

2022 GLOBE International Virtual Science Symposium

**An Analysis of the Various Aspects of the Rueifong Night
Market and Liuhe Night Market in Kaohsiung, Taiwan, and
air pollution**

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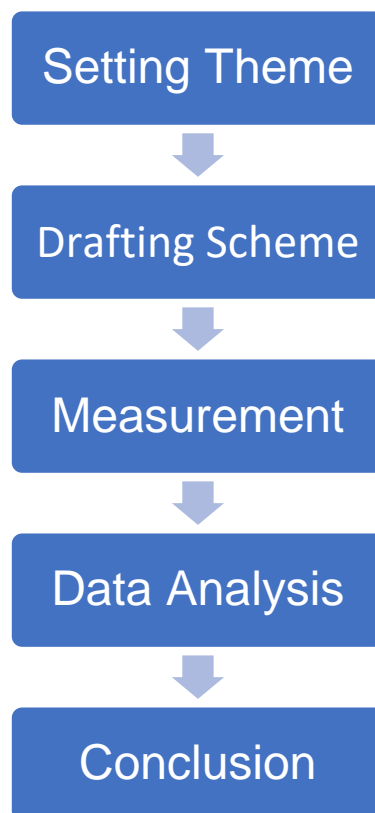
Abstract

This research aims to find out different factors that might affect the TVOC, Carbon Dioxide, Particulate Matter 2.5 and 10 in the night markets in Taiwan. We visited Liuhe and Ruiefong Night Market, using Mobile Nose to investigate the variation of the four variables. At last, we found them mostly affected by the types of the stands and traffic flow near the markets. And the huge number of people would prevent our device from detecting air pollution caused by those stands.

Motivation

When we visited night markets, we found out that food stands produce a considerable amount of cooking fumes. Besides, we noticed that different night markets vary in types of stands, surrounded traffic flows, the number of visitors, etc. Therefore, we want to investigate the connection between these elements and the magnitude of pollution that these night markets produce.

Structure



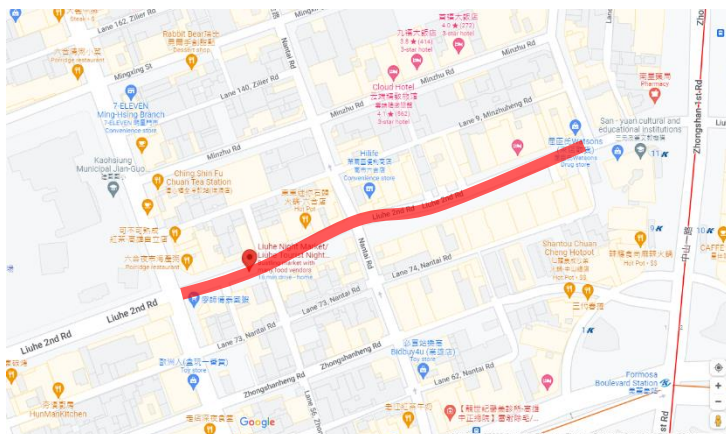
Research Methods

Materials: Mobile Nose 、smartphone(app: ADDWII)

Methods: We connected the Mobile Nose to our smartphone, imitating visitors' walking speed along their path and collecting data through the app.

Data Analysis and Discussion

Measurement at Liuhe Night Market



Picture 1

Liuhe Night Market (red bold line) is an east-west road, being 380 meters in length.



Picture 2

We started from the west to the east of the night market for the first measurement, then came back to the starting point for the second one, both times walking along the right side of the road.

First Time Measurement

Time:12/26/2021 19:00

Background Factors (Qianjin station)

PM2.5	20ppm
PM10	-
SO ₂	2.3ppb
CO	0.38ppm

O ₃	20.2ppb
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Figure 1
Meteorological Factors (Qianjin station)

Temperature	19.2°C
Humidity	79%
Wind Direction	350 degree
Wind Speed	2.1 m/s

Figure 2



Result

West → East

1. We figured out that the tendencies of PM2.5 and PM10/TVOC and Carbon Dioxide concentration are almost the same, therefore, we discussed them separately as two groups.

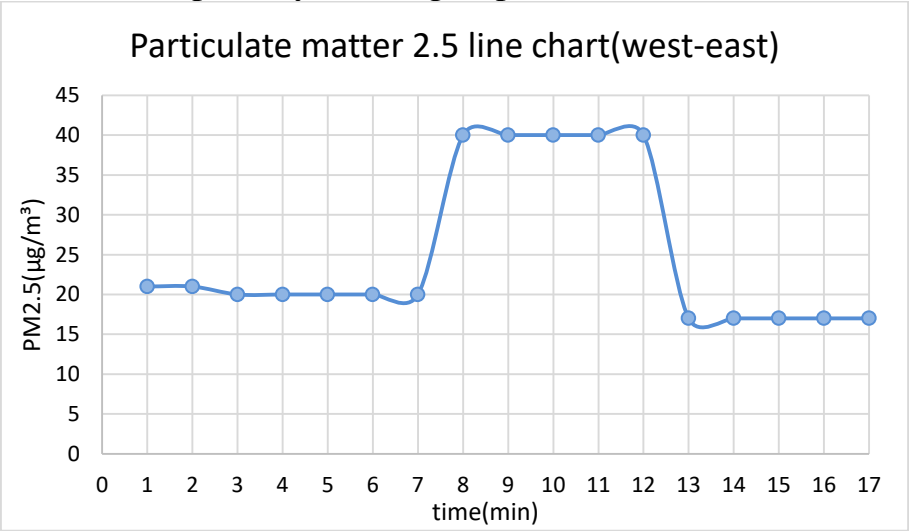


Chart 1

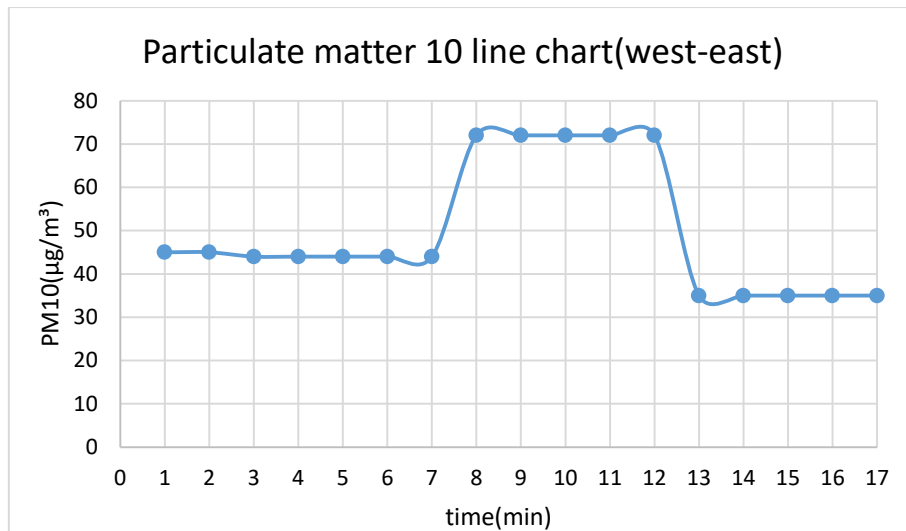


Chart 2

1. From the 7th to 12th minutes, the Mobile Nose detected a higher emission of PM2.5 and PM10, and then they remained stable for a couple of minutes.
2. Other than the sudden rise in the 7th and 12th minutes, the rest of the time, PM2.5 and PM10 remained steady, and are a bit higher than the background variable.

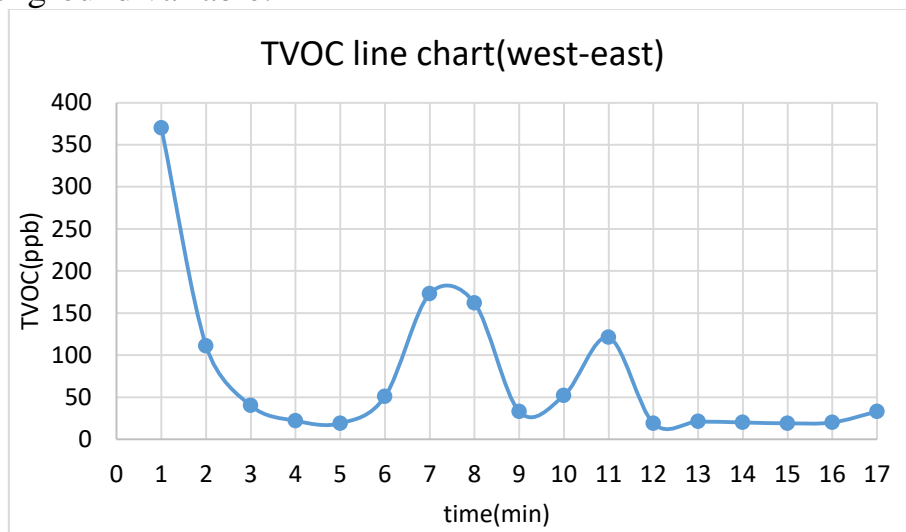


Chart 3

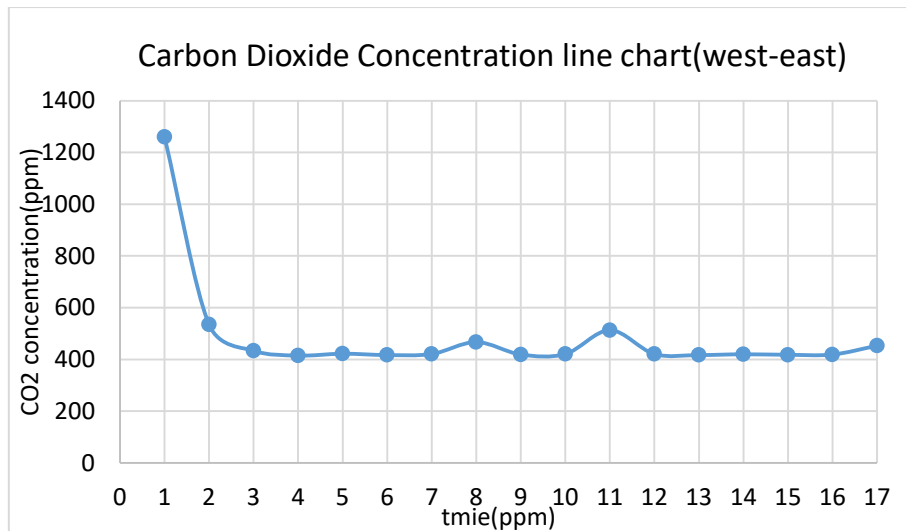


Chart 4

1. In the first minute, we detected the highest amount of TVOC and CO₂ concentration, and then dramatically dropped at the second minute.
 - (1) We speculated that it was the entrance where more vehicles passed by that brought the highest amount of TVOC and CO₂.
 - (2) Also, most of the fried food stands such as grilled shrimp and fried chicken, gathered densely at the entrance.
2. We found a slight rise in the 8th and 11th minutes. As for the remaining time, TVOC was under 50ppb, and CO₂ stayed approximately at 400ppm.
 - (1) The scooters that occasionally went through while investigating resulted in the slight rise of the data.

East → West

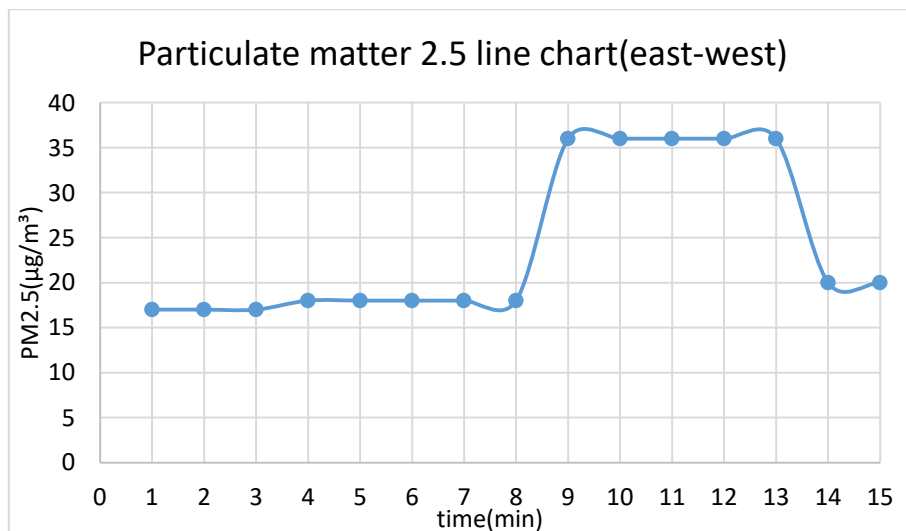


Chart 5

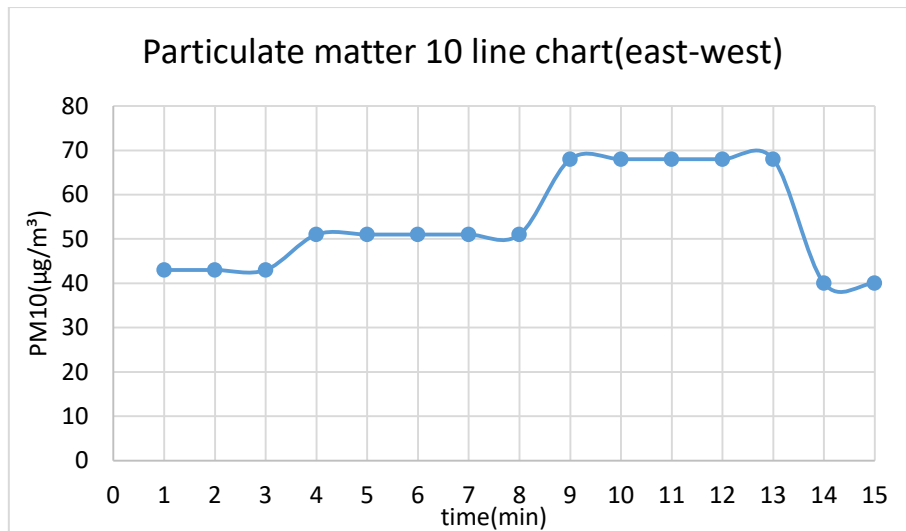


Chart 6

1. From the 3rd to 13th minutes, there's a gradual rise.
2. From the 9th to 13th minutes, the Mobile Nose detected a higher emission of PM2.5 and PM10, and then they remained stable for a couple of minutes.

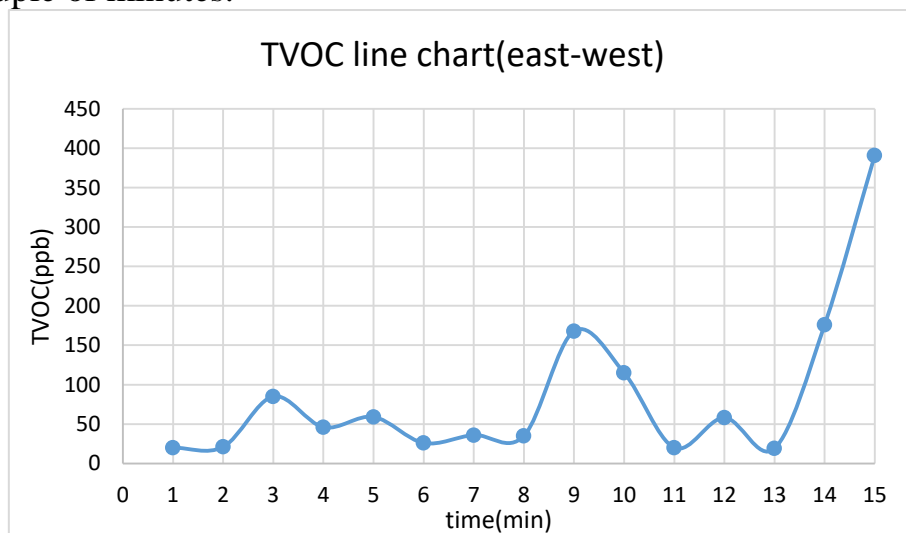


Chart 7

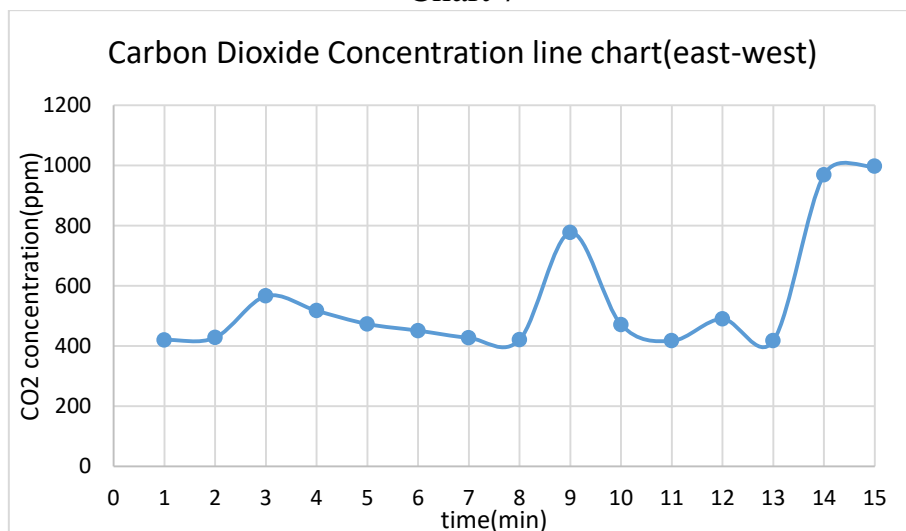


Chart 8

1. There are some increases along the way, showing both of the charts.
 - (1) We supposed that this might be because of the vehicles that passed by.
2. In the 14th and 15th minutes both dramatically increase.
 - (1) Those were the place where food stands concentrated.
 - (2) Also, it was the entrance, which bore a higher traffic flow.

Second Time Measurement

02/20/2022 19:00

Background Factors (Qianjin station)

PM2.5	15ppm
PM10	11ppm
SO ₂	2.2ppb
CO	0.37ppm
O ₃	27ppb

Figure 3

Meteorological Factors (Qianjin station)

Temperature	20.1°C
Humidity	63%
Wind Direction	350 degree
Wind Speed	2.1 m/s

Figure 4



West → East

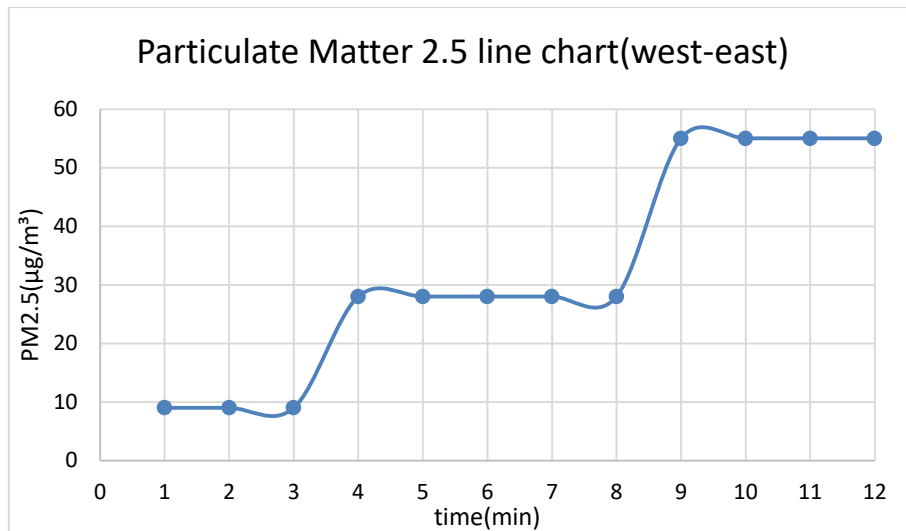


Chart 9

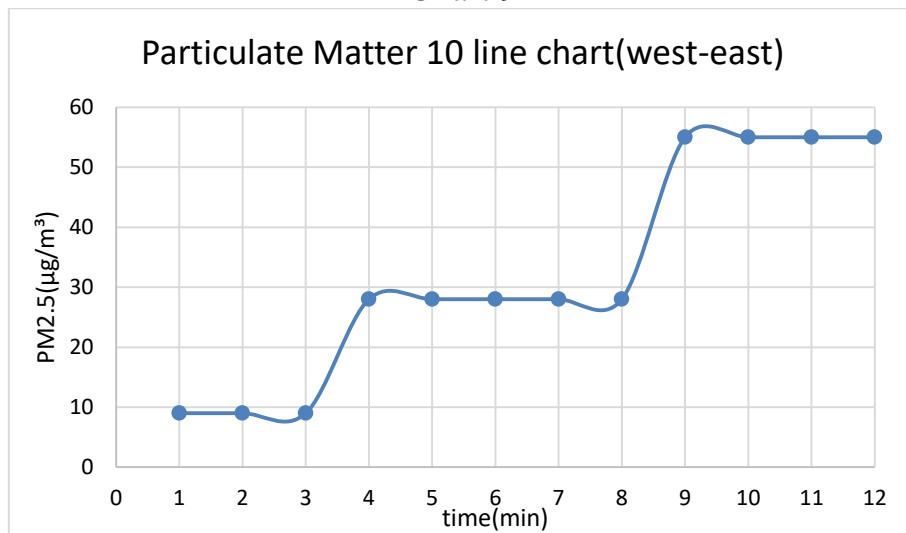


Chart 10

1. The number kept rising till the end of the road and stayed stable for several minutes.

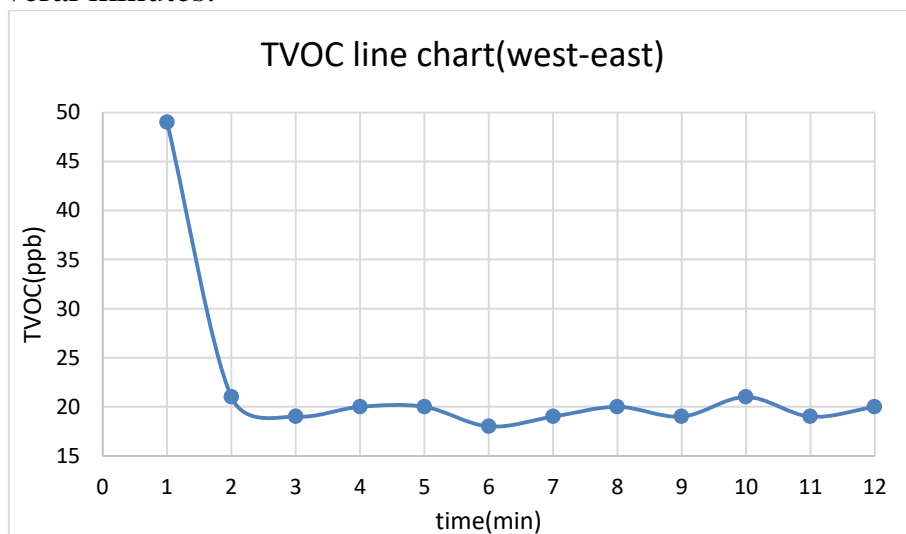


Chart 11

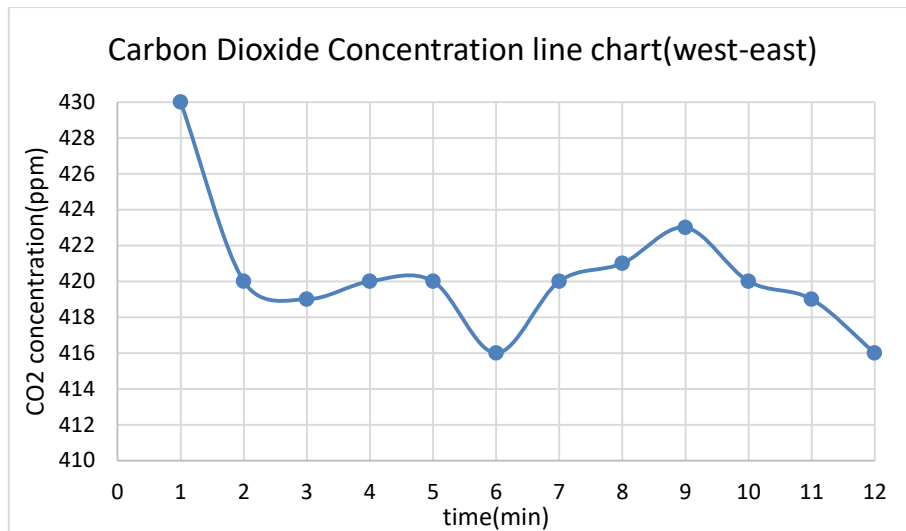


Chart 12

1. Both TVOC and CO₂ are high at the beginning, and then dropped suddenly at the second minute.
 - (1) We speculated that it was the entrance where more vehicles passed by that brought the highest amount of TVOC and CO₂.
 - (2) Also, most of the fried food stands such as grilled shrimp and fried chicken gathered densely at the entrance.
2. There are some slight rises and drops that emerged in the charts.
 - (1) The rises may be caused by the vehicles passed by.
 - (2) The drops were vacancies or vendors that didn't sell clothes or toys.

East → West

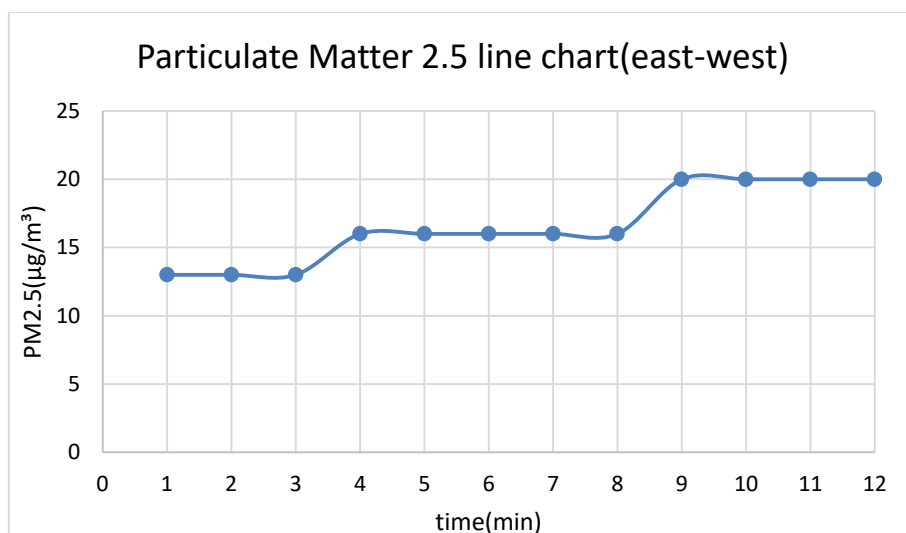


Chart 13

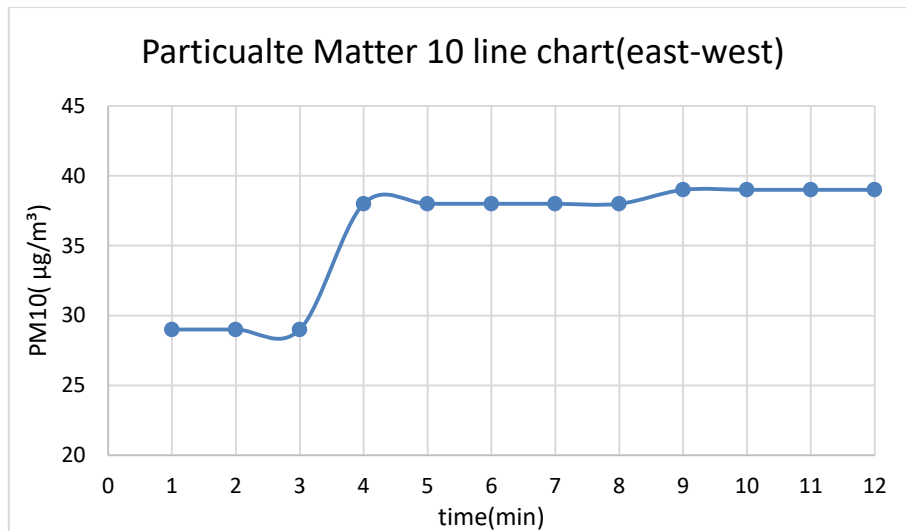


Chart 14

1. The PM2.5 and PM10 both kept increasing since the 4th minute and last till the end.

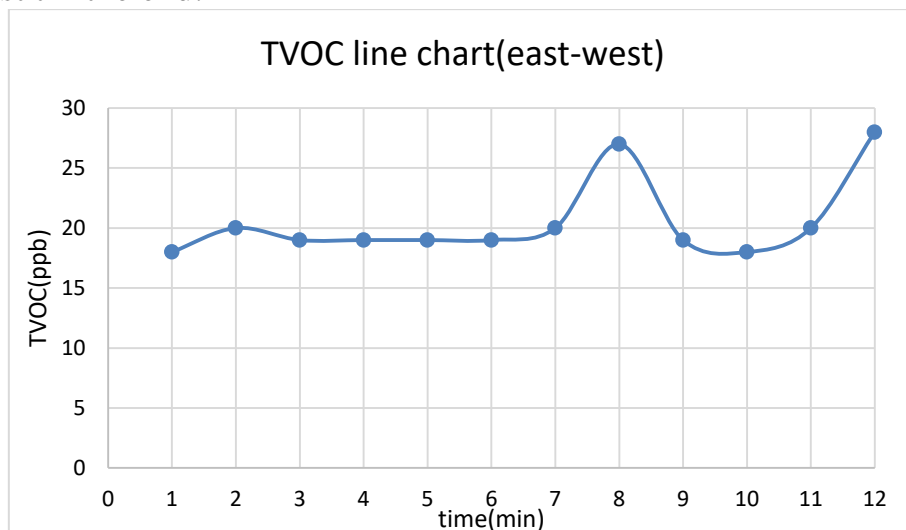


Chart 15

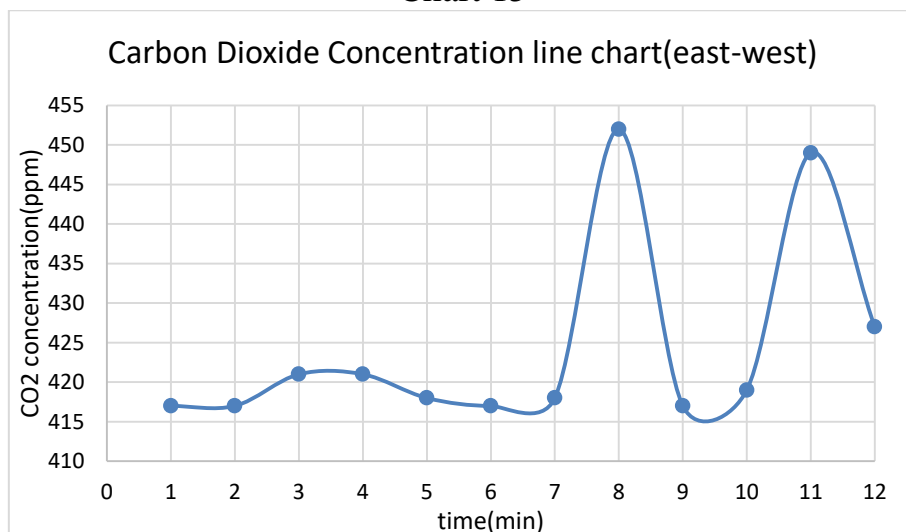


Chart 16

1. Both increased at 8th and dropped at 9th minutes and rose again at 11th

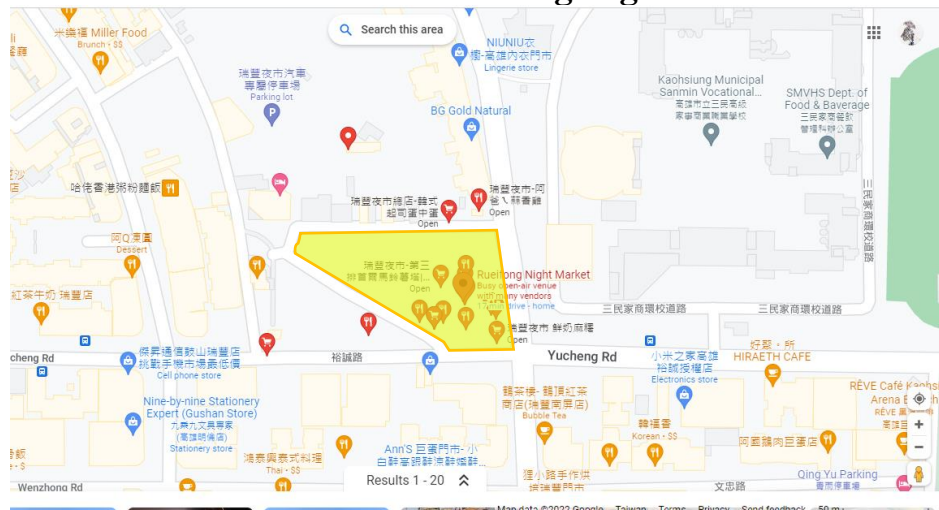
minutes.

- (1) We guessed that it was the entrance where more vehicles passed by that brought the highest amount of TVOC and CO₂.
- (2) Also, most of the fried food stands such as steak and fried chicken gathered densely at the entrance.
- (3) The lower parts were vacancies or vendors that didn't sell clothes or toys.

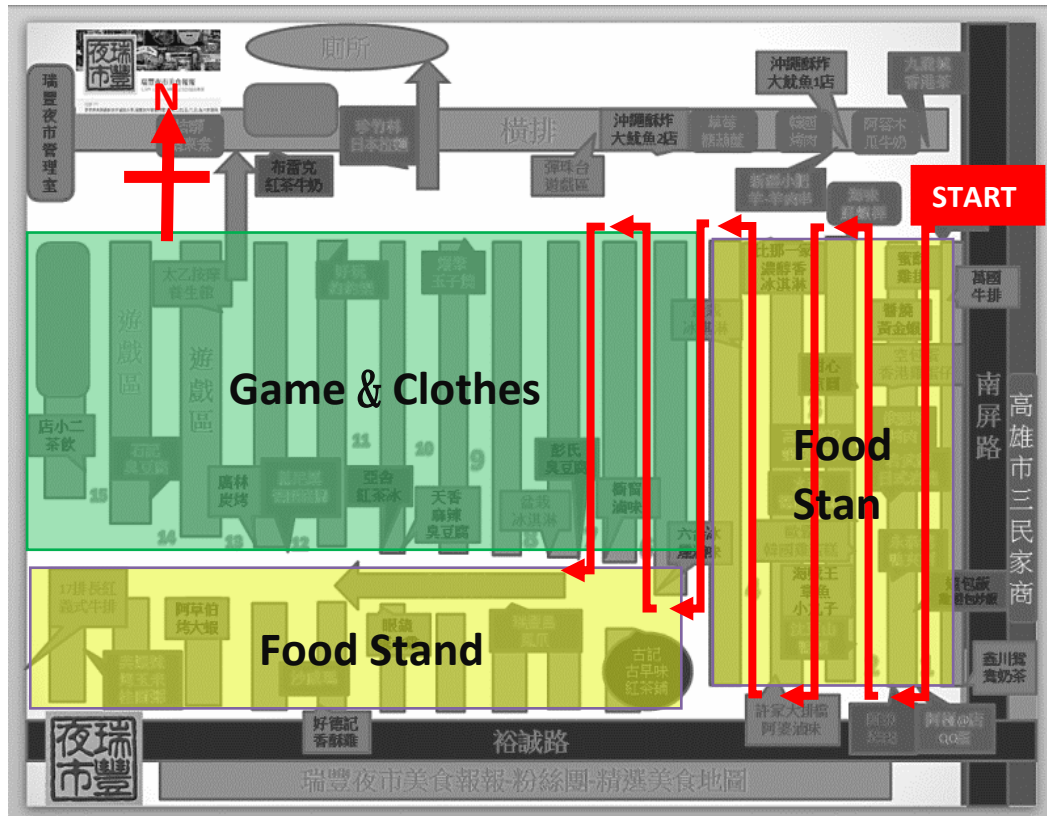
Discussion and Comparison Between Two Times of Research

1. The meteorological factors of the two times of investigation were highly similar, therefore, we focused on the other factors that made them different.
 - (1) The wind direction and the Liuhe Night Market is perpendicular, so we excluded the factors of wind transmission.
 - (2) The second time was nearly after a sudden outbreak of a pandemic, therefore, there were fewer visitors and vendors, which made the overall data lower than the first time.
2. We tried to connect several factors with the changes among these data, and found the TVOC and CO₂ were mainly affected by traffic flow and the distribution of the food stands.
3. However, the variables of PM remained uncertain, there might be other factors that affected, which could be further investigated in the future.

Measurement at Rueifong Night Market



Unlike the Liuhe Night Market, Rueifong Night Market is a close one, with a 3,000 m² total retail floor area. And it has a restriction on vehicles, which requires people to visit here on foot, neither scooters nor cars are allowed to go inside.



It was mainly separated into sections, food and shopping, we walked along for aisles in food sections first, then went collecting data from game and clothes sections for contrast.

First Time Measurement

Time: 01/20/2022 19:00

Background Factors (Zuoying Station)

PM2.5	33ppm
PM10	61ppm
CO	0.52ppb
O ₃	29.9ppm
SO ₂	2.6ppb

Figure 5

Meteorological Factors (Zuoying Station)

Temperature	21.8°C
Humidity	78%
Wind Direction	0 degree
Wind Speed	0 m/s

Figure 6



Result

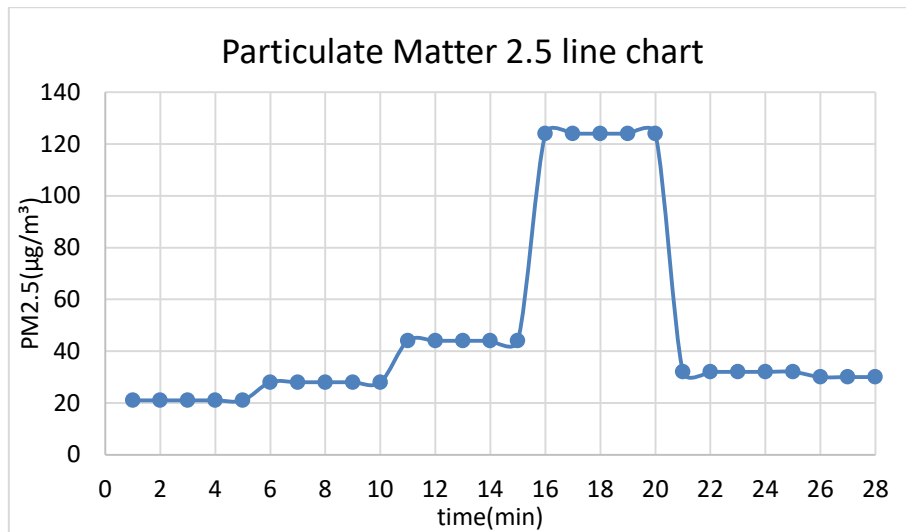


Chart 17

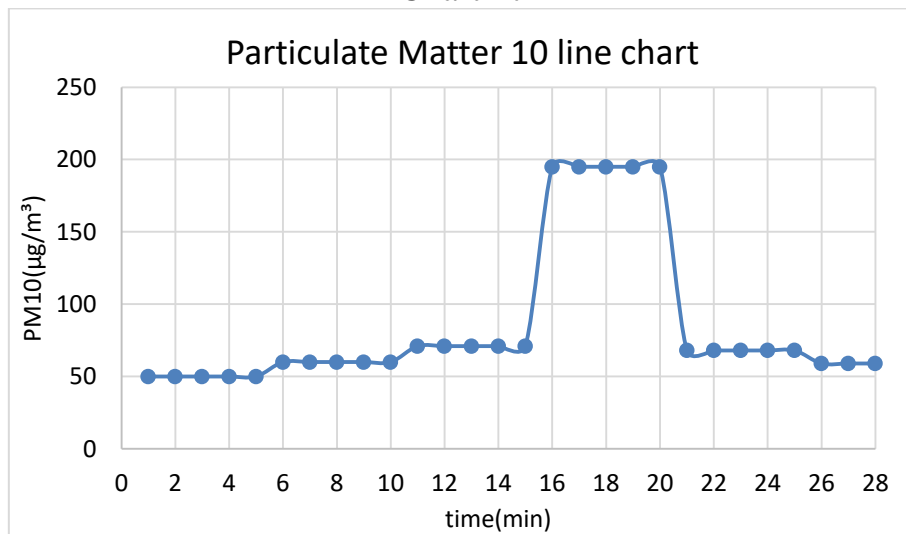


Chart 18

1. In the 15th to 20th minutes, it was 124µg/m³ for PM2.5 and 195µg/m³ for PM10, which was the highest amount of PM during the whole

process. The other was generally a bit higher but close to the background factors.

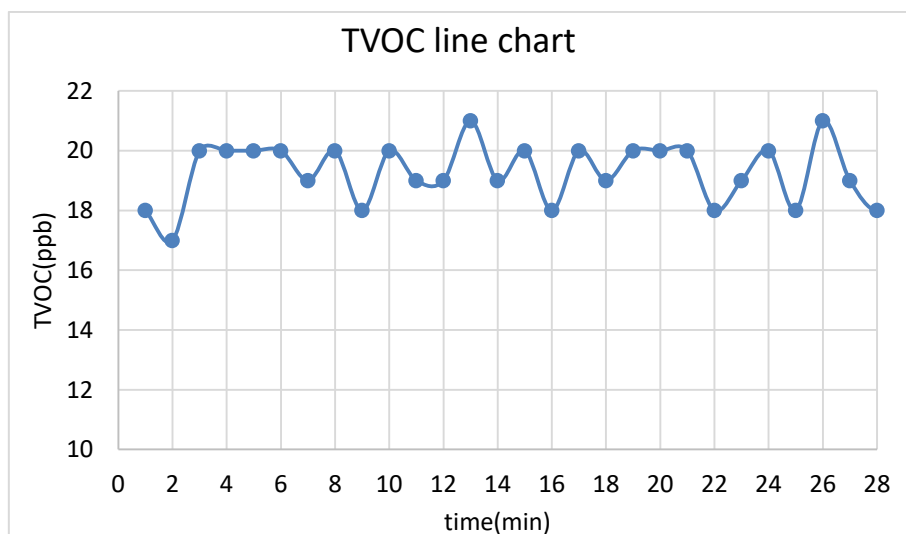


Chart 19

1. The TVOC was unstable and went up and down within the range from 17ppb to 21ppb, which was not a huge variation compared to the previous one.

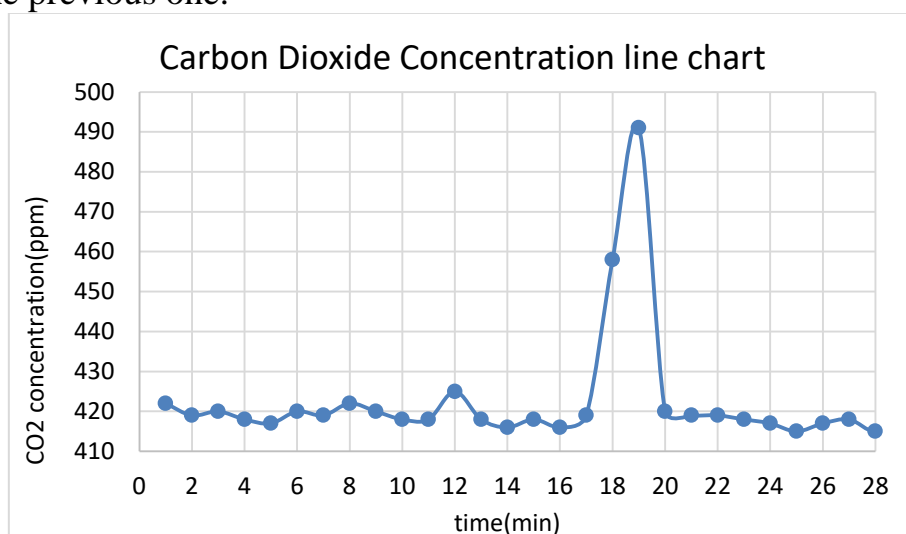


Chart 20

1. In the 18th to 19th, the CO₂ concentration increased up to 490ppm, the other stayed nearly 420ppm.
(1) It was a fried chicken stand where the tendency went high.

Second Time Measurement

Time: 02/08/2022 19:00

Background Factors (Zuoying Station)

PM2.5	26ppm
PM10	59ppm

CO	0.43ppb
O ₃	29.3ppm
SO ₂	2.5ppb

Figure 7
Meteorological Factors (Zuoying Station)

Temperature	20.8°C
Humidity	80%
Wind Direction	279 degree
Wind Speed	0.5 m/s

Figure 8



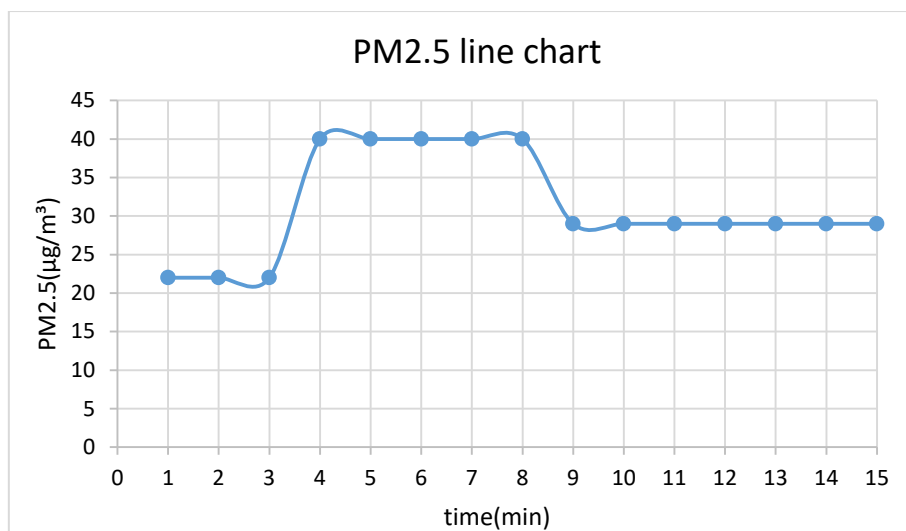


Chart 21

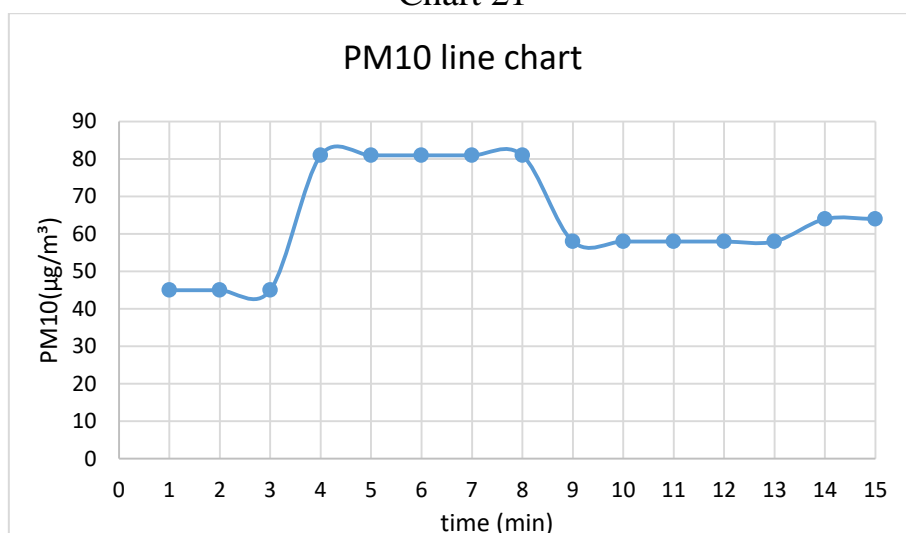


Chart 22

1. The first three minutes, both PM2.5 and PM10 were lower. The PM was higher from 3rd to 8th minutes, then dropped to the levels that were as same as the background factors.

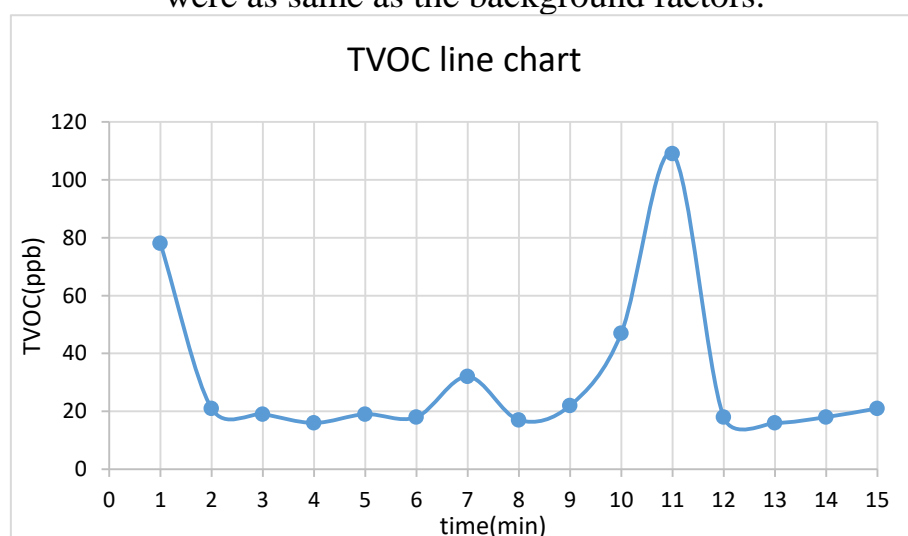


Chart 23

1. The amount of TVOC was relatively high at the beginning, and reached the peak at the 11th minute.
 - (1) The peak was caused by a fried chicken stand.

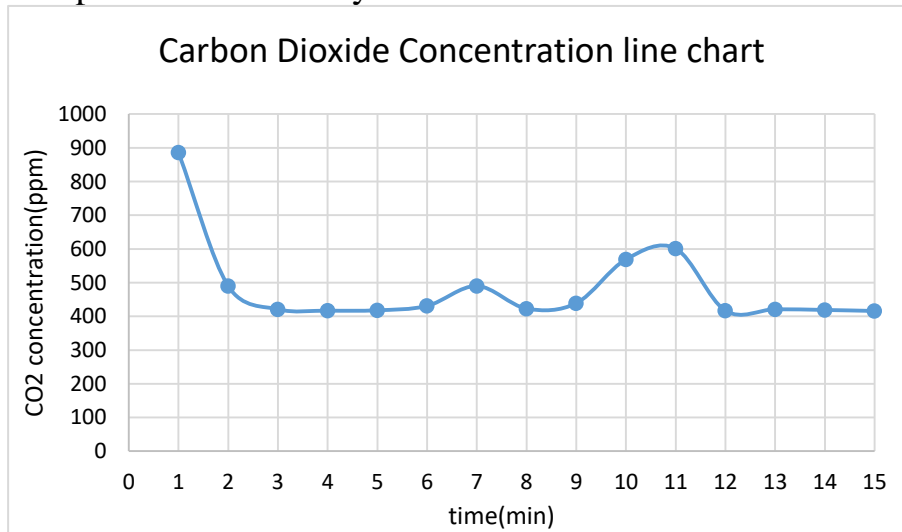


Chart 24

1. CO₂ dropped at the first minute and rose a little at the 7th and 10th minute.
 - (1) The little rise at 10th to 11th minutes resulted from the fried chicken stand.

Discussion and Comparison Between Two Times of Research

1. When walking through the fried chicken stand, all variables suddenly went high, except for the first time measurement of TVOC(which was still uncertain to find out the reason)
 - (1) Connecting the data to our route, we found out that the data collected at the third aisle was higher than the others. We've observed that was because the exhaust fans at the first and second aisle were either toward to road or the opposite side we walked, while the vents at third one were more close to our route.
 - (2) We supposed that these variables are mainly affected by the type of stand, for example, they rise when passing through a food stand that produces a substantive amount of smoke.
2. The TVOC and CO₂ concentrations were higher the second time.
 - (1) The second measurement was after a little outbreak of a pandemic, so the visitors were fewer than the first time. However, most of the stands were still open and cooking food.
 - (2) The fewer the people there are, the higher the TVOC and CO₂ are. We suspected that people might be barriers that stop the Mobile Nose from detecting the smoke.
3. Similarly, we found that the variations of PM were uncertain since it went high when we walked through the aisle with fewer stands and

people. Therefore, it could also be investigated in our future work.

Conclusion

1. The variations TVOC and CO₂ are mainly caused by the types of stands and traffic flow, being higher especially when passing through the stands that sold fried food.
2. People may be a barrier for our Mobile Nose to detect the pollution.
3. The wind direction and the Liuhe Night Market is perpendicular so it was not affected much by this factor.
4. Rueifong Night Market's aisles are much more narrow than the Liuhe Night market, so it was easier to detect the smoke, also the effect of people flow obviously showed up at Rueifong.
5. We found that both PM_{2.5} and PM₁₀ didn't have a direct relationship with the man-made, meteorological factors previously mentioned, therefore, they could be parts to further work on in the future.

Reference

吳俊樺（2014）。高屏地區七個夜市室外 CO、CO₂、Total-VOC 及懸浮微粒濃度之探討。大仁科技大學環境管理研究所碩士論文，屏東縣。取自

<https://hdl.handle.net/11296/zguv4e>

林憶茹（2021）。夜市懸浮微粒質量濃度及油煙防制效率分析-以花蓮東大門夜市為例。大漢技術學院土木工程與環境資源管理研究所碩士論文，花蓮縣。取自

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