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Pollution indicators to achieve sustainable transport, Case study: Al Ramadi City

Efecto de las fibras de PET sobre las propiedades mecánicas, la relación tensión-deformación y la contracción por secado del hormigón

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ABSTRACT/ Environmental indicators of urban sustainable development are very important especially in sustainable transportation in cities and towns. This research evaluates the environmental indicators, such as air and dust pollutants and noise, consequent to transportation and traffic in Ramadi city. There is a clear lack of attention to such indicators in the planning of sustainable transportation in the city in spite of the fact that the pollution it causes far exceeds the standards rates. The research analyzes the data collected from the eight sectors of the city. The research uses analytical method of spacial-quantitative analysis. This method was never used before in studies on Iraqi cities which preferred general indicators only. Findings show that the city suffers many pollutants which exceeds standards rates in most of its sectors. Sectors 4 and 8 show the highest level of pollution whereas sectors 1 and 2 show the lowest rate of pollution. These high levels of pollution have serious future consequences that needs to be addressed by specific strategies. The method and findings of this research can be extended to other cities in Anbar province and other Iraqi cities to achieve an acceptable level of sustainable urban transportation standards.

Keywords: Pollution , Sustainable Transport , Environmental indicators , Ramadi city

RESUMEN/ Los indicadores ambientales del desarrollo urbano sostenible son muy importantes, especialmente en el transporte sostenible en ciudades y pueblos. Esta investigación evalúa los indicadores ambientales, como los contaminantes del aire y el polvo y el ruido, como consecuencia del transporte y el tráfico en la ciudad de Ramadi. Existe una clara falta de atención a tales indicadores en la planificación del transporte sostenible en la ciudad a pesar del hecho de que la contaminación que causa supera con creces las tasas estándar. La investigación analiza los datos recopilados de los ocho sectores de la ciudad. La investigación utiliza un método analítico de análisis espacial-cuantitativo. Este método nunca se usó antes en estudios sobre ciudades iraquíes que preferían solo indicadores generales. Los resultados muestran que la ciudad sufre muchos contaminadores que exceden las tasas estándar en la mayoría de sus sectores. Los sectores 4 y 8 muestran el nivel más alto de contaminación, mientras que los sectores 1 y 2 muestran la tasa más baja de contaminación. Estos altos niveles de contaminación tienen graves consecuencias futuras que deben abordarse mediante estrategias específicas. El método y los resultados de esta investigación pueden extenderse a otras ciudades de la provincia de Anbar y otras ciudades iraquíes para lograr un nivel aceptable de estándares de transporte urbano sostenible.

Palabras clave: contaminación, transporte sostenible, indicadores ambientales, ciudad de Ramadi

1 Introduction:

Environmental indicators for sustainable development have a great importance, especially in the sustainable urban transport of cities, This study, has focused on studying environmental indicators and their applicability

to one of the big cities in Iraq, Ramadi city, capital of Anbar province. Traffic noise, gas pollution and particulate pollution resulting from traffic and transport in the city have been studied. Despite the lack of interest in this subject, the results of the examination were

unexpected, as most field results exceed the standard rates, according to environmental standards.

The difficulty of research lies in the lack of a centralized monitoring system to measure air quality in the city and the lack of previous measurement data for comparison purposes, which led researchers to resort to the on-site examination by taking a number of points within each of the sections of the study area.

Research Problem 1-1

Ramadi City is exposed to air pollution from the gases emitted from the exhaust of cars, which is reflected in the impact on humans and the environment.

Research Objectives 2-1

The objectives of the research are to calculate the percentage of pollutants resulting from vehicle exhausts, the most important of which are carbon oxides, nitrogen, sulfur oxides, ozone and other pollutants, This work shall be conducted on the basis of scientific methodology to determine the dimensions of the problem of air pollution in the city, which is increasing in intensity day after day with the increase in the population and means of transport .

The research also aims to develop some solutions and measures that will alleviate the problem and the damage that may result from it now and in the future.

The role of environmental indicators in sustainable urban transport 2 -

The experiences of economic and social development resulted in side effects that affected the nature of the environment, which led to the need to adopt a new approach to development which is a sustainable development approach that rationalizes energy consumption and efficiency in its use. In addition to reducing the effects on the environment due to the use of natural resources such as air, water and soil (Hisham, 2014), the transport sector represents the main consumer of fuel, and hence the consequences of fuel combustion, and the emission of gases that come out of car exhausts serious which pollute the

environment and have adverse effects on public health and here shows the importance of research on the subject of sustainable transport, therefore this is one of the most important topics in the field of transport which requires solutions as it is one of the areas that serve sustainable development. Sustainable development is defined by the council of Ministers of the European Union as transportation that provides the needs of the individual and the society in a safe manner which is consistent with human health and the environment, and promoting equality between successive generations at reasonable prices (Zakya, 2017) It is often difficult to observe air pollution with the naked eye and identify its components. It is multi-sources and complex in structure, cars have become the primary contributor to air pollution by releasing pollutants and harmful gases. A small car consumes a hundred times as much as one person consumes oxygen (2017, Kadhem). Studies have shown that other sources of emissions, as well as exhaust gases, account for 65% to 85% of total emissions from the vehicle, and gas tank gases, which account for 5% of total emissions. 5% to 15% of the capitore gases and gases caused by tire erosion, Therefore, the car is a source of pollution in all its components and this makes them a source of danger to the existing environment (Basma & Ekhlis, 2014). Pollution is caused by incomplete fuel combustion ,and the slow movement of cars at intersections and congested areas, Transportation alone accounts for 60% of air pollution and the consumption of a large amount of fuel. The transport sector is the first in terms of its contribution to the global emissions of greenhouse gases by 26 %of which (Samia and Rawaya, 2014), especially small cars that emit 60 m3 of gas per hour (Salah, 2010). In order to identify the theoretical aspects of the impact of sustainable transport on environmental protection by identifying the role of each dimension of sustainable transport in protecting public health, we review the most important reasons

why cars are the main cause of pollution (Ahmad & Usama, 2015) :

A - Traffic congestion: where the number of cars doubled but not accompanied by the construction of new roads , This creates the problem of congestion. Traffic congestion means that the vehicle is either in a stopped state and the engine is working or in slow motion. In both cases the pollutant emission rate is at its peak.

B- Vehicle consumption and lack of maintenance: Old vehicles are among the most important reasons that lead to increased emissions of pollutants. The new vehicle is more fuel efficient than the old vehicle and therefore less polluting. Maintenance plays an important role in low pollution (Ahmed & Osama, 2015).

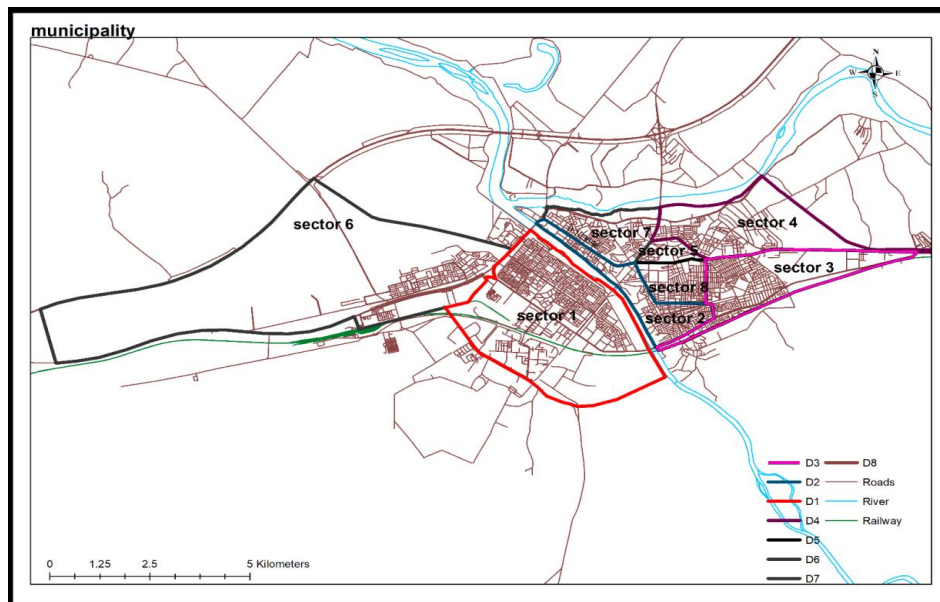
C - Lack of trees especially on the edges of the roads: Studies have shown that the reduction of green areas and the extent of their spread within the cities have a negative impact on the environment in general. Trees can reduce airborne dust by 40-80% by reducing wind speed and absorbing more than 60% of carbon dioxide (Yassin & Makhlafi , 2017).

D- Use of leaded fuel: To increase the performance of the gasoline engine, the tetraethyl lead is added by 0.4-0.7 g / L. After the burning process, solid particles with a diameter of less than(1) micrometer are released from exhaust. (Assam And Abbas, 2017). The problem of air pollution due to the excessive use of transportation is one of the most important problems facing the world now. It is one of the most important gases and solids that disturb human life and affect it Carbon dioxide, nitrogen oxides, sulfur oxides

and partially oxidized hydrocarbons as well as lead are negatively affected, which has a direct impact on human health (Yassin & Makhlafi, 2017).

3. Study area

Ramadi City is located in the southeast of Anbar province, At the intersection of rivers Euphrates and Al Warar, and is the political and administrative center of the province. The city was established as one of the important commercial stations, and is now the main port for the transit of tankers towards Syria and Jordan Ramadi is located in the southeast of Anbar province. It is about 283 km from the Jordanian border to the west and about 290 km from the Iraqi-Syrian border to the north. As well as transport routes linking the Mediterranean Sea with the Arabian Gulf coasts run through the city (Anbar Response Plan, 2017). The main strengths of the city include its location on the international road and railway, as well as its central location in the middle of the governorate-local roads, gave it a central role in administration and services (Anbar Provincial Response Plan, 2017). The boundaries of the study area are the boundaries of the municipality of Ramadi, which is the basic master plan in force on an area estimated at (19783297.36) km². It consists of 30 residential neighborhoods spread over the area of the master plan of the city. The Euphrates River runs through its, and on the western side there is AL Warar canal which runs into Habanyiah luck(Ramadi municipality, 2018). For the purpose of the study, the city was divided into (8) sectors depending on the municipal sections as defined in the map(1).



Map (1) Showing the municipal divisions of Ramadi city
Source / Researchers using ARC G.I.S

The city witnessed a significant increase in population in recent years, which led in turn to an increase in the demand for transport. The number of vehicles increased from (39706) vehicles in 2017 to 42634 vehicles at the beginning of 2018 (Anbar Traffic Directorate, 2018). It was supposed to have a central system in the Directorate of the environment of Anbar to measure the proportions of pollution with high accuracy, due to the lack of means of measurement and readings can be relied upon. We ,therefore conducted afield examination by a team of physicists from the Ministry of Environment ,in 26\ 10 \2018 , Three indicators were used to measure pollution in the City .

- Noise Pollution
- Percentage of gaseous pollutants
- Pollution of suspended particles

4 - Findings and discussion

In order to arrive at an assessment of the environmental indicators affecting sustainable transport in Ramadi, Minitab program was used to analyze the results obtained from the field inspection, We conclude a field measurements of the seven environmental indicators. These are:

- First: - Measurement of noise pollution
 - Second: - Measurement of the following gaseous pollutants:
 - A-Nitrogen oxides (NO)
 - B. Carbon oxides
 - C. Ozone (O3)
 - Third: - Measurement of the following pollution particles suspended:
 - A - Indicators of suspended particlesT.S.P
 - B. Indicators of suspended particles10
 - C- B. Indicators of suspended particles2.5
- Three issues were selected in each section of the eight municipal section of the city .There issues were measured randomiy as shown in fig(1) and listed in table (1) which shows the differenses between field measurments and standard values . These measurments and differences are the data for analysis in this study . The field results of selected points in the eight municipal districts in Ramadi were compared with standard values for each type of pollutant. The results ,shown in Table (1) ,indicate that most of the measurements were higher than the standard values and the high field values of pollutants.

Table-1 Shows the final results after comparing the measured spatial values with the specified standard values

	Municipal Section	Points	Noise Pollution) N(Gaseous pollutants			Pollution of suspended particles		
				(NO)	(CO)	(O3)	(T.S.P)	(P.M.10)	(P.M.25)
First Municipal Section	1	a	9	1.03	-5	0.09	-30	71	-14
	1	b	8	1.1	-6	0.1	-31	72	-13
	1	c	6	1	-3	0.11	-32	70	-14
Second	2	a	15	0.68	14	0	-25	10	-12
	2	b	14	0.7	13	0	-24	8	-13
	2	c	13	0.65	12	0	-27	7	-11
Third	3	a	5	1.28	35	0.2	130	180	40
	3	b	6	1.3	34	0.22	128	170	41
	3	c	7	1.32	30	0.21	125	175	42
fourth	4	a	11	9	40	1	150	160	-10
	4	b	10	9.7	39	1.1	155	165	-11
	4	c	10	9.8	38	1.1	145	166	-12
Fifth	5	a	14	3.8	-7	0.3	-10	52	-15
	5	b	15	3.9	-8	0.35	-11	50	-14
	5	c	13	3.7	-9	0.32	-12	51	-14
sixth	6	a	9	1.34	43	0.05	-15	40	-10
	6	b	8	1.3	42	0.06	-16	42	-11
	6	c	8	1.4	41	0.07	-17	44	-12
Seventh	7	a	8	0.21	70	0	250	200	0
	7	b	9	0.22	72	0	245	210	0
	7	c	8	0.2	72	0	255	220	0
The Eighth	8	a	12	2.58	85	0.19	450	250	0
	8	b	13	2.6	86	0.2	460	240	0
	8	c	13	2.5	87	0.2	450	330	0

4-1 Analyzing the correlation between environmental indicators affecting the sustainable transport of Ramady city

Three intersections were selected from the same sector for three consecutive days, Monday, Tuesday and Wednesday.

The results of the analysis of the measured values after Comparison with the standard values of each of the environmental indicators affecting the sustainable transport of Ramadi city (Table 1) show that the strong correlation between indicators is limited to five relationships.

- A) NO nitrogen oxides are associated with the ozone index (O3)
- B) the ratio of the carbon oxides (CO) with the suspended material index (T.S.P)

C) The relationship of the index (T.S.P) with the index (P.M.10)

D) The noise index (N) relationship with the indicator (P.M.2.5)

E) The relationship of the index (P.M.10) with the index (P.M.2.5)

4-2 Using a Comparative Analysis (Fisher PairwiseComparision) for section sites Municipality of Ramadi city among the influential environmental indicators show :

Examination of the noise pollution indicator in the city 4-2-1

Noise or auditory pollution is any unwanted sound that can affect the health, comfort of people, and have a negative impact on the environment (Basma & Eklass, 2014)

As stipulated in the Noise Control Law, which was approved by the House of Representatives

in accordance with the provisions of Article (1) of clause (61) and Article II of clause (73) of the Iraqi Constitution on 7/12/2015 (Iraqi Chronicle, 2015). This law considers transport as one of the most prominent manifestations of audio pollution in cities and called for the development of processors along the roads using means that reduce noise such as forestry , raising the efficiency of tiling , the establishment of a garage parking in non-residential areas , the establishment of multi-storey garages, in crowded areas, and a garage to accommodate the mechanisms of trucks and large buses The law prohibits its movement into the residential areas and the

use of horns, except in cases of extreme necessity, as the law imposes penalties and fines for violators(Nedaa, 2008).

A svan955 (sound level meter) device was used to conduct field tests of selected areas in Ramadi ,such as residential,service , and commercial areas. Only how caused by transport was tested in accordance with national regulations . Most of the results were higher than the national limits allowed in the points measured on the basis of maintaining human health and comfort according to the results shown in Table(1)

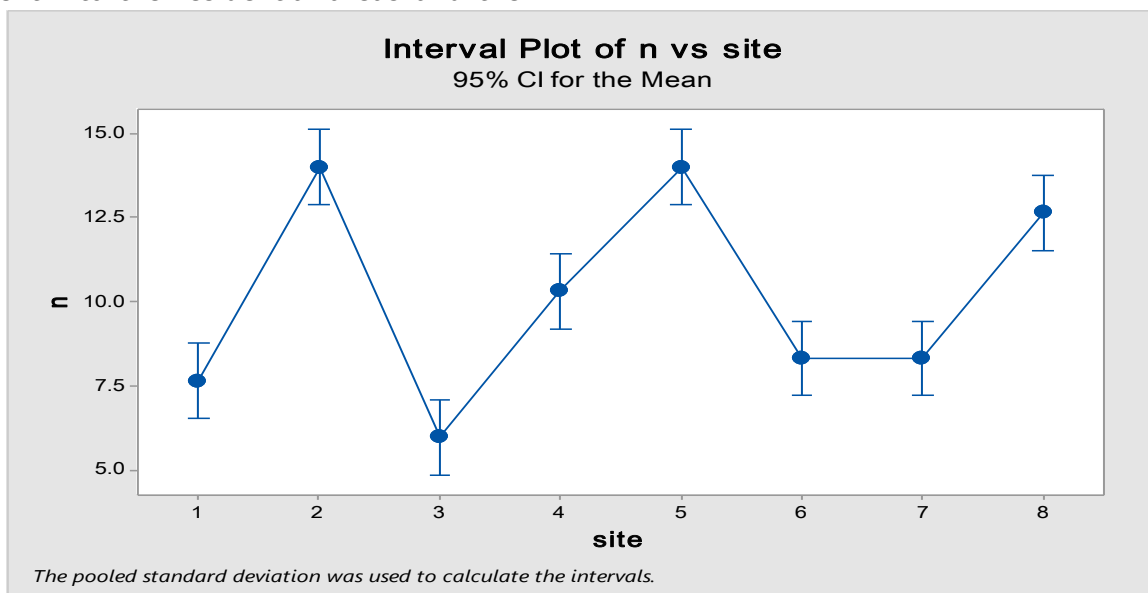


Figure (1) Shows the results of the examination of noise pollution rates

The observed noise levels in the municipal divisions (8, 5 and 2) show that these two divisions are the most affected by noise and are close to the municipal divisions (7, 6, 1) . , Followed by municipal section (4). Municipal section (3) which are the least affected by noise

4-2-2 Examination of gaseous pollutants

The cessation of most industrial activities , and the non use of heating devices in summer made the generators of electricity in residential areas and high traffic density, are the most prominent air pollutants within the city according to the views of specialists .Therefore, the presence of generators and the

visibility of pollution resulting from vehicles have been avoided .

The field detection was conducted for several selected points within Ramadi city which included residential, commercial and service areas using a(GASMET) device. The results are shown in Table (1) .

The device contains a plastic tube, that is raised by the level of breathing per capita, to record the resulting readings taking into account the direction of wind, temperature, and other determinants affecting the readings of the device

The most important types of gaseous pollutants

A. Pollution of nitrogen oxides

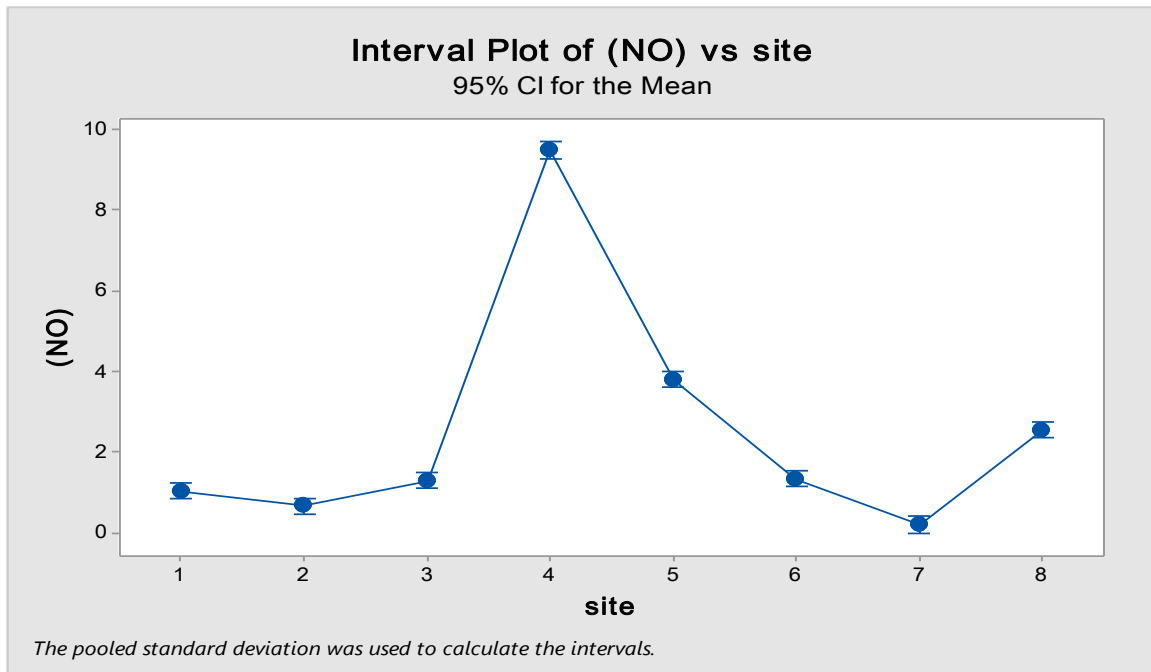


Figure (2) Shows the percentage of NOx pollution

The results show that pollution levels in all test points are higher than the national limits, which stipulate that nitrogen oxides should not exceed 0.1 mg. Especially in Sector (4)

The municipal divisions in the city differ gradually and according to a hierarchy from top to bottom in which sector (4) is the highest followed by the fifth sector and then the eighth, while Sector (7) is the least affected by the pollution of nitrogen oxides.

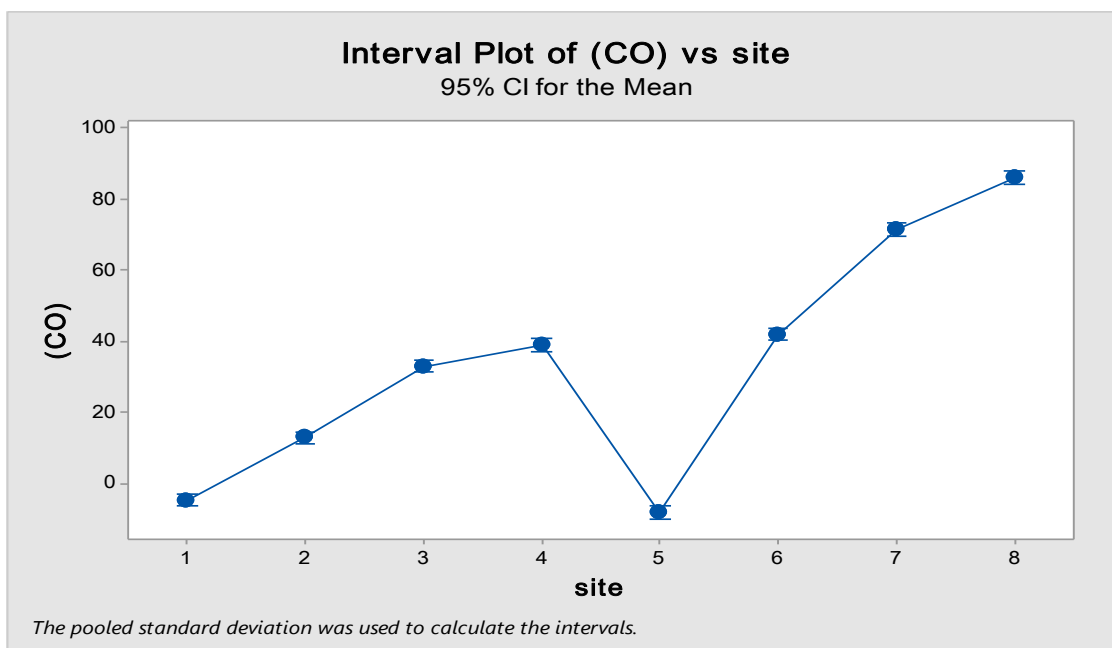
B. Carbon monoxide (CO) ratios

It is a gas that has no odor, no color, and is a poisonous gas. it causes death within 30 minutes if present in the air with a concentration of 0.3% as a percentage of air in room (Ahmad, 2006). Exhaust is shown as a result of combustion within the engine is incomplete (due to operating conditions, or malfunction). It usually appears as a result of

a lack of air in the charge or increased fuel (Faten, 2008).

The national parameters for permissible carbon monoxide (CO) ratios are different in the air, where the moderate rates (0.5-5) are a fraction of a million, where no one feels any symptoms within these limits and, when exceeding 35 ppm, causes exhaustion and fatigue when exposed to pollution in the short term, and contraction of in the nerves when exposed for long periods. This gas also becomes deadly in high concentrations.

the development of the symptoms of poisoning with carbon monoxide depending on the use of oxygen, the central nervous system, and the heart. It is, therefore, very difficult to establish fixed determinants of the ratio of carbon monoxide. Table (1) shows the rates of pollution registered in Ramadi city :



Figure(3) Shows carbon monoxide pollution ratios

It is clear from the above figure that the highest percentage of pollution is in municipal (8), followed by municipal (7), while municipal (5) obtained the lowest values recorded.

C - Percentage of pollution with ozone gas
Ozone at low altitudes is a very harmful gas, and has a jet smell. Ozone is formed by the interaction of hydrocarbons with nitrogen

oxides with the presence of sunlight. It is one of the causes of the phenomenon of smog (Ahmed, 2006). The inhalation of ozone gas causes irritation and allergies in the respiratory system. while exposure to this gas for long periods may cause malignant tumors in the lungs. Table (1) shows the examination rates

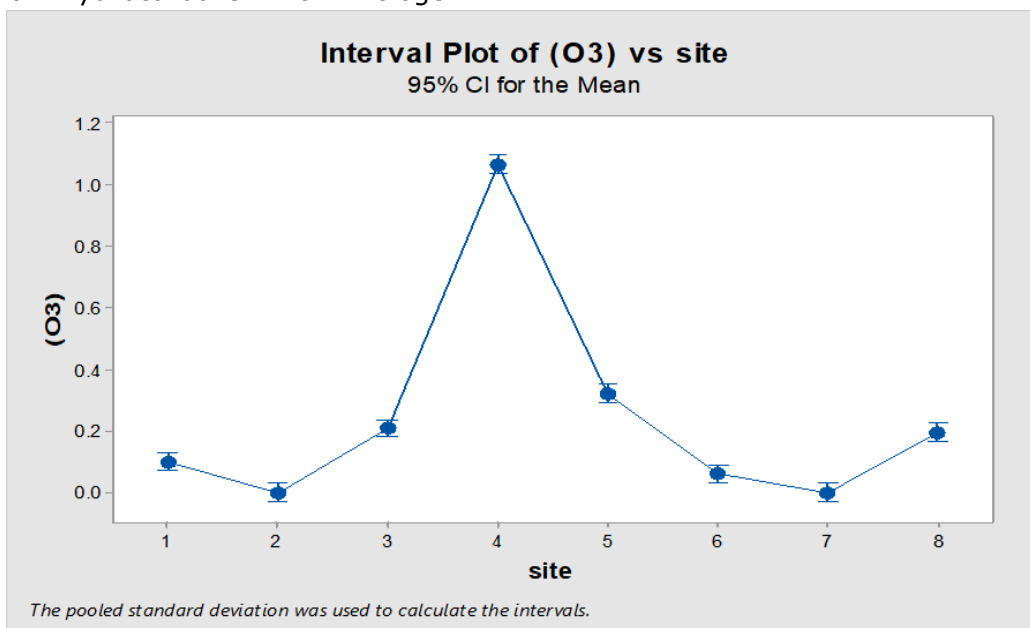


Figure (4) Shows percentages of ozone gas pollution

It is noted that ozone concentrations O3 exceeded the national limit in six locations and ranged between (0.01 - 1.16) PPM. In general, the results reflect the apparent effect of vehicle

exhaust emissions. The highest reading was in the municipal section (4) followed by Sector (5) and finally (2, 7) with close readings.

The SO₂ ratios were also examined using the GASMET device but no significant value was recorded in the eight test locations. All readings were equal to zero.

Examination of suspended particles:

4-2-3

The field detection was conducted for several selected points within the city of Ramadi which included residential, commercial and service areas using GASMET (MET1) and the results were as shown in Table(1)

High concentrations of suspended molecules have been observed in most sites, especially in respect to PM₁₀ & TSP.

A- Total Suspended Particulate Pollution (TSP).

These are solid particles, which are released into the atmosphere from various sources that may be natural or industrial as a result of combustion processes, and gas transformations. These particles contain organic compounds, minerals and the most important element is the lead emitted from vehicle exhausts (Suad,2016)

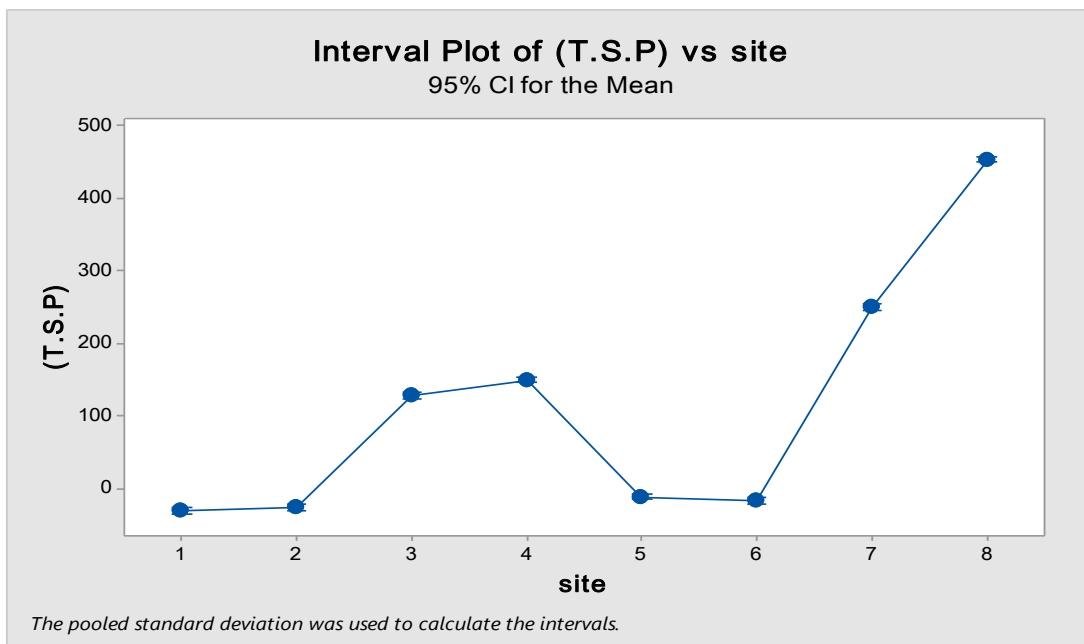


Figure (5) Shows the percentage of contamination with the suspended particles (8) while the first sector recorded the lowest values .
 The results indicate that the total solid plankton concentrations ranged between (883-159) mg / m³, most of which exceed the permissible national limits. With the highest percentage of pollution in the municipal section
 B- Pollution of suspended particles. Solid particles with diameters less than or equal to 10 micron , Results are shown in Table 1:

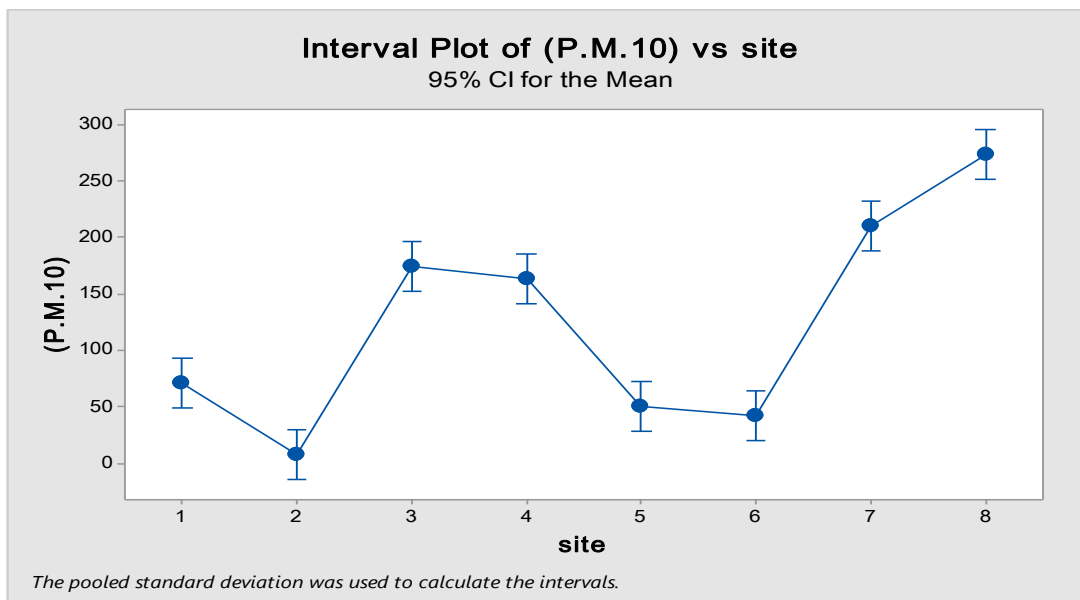


Figure (6) Shows Pollution of suspended particles

The results indicate that indicators were high in all inspected sites, especially the eighth sector, which represents the central business area, followed by sector (7), and (3) the lowest readings were recorded in sector(2).

This type of molecule is very dangerous to humans because of its smallness and the possibility of inhalation within the respiratory system, which makes people vulnerable to respiratory diseases (Ahmed & Osama, 2015)

C- Pollution by PM2.5

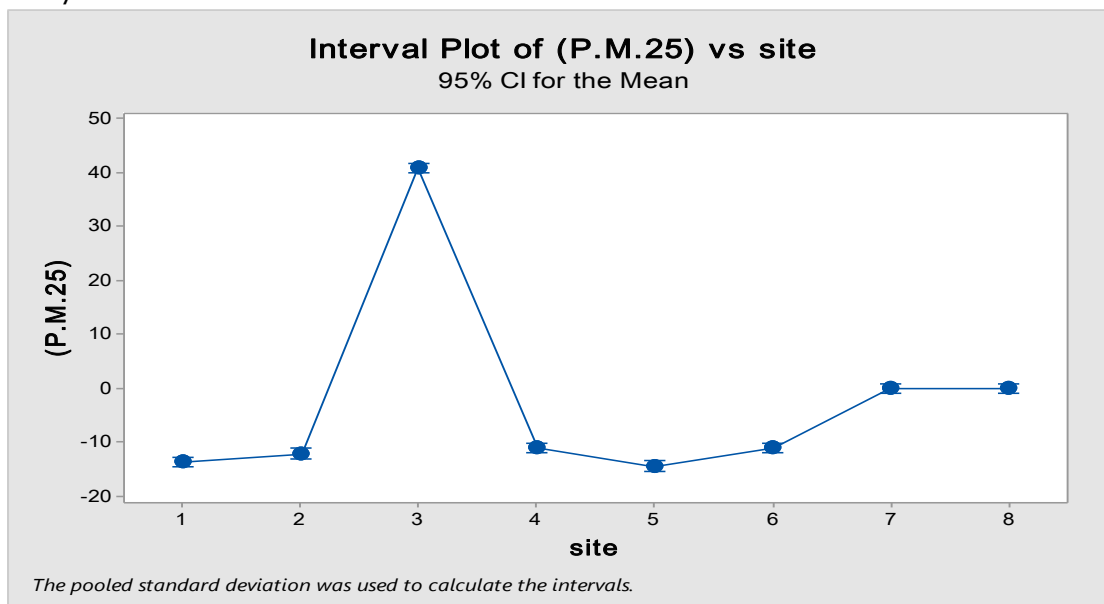


Figure (7) Shows the percentage of contamination of suspended particles PM2.5

The figure shows the increased rates in the third sector. Which is(Al-dubat)neighbor near the health center ,this is a residential or service area. It is followed by sectors (8,7) and the lowest sector (1), the area of the ceramic street near the industrial zone, due to the low rates of pollution in general in this sector is the cessation of laboratories and the lack of traffic

in that area. It was found that the municipal section (8) is the most polluted areas, namely the central business district (the intersection of the Grand Mosque), a congested traffic area throughout the day, and then sector (4)

5. Conclusions and Recommendations:

The research has reached a set of conclusions on the assessment of environmental indicators in sustainable urban transport in Ramadi .

1- The city of Ramadi with its eight municipal divisions suffers high pollution rates due to transport and traffic of various kinds. Hence the importance of sustainable transport of the city and its applications.

2- The municipal sections No. (4) & (8) recorded very high rates of different environmental indicators that express pollution of various kinds.

3-Although Municipal sections (1) & (2) are the lowest among municipal sections of the city.in terms of pollution, they suffers very high rates in various measured environmental indicators in comparison with the standards of pollution

4 - There is a clear disparity in the quality of environmental indicators ,and we conclude that there are strong links between these environmental indicators, and some times, weak on the other side of them. Therefore, in order to benefit from the research and its results, we advance a set of recommendations that serve the sustainable urban transport strategy.

First: Accelerate the planning of a special strategy for sustainable transport in Ramadi city to address the high rates of traffic pollution attending it.

Second: This study can be applied to other cities in Anbar province in comparison with the city of Ramadi, and explain the reasons and conduct field analysis .

Third: This research experiment can be shared and applied at the level of other Iraqi cities. to assess environmental indicators for sustainable urban transport planning.

Fourth:, introducing other standards of environmental indicators that can be standardized and compared with their standard criteria for the general benefit and to optimize the treatment of pollutants due to traffic and traffic in cities.

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