitored, 357 (56.00 %) were found to be clean, 231 (36.00 %) slightly polluted and 50 (8.00 %) polluted [8]. A study that was carried out by [9] in 2015 on the water quality assessment of the tropical rivers in the Penang Island revealed that none of the rivers in Penang Island was considered as clean. Furthermore, in 2018, the water quality assessment of the Selangor River [10] found out that most of the stations in Selangor River basin recorded water quality as Class III.

Renchong river is a part of the Muar River and is located at latitude 2°12'23.36” N and longitude 102°46'44.82” E. There are many activities that are carried out surrounding Renchong River. One of the main activities that is carried out by the locals include husbandry livestock, cattle, fowl, sheep, and goats breeding. There is also palm oil plantations located nearby the area in addition to the jetties that were built for the convenience of the locals. The jetties are located at the riverbank, where it raised fish, lobster, and other aquatic life. Other than that, one of the jetties at the Renchong River is also famous for fishing related activities, where there have chalets and boats for rent to people who come for fishing in Renchong River.

In 2017, Muar has been named as one of the cleanest cities and won the ASEAN Clean Tourist City Standard Award. Subsequently, many activities have been carried out to keep Muar's reputation as one of Asia's cleanest cities. Among the activities organized by the local council include the World Clean Up Day. Apart from that, activities with the local community, the local councils also conducted activities with the local universities for clean-up activities. In term of river cleaning, in conjunction with the Muar District Municipal, local universities, the communities have organized activities to clean up the rivers such as plogging around riverside, the ECO-BSM13 project to ease the river cleaning process and to date, the largest mud balls throwing events have been conducted in Muar, Johor to clean the Muar River. Therefore, this research is interested to investigate how far the human activities are affecting the water quality of the Renchong River at Muar, Johor.

1.1 Water Quality Index and its parameters

Water Quality Index (WQI) is an important parameter for assessing the quality of drinking water for the public [11]. In Malaysia, the status of river water quality is evaluated by using the WQI index. The WQI is the basis of the water quality assessment and has been used for more than 30 years. Basically, there are 6 WQI parameters namely: i) Dissolved Oxygen (DO), ii) Biochemical Oxygen Demand (BOD), iii) Chemical Oxygen Demand (COD), iv) pH, v) Ammoniacal Nitrogen, and xi) Total Suspended Solid (TSS).

1.1.1 Dissolved Oxygen (DO)

Dissolved Oxygen (DO) refers to an oxygen gas that is dissolved in the water [12]. The higher the DO values the better is the water quality and best for a healthy ecosystem. However, there is a limit of

DO level for aquatic species and it is not good if the value of DO are too high. Likewise, low DO in any river water brings negative impact and makes aquatic species move away, weaken or even die.

1.1.2 Biochemical Oxygen Demand (BOD)

Biochemical Oxygen Demand (BOD) is one of the most important and commonly used criteria for characterizing organic contamination in water [13]. A low BOD is an indicator of good quality water while a high BOD indicates polluted water.

1.1.3 Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) is the amount of oxygen needed to oxidize the organic matter present in water [14]. The amount of organic matter or oxygen demand is determined by calculating how much oxidizing chemical was absorbed during the test. The COD test is commonly used because it is a short-term, precise test with little interferences.

1.1.4 pH

pH is a measurement scale that ranges from 0 to 14, with 7 being neutral or less reflecting an acidic atmosphere and greater than 7 indicating an alkaline environment. It can help to measure the relative amount of hydrogen ions and hydroxyl ions in the water. As result, high contains of hydrogen ions indicates acidic while high in hydroxyl ions indicates alkaline of the water.

1.1.5 Ammoniacal Nitrogen (NH_3-N)

Ammoniacal nitrogen test is a measure for the amount of toxic pollutant like ammonia that often found in landfill leachate and waste products such as sewage, liquid manure, and other liquid organic waste products [15]. It is a good parameter in order to measure the water quality or health of the water in natural bodies such as rivers, lakes, or in man-made water reservoir.

1.1.6 Total Suspended Solid (TSS)

Total Suspended Solid (TSS) are particles in the water column greater than 2 microns in size or a dissolved solid that described as anything smaller than 2 microns. These solids include anything drifting or floating in the water from sediment, silt, and sand to plankton and algae. High TSS in the water will degraded the water quality of the river as well as effect on environmental health.

1.1.7 Water Quality Index

In order to calculate the WQI, all the values of WQI parameters must obtained. After that, the values of the WQI parameter will first calculate to get the sub-index values. All the sub-index values for the parameters are then calculated using the Equation 1 [16].

$$WQI = (0.22 * SIDO) + (0.19 * SIBOD) + (0.16 * SICOD) + (0.15 * SIAN) + (0.16 * SISS) + (0.12 * SIpH) \quad Eq. 1$$

Through WQI parameters testing, the results obtained from each parameter will be classify into Class I, II, III, IV, and V. The classification is based on the water quality status which class I (excellent), II (good water), III (poor water), IV (very poor water) and V (unsuitable water). The value obtained from ammoniacal nitrogen, BOD, COD, DO, and TSS will be expressed in unit mg/L.

2. Materials and Methods

The data collection is carried out in 3 stages. Stage 1 is the site observation. In order to determine and explore the detail of the study area, Google Earth Pro and site visit were used and carried out respectively. In Stage 2, water samples of every station were taken for lab testing. A total of 6 tests will be conducted from the water samples of every station in order to identify the WQI parameters values.

The tests conducted include: i) DO; ii) BOD; iii) COD; iv) pH; v) NH_3-N; and vi) TSS. In the last stage, after the results of WQI parameters obtained, all the values of the WQI parameters will be calculated to get the WQI index. The flowchart of the research methodology is presented in Figure 1.

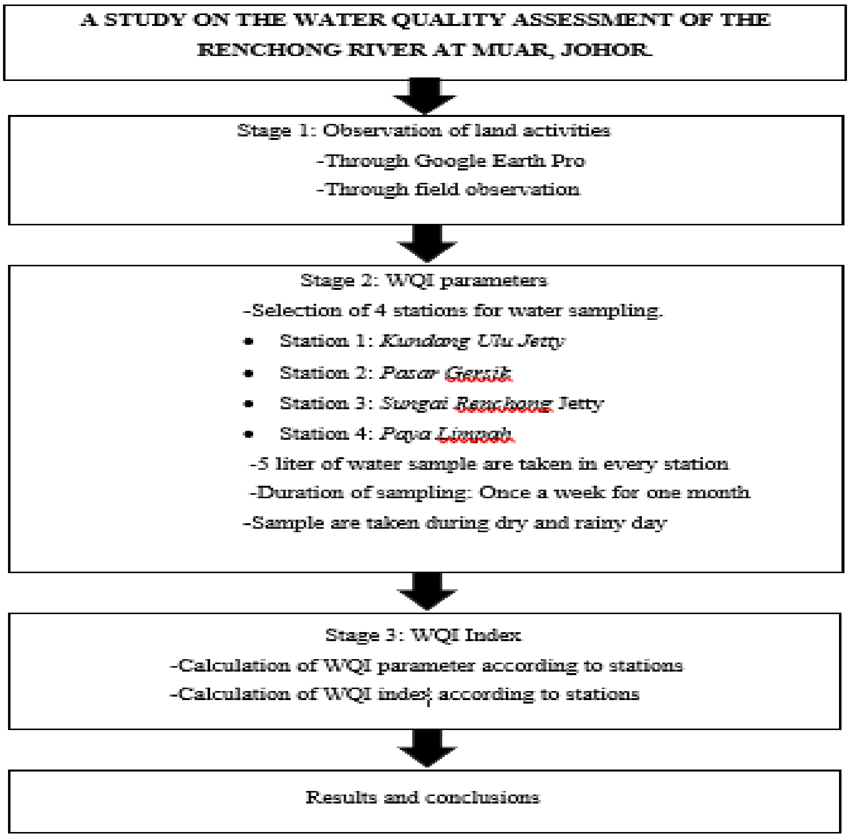

Figure 1: Flowchart of research methodology

3. Results and Discussions

3.1 WQI Parameter

4 stations have been selected for the data collection which are: i) Station 1 (*Kundang Ulu* Jetty); ii) Station 2 (*Pasar Gersik*); iii) Station 3 (*Sungai Renchong* Jetty) and iv) Station 4 (*Paya Limpah*). The data collection was conducted in 4 weeks (one month) in November 2021. During the sampling period, 2 weeks were raining days and another 2 weeks were sunny days. In addition, the samplings were conducted in the morning and evening for two weeks respectively.

3.1.1 Dissolved Oxygen (DO)

In general, throughout the sampling period, it can be summarized that the results of Station 4 *Paya Limpah* is better than other three stations which categorized as Class I for 4 weeks. For Station 1 the range is fall between 4.85 mg/L (Class III) to 7.15mg/L (Class I), Station 2 is between 4.91 mg/L (Class III) to 6.06 mg/L (Class II) and Station 3 is lies between 5.87 mg/L (Class II) to 6.98 mg/L (Class II). It can be concluded that Station 4 is suitable for aquatic living as the values fall between the range of 6.50 mg/L to 8.00 mg/L. Table 1 show the results of DO for the 4 Stations throughout sampling period.

Table 1: Results of Dissolved Oxygen (DO) for the 4 Stations throughout sampling period

Parameter	DO (mg/L)							
Station	Week 1	Class	Week 2	Class	Week 3	Class	Week 4	Class

Station 1	4.85	III	7.07	I	6.68	II	7.15	I
Station 2	4.91	III	5.43	II	5.96	II	6.06	II
Station 3	6.24	II	5.87	II	6.98	II	6.9	II
Station 4	7.18	I	9.18	I	8.5	I	7.04	I

3.1.2 Biochemical Oxygen Demand (BOD)

In term of BOD level, Station 2 had the highest BOD level for 4 weeks which is the worst as compared to the other three stations. The range of the BOD level in Station 2 is from 1.78 mg/L (Class II) to 6.16 mg/L (Class IV). This is probably due to the wastewater generated from the chicken processing stall and food court [17]. In comparison to other stations, Station 1 is lies between range of 0.09 mg/L to 1.72 mg/L, Station 3 fall between range of 0.60 mg/L to 1.32 mg/L and Station 4 lies between 0.115 mg/L to 1.795 mg/L where all were categorized within Class I to Class II. Table 2 illustrated the results of BOD for the 4 Stations throughout sampling period.

Table 2: Results of Biochemical Oxygen Demand (BOD) for 4 stations throughout sampling period

Parameter	BOD (mg/L)							
Station	Week 1	Class	Week 2	Class	Week 3	Class	Week 4	Class
Station 1	0.09	I	0.71	I	0.51	I	1.72	II
Station 2	1.78	II	6.16	IV	6.14	IV	5.25	III
Station 3	0.97	I	0.60	I	0.67	I	1.32	II
Station 4	1.67	II	1.08	II	1.795	II	0.115	I

3.1.3 Chemical Oxygen Demand (COD)

For the Station 4, it can be summarized that the range of COD level is from 14.0 mg/L to 73.5 mg/L which lies between Class II and Class IV throughout the sampling period. Based on the results obtained, during rainy days in Week 1 and Week 3 the COD level is higher. This is probably because during rainy days, the residuals of chemical pesticides or fertilizer in the palm oil plantation area were washed off and leached into the river causes the COD level becomes higher [18]. In comparison to other stations, Station 1 lies with value of 17.0 mg/L to 30.5 mg/L, Station 2 lies between 22.5 mg/L to 36.0 mg/L and categorized between Class II and Class III. Station 3 have shown the stable data which lies in Class II for four weeks with range of 17.5 mg/L to 24.0 mg/L. Table 3 illustrated the results of COD for 4 Stations throughout sampling period.

Table 3: Results of Chemical Oxygen Demand (COD) for the 4 Stations throughout sampling period

Parameter	COD (mg/L)							
Station	Week 1	Class	Week 2	Class	Week 3	Class	Week 4	Class
Station 1	30.5	III	28	III	28	III	17	II
Station 2	29	III	36	III	32	III	22.5	II
Station 3	19.5	II	24	II	17.5	II	21.5	II
Station 4	51.5	IV	17	II	73.5	IV	14	II

3.1.4 pH

Next, the overall pH value for 4 weeks obtained in both Station 2 and Station 3 are in good quality except in Week 1 which categorized in Class V (refer to Table 4). This may be due to the rainy weather conditions in which the acid rain entered the watershed causing the pH of the river water to drop and became more acidic [19]. In contrast to Station 1 and Station 4, the overall values throughout the data collection period were acidic and categorized as Class V that ranged from 2 to 5. This is probably due to the excessive use of fertilizer in the palm oil plantation area that dangerously polluted the river water seeing that the chemical in fertilizer will leached into the river water and lead to an increase in acidity of the river.

Table 4: Results of pH for the 4 Stations throughout sampling period

Parameter	pH							
Station	Week 1	Class	Week 2	Class	Week 3	Class	Week 4	Class
Station 1	3.72	V	4.28	V	4.38	V	4.01	V
Station 2	2.84	V	6.53	I	6.2	II	7.11	I
Station 3	2.82	V	6.84	I	6.17	II	6.73	I
Station 4	2.76	V	4.14	V	4.39	V	4.23	V

3.1.5 Ammoniacal Nitrogen (NH_3-N)

Table 5 shows the results of Ammoniacal Nitrogen for all of the 4 Stations that are located along the Renchong river. The NH_3-N level of Renchong river during the period of study was in the range of 0.45 mg/L and 5.31 mg/L. In Station 2, the NH_3-N level was the highest for 4 weeks among the other stations which range from 1.88 mg/L to 5.31 mg/L and is in between Class IV and Class V which indicate a poor quality. All of the stations had a moderate quality of NH_3-N level that is not in the acceptable range for freshwater aquaculture [20]. The high values of NH_3-N recorded in Renchong river during the study period showed that the river was mildly polluted with ammonia and nitrogen pollutants.

Table 5: Results of NH_3-N for 4 stations throughout the sampling period

Parameter	NH_3-N (mg/L)							
Station	Week 1	Class	Week 2	Class	Week 3	Class	Week 4	Class
Station 1	1.48	IV	1.05	IV	1.26	IV	1.21	IV
Station 2	1.88	IV	3.93	V	2.42	IV	5.31	V
Station 3	1.1	IV	0.78	III	0.86	III	1.2	IV
Station 4	0.56	III	0.45	III	0.56	III	0.5	III

3.1.6 Total Suspended Solid (TSS)

The results of TSS in Table 6 revealed that the highest TSS concentration was recorded in Station 4 at *Paya Limpah* in Week 1. For Station 1, the values recorded is range from 10 mg/L to 70 mg/L (Class I to Class III), Station 2 is from 10 mg/L to 25 mg/L categorized as Class I and Station 3 is categorized between Class I to Class III with range of 5 mg/L to 55 mg/L. The high concentration of TSS at Station 4 is 320 mg/L and lies in Class V. As mentioned earlier, in the previous section, Week 1 and Week 3 are rainy days. Therefore, the weather condition in those weeks causes the TSS level become higher at Week 1 and Week 3 with 320 mg/L and 170 mg/L respectively. In contrast to sunny days, the values of TSS in Week 2 and Week 4 is lower with values of 10 mg/L and 25 mg/L respectively. Therefore, it can be said that during rainy days caused the soil erosion to occur in the catchment which leads to the high TSS level of the river water [21].

Table 6: Results of Total Suspended Solid (TSS) for the 4 Stations throughout sampling period

Parameter	TSS (mg/L)							
Station	Week 1	Class	Week 2	Class	Week 3	Class	Week 4	Class
Station 1	70	III	10	I	15	I	10	I

Station 2	10	I	15	I	10	I	25	I
Station 3	55	III	5	I	35	II	15	I
Station 4	320	V	10	I	170	IV	25	I

3.2 Water Quality Index (WQI index)

The results of the subindex and WQI for all of the 4 Stations during the study period is summarized in Table 7 until Table 10.

Table 7: Subindex (SI) and Water Quality Index (WQI) in Station 1 for four weeks

Descriptions	siBOD	siCOD	siNH$_3$-N	siTSS	sipH	siDO	WQI	Class
Week 1	100.02	62.59	37.66	64.25	22.5	72.25	63.54	II
Week 2	97.3967	65.25	46.76	91.63	35.36	97.74	76.37	II
Week 3	98.2427	65.25	41.97	88.85	37.99	96.3	75.36	II
Week 4	93.1244	78.19	43.04	91.63	28.95	98.5	76.46	II

Table 8: Subindex (SI) and Water Quality Index (WQI) in Station 2 for four weeks

Descriptions	siBOD	siCOD	siNH$_3$-N	siTSS	sipH	siDO	WQI	Class
Week 1	92.87	64.17	31.41	91.63	8.66	73.86	64.57	II
Week 2	74.3432	57.09	0.24	88.85	97.2	79.62	66.69	II
Week 3	74.4278	61.05	21.39	91.63	93.71	84.98	71.72	II
Week 4	78.1925	71.45	0	83.59	99.02	90.24	71.40	II

Table 9: Subindex (SI) and Water Quality Index (WQI) in Station 3 for four weeks

Descriptions	siBOD	siCOD	siNH$_3$-N	siTSS	sipH	siDO	WQI	Class
Week 1	96.30	73.17	45.55	69.98	8.43	91.23	69.12	II
Week 2	97.88315	69.71	53.87	94.51	99.16	83.07	83.13	I
Week 3	97.5659	75.83	51.73	78.71	93.32	98.08	83.80	I
Week 4	94.8164	72.63	43.26	88.85	98.61	98.08	83.75	I

Table 10: Subindex (SI) and Water Quality Index (WQI) in Station 4 for four weeks

Descriptions	siBOD	siCOD	siNH$_3$-N	siTSS	sipH	siDO	WQI	Class
Week 1	93.36	43.83	61	14.88	7.79	97.78	58.73	III
Week 2	95.85275	78.19	64.89	91.63	31.85	97.88	80.47	I
Week 3	92.80715	29.55	61	25.32	38.26	99.25	61.99	II
Week 4	99.91355	80.48	63.09	83.59	34.09	97.78	80.30	I

Based on the results obtained from Table 7, it can be concluded that the water quality in Station 1 is slightly polluted despite of the weather conditions. This is probably because Station 1 is an area that have various human activities such as residential areas, food court and public market. Hence, it can be said that the human activities play a contributing role in affecting the river water quality [22]. Next, for Station 2, results from Table 8 indicated that the WQI throughout the sampling period is slightly polluted despite of the weather conditions. Similar to Station 1, Station 2 is also a research area that consists of different human activities such as public market and food court. The results obtained indicated that the human activities have an influence towards the river water quality. In addition, Station 2 which is *Pasar Gersik* also discharged wastewater from chicken processing stall into the drains. The wastewater from chicken processing that are disposed of directly into a river without any pre-treatment methods play a significant factor in decreasing the water quality of the river [23]. In Station 3, except for week 1, results from Table 9 indicated the water quality during the sampling period was clean. From observation, Station 3 is an area that breeds aquatic species such as shrimp and fish in the cage. Research conducted on the effect of fish farming on river water quality in Northeast Spain, stated that the fish farm activities have shown significant effect towards the water quality of the river [24]. Lastly, results from Table 10 indicated that there is difference in water quality during sunny and rainy days in Station 4. As mentioned earlier, Station 4 is a palm oil plantations area. During rainy days (Week 1 and Week 3), the river water quality was classified as polluted and slightly polluted respectively. On the other hand, in sunny days, the water quality in Station 4 was clean. This probably due to the residuals of chemical fertilizer and pesticides in the palm oil plantations that had been washed off and leached into the river water during rainy days [25]. The WQI for all the Station throughout the sampling period is illustrated in Figure 2.

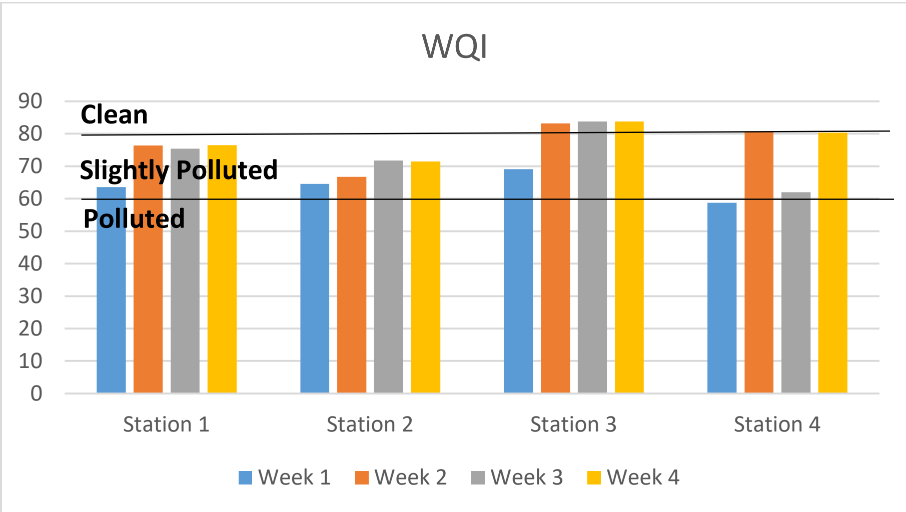

Figure 2: WQI for 4 Stations in four weeks

4. Conclusion

One of the biggest limitations while carrying out this research is that the enforcement of the Movement Control Order (MCO) due to pandemic Covid-19. The implementation of MCO resulted in a shorter time period for data collection. Therefore, to overcome the limitations of the research, it is recommended that sampling should be conducted in a longer period of at least three months to ensure the accuracy of results for analysis and comparison.

Acknowledgement

The authors would like to thank the Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia for its support.

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