The role of sustainable transport in eliminating traffic bottlenecks

Muthanna Province

Assistant Professor/ Huda Abdelkader Aziz

Iraqi University/Faculty of Arts

Geography and Geographic Information Systems Section

Hudaaziz1245@gmail.com

Abstract:

The research aims to evaluate the current transportation system in Al-Muthanna Governorate, according to the concept, indicators and determinants of the sustainable transport system. It aims to develop a vision for the development of the current transportation system in the region towards sustainability and direct the various interventions in this system according to the principles and requirements of sustainability.
The research relies on the descriptive and analytical approach in monitoring the current status of the transport network in the governorate, in monitoring the policies followed for developing transport networks, and then presenting a vision for developing transport networks towards sustainable transport. The importance of research comes from the lack of a clear understanding of the development of transport systems in the province to achieve easy access, in a manner consistent with the actual need for transportation in a sustainable manner that meets social, economic and environmental requirements. Many cities have developed plans to address traffic congestion in a thoughtful manner, so the importance of the research stems from of the importance of sustainable transportation systems and the extent of their impact on the city's planning to meet the need for transportation easily and in a way that improves the social, economic and environmental aspects. As for the research hypothesis based on that sustainable transport applications provide effective solutions to the current traffic congestion in the study area and addresses the challenges posed by the current transportation system to the governorate. Based on partial treatments, which do not take into account the negative repercussions on the transport system and the ecosystem, which is currently being planned, in a way that adopts sustainable systems in the 2030 Vision. The research arrives at the conclusion that the road density for the population was low compared to the global level, while the per capita share of the road was low. By analyzing the degree of correlation using the beta indicator, it was proved that there is more than one interconnected transport network, while the use of the gamma index indicated the existence of interconnectedness. The average in the network of the transport system, as for ETA, indicates the deficiency of the transport network in the study area and the current obstacles that must be addressed to achieve sustainable transport. The research concluded accordingly to developing a vision to improve the transport network in the governorate based on a set of principles that take into account sustainable transport tools and global and regional experiences in this field.
Key words: transportation, sustainable transport, systems, infrastructure.

Research introduction: -

Transport is central to achieving sustainable development in a rapidly changing world, as growing economic, environmental and social aspirations, changing consumption and production patterns, and limited natural resources - are all factors that stimulate innovation in the transport sector.

Transportation services and the infrastructure needed for them should not be seen as just a way to move people and goods from one point to another. Rather, mobility and logistics are important factors in order to achieve change. There is a large group of intractable problems that are directly related to the current transportation systems, such as polluting emissions, noise, traffic accidents, depletion of resources, and the difficulty in accessing the causes of well-being. Developing and emerging countries are affected in many cases by these problems more than developed countries. As the high cost of transportation and the lack of access to transportation impede economic growth and trade in many developing countries, and air pollution increases health problems at the same time. Around 1.3 million people annually fall victim to traffic accidents around the world - the vast majority of them in developing countries, and it appears that these negative developments will continue if sustainable transport solutions are not systematically and comprehensively pursued.

Research hypothesis:

The researcher assumes that sustainable transport applications provide effective solutions to the current traffic bottlenecks in Muthanna province and address the challenges by the city's current transportation system based on partial, ad hoc treatments and improvised solutions that do not take into account the negative repercussions on the transport system, the ecosystem and life in general, which gives great importance to adopt sustainability principles in transportation planning and development processes.

Research hypothesis:

In this study there is a set of questions that form the basis for examining the research hypotheses, namely:

1- What is the concept of sustainable transportation?
2- What is the concept of traffic bottlenecks?
3- What is the status of the road network in the governorate?
4- What is the role of sustainable transport in restructuring the governorate?
5- To what extent is the road network and traffic plan adopted in maintaining the principles of sustainability?

6- How can the road network and traffic plan be developed in the governorate towards sustainable transportation?

Importance of research:

The importance of studying this subject is a serious consequence of its positive impact on the region and on the quality of life in the region. The transport system is the backbone of civilian life, because it has a role to play in linking different components of the region and levels of life to each other and in creating physical and space integration. and because of its negative repercussions that also affect The various social, economic and environmental aspects of the city, and this research is of particular importance due to the lack of a clear vision of ways to achieve the sustainability of the transportation systems in the Governorate of Al-Muthanna to achieve easy access, and in a manner consistent with the actual need for sustainable transport that meets the social, economic and environmental requirements. Therefore, the importance of research comes from the importance of transportation systems, the foundations of their sustainability, and the extent of their impact on city planning to meet the need for transportation easily and in a way that improves the social, economic and environmental aspects.

Research goal: -

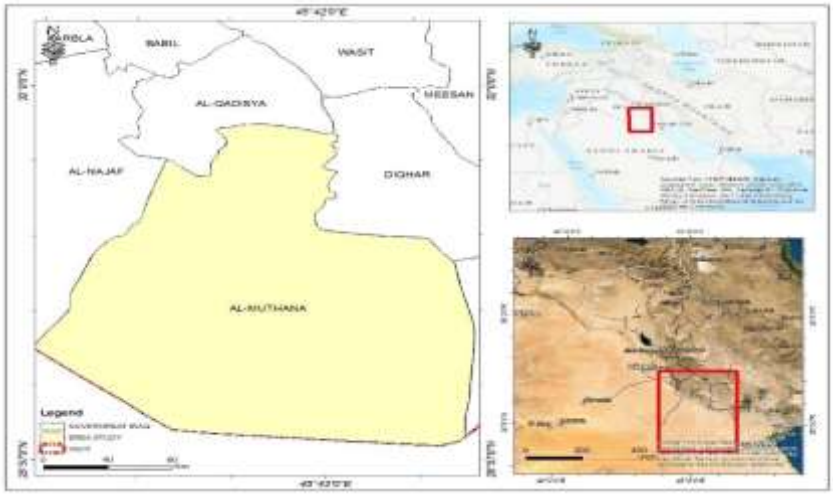
The research aims to define a sustainable transportation system and evaluate the current transportation system in Al-Muthanna governorate, according to the sustainable transportation system, develop a vision for the development of the current transportation system in the governorate towards sustainability, and direct various interventions in this system in accordance with the principles and requirements of sustainability.

Research limits: -

Spatial boundaries: - Muthanna governorate is astronomically united between latitude (3'029-48 0 31) north and longitude (050 -'43, 32 046) to the east, and it is bordered on the north by Qadisiyah governorate, and on the east by the governorates of Dhi Qar and Basra, and from the south and southwest of the Kingdom. Map (1) in Saudi Arabia and Najaf Governorate to the west. Temporal boundaries: - The study data were determined by data for the year 2018.

Map (1)

The location of the study area



Source: Based on: The Ministry of Water Resources, General Directorate of Survey, Map Production Division, Al-Muthanna Governorate map, a map on a scale of 1: 500 000, for the year 2012

- Using Arc Map V.10.7 software.

Concept of sustainable transport:

Cities face increasing pressures in their quest to meet the challenges of daily transport. With rapid urbanization, declining infrastructure, increasing populations and climate change, these challenges become more difficult and require bold steps to develop and diversify transport systems with a view to ensuring their sustainability and integration and giving cities additional advantages in terms of productivity, attractiveness and quality of life.The concept of sustainable transport [1] refers to the provision of services and infrastructure for the movement of people and goods in order to promote economic and social development for the benefit of current and future generations in a safe, affordable, accessible, efficient, and flexible manner, while minimizing emissions and other environmental impacts.

The concept of sustainable transportation is related to the concept of "sustainable development", and the transportation by means that preserve the safety and cleanliness of the environment from pollutants, in order to achieve a clean environment, rationalize consumption, rational use of resources, and provide citizens with good health.

The philosophy [2]followed to achieve sustainable transportation is based on the minimalistic use of fuel-powered means of transportation. An example of this: relying on bus and other public transport means, metro or trains powered by electric power, and limiting the use of private cars except when absolutely necessary, and it helps to achieve this by not buying a car in the first place, and sharing with others in owning a car and organizing its use together in a way Or another, or by walking, when possible, while preserving the environment from pollution by burning fuels. The use of cleaner fuels that meet environmental requirements is assumed to be beneficial in many ways, and the aforementioned public transportation is considered to be economically good, in terms of cost, and environmentally speaking, preserving natural resources, and reducing air pollution and harmful ozone levels. For every kilometer traveled, public transport emits fewer pollutants than a single passenger's car.

Second - Challenges of moving to a sustainable transport system: -

There are many challenges facing the transition to a sustainable transport system, some of which are the result of achieving social sustainability, some are related to economic sustainability, and there are environmental challenges:

1- Challenges related to social sustainability: It is a challenge that arises from ignoring the link between land use and the transport sector, which leads to manifestations of urban sprawl in various cities, and to large differences in transportation systems due to differences in the urban pattern such as places of random housing, and all of this impedes the achievement of distribution Fair and equal transportation advantages, far from differences in income level or social or material differences, and this limits the social sustainability of the transport sector, which is based on equality between different segments in obtaining goods and services, on top of which is fair and equal transport services.[3]

2- Environmental challenges: they arise as a result of dependence on non-renewable fuel sources and the resulting increase in pollutant emissions of carbon dioxide, in addition to noise pollution and the harmful effects on public health, which calls for alternatives to oil derivatives and motor vehicles.

3- The challenge of economic sustainability: It is related to the optimal and more efficient distribution of resources and contributes to maximizing benefits as well as reducing the external costs of transportation. The infrastructure facilities of the urban transport sector are characterized by their high cost, and public transport systems suffer from serious financial challenges due to their dependence on government resources and forms of support, On the other hand: -

- Urban centers with high density require less expensive infrastructure.
- Bicycle facilities require less expensive infrastructure.
- Road construction creates fewer job opportunities compared to investing in other forms of infrastructure.
- The amounts allocated to public transport in the community remain much higher than the sums spent on a car.

Reducing car traffic in city centers usually stimulates retail trade.

Third - sustainable transport planning tools: -

1- Control of demand for transportation[4]:

a) Planning tools: It reduces the need for mobility by bringing the population closer to the activities they need to access. Planning also allows the implementation of transportation infrastructure in an easier and better way. Among the planning tools used are the establishment of major parking lots around cities:

To reduce traffic congestion within cities and encourage the use of mass transit.

Protect the city environment from pollution.

Among the organizational tools is determining parking places within cities, especially in the city center, or increasing the cost of parking, which leads to reduced traffic and the direction of public transport.

Employers contribute to solving congestion problems as one of the organizational tools through (working hours, setting work programs) that determine the demand for transportation and reduce the use of private cars in accessing work, and these programs include:

- Shared car program: grouping more than one passenger in one car.

Reducing the number of parking spaces to encourage the use of alternatives to private cars.

Encouraging mass transportation by reducing costs.

b) Regulatory tools: Regulatory tools are used to limit the use of certain vehicles, and affect the types of vehicles used and the specifications that restrict vehicle performance and regulate roads.
The regulatory tools include allocating roads by separating the lanes of public transport by specifying a section of public roads with their own use to reduce congestion and regulate speeds and movements. The regulatory tools are divided into:
- Dedicated lanes: part of the public roads is designated for public transport through signs drawn on the street, which is a technology for areas in which the flow of traffic is difficult, and these lanes can be available for buses, taxis and ambulances.
- Private lane: The public transport path is separate from the rest of the road or is created specifically for public transport, such as the tramway.
- Allocation of mixed roads: public traffic is banned, and only pedestrians and public transport are allocated, and sidewalks are larger to provide more pedestrian areas and are on the same level of the road. This technology is often located in the city center and for relatively short distances.
2- Mass Transfer: -
Mass transit is the backbone of modern cities to reach workplaces, shopping and services, and mass transit via private corridors is considered one of the basics of sustainable transportation.
Mass transport policies have become one of the axes of city planning and they open the door to the establishment of many urban planning projects and economic and commercial projects, especially around multi-modal transport stations.
- Subway (metro), urban train (tramway), electric bus (trolleybus), cable train and metrobus.
Mass transportation is a pillar of sustainable transportation and contributes to reducing pollutant emissions, traffic congestion, noise and transportation costs, especially as modern technology has made transport modes more environmentally friendly and of high quality of service, dealing with more sophisticated and widespread infrastructure and logistical requirements.
3- Non-automatic navigation:
It is subdivided into walking and cycling that complement mass transit and contribute to a significant proportion of transportation in the event that cities turn their attention to the needs of pedestrians and cyclists.
- Walking: It is the most widespread method of transportation in cities for certain groups, such as children, women, and retirees. It is a limited movement pattern that varies according to the structure and physical energy of individuals.
- The bicycle is a pattern that is getting more and more widespread day by day and is characterized by being a very economical means of transportation that does not occupy a large space, is highly flexible, does not pollute the environment, and is beneficial to physical health.
- Shared car: it means that several people share in the use of one car to reduce the use of private cars, and it is one of the important transportation alternatives, especially in places that suffer from poor public transport services.
4- Sustainable technological solutions to transportation problems: Technology has provided many solutions for means of transport, the most important of which are:[5]
- Biofuels: a component of plant-based ethanol, which is characterized by the fact that the CO2 released by it is balanced with the CO2 released by plants. Therefore, consuming 1 liter of this fuel reduces emissions by 75% compared to using 1 liter of hydrocarbon fuel.
- Electric cars that operate with an electric battery can be charged and hybrid cars that run on fuel and electric batteries at the same time.
Infrastructure: The improvement of the infrastructure has facilitated the flow of traffic and thus reduced emissions, and technological solutions have allowed the improvement of the infrastructure based on environmentally friendly materials in addition to relying on recycling waste.
Intelligent transport system: It depends on the integration of modern technologies in transport with the aim of:
Assistance in driving vehicles and positioning, especially using the GPS system
• Facilitating traffic and improving the flow of traffic flows by controlling traffic lights, achieving integration between tracks and different modes of transport, and sending information to drivers about shorter roads and better paths of movement.
• Improving traffic safety by sending drivers information about road conditions.
Fourth - metro, light rail and bus systems: -

The metro, light rail and express bus systems constitute one of the public transport options with a high carrying capacity that provide successful solutions to improve transport levels in cities and to improve the quality of life and environmental conditions in developing and developed countries, thus offering better alternatives to the use of private vehicles and these systems play a strategic role in shaping Urban pattern and the promotion of density rates and the multiple available uses of the land.

Fifth - types of sustainable transport indicators: -[6]

Sources for sustainable transport planning divide transport indicators into environmental, economic and social indicators:

1- Environmental indicators: It includes different types of environmental impacts such as air pollution (including gases that contribute to climate change), noise, water pollution, depletion of non-renewable resources, landscape degradation, and wildlife destruction. There are different methods for measuring these impacts and determining their environmental and human costs.

2- Economic indicators: reflect the benefits and costs of using cars and the possibility of mobility in public vehicles that cause a decrease in accessibility and diversity in transportation instead of achieving social welfare gains. Among the most important ways to identify economic indicators for assessing sustainable performance are:

- Affordability: means of transportation available and accessible to individuals.
- Mobility: Transportation provides efficient movement for people and goods for economic activity.
- Equity of financing: that the transportation is financed in a fair way in which all the beneficiaries participated in an equitable manner.
- Flexibility: that transport possesses the flexibility required to face economic fluctuations.

3- Social indicators: include social impacts such as equality, human health and community cohesion (interactions between members of society) and the impact on historical, cultural and aesthetic resources, as transport justice can be assessed by comparing transportation options, service quality and impacts between different groups, especially on economically, socially and physically vulnerable groups, and includes health effects For transporting accidents, illness, pollution and lack of physical activity.

Fifthly: - The transmission network system in the study area: -

The study area includes the main and secondary roads and has been distributed as follows:

Main roads: They are the roads that link the governorate with other governorates, and link the urban centers of the governorate with each other. One of the numbered roads passes through Al-Muthanna Governorate, one of the numbered main roads, Road No. (8) (which starts from Baghdad and passes through Babel Governorate, then Qadisiyah Governorate, and enters Al-Muthanna Governorate in Al-Rumaitha district, then Al-Samawah district, and Al-Khader district, and continues to Dhi Qar Governorate, reaching Basra Governorate in Safwan Near the Iraqi-Kuwaiti borders, the number of main roads reaches (6) and their total lengths are (5,414), as Table (1) shows the variation in the length of the main roads, as the Samawah - As Saman - Saudi border road is the length of the roads, with a length of (1200) km. It was established for the purpose of linking the governorate with the district of Samman down to the Kingdom of Saudi Arabia, Map (2).

Table (2)

The main roads in Al-Muthanna Governorate

1	Samawah - Samawah - Saudi border	200	8	One lane
2	Al Samawah - Al Mamhamah - Al Shanafia - Najaf	78	8	One lane
3	Samawah - Nasiriyah	48.5	21	Two lanes
4	Samawah - Diwaniyah	35	21	Two lanes
5	Main Street - Highway Road 8	28	36	Two lanes
6	Rumaitha - Hamza Tourist	25	6	One lane
	Total		414.5	

Source: - Directorate of Roads and Bridges in Al-Muthanna Governorate, Planning Department, unpublished data, 2016

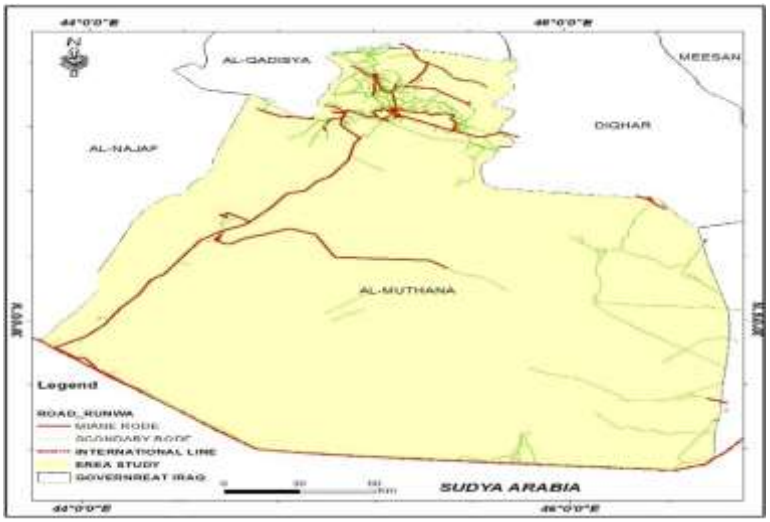
- Secondary roads: - Table (2) shows that the number of secondary roads in the Governorate of Muthanna is (20) roads, some of which connect the governorate center with other urban centers, and some connect urban centers between them, and their total lengths are (5.558 km), The longest secondary roads in Al-Muthanna Governorate varied according to the difference in distance and proximity between the administrative units that connect them, as it is noticed that the linking road between Salman district and Busayyah district is the longest road, as the length of the road is 176 km, due to the distance between the Salman district and the Basra district. They are located in the southern desert in the southwestern part of Muthanna Governorate, while the Al Majd - main road (Al Samawah - Al Rumaitha) and Al Warka - the main road (Al Samawah - Al Rumaitha) are the shortest secondary roads in the Darsa area, as each one is 6 km long. The Al Majd - Main Road, Samawah - Rumaitha was extended in 1982,[7] while the first lane was extended from Warka - Main Road, Samawah - Rumaitha in 1978, and the second lane was completed in 2014, map (2)

Table (2): The length of secondary roads in Al-Muthanna Governorate for the year 2016

Serial	Road Name	Length / km	Width / m	Number of lanes	year
1	Salman-Busayyeh	176	7	One lane	2007
2	Warka – Athar Al-Warka	40	7	One lane	1982
3	Al-Majd - Al-Suwair Bridge	47	6	One lane	2014
4	Samawah - Al Khader Tourist	36	6	One lane	2010
5	Samawah - Mahdi	28	6	One lane	1997
6	Acer Al-Furat - Al-Sawyer	27	6	One lane	2012
7	Rumaytha-Warka	25	6.50	One lane	1995
8	Al Khedr-Al-Darraji	20	6	One lane	2005
9	Al-Warka - Al-Suwair	18	6	One lane	2010
10	Al-Najmy- Al-Rumaithah	19	6.50	One lane	1994
11	Al-Rumaitha - Al-Majd Abu Shuraish Road	15	6	One lane	2000
12	Main Road –Al-Helal	13	7.80	One lane	1997
13	Ain Said - Al Khader	17	7	One lane	2006
14	Samawah - Al Sawyer	15	6	One lane	1983
15	Al-Samawah – Al-Majed Umm Al-Akf Road	13	6	One lane	1987
16	Al-Majd - Al-Hilal (Ayman Al-Furat)	14.500	6	One lane	1989
17	Al-Majd - Al Hilal (the left of Euphrates)	12	6	One lane	1989
18	Al Hilal - Al Jamjah	11	6	One lane	2007
19	Al-Majd - the highway	6	6	One lane	1983
20	Warka - the main road	6	6	Two lanes	1980
Total		558.5 KM			

Source: Directorate of Roads and Bridges in Al-Muthanna Governorate, Planning Department, unpublished data, for the year 2016.

Map (2): - Main and secondary roads in Al Muthanna Governorate



Source based on: - Directorate of Roads and Bridges at Al-Muthanna, Projects Department, Road Map, scale for a year scale of 1: 500,000. For the year 2016

- Using Arc Map V.10.7 software

3 - Rural roads: - The total length of rural roads in the governorate is (259,700) km, and the roads are characterized by being all of one lane, and their number has reached (52) roads. The lengths of rural roads are noticeable, as it turns out that the longest rural road is the star road. Mesaieeda, and then this purpose was extended to link the highway to Al-Najmi sub-district, and from there to Al-Rumaitha district, where its length reached (17) km, while the Jubbah road is the shortest rural road in the governorate, table (3).

Table (٣)Lengths of rural roads in Al-Muthanna Governorate for a year٢٠١٦

Width / m	Length / km	Road name	Serial
6	17	Najmy - Mesaieeda	1
6	15	Al Sayed Hadi - Al-Oweimiyin - Al-Tawayil	2
6	10	Warka - Rumaytha (Albu Hawijma)	3
5	9	The highway Al Miffa - Abu Awani - Al Majd	4
6	10	Warka - Al-Bayda - Syed Sumiman	5
6	10	Al-Rumaythah - Al-Kata'a Al-Fariaa	6
6	8	(Al-Khader - Aldarji) Ayman of the Euphrates	7
5	8	Najmiy - Jabour	8
5	8	Al-Matook -Al Matook- the karma	9
5	7	Al Masaifia	10
5	6.250	Al Bu Hajar, in the direction of Al-Shuweima	11
5	6.100	Al Huwaish	12
6	6	Al-Yaymah - Albu Musa - Al-Rumaitha	13

6	5.750	Al-Hodeidah - Al-Suwair District	14
5	5.700	Shanabara Road	15
6	5.500	Shweima - Ain Said Bridge	16
6	5.500	Debis Al Samih	17
5	5.500	Al Darb	18
5	5.300	Al Sohour Al Bu Ainain	19
5	5.300	Nash – Al-Khedr	20
6	5.200	Syed Sumiman - Warka	21
5	5	Al Syed Joudeh	22
5	5	Western Jamma –Al Helal	23
5	5	Abu Rawaya Road - Jrukhi Bridge	24
5	4.500	Al-Karimat – Al tboul- Al Hariz	25
6	7.500	Al Khader - Al Dhahira	26
5	4	Warka - Al Antar	27
5	6	Al-Khader - Al-Darji (the left of the Euphrates)	28
5	3.800	Al Zain - Al Ajel and the Lotti	29
5	3.700	Gentlemen Al Musamam and Al Mazroub and Al Hamid	30
5	3.600	Al Karim - Al Aswad	31
5	3.450	Al Syed Raad	32
5	3.250	Al Ghanim – Al mohadad in the Sawyer	33
5	3	Al-Massal - Al-Dukhan / Al-Warka	34
5	3	Village Al Najm Al Obaid	35
5	3	Al-Haffar / Musa Anad - Al-Rumaitha	36
5	3	Al Bahr - Al Muhammad - Al Affan	37
5	2.800	Small Sulimia or second	38
5	2.600	Abbasia Al Abdul Hussein - Rumaitha	39
5	2.500	Al-Jhimi –Audt Dai /Al Zwalem	40
5	2.300	Al Windows Al Abs	41
5	2.300	Al Shweijah Nir Abu Kahouf	42
6	2.200	Alkarma – Archeology Road	43
5	2.200	Al Ghareb Alzail - Warka	44

5	2	Al Batti - Al Ghazi	45
5	1.800	Al Massal - Bani Azrij-	46
5	1.800	Al Mashraa-Al Shakha	47
5	1.800	Al-Auja - Prophet Solomon	48
5	1.400	Al-Amaya - Al-Zawalim (Abu Shweit)	49
6	1	Sayed Ab Ariim Road	50
5	1	Al-arifat Road	51
5	0.600	Al-Jabba Road	52
	259.700	Total	

Source: From the researcher's work based on: Directorate of Roads and Bridges in Al-Muthanna Governorate, Planning Department, unpublished data, 2016.

4- Bridges: Table (4) shows that there is a variation in the number of bridges in the governorate, as it reached (28) bridges that differ in terms of their design, lengths and importance. It is noticed that Samawah district is the highest percentage in the number of bridges, as the number reached (10) bridges, while The district of Warka and the sub-district of As-Suwayer recorded the lowest number, as it reached only one bridge, while the district of Busayyah was empty of bridges due to the absence of rivers within its administrative borders.

Table (4): - Bridges and their types in the governorate for the year 2016

Bridge site	Bridge type	Bridge length (m)	Bridge name	Serial
Samawah District Center	Concrete	380	Samawah Bridge	1
Samawah District Center	Concrete	365	Shida Bridge	2
Al-Rumaitha District Center	Concrete	30	Rumaitha First Bridge	3
Al-Rumaitha District Center	Concrete	40	Rumaitha Bridge (North)	4
Al-Rumaitha District Center	Concrete	40	Rumaitha Bridge (Al-Isala side)	5
Al Khader District Center	Concrete	850	Al- Khedr Bridge	6
Samawah Road – Midi-Mammaha	Concrete	85	Medi Bridge, Amy Ner Sumaibat	7
Al-Samawah Road	Concrete	100	Al-Qadisiyah Bridge, Amy Ner Sumaibat	8
Samawah Road - Diwaniyah	Concrete	176	Al-Jroukhi Bridge	9
Samawah Road - Diwaniyah	Concrete	24	Abu Sakheer Bridge) Rumaitha entrance	10

Samawah-Diwaniyah Road	Concrete	27	Al-Rumaitha Bridge (Al-Rumaitha entrance)	11
Rumaitha - Warka Road	Concrete	12	Qazwini Bridge	12
Samawah Road - Diwaniyah	Concrete	550	Al-Majd Bridge	13
Samawah-Nasiriyah Road	Concrete	800	Daraji Bridge	14
Samawah Road - Mammaha	Concrete	720	Sawa Bridge	15
Samawah Road - Mammaha	Concrete	500	Badia Gate Bridge	16
Al- Masfa Road	Concrete	500	Al-Masfa Bridge	17
Cement factory road	Concrete	350	Wadi Kharaz Bridge	18
Old Quail Road	Concrete	78	Al-Muthanna Bridge	19
Al-Suwayer sub-district	Concrete	386	Al Suwair Bridge	20
Al-Samawah-Al Majd Road	iron	190	Al-Atshan Bridge	21
Samawah District Center	iron	148	The twentieth revolution bridge	22
Al-Layal district center	floating	140	Al Layal Bridge	23

Source: Directorate of Roads and Bridges in Al-Muthanna Governorate, Planning Department, unpublished data, for the year 2016

Sixth: - Measuring road density in the study area: -

A- Road density at the area level: It is one of the important criteria to measure the efficiency of the transport network inside and outside the region, and it also reflects the extent of the economic development of that region, with regard to the study area, the network density reached (47.6) km per 1000 km2, and this density is considered Low, as it was compared to the global average density of 105 km per 1000 km2, while at the district level, it varied from one district to another. The Warka district recorded the highest density, reaching (527.1) km, and it is due to the small area of the district and the concentration of human settlements in it. The length of roads is high, and the lowest density was in the Salman district, which reached (19.9) km, which is attributed to the large area, which occupies the desert part of the governorate, Table (5).

B- Density of roads at the population level: - The density of roads at the population level reached (302.2) per 100 inhabitants, and this percentage is low compared to the global level of (496) km per 100 inhabitants, and this matter is not due to the shortcomings of the transport network only, but to the extent that it concerns With the growth of the population and the decrease in road density in the district of Hatra and Salman, Table (5).

C- C- The per capita share of roads: - The per capita share of roads reached (3.0), which is a low percentage, and it is due to the high numbers of the population and the scarcity of roads. As for the qada'a level, the highest percentage was in the district of Salman, and the lowest of it was in the district of Samawah, Table (5).

Road density in terms of area, population, and per capita share in Al-Muthanna Governorate for 2018

Per capita share / By meters ***	Density / population ** Km / 100 thousand people	Density / * area Km / 1000 km2	population	Total area / km2	Road lengths / km	Administrative unit
0.9	94.7	350.7	٣٤٨٥٧١	941	330.01	Samawah
1.2	124.2	246.3	243047	1226	301.93	Rumaithiya
3.4	336.5	225.8	111827	1667	376.35	Al-Khadra
84.7	8471	19.9	11070	46928	937.78	Salman
5.2	516.3	527.1	99856	978	515.54	Warka

Source: From the researcher's work, depending on: -

1- Republic of Iraq, Ministry of Planning and Development Cooperation, Directorate of Statistics of Muthanna Governorate, unpublished data for 2018.

Republic of Iraq, Ministry of Housing and Construction, Directorate of Roads and Bridges in Al-Muthanna Governorate, Technical Division, data for 2-2018

3- Republic of Iraq, Ministry of Planning and Development Cooperation, Muthanna Governorate Statistics Department, population estimates, unpublished data for 2018

* The road density was calculated with respect to the area according to the following equation:

Road to Area Ratio = Total length of roads (km) / Area area km / * 1000[8]

The road density with respect to the population was extracted according to the following equation: - **

The ratio of roads to the population = total length of roads (km) / total population * 100,000[9] The per capita share of the road was calculated according to the following equation: - [10]

The per capita share of roads = the total length of the roads (km) / the population of the area.

D- The degree of spread of roads in the governorate: -

The road network is a complex spatial system that is difficult to analyze in its real form, so it is necessary to resort to abstaining the real network of roads in the form of a graph consisting of a number of lines and points (nodes), and in this way it is easy to measure the degree of spread and to know the spacing and convergence between the network nodes (Table 6) It is noticed through analyzing the table data that the indicator of the degree of dispersion in the province of Muthanna reaches (1.2) km / link and this indicates the relative shortcomings between the network nodes, which in turn indicates the clear convergence between cities, and the convergence of distances and irregularities that are not characteristic of cities Trendy Map (3).[11]

E- Analyzing the degree of road interconnection in the governorate: -

The degree of correlation is used in assessing the extent of interconnection between the network and it gives a comprehensive evaluation of the effectiveness of that network through the verification of the connection between the nodes, and the beta indicator usually ranges between (zero-1), while the zero means that the network consists of only nodes and has no links, meaning that it is non-existent. In the event that the index exceeds the correct one, it indicates the existence of more than one interconnected network, while the gamma index when it reaches the zero value indicates that the network is unconnected and the correct one is fully interconnected, and through the application of the above indicators, the beta index reached (0.5)

indicating the presence of more From an interconnected network, while the Gamma Index, which has a value of (0.18), indicates the presence of more than one interconnectedness Table (6) Map (3).

Table (6)

The degree of spread of paved roads in the districts

Gamma Index (Correlation) ***	Beta Index (Correlation) **	Degree of change, any km / knot *	Number of nodes	The number of connections	Road lengths / km	Administrative unit
0.17	0.5	0.3	2028	1072	330.01	Samawah
0.19	0.6	1.9	270	154	301.93	Rumaithiya
0.2	0.5	1.2	554	304	376.35	Al-Khedr
0.2	0.7	12.3	114	76	937.78	Salman
0.19	0.6	1	928	534	515.54	Warka
0.18	0.55	1.2	3894	2140	2461.61	Al-Modal

Source: The table is from the researcher's work based on Map No. (3)

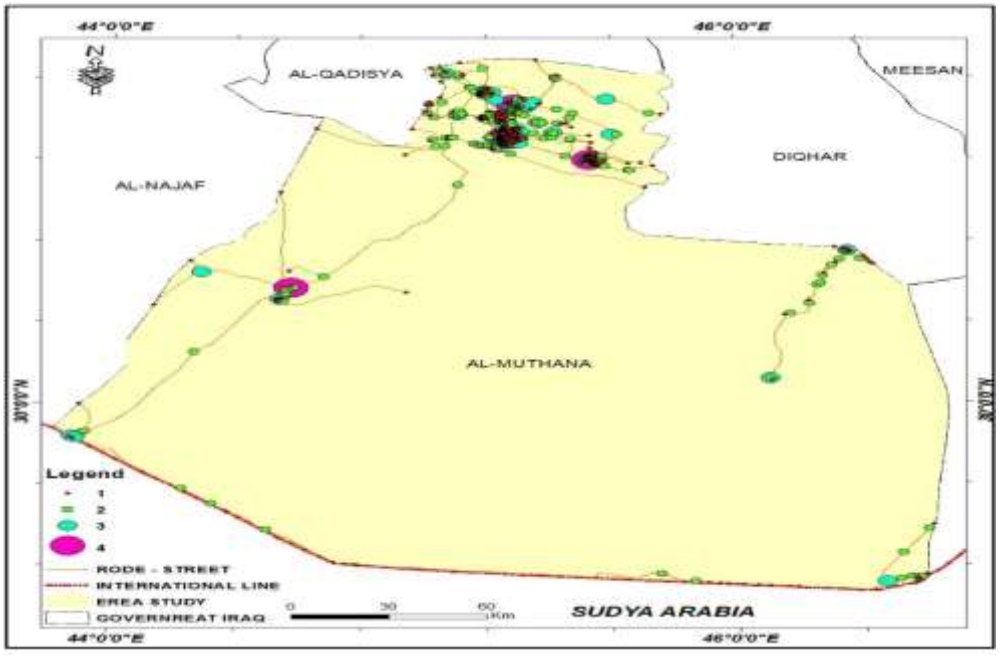
The indicators were extracted as follows:[12]

ETA indicator = total road length / number of connections

Beta = number of connections / number of nodes

Gamma indicator = number of connections / 3 * (number of nodes -2)

Map (3)



The source is from the researcher's work based on: - The source is based on: - Directorate of Roads and Bridges in Al-Muthanna Governorate, Projects Department, Road Map, scale for a year scale of 1: 500,000. For the year 2016

- Using Arc Map V.10.

Fourth - the basic principles for developing transport in the study area towards sustainable transport: -

1- Greater focus on pedestrian traffic in the most important areas, with less emphasis on private cars.

2- Improving pedestrian areas to support the presence of safe, comfortable, convenient and easy-to-access paths and sidewalks, provided that their importance and carrying capacity increase when approaching important commercial, administrative and tourist areas.

3- An effective transportation system based on balance and integration between multiple modes of transportation, linking different neighborhoods with the adoption of flexible public transport that meets the needs.

4- Establishing a transport hierarchy that supports pedestrians, public transport and cars with high carrying capacity, and then cars with low carrying capacity, in descending order of priority.

5- Providing elements of open spaces commensurate with meeting the expected demands of the needs of pedestrians and visitors.

6- Using the smart transportation system in intersections and streets through an integrated electronic system reinforced with surveillance cameras and light signals to monitor the movement of vehicles and discharge traffic according to traffic density and monitor violators. To improve safety and implement traffic regulations, in a way that greatly reduces the preparation of traffic violations and road accidents and allows traffic flows to be distributed between different lanes and modes of transport according to smart programs that operate traffic lights in proportion to that.

Conclusions: -

1- The transportation network in the governorate is devoid of clear government strategies to address its problems, whether they are immediate or future treatments, which made it a deteriorating transport network.

2- The absence of a clear structure in the design of the current basis for the city (2020-2030) for urban transport in comparison to its presence in the previous basic designs, and this is what constitutes a major problem in this current design.

3- The apparent lack of effectiveness of mass transit, which is a reason for not paying attention to the transport function and its functional strategy.

4- The lack of interest in transport planning and studies in the governorate has a negative impact on making the urban transport network suffer from a clear rise in the rates of transport and traffic problems, the most of which is the problem of traffic congestion occurring in the main intersections, most of which are devoid of traffic signals, which is negatively reflected in the increase and emergence of problems Others that come in second place, such as traffic accidents and environmental pollution.

Recommendations: -

1- Developing current and future plans and strategies to address transportation problems in the Iraqi governorates to create sustainable urban transport in line with environmental standards.

2- Identifying an agency responsible for managing traffic congestion in the governorate and defining its tasks that include: Congestion management on a scientific basis that includes expertise and specialized cadres.

3- Building an integrated database with a forecast system.

4- Developing operational capabilities and adopting an effective traffic management system.

5- Development of traffic lights and a central control system, and an effective system for managing transportation demand and promoting the uses of mass transit, school transport, and the participation of the government and private sector.

References

1- Ismail, Ahmed Ali. Studies in Urban Geography, House of Culture, Publishing and Distribution, 4th Edition, Cairo, 1988

2- Bin Abdul Aziz, Halima. “The Reality and Future of Sustainable Transport in Algeria”, Master’s Memorandum, Faculty of Economic, Business and Management Sciences, University of Batna, 2018.

2- Republic of Iraq, Ministry of Planning and Development Cooperation, Directorate of Statistics of Muthanna Governorate, unpublished data for 2018.
3- Republic of Iraq, Ministry of Housing and Construction, Directorate of Roads and Bridges in Muthanna Governorate, Technical Division, data for 2018.
4- Republic of Iraq, Ministry of Planning and Development Cooperation, Muthanna Governorate Statistics Department, population estimates, unpublished data for 2018.
5- Humaidan, Qadeed Mahmoud. "Urban Transport Planning", The Arab Academy, Denmark, 2009.
6- Abdul-Wahab, Areej Mohi., Sustainable Transportation in Madinah, College of Engineering, Al-Mustansiriya University, Baghdad, 2015.
7- Othman Muhammed Ghoneim. Sustainable Development, Amman, Dar Al-Safa for Publishing and Distribution, 2007.
8- Ashmawy, Saad Eddin. Transportation Organization and Management, Foundations, Problems and Solutions, Fifth Edition, Mars House, Riyadh, 2008.
9- Imad bin Nasser Al-Mutair. Quantitative Indicators of Traffic Accidents, Center for Studies and Research, Naif Arab University for Security Sciences, Riyadh, 2005.
10- Ghanem, Ibrahim Ali; The Geography of Transport, Dar Al-Qassim Publishing and Distribution, Saudi Arabia, 1994.
11- Directorate of Roads and Bridges in Al-Muthanna Governorate, Projects Department, Road Map, Scale for the Year of Scale 1: 500,000 for the year 2016
12- Directorate of Roads and Bridges in Al-Muthanna Governorate, Planning Department, unpublished data, for the year 2016.
13- Directorate of Roads and Bridges in Al-Muthanna Governorate, Technical Section, unpublished data, for the year 2016.
14- The Ministry of Water Resources, General Directorate of Surveying, Department of Map Production, Map of Al-Muthanna Governorate, on a scale of 1: 500 000, for the year 2012.

English References

1-Edward Amold "Haggett prtter "location Analysis Human, geography ",London,1971,p87
2- Jean-Paul rodrigue,the Geography of transport system third edition ,New york ,2013,P355.

[1] Othman Muhammed Ghoneim, Sustainable Development, Amman, Dar Al-Safa for Publishing and Distribution, 2007, pp. 30-37
[2] Halima Ben Abdelaziz, "The Reality and Future of Sustainable Transport in Algeria", Master Note, Faculty of Economic, Business and Management Sciences, University of Batna, 2018, p. 40-45
[3] Jean-Paul rodrigue,the Geography of transport system third edition ,New york ,2013,P355.
[4] Qadeid, Mahmoud Hamidan, "Urban Transport Planning", The Arab Academy, Denmark, 2009, p. 55
[5] Areej Mohi Abdul-Wahab, Sustainable Transportation in the City, College of Engineering, Al-Mustansiriya University, Baghdad, 2015.
[6] William and Harry, Introduction to Transportation Engineering, translated by Dr. Saeed Abdul Rahman, King Saud University Press, 1999, pp. 70-75.
[7] Directorate of Roads and Bridges in Al-Muthanna Governorate, Technical Section, unpublished data, 2016
[8] Edward Amold "Haggett prtter "location Analysis Human,geography ",London,1971,p78
[9] Ibrahim Ali Ghanem, The Geography of Transportation, Dar Al-Qassim Publishing and Distribution, Saudi Arabia, 1994, p. 221
[10] Ahmed Ali Ismail, Studies in the Geography of Cities, House of Culture, Publishing and Distribution, 4th Edition, Cairo, 1988.
[11] Imad bin Nasser Al-Mutair, Quantitative Indicators of Traffic Accidents, Center for Studies and Research, Naif Arab University for Security Sciences, Riyadh, 2005, p. 15
[12] Imad bin Nasser Al-Mutair, previous source, p.20