EFFECT OF VEHICULAR EMISSION ON AIR QUALITY OF ZARIA METROPOLIS, KADUNA, NIGERIA

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INTRODUCTION

- Vehicular emission is the release of toxic substances mostly gaseous, liquid or solid form into any of the environmental media by vehicles as a result of operation and fuel burning (Benebo, 2011).

- These substances when released into the environment change the natural composition of the environment creating a negative impact (Adefila, 2011)

Literature review

Vehicular emissions

- Increases the concentration level of gaseous pollutants in the atmosphere affecting air quality (Abbaspour and Soltaninejad, 2004; Abam and Unachukwu, 2009)

- Contribute to accumulation of particulate matter in the environment (Vliet and Kinney, 2007)

- Decrease the growth rate of plants (Andrew *et al*. 2007)

- Negatively affect health of man (Ojolo *et al*.2007; Adefila, 2011)

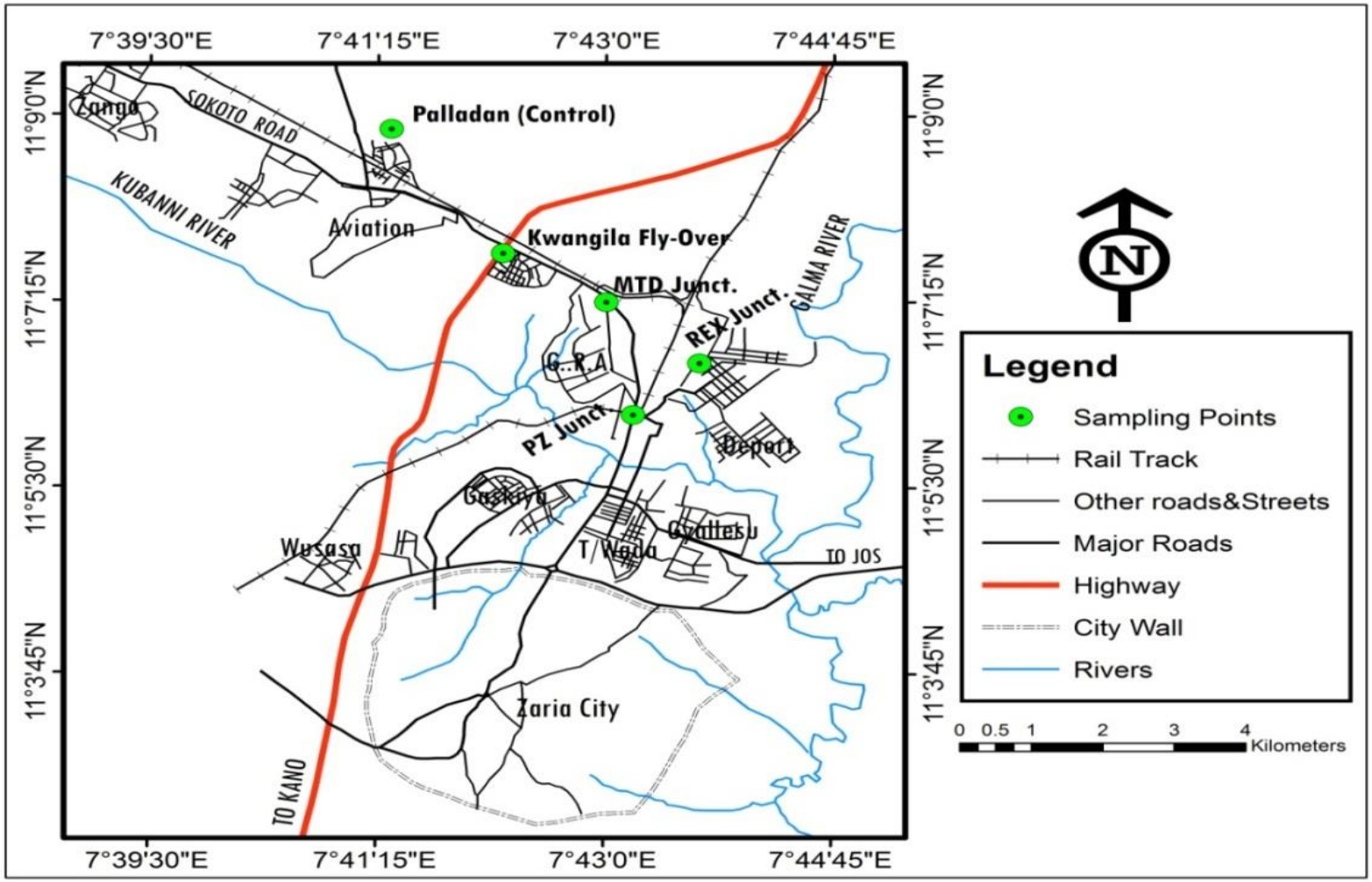
MATERIALS AND METHOD

- Conducted over a period of six weeks between the 4th of March to 14th of April, 2013 in Zaria

- Sampling points
  - Four (4) points were considered:- REX junction, PZ junction, MTD junction and Kwangila Fly-Over

- Location of sampling points
  - 11°6′25′′N 7°43′26′′ E; 11°6′17′′ N, 7°43′13′′ E; 11°7′26′N, 7°42′48′′ E and 11°81′35′′ N, 7°42′73′′ E respectively.

MATERIALS AND METHOD CONT…



- Figure 1: Map of Zaria showing sampling points.

MATERIALS AND METHOD CONT…

- Collection of data from the sampling points was carried out in three (3) time periods for three working days within the study time frame.

- These three times periods are as follows:
  - 7.00 am – 10.00 am morning peak hours
  - 10.00 am – 1.00 pm off-peak hours
  - 4.00 pm – 7.00 pm evening peak hours

- Data collection consists of traffic flow survey and environmental survey.

MATERIALS AND METHOD CONT…

➢ Sampling for Air Quality Parameters

- climatic elements sampled were ambient temperature (^oC), relative humidity (%), and wind velocity ms^{-1}

- Air pollutants from vehicular emissions sampled were (PM), (NO_2), (SO_2), (CO), (CO_2) and hydrocarbons (CxHy).

- NO_2, SO_2, CO, CO_2 and CxHy (Growncon Gasman single gas auto samplers)



- Plate 1: Air pollutant measuring sensors



- Plate 2: measuring the pollutants

MATERIALS AND METHOD CONT…

- PM measured with Hazdust emission analyzer (HD 1000 model).
- Temperature, humidity and wind speed (Kestrel 4000 weather tracker)
- Coordinates of the sampling locations (GPS equipment Model GP220X)
- Measuring equipment were obtained from Kaduna Environmental Protection Authority (KEPA)

➢ **Traffic count**

- Carried out through direct counting method (tally sheet method).



- Plate 3: measuring pollutants with Malam Hussaini Amisu of KEPA



- **Plate 4: Traffic Congestion at PZ Junction, Zaria**



MATERIALS AND METHOD CONT…

- **Data Analyses**

- done in triplicates.

- mean and standard deviation determined

- Pearson Product Moment Correlation Statistical tool for relationship between traffic density and pollutants concentration

RESULT AND DISCUSSION

➢ Climatic Elements

- **Wind Speed**

Average wind speed at all sites varied between 3.40 ± 0.36 – 3.73 ± 0.35 ms^{-} during morning peak traffic period; 3.53 ± 0.50 – 3.77 ± 0.25 ms^{-1} during evening peak traffic period and 3.53 ± 0.05 – 3.77 ± 0.25 ms^{-1} during the off-peak traffic period.

- **Air Temperature**

Average temperature at all sites ranged from 28.00 ± 1.00 – 29.20 ± 0.20 ^{o}C during morning peak traffic period; 33.00 ± 0.50 – 34.00 ± 1.00 ^{o}C during evening peak traffic period and 33.00 ± 2.00 – 35.5 ± 0.20 ^{o}C during off-peak traffic period.

- **Humidity**

Average humidity were in the range of 36.50 ± 2.00 – 40.00 ± 2.00 % during morning peak traffic period; 30.00 ± 0.50 – 35.20 ± 0.40 % during evening peak traffic period and 30.20 ± 0.40 – 32.00 ± 0.20 % during off-peak traffic period.

RESULT AND DISCUSSION CONT…

➢ Air Quality Parameters

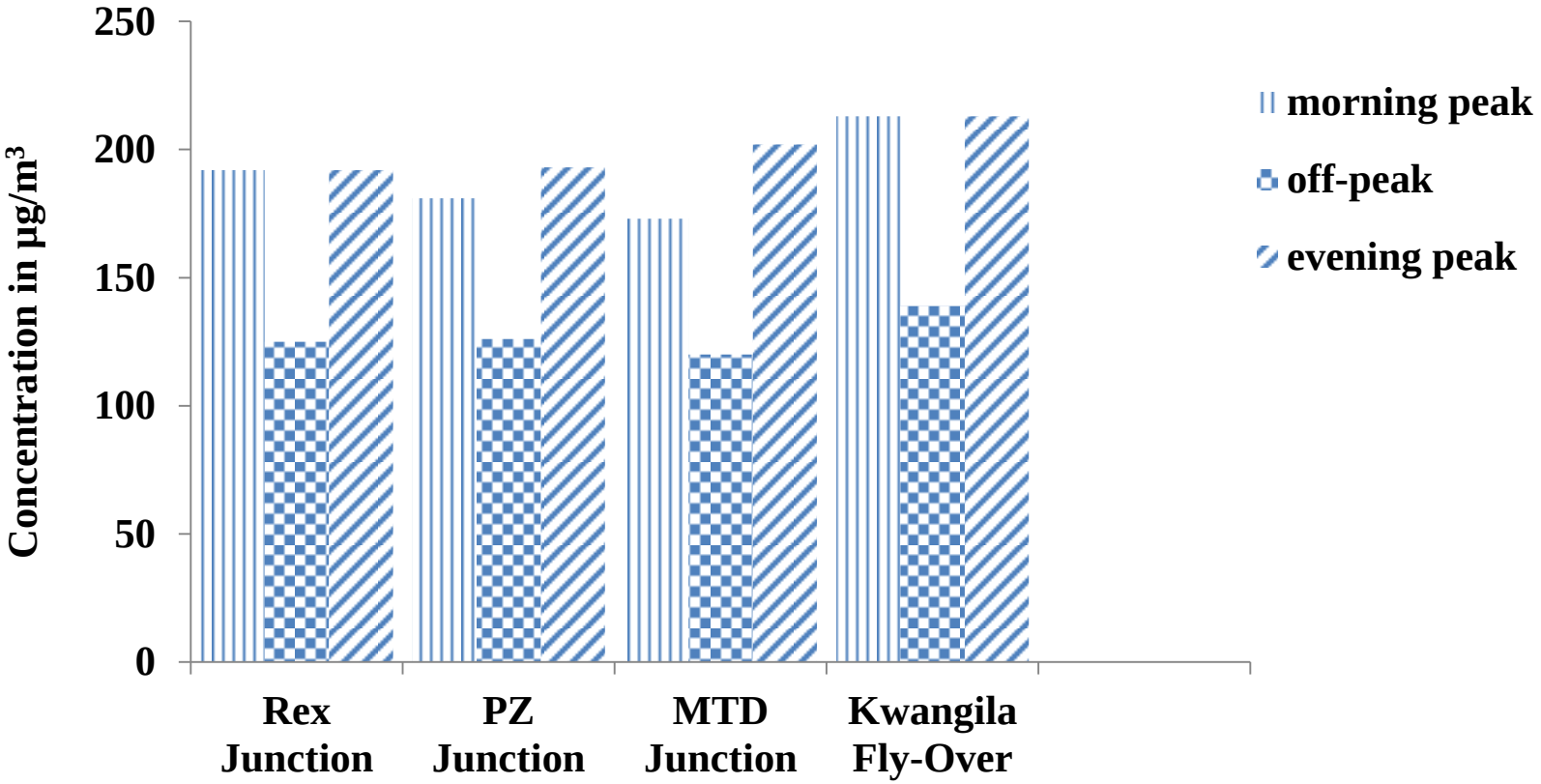


Figure 2: Concentration of PM in the Air of Zaria

NAAQS limit = 250µg/m^3

RESULT AND DISCUSSION CONT…

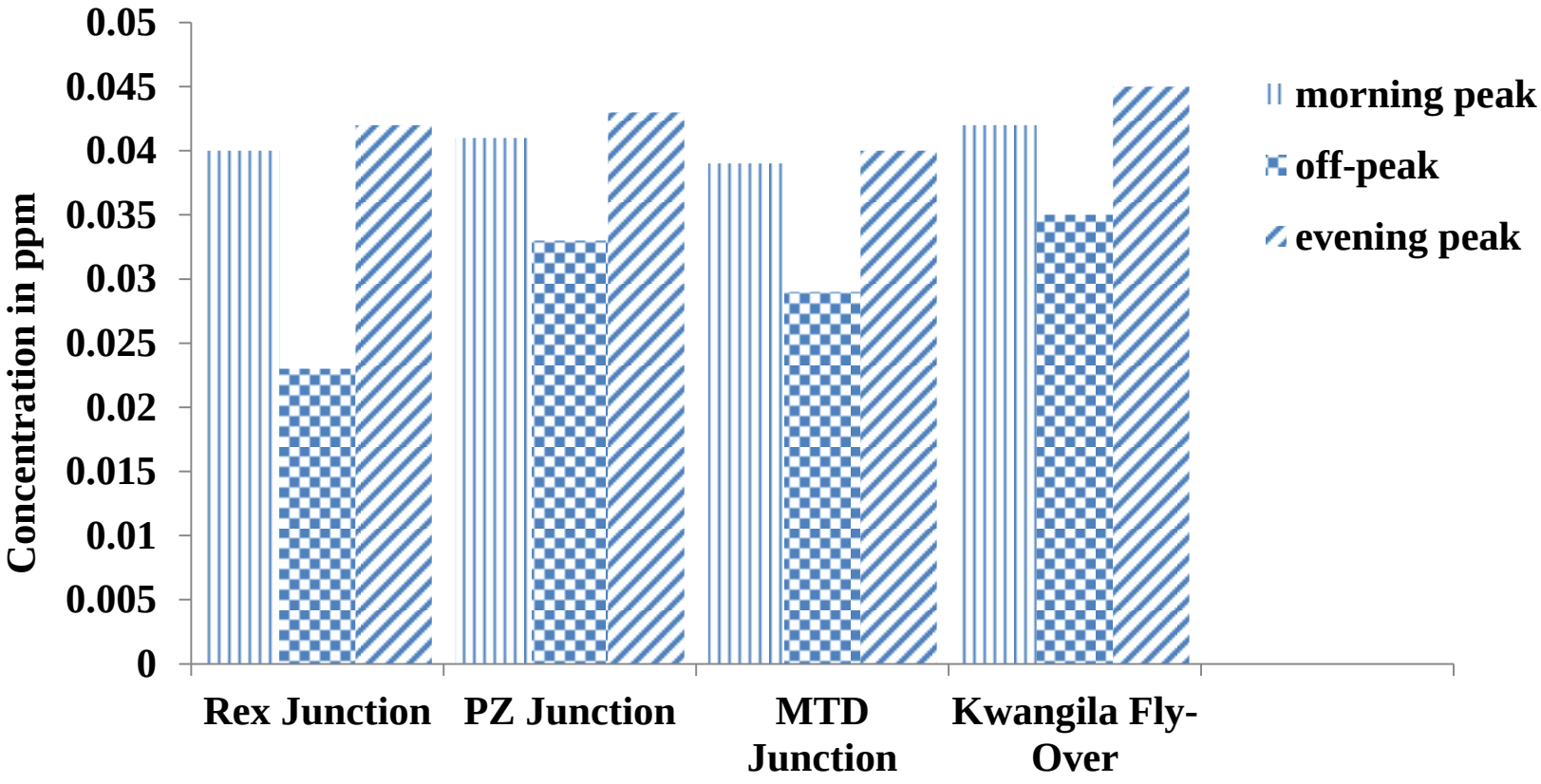


Figure 3: Concentration of NO_2 in the Air of Zaria

NAAQS limit range = 0.04 – 0.06 ppm

RESULT AND DISCUSSION CONT…

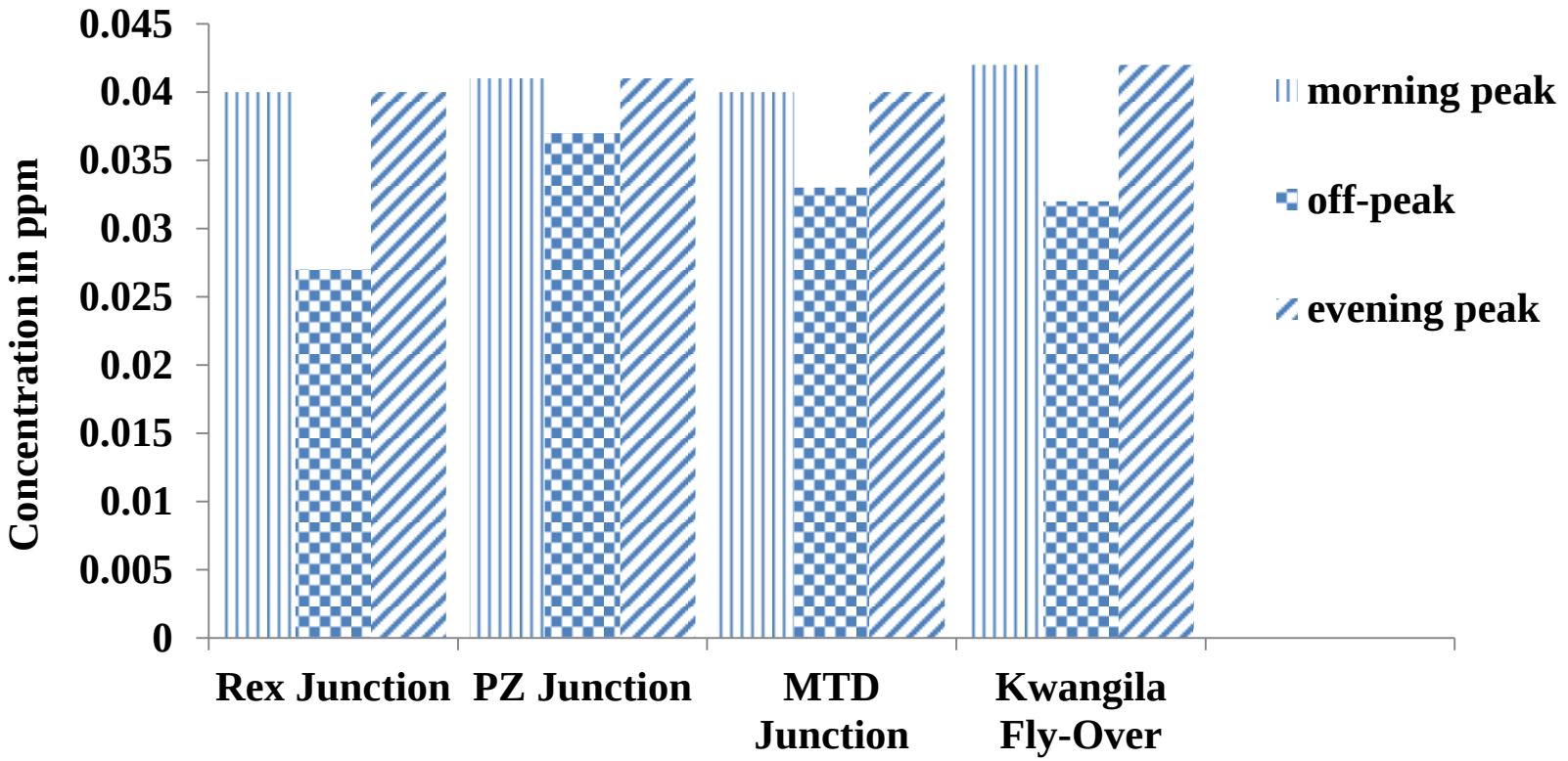


Figure 4: Concentration of SO_2 in the Air of Zaria

NAAQS limit range = 0.01 – 0.1

RESULT AND DISCUSSION CONT…

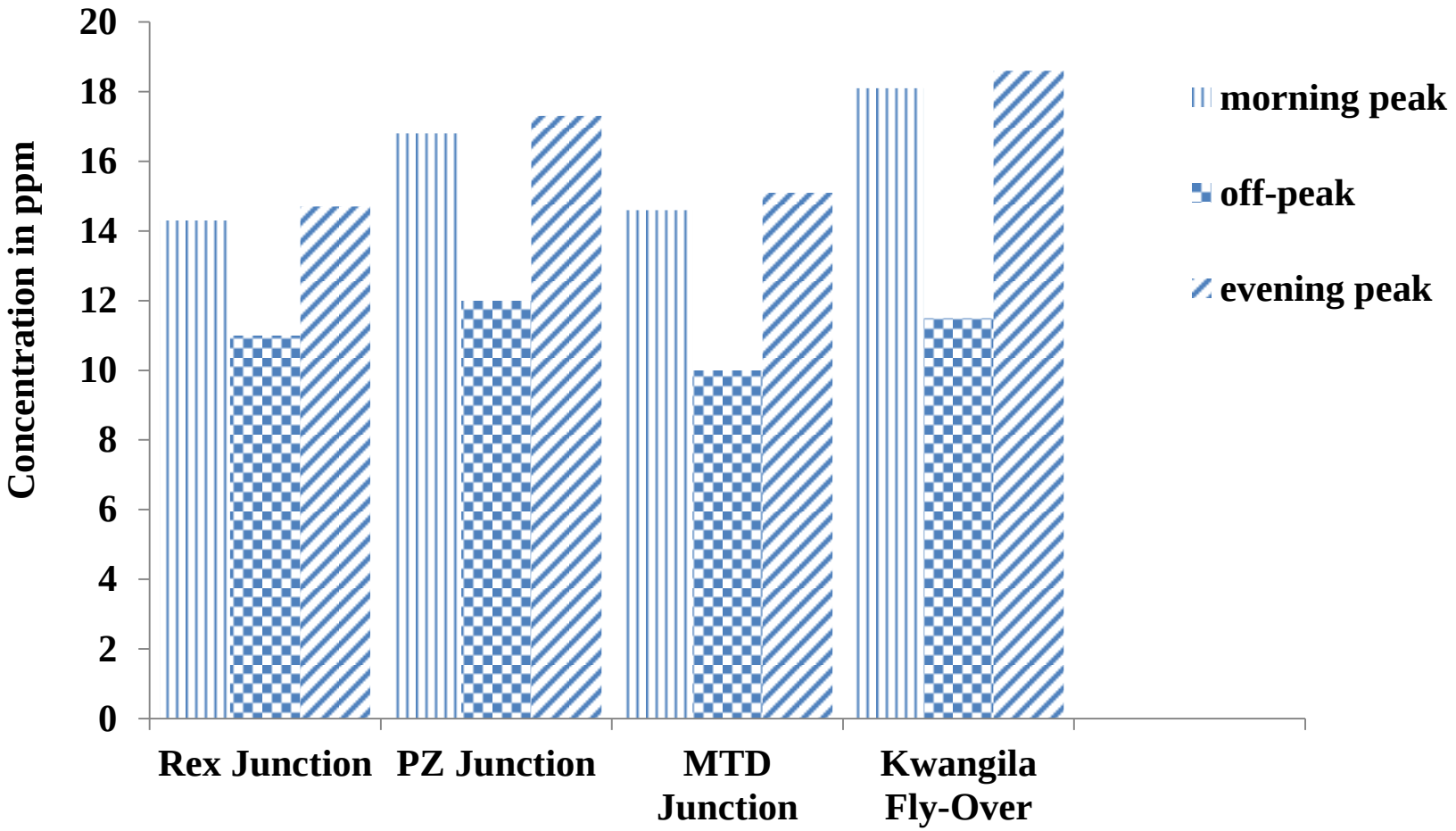


Figure 5: Concentration of CO in the Air of Zaria

NAAQS limit range = 10 – 20 ppm

RESULT AND DISCUSSION CONT…

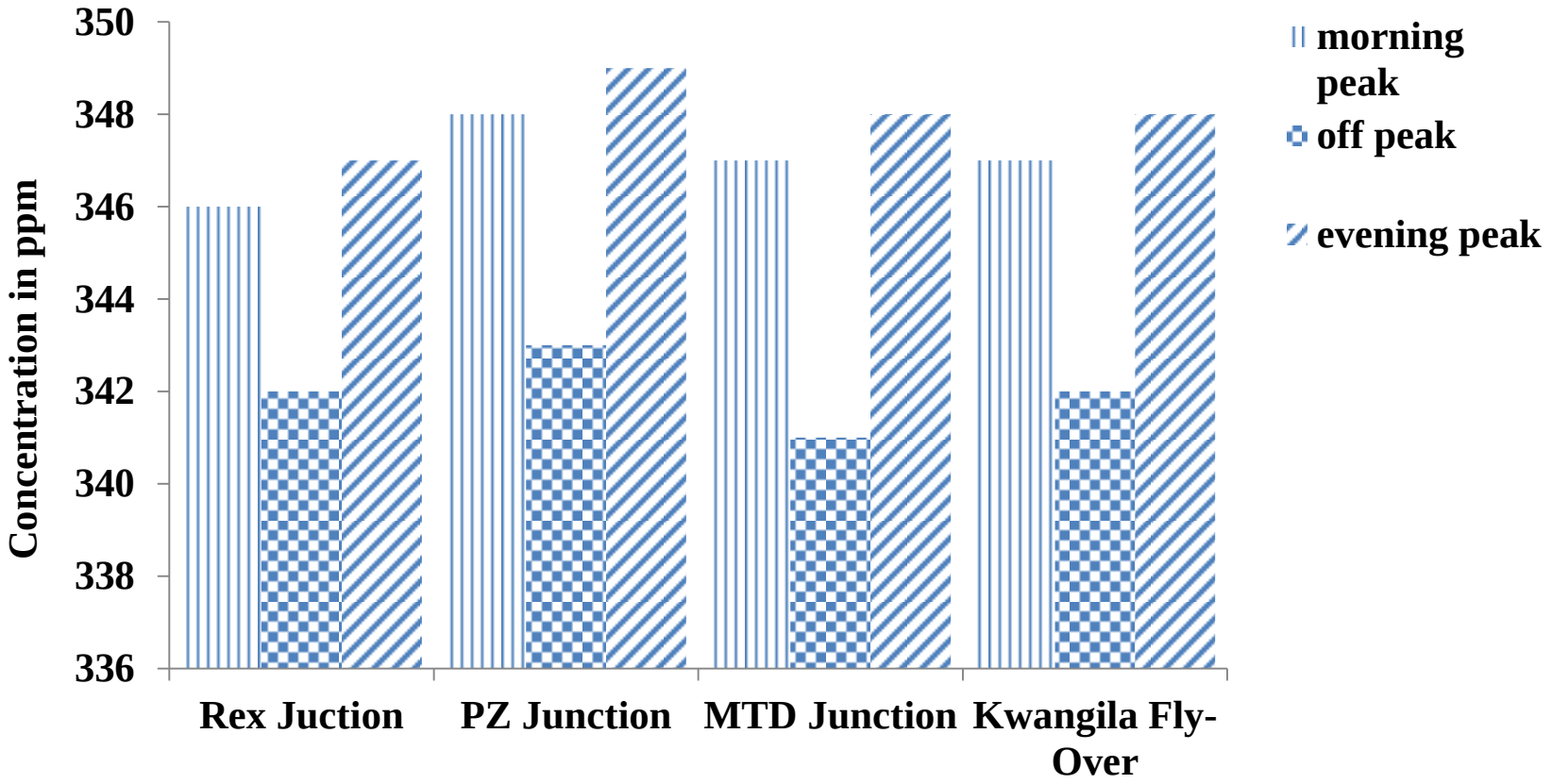


Figure 6: Concentration of CO_2 in the Air of Zaria

NAAQS limit = 600 ppm

RESULT AND DISCUSSION CONT…

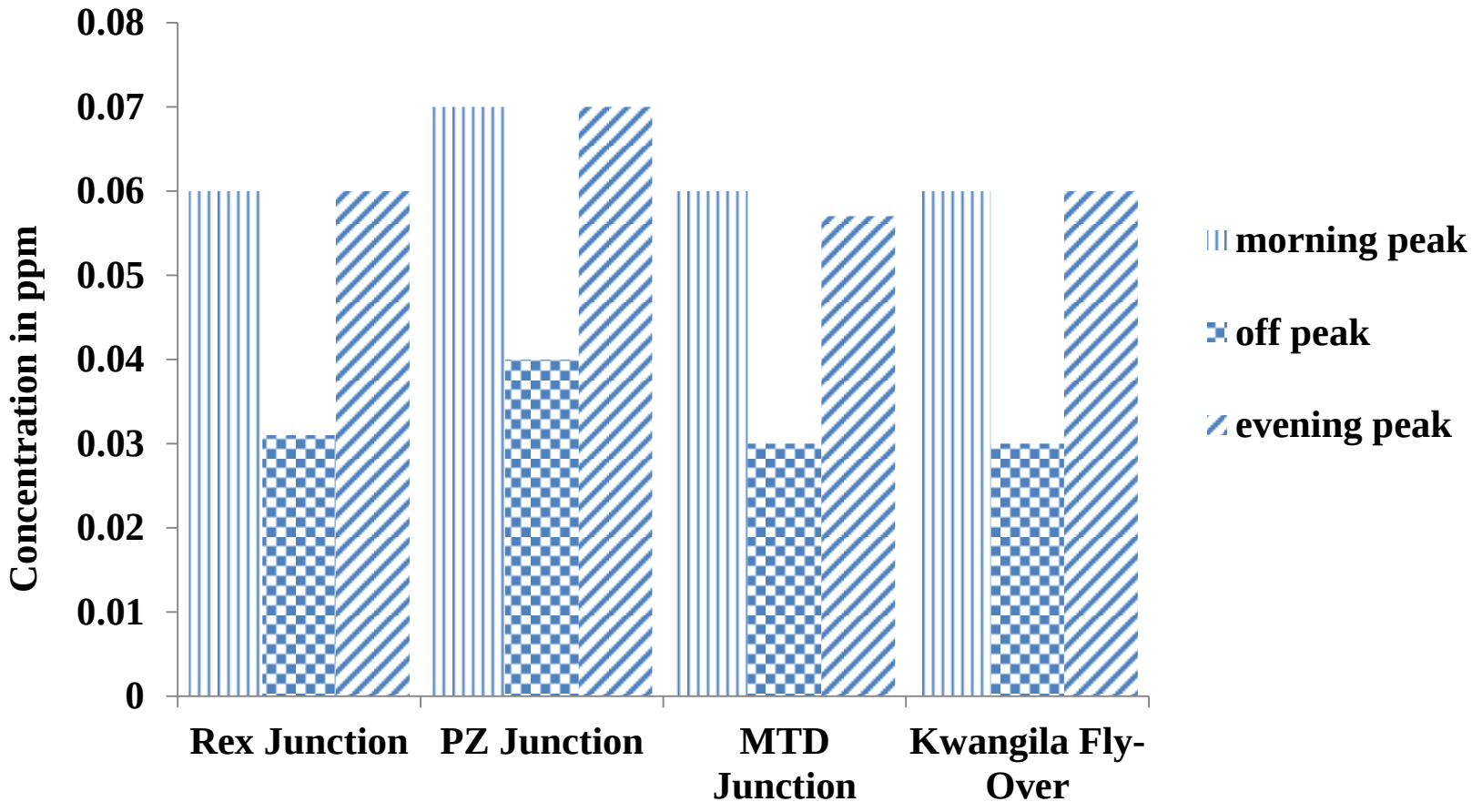


Figure 7: Concentration of HxCy in the Air of Zaria

NAAQS = 0.05 ppm

RESULT AND DISCUSSION CONT…

- Deductions

- Higher concentration during peak periods

- higher concentration in the evening (except for HxCy and SO_2)

- PM and NO_2 highest at kwangila (heavy duty vehicle.)

- PM and CO_2 below NAAQS limit (250µg/m^3 and 600 ppm)

RESULT AND DISCUSSION CONT…

- NO_2, SO_2 and CO within NAAQS limit range of 0.04 – 0.06 ppm, 0.01 – 0.1 ppm and 10 – 20 ppm respectively.

- HxCy above NAAQS limit of 0.05 PPM

- CO_2 >>> CO (oxidation)

- showing that all the air pollutants from vehicular emissions at the experimental sites were either below or within the NAAQS limit except HxCy

RESULT AND DISCUSSION CONT…

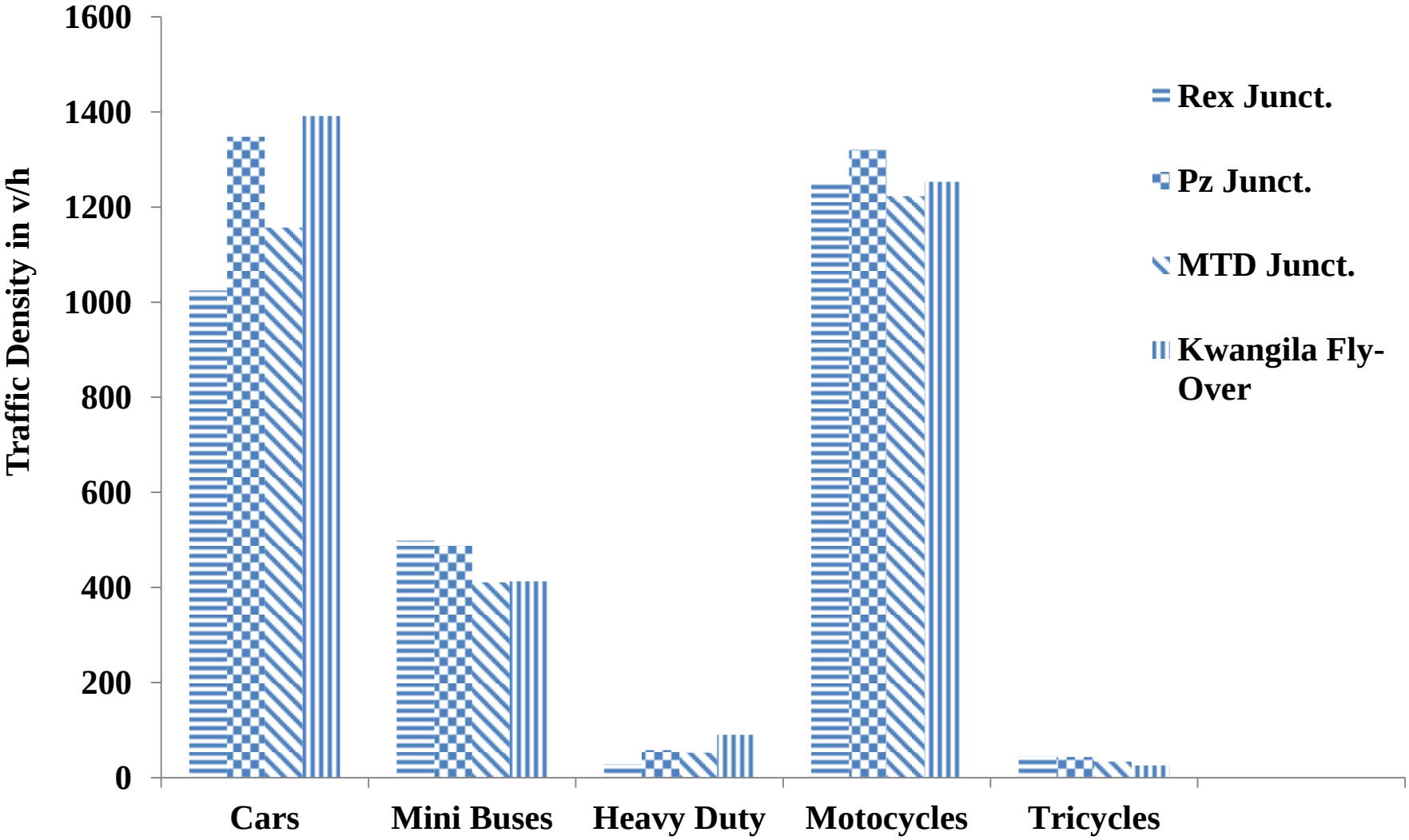


Figure 8: Morning Peak Traffic Density in Zaria for each vehicle type

RESULT AND DISCUSSION CONT…

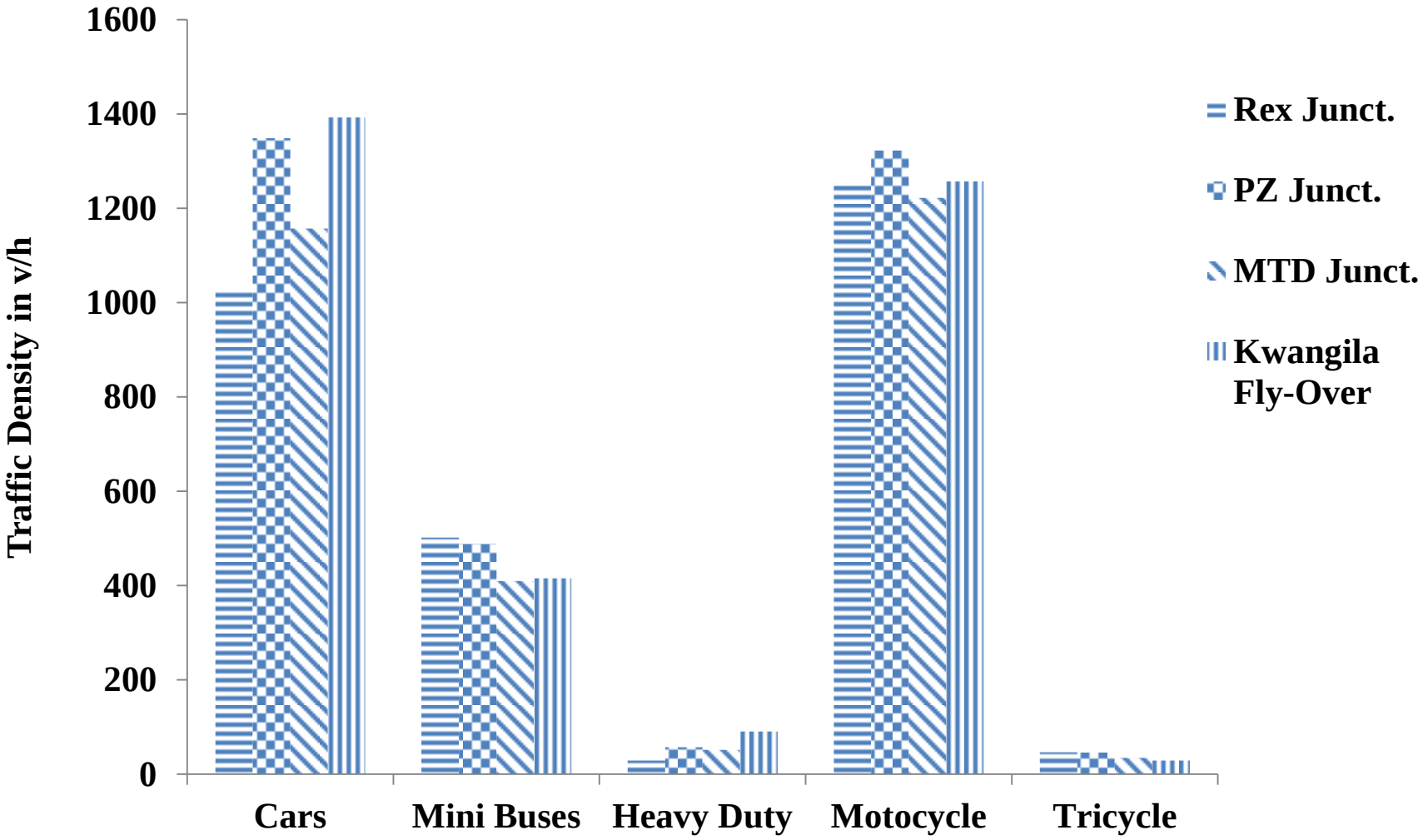


Figure 9: Evening Peak Traffic Density in Zaria for each vehicle type

RESULT AND DISCUSSION CONT…

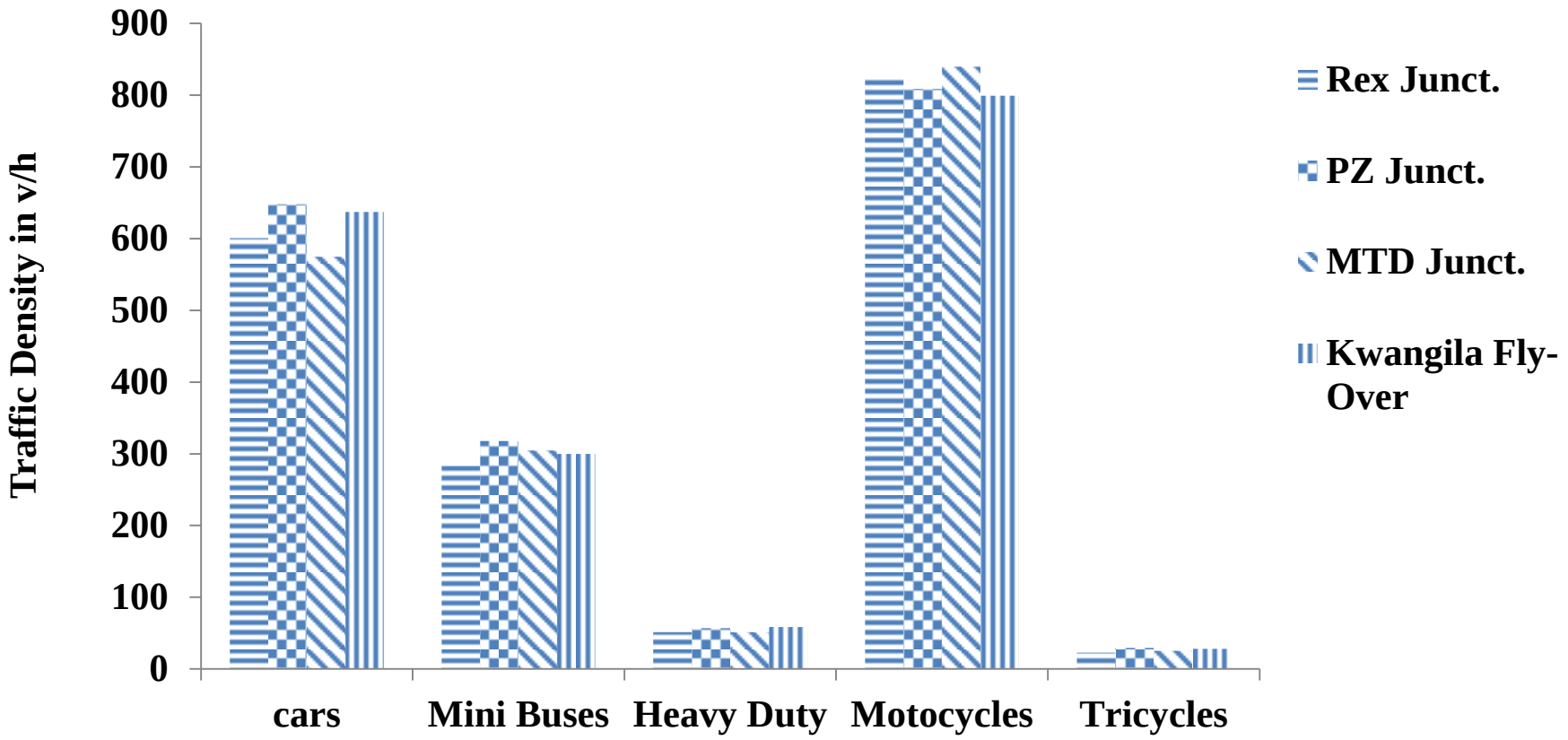


Figure 10: Off-Peak Traffic Density in Zaria for each vehicle type



- Plate 5: Evening Peak Traffic at MTD



- Plate 6: Evening peak Traffic at Kwangila

RESULT AND DISCUSSION CONT…

- Deductions

- PZ had the highest traffic density of 3257.33 ± 0.58 v/h, 3264.00 ± 1.73 v/h and 1861.33 ± 16 v/h at morning peak, off-peak and evening peak periods respectively.

- Highest heavy duty vehicles at Kwangila

RESULT AND DISCUSSION CONT…

- **Relationship between each Pollutants and Traffic Density**

- PM showed a negligible correlation with traffic density at R = 0.30, 0.30 and 0.22 for morning peak, off-peak and evening peak periods respectively.

- NO_2, SO_2, CO, CO_2 and CxHy showed high correlation with traffic density at R = 0.80, 0.80, 0.88, 0.82 and 0.72 respectively during morning peak traffic period.

RESULT AND DISCUSSION CONT…

- During the evening peak traffic period; NO_2, $SO_{2,}$ CO, CO_2 and CxHy showed high correlation with traffic density at R = 0.73, 0.82, 0.89, 0.81 and 0.77 respectively.

- During off-peak traffic period; NO_2, $SO_{2,}$ CO, CO_2 and CxHy showed high correlation with traffic density at R = 0.77, 0.86, 0.79, 0.78 and 0.84 respectively.

RESULT AND DISCUSSION CONT…

- **Table 1: Correlation Coefficients for Relationship between Air Quality Parameters and Traffic Density**

Coefficients	Parameters for Morning Peak					
	PM	NO_2	SO_2	CO	CO_2	HxCy
R	0.30	0.80	0.80	0.88	0.82	0.72
R^2 (%)	9.00	64.00	64.00	77.44	67.24	51.84
Parameters for Evening Peak						
	PM	NO2	SO_2	CO	CO_2	HxCy
R	0.22	0.73	0.82	0.89	0.71	0.77
R^2 (%)	4.84	53.29	67.24	79.21	50.41	59.29
for Off-peak Parameters						
	PM	NO_2	SO_2	CO	CO_2	HxCy
R	0.30	0.77	0.86	0.79	0.78	0.84
R^2 (%)	9.00	59.29	73.96	62.41	60.84	70.56

CONCLUSION

- The concentration of the pollutants (NO_2, SO_2 and CO) emanating from vehicular emissions in the air of Zaria were within the NAAQS limit.

- The concentration of PM and CO_2 were below the NAAQS limit.

- Concentration range (0.057 – 0.070 ppm) for HxCy at all experimental sites during traffic peak periods was above the 0.05 ppm NAAQS limit. (pollution)

- pollutants showed high correlation with traffic density at all time and locations except for PM which showed a very low correlation.

CONCLUSION CONT…

- This high correlation could lead to pollution of Zaria environment by other pollutants (PM, $NO_{2,}$ SO_2, CO and CO_2).

RECOMMENDATION

- The high correlation between vehicular emissions and traffic density can increase the concentration of air pollutants in Zaria and could lead to pollution in near future given the increasing population influx and vehicular traffic, hence should be checked through:-

- Improved road network
- Emission monitoring and control
- Enforcement of emission laws

- These could help reduce emissions volume to avoid further pollution by other pollutants in Zaria.

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