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## Urban Transport and Growth: Dynamic Indicators in Diwaniyah City

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# Urban Transport and Growth: Dynamic Indicators in Diwaniyah City

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**Abstract.** This research takes one of the important aspects that expose with cities in general and specially Diwaniyah city, this aspect is urban transportation and growth.

The Dynamic is an urban phenomenon exposed to the urban system exposed by external and internal factors, are shown through the manifestations of urban growth of the relations and properties of element of urban system. The dynamic indicator that designed to study the spatial examine the spatial time-based relationship for the transport system and the urban growth that doing in Diwaniyah city and quantify dynamic of urban growth and transportation.

The indicators that consuming to measuring besides analyzing the urban dynamic for the transport system and their effective on the urban growth. Using dynamic indicators is the analysis of the change in transport system and its effect effective on urban growth. The indicators that using to measuring and analyzing the urban dynamic for the transport system and effective on urban growth. Using dynamic indicators is the analysis of the change in the transport system and its effect effective on urban growth. These indicators are dynamic addressing and behavioral indicators of form and structure of the excited and reactive and move by the power of this tested for the study area and of the indicators of the urban transport and integrates the density of roads and ease of access, location and interdependence of transportation and growth indicators in economic, social, political, environmental, and dealer dynamic and their inputs and access to the city's status of understanding the relationship of spatial and temporal scales between the transport and take her to the city with all systems urban this What continue to you our research in the leadership dynamic of the relationship and orientation of the damaging and positive consequences on the city.

This research has been reaching to the fact that the urban transport is affecting on the growth and distributions of the urban land use from a group of spatial relations represented in this take to increase the competition between the uses, values, types, positions, destinations, and finally the inside value motion. The research found that the Iraqi reigns in Iraq has changed its place and (the spatial behavior) of every 5.4 times during the time period studied. And reached the mouth of the how to change the cities spatially and temporally by the access relations and interactive between the transport and the dealer all of them on the other this many the goal of our research.

## 1. Introduction

The existence of a dynamic relationship between transportation and urban growth, as each affects the other, and produces a result of this relationship, functional interactions are complex dynamic between them, and



through them understand the movement of the city and its future directions , and the efficiency of the transport system in securing the needs of the population to carry out their various purposes to reach easily to their seats (Destination) within the city or others .

Will be detailed by the field surveys and one case of urban transport system and urban transport in the city of Diwaniyah prove that calculation of the indicators of the dynamic that has been identified and agreed to measure. Afterward, it struggles to relate and analyze the link between the urban growth and transport from spatial time-based indicators.

## **2. Literature review**

Urban growth is prejudiced by different urban structures Transportation productions a vital role in urban progress and growth. The structures provide flexibility for people, and they implementation the forms of growth. The accessibility that they provide to the land. The transportation infrastructure is reflected one of the main foundations of urban growth. Several studies demonstrated that transportation infrastructure is one of the main driving forces of urban growth, spatial expansion and land use changes.

Population growth is one of important driving forces of change in any urban system. If urban population grow, the city must expand upward or outward. Along with economic development and technologies (mainly transport and communication) revolution, rapid urban growth can be characterized by the development of suburban expansion and redevelopment in the city.

## **3. Procedure**

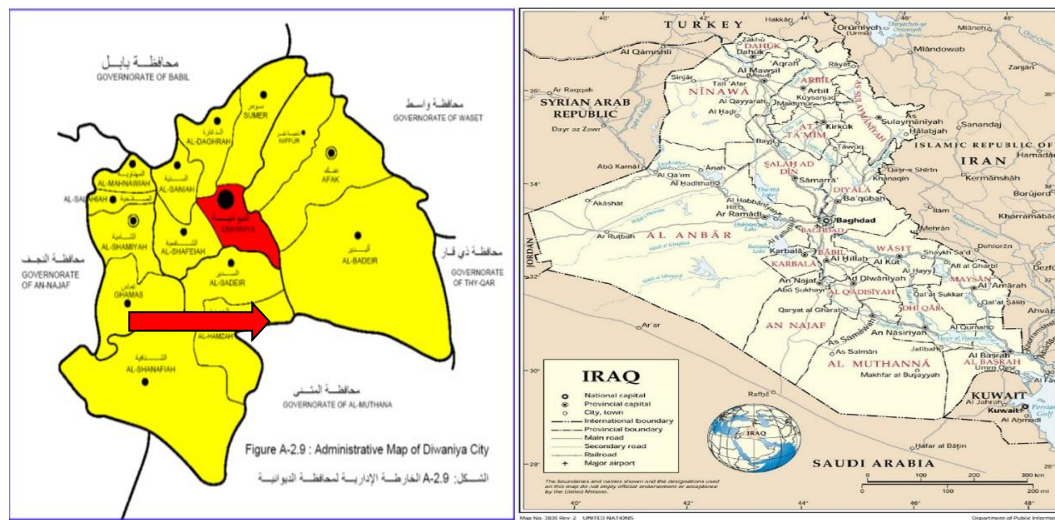
### *3.1. Study area:*

The study region is the diwaniyah city, represent the city one of the phenomena of civilization on the same page of organic by the human on the ground. It has evolved from the urban core to small shapes that link , its currently expressing any human interaction with his environment<sup>1</sup> according to the stages of civilization of a certain , as can any area that appear without that there will be consequences, both natural and Human play a prominent role , in varying influence in the process of active development, this reflects the organic nature of photos the proximal world of the city of Diwaniyah, like many other cities. And the city has grown, and the uses of urban land, where, after the population has increased; as a result of economic, social, health and experienced by.

### *3.2. Geographic Location of Diwaniyah*

Iraq's center-south city of Diwaniyah, lying on the Euphrates River, is about 180 km south of Baghdad and about 320 km north of Basra. Diwaniyah is situated to the south of Baghdad on the eastern branch of Euphrates River in Iraq. It is located on 31o 59/ 4.88// north of the equator, and 44o 55/ 29// east of Greenwich.

The alluvial plain begins north of Baghdad and extends to the Arab Gulf. Diwaniyah is located within the areas of the sedimentary and delta plains. It consists of agricultural land and interspersed with orchards which start from the north and continues towards the east, especially in Nahiah Sumer and the center of Qadha Afak. Finally, the ranges of ground elevations (latitude) of the land are between 13-23 m.



**Figure 1.** Location of Study Region Diwaniyah City (General Authority of Survey)

### 3.3. Define of the study area and evaluation (Zoning)

Are usually select the area to be covered to study and collect information about the dynamic variables affecting the urban transport system, by restricting the region and the assessment area core to (7) sectors (Districts) except by the size of the urban area , and that type of the information required to be collected, which is other divided into the traffic zones (Traffic Zones) to facilitate the collection of information from households settle in housing units, This was in a detailed study to find out the relationship of the system of urban transport with land use.

### 3.4. Land uses to the year 2018

After making the survey process uses ground with a stadium to the data, circles and match with the reality and space is connected Lenape uses of the land to the city in 2018 and includes each sector of the town in the city of Diwaniyah, which is to train service. Includes the uses of land in the city of diwaniyah, area of uses mixed such as: Residential, Commercial, Industrial, Light, and areas that are state residential or commercial only, and notes in the Old area, a mixture of uses-residential and small workshops, and probably Michael were in the same building, while containing new areas in the city residential neighborhoods pure, and alive.

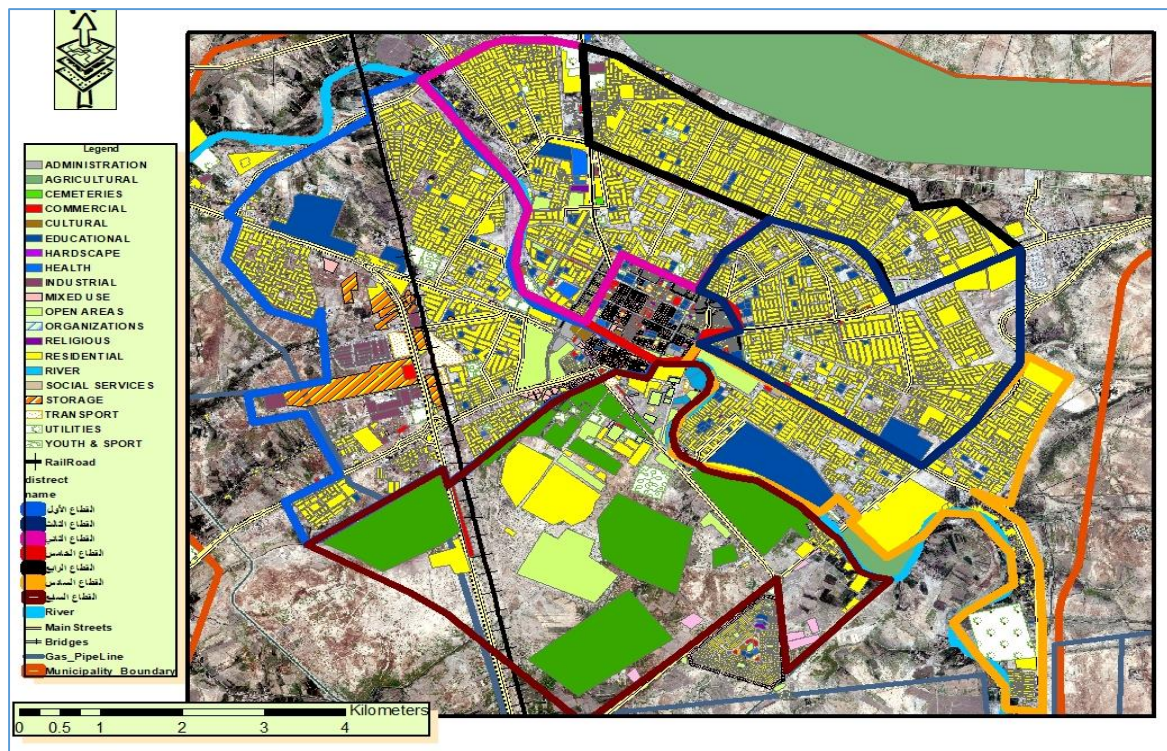
## 4. Urban growth and transportation indicators

Indicators derived dynamics of urban growth, Indicators are used as a tool to effectively measure and analyze the relationship of space-time concerning urban growth and transportation, (8) indicators industrialized to measure the dynamic in the urban transport and urban systems, and these indicators are:

### 4.1. Annual Urban Spatial Expansion Index

TIEI is designed to examine the spatial time-based variation of the transport system in Diwaniyah. It is calculated in lengths of transportation in km and is defined in percent:

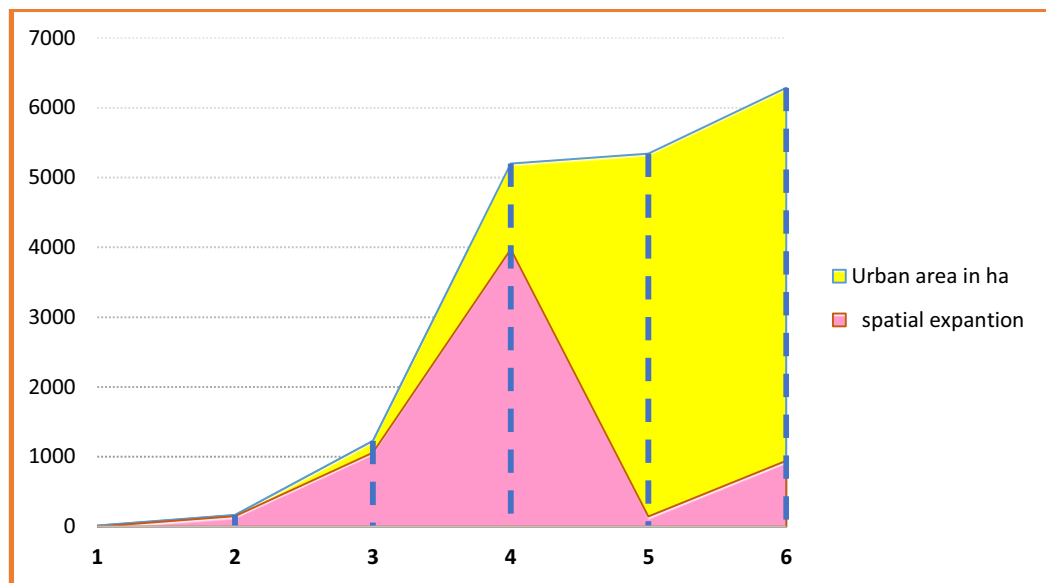
$$AUSEI_t = \frac{(U_t - U_{t-1})/U_t}{(N_t - N_{t-1})} \times 100$$



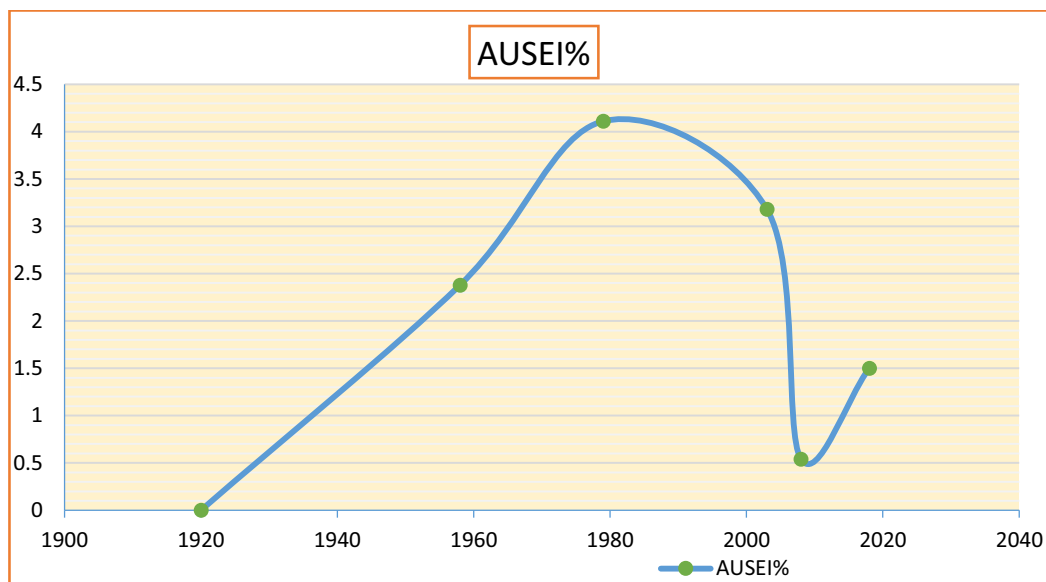
**Figure 2.** Landuse of Diwaniyah City (General Authority of Survey)

**Table 1.** AUSEI and Spatial-temporal Expansion of Diwaniyah from 1920 to 2018

Year	Urban area (ha)	Spatial expansion (ha)	AUSEI %
1920	16	—	0
1958	166.8	150.8	2.38
1979	1227.27	1060.47	4.11
2003	5200	3972.73	3.18
2008	5345	145	0.54
2018	6285.84	940.84	1.5



**Figure 3.** Spatial-temporal Expansion of Diwaniyah



**Figure 4.** AUSEI of Diwaniyah

Figure (3&4) shows the connection between urban spatial development and transportation infrastructure increase in Diwaniyah from 1920 to 2018, the transportation structure gradually protracted and that might have uninspired the urban spatial expansion with a sprawl pattern, both the transportation infrastructure expansion and urban spatial expansion rates decreased, the transportation infrastructure expanded slightly,



and the urban spatial expansion fell again because of the continuing sprawl at the fringes, which suggests that the spatial expansion is generated.

#### 4.2. Annual Land Use Change Index:

Land use change is critical, not only in spatial temporal urban growth and transport analysis, but also in different global, regional and urban analyses. It reflects the dynamics of urban areas and is one of the driving forces of urban growth. Hence, a land use change index (LUCI) is considered to determine the land uses changes as follows:

$$ALUCI_{a,t} = \frac{(LU_{a,t} - LU_{a,t-1})}{(N_t - N_{t-1})} \times 100$$

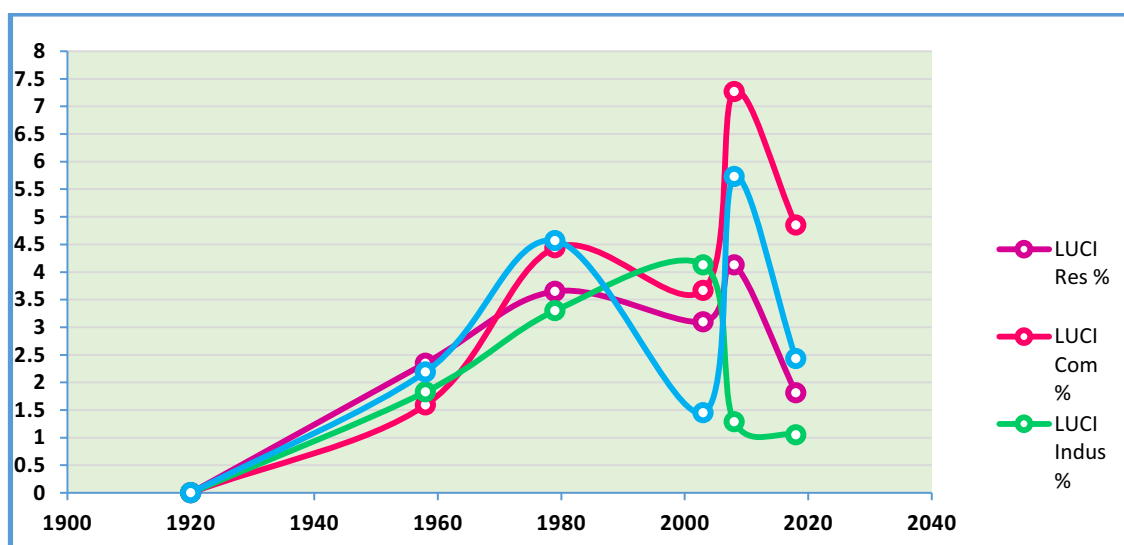


Figure 5. LUCI of Diwaniyah

Table 2. LUCI and Land use change in Diwaniyah from 1920 to 2018

Year	Res. Area (ha)	LUCI Res. %	Com. Area (ha)	LUCI Com. %	Indus. Area (ha)	LUCI Indus %	Public Area (ha)	LUCI Pub. %
1920	11.1	0	0.42	0	0.3	0	2.8	0
1958	102.2	2.35	1.06	1.59	0.92	1.83	16.82	2.19
1979	437.64	3.65	15.88	4.44	3	3.3	409	4.57
2003	1714	3.1	134	3.67	318	4.13	628	1.45
2008	2159.41	4.13	210.47	7.27	340	1.29	879.976	5.73
2018	2635.21	1.81	408.82	4.85	380	1.05	1162.92	2.43

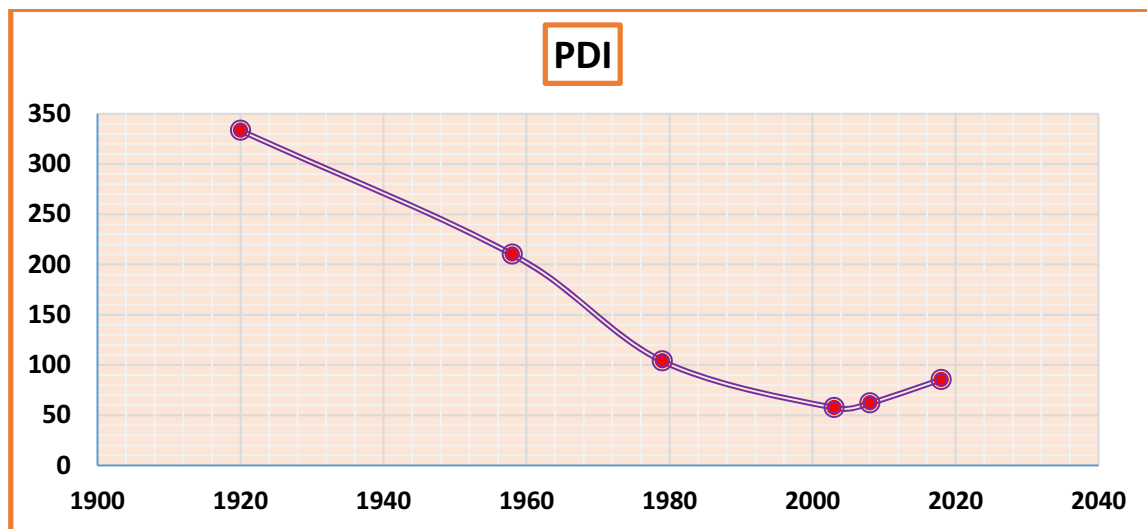
#### 4.3. Population Density Index:

That this indicator be critical also in the analysis of space-time for urban transport, this replicates the form and characteristics of growth of urban facilities, transportation system effectiveness, the Many of the Urban Studies calculated the population density from the total number of populations in Urban to the urban area, accordingly, calculates the index population density by the following equation:

$$PDI_t = \frac{P_t}{U_t}$$

**Table 3.** PDI and Population Growth of Diwaniyah from 1920 to 2018

Year	Population	Change	Rate %	Urban	PDI (P/ha)
1920	5333	-----	-----	16	333.31
1958	35038	29705	4.8	166.8	210.06
1979	127413	92375	6.1	1227.27	103.82
2003	298674	171261	2.6	5200	57.44
2008	331600	32926	2.8	5345	62.04
2018	537285	205685	3	6285.84	85.48

**Figure 6.** PDI of Diwaniyah

#### 4.4. Transportation Infrastructure expansion Index

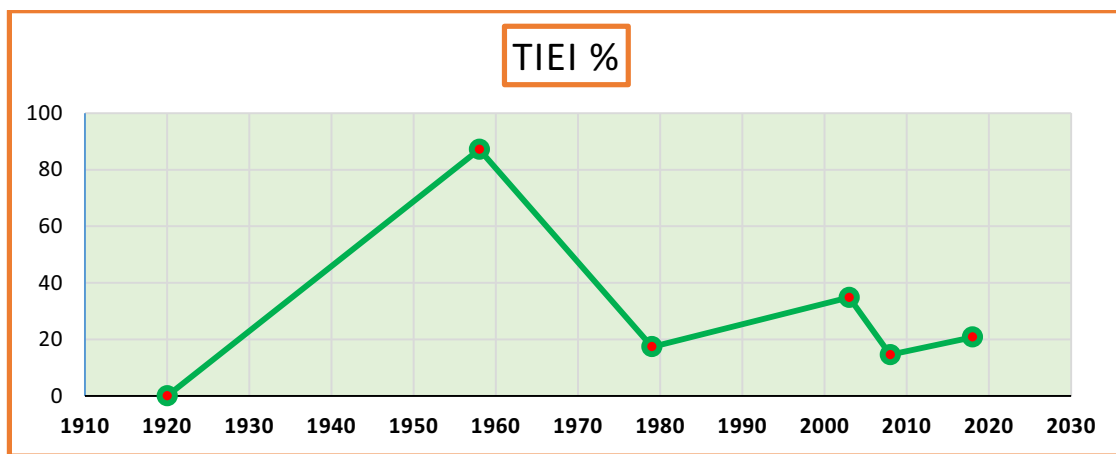
If this indicator is designed to change the space-time in the transportation system, calculated through the extents of the infrastructure in kilometers, this is known as the index treatment of the following:

$$TIEI_t = \frac{(TIL_{l,t} - TIL_{l,t-1})}{(TIL_{l,t})} \times 100$$



**Table 4.** TIEI and Spatial-temporal Expansion of Diwaniyah from 1920 to 2018

Year	Road Length (km)	Change LR	TIEI %	Annual LR %
1920	25	----	-----	-----
1958	195	170	87.18	2.29
1979	236	41	17.37	0.83
2003	362	126	34.81	1.45
2008	423.68	61.68	14.56	2.91
2018	534.97	11.29	20.80	2.08

**Figure 7.** TIEI of Diwaniyah

#### 4.5. Road Density Index (by area and per capita):

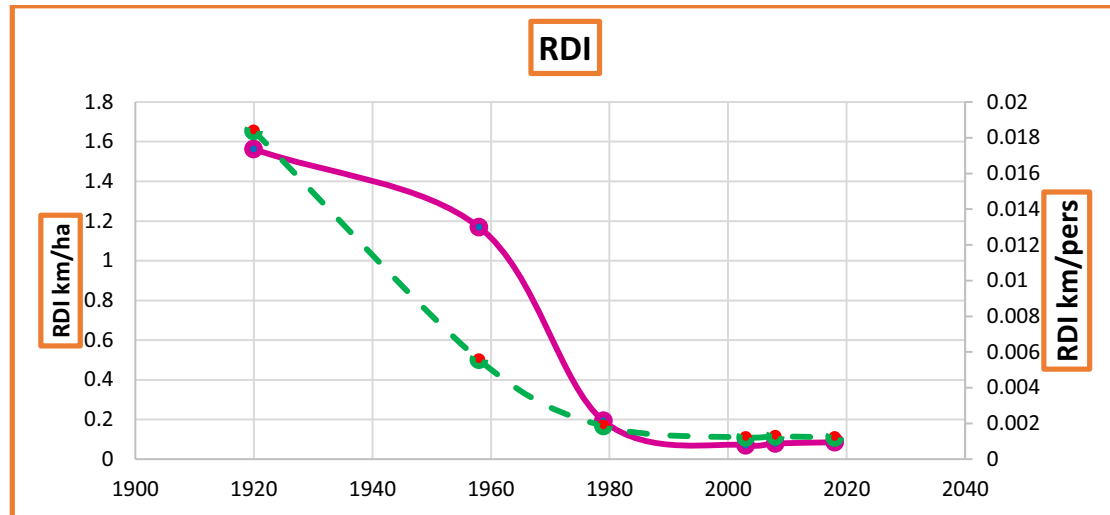
This indicator is calculated to chart the change in the transport infrastructure over time. It is calculated through the following transactions:

$$RDI\_A_t = \frac{RL_t}{UA_t}$$

$$RDI\_CAP_t = \frac{RL_t}{UP_t}$$

**Table 5.** Road Density Index of Diwaniyah from 1920 to 2018

Year	Road Length (km)	Population (person)	Urban Area (ha)	RDI (m/person)	RDI (m/ha)
1920	25	5333	16	0.005	1.563
1958	195	35038	166.8	0.006	1.169
1979	236	127413	1227.27	0.002	0.192
2003	362	298674	5200	0.001	0.070
2008	423.68	331600	5345	0.001	0.079
2018	534.97	442533	6285.84	0.001	0.085



**Figure 8.** Road Density Index of Diwaniyah

#### 4.6. The Index of Road Area Density:

Developed this indicator to test the relationship of space-time between transport and urban transport this indicator imitates the proportion of transportation infrastructure to the urban area floor space roads total for the company through time, as well as expresses this index by the following transactions:

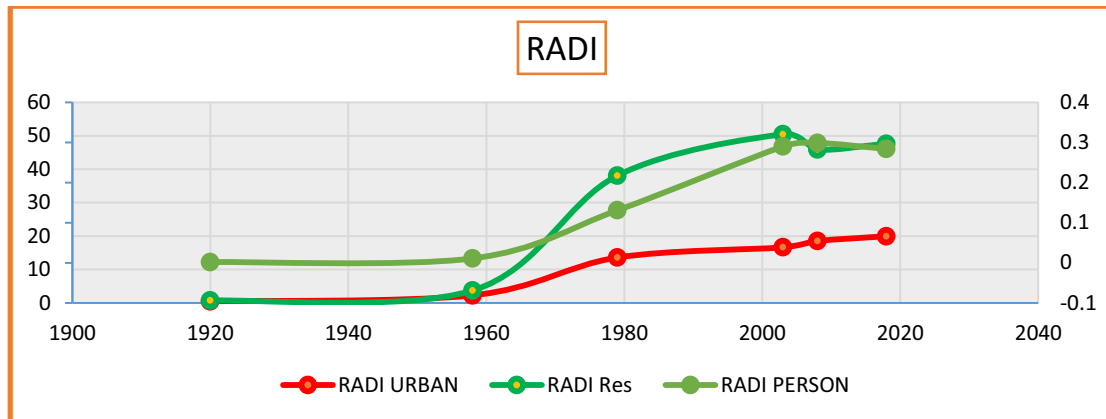
$$\text{RADI\_A}_t = \frac{\text{RA}_t}{\text{UA}_t} \times 100$$

$$\text{RADI\_CAP}_t = \frac{\text{RA}_t}{\text{UP}_t}$$

$$\text{RADI\_RES}_t = \frac{\text{RA}_t}{\text{URA}_t}$$

**Table 6.** Index of Road Area Density of Diwaniyah from 1920 to 2018

Year	Road Area (ha)	Urban Area (ha)	RDI %	Res. Area (ha)	RDI Res. %	Population (person)	RDI (m <sup>2</sup> /person) %
1920	0.08	16	0.5	11.1	0.721	5333	0.002
1958	3.80	166.8	2.278	102.2	3.718	35038	0.011
1979	166.75	1227.27	13.587	437.64	38.102	127413	0.131
2003	865	5200	16.635	1714	50.467	298674	0.290
2008	991.1	5345	18.543	2159.41	45.897	331600	0.299
2018	1255.02	6285.84	19.966	2635.21	47.625	442533	0.284



**Figure 9.** Index of Road Area Density (RADI) of Diwaniyah

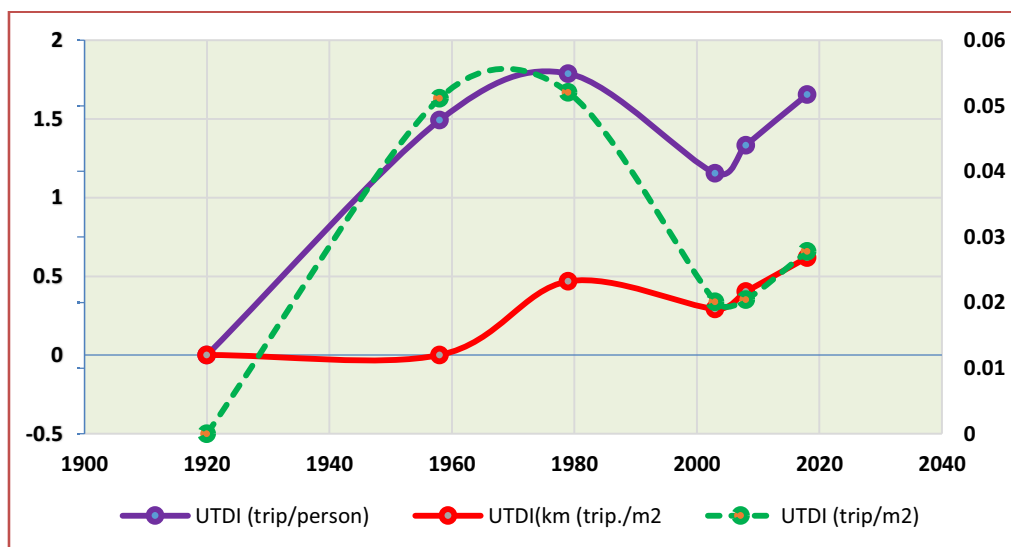
#### 4.7. The Index of Urban trip density:

Developed this indicator link to space-time. urban growth and urban transport, was intended to calculate the upturn in urban trips for the growth of population and expansion of residential space, as well as the total number of trips of urban proportion to the amount of mileage in travel, and illustrate through the following transactions:

$$UTDI\_CAP_t = \frac{UT_t}{UP_t}$$

$$UTDI\_RES_t = \frac{UT_t}{UAR_t}$$

$$UTDI\_RA_t = \frac{(DCT_t \times AVTL_t)}{(RA_t)}$$



**Figure 10.** Index of Urban trip density (UTDI) of Diwaniyah

**Table 7.** Index of Urban trip Density (UTDI) of Diwaniyah from 1920 to 2018

Year	Trips	Population	UTDI (trip/person)	Res. Area (trip/m <sup>2</sup> )	UTDI (trip/m <sup>2</sup> )	Road Area m <sup>2</sup>	Avg. trip Length (km)	daily car trip	UTDI (km tr./m <sup>2</sup> )
1920	0	5333	0	111000	0	800	0	0	0
1958	52271	35038	1.492	1022000	0.051	38000	0	0	0
1979	227828	127413	1.788	4376400	0.052	1667500	4.1	190324	0.468
2003	344989	298674	1.155	17140000	0.020	8650000	6.5	390388	0.293
2008	441945	331600	1.333	21594100	0.021	9911000	7.1	561982	0.403
2018	732118	442533	1.654	26352100	0.028	12550200	8.3	936554	0.619

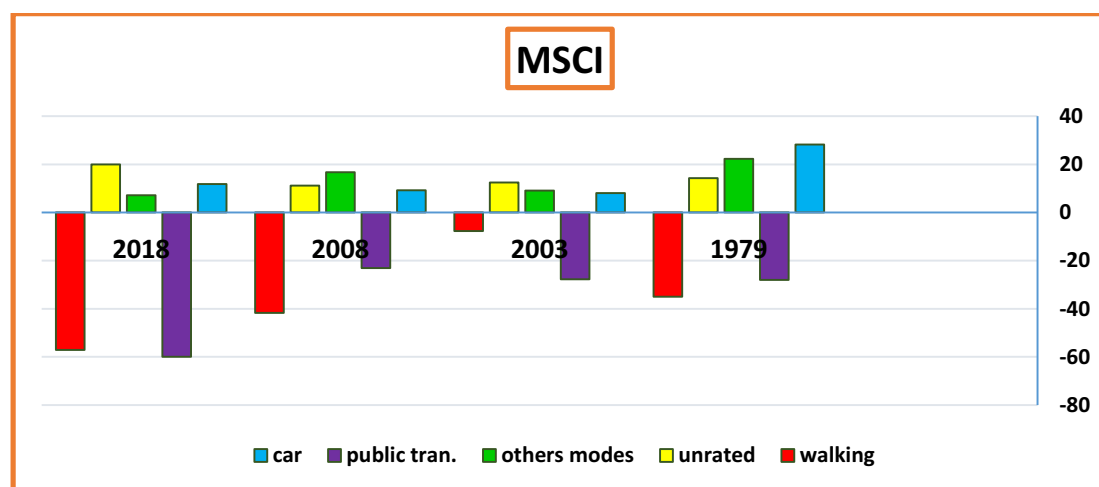
#### 4.8. The Index of Modal Split Change

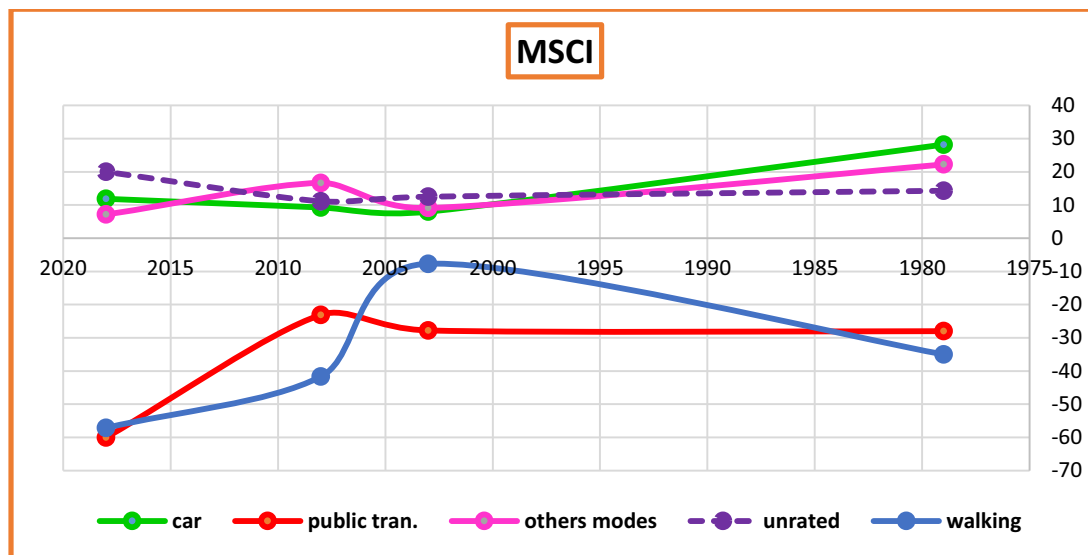
The (MSCI) was advanced to examine the result of spatial expansion on the modes over time and is articulated as follows:

$$MSCI_{a,t} = \frac{(DT_{a,t} - DT_{a,t-1})}{(DT_{a,t-1})} \times 100$$

**Table 8.** Modal Split Change Index of Diwaniyah from 1920 to 2018

Year	Total Daily Trips	Walking		Unrated		Other modes		Public Transport		Car	
		Change %	Share %	Change %	Share %	Change %	Share %	Change %	Share %	Change %	Share %
1920	0	0	0	0	0	0	0	0	0	0	0
1958	52271	0	20	0	7	0	9	0	25	0	39
1979	227828	-35	13	14.29	8	22.22	11	-28	18	28.21	50
2003	344989	-7.69	12	12.5	9	9.09	12	-27.78	13	8	54
2008	441945	-41.67	7	11.11	10	16.67	14	-23.08	10	9.26	59
2018	732118	-57.14	3	20	12	7.14	15	-60	4	11.86	66

**Figure 11.** Modal Split Change Index



**Figure 12.** Index of Urban trip density (UTDI) of Diwaniyah

### 5. The Argument

The expansion and land use change in Diwaniyah look to be catalyzed by the transportation structure and population growth has affected travel demand over time. In recitation “population growth and transportation structure expansion, three main gaps were clearly distinguished. Initially, from the period of 1920 to 1979, the population grew rapidly and then the transportation infrastructure rapidly expanded. From 1979 to 2003, the transportation infrastructure expansion abruptly dropped in evaluation with the steady decrease in population growth”.

### 6. The Assumption

Diwaniyah city, for the period 1920-2018, is expanded randomly in all directions but the major expansion was in the south and west of the city. Growth of Diwaniyah to the east direction is simpler (after the military zone was removed) than its growth to the west, and the east direction would never interfere with natural features. The other axes of Baqubah growth interfered with natural features (river or orchard). To evaluate spatial-temporal urban development and transportation changes are used eight urban development and transportation indices (ATIEI, AUSEI, LUCI, PDI, RDI, RADI, UTDI and MSCI). The results show that Diwaniyah takes experience quick population progress, a great spatial extension, fast changing land use and increasing transportation structure during the past times (1920-2018).

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