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The Engineering dimensions and its impact on the sustainability on the roads network in Ramadi city

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ABSTRACT

Transport is one of the most critical areas of urban life and an essential base for developing and developing societies. It is a crucial indicator of the progress and development of cities and their great benefits. It saves from the movement of people and goods and the prosperity of the economy-social, economic and environmental issues globally and what we are witnessing in recent times. However, despite the tremendous advancement in technology, it continues to face numerous challenges in developed and developing nations, including our own. The absorption of the irrigated volume and any defect in the gradient causes many problems such as congestion, delays, traffic jams and the accompanying psychological, economic, social and environmental effects, energy consumption, depletion of natural resources and lifestyle. So transportation has become a concern. And it became a topic of concern that imposes the need to think about the preparation and development of the transportation system towards sustainability based on meeting transportation needs. In light of the negative impacts of the sustainable planning engineering dimension on the urban road network in Ramadi and for the Iraqi cities, we have thus attempted to study the effect of this project, given the critical impact on sustainable development and the approach used by thinking people and scholars in their studies and documents in Agenda 2030. Through evaluating the data from the research region, which comprised 27 Ramadi neighbourhoods, and applying them to the statistical analysis software (SPSS), it discovers that the schematic engineering dimension indicator represented by the hierarchy has direct and decisive connection significance. The local road area index achieved the most substantial linear relationship, followed by the collective, secondary and major roads indicators. They reached a medium relationship to formulate a sustainable development system based on Ramadi and other Iraqi cities. A decision is making about sustainable urban engineering transportation. And take an approach with whatever is good for the state.

1. Introduction

The urban roads network is among the most widely used and essential urban planners and transportation engineers. The gradation of urban roads has become one of the most important basic principles adopted in drawing urban plans and the basic design of the city and road networks.

Suitability of the urban hierarchy of roads is necessary for the construction and organization of the city and its general environment, and the traffic requirements of the road (Abrahim, 2019).

The hierarchy aims to organize the street network to achieve flow, safety and security in the traffic. Therefore, it is a system for classifying the street network in the city based on determining the general function

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of the road and its specifications (Sahli, 2016) .

Roads categorize according to diversity, traffic, and purposes in several classifications for each country. The particular system in this arrangement has its components, names and standards, so the first factor to be determined is to determine the functional classification and the nature of the service that the road should provide. The basis for classifying urban roads varies from state to state, but the most general classification is by road width and traffic capacity.

There are several types of roads. The most widespread of them are according to the functional classification of urban streets. Each country has a particular system of functional classification with its components, names, and measures.

Functional classification is how roads divide into types or classes according to the nature of the service they perform. One of the fundamentals of this process is realizing that individual routes do not serve travel and transport in their independent mode service of great importance. It is, therefore, necessary to decide how we can direct traffic within the road network as a whole in an efficient manner, and herein lies the importance of the functional classification in which the role that each road plays in the service of traffic and transportation determine.

Kevin Lynch Paths define the paths in his book (The Mind Image) as the main channels of movement through which the city views (Filomena, Verstegen and Manley, 2019).

The classification theory is prepared and categorized from major to secondary, then aggregate and local arterioles. The larger the order of the road, the greater the number of traffic zones and the wide area, the quicker the cars on it, the more artificial barriers and intermediate islands separate the two sides, the few openings that lead to and connect off the road, and the few crossings of the road. The degrees of urban streets vary according to their areas, whether residential, commercial or residential, according to the total traffic that will arise from those serviced areas(Othman, 2008).

2. Previous Studies

2.1. By balancing the three main dimensions, local conditions for each country, they prepared a set of final indicators that consider turning to a participatory understanding of the local community and local government. ***(Hamid, 2015***).

2.2. As a result of the enormous preparation of visitors to Iraqi cities, the study addresses sustainability and transport. It uses evaluation methods to reach recent ways of transportation planning for suffering Iraqi cities, especially in holy cities, and pressure from the capacity of roads and transport***. (Ahmed and Wahab, 2015)***.

2.3. The research consists of two fundamental axes of the stimulant city, its indicators and the second sustainability study and its dimensions by applying the principles of sustainable urban format to achieve the mechanism for conducting the research hypothesis, which is the tasty city relationship with urban sustainability***(ALBazzaz and Omairy, 2016)***.

2.4 The city of Algeria suffers from unorganized urban growth, so he studied the reality of the traffic problems in Algeria at the level of transportation because it did not keep pace with and its integration with development lines and its analysis. Practical strategies to face urban transport challenges in light of sustainable development controls to evaluate transport performance***(Bouzidi, 2012)***.

2.5 Studying sustainability as one of the basic concepts for sustainable transport planning and achieving livable cities and analyzing various problems, including traditional issues that neglect the environmental impacts. The medina experience is considered one of the integrated experiences to achieve sustainable Transport ***(Al-Wahab, 2017)*.**

2.6 The study aimed to identify the importance of sustainable transport and how to benefit from it in the future and determine the extent of the urban transport response to intelligent transportation

systems and how it addresses the problems***(Al-Mashhadani, 2019)***.

2.7 This study examined British experience in sustainable urban coordination to accomplish the sustainability framework and extract indicators by way and corridors - South False Creek Trails - Burnaby Mountain Tracks - Coquitlam Riverwalk - East Clayton Trails & Lanes according to the topography of the region***(Lafah, 2014).***

2.8 The city of Sydney has adopted a long-term strategy (the target year 2031) that developed an integrated action plan for the transportation network by applying the foundations of sustainable development***.***

It made the citizen in the first place. It adopted to obtain sustainability, re-changing transportation methods, rely on pedestrians and public transport and create a clean, healthy environment and development. ***(Shaheen and Mohsen, 2019)***.

2.9 Germany is a guideline for sustainable mobility solutions and supports the transformation towards sustainability in developing and emerging countries that cannot create reliable transport. Germany is internationally playing a pioneering role in policy development and innovation. Environmentally friendly technologies. Hence, it offers many comprehensive solutions in the field of sustainable mobility and logistics services.

They analyzed the data to see how the schematic engineering dimension affects the urban road network, which means whether the urban road network hierarchical index meets the requirements of sustainable development that the study area reaches the sustainability of urban roads ***(Fremer,2015)***.

3. Urban Road Network and Sustainability are the Basic of Planning:

The urban road network in any area exceeds the degree of human progress under natural conditions and the road transport network that works to make the urban city an accessible place and the extent of technical progress in it (Al-Sahili 2016).

The network consists of two dimensions of length and width. Bypassing secondary and subsidiary centres, as well as essential public utility equipment such referendum centres and stations such as railroads, promotions, airports, schools and utility lines, the road network connects the various communities. There are unnecessary or essential lines, but they enable users to navigate through them easily, quickly and comfortably, facilitate social communication between individuals, and thus strengthen social relationships between individuals and strengthen social ties (Godiyah, 2017). Lines can also be arranged based on urban standards that relate to the study of road planning by choosing the means of transportation used, and according to the planning of roads and corridors, and urban lines that constitute and shape the basic urban structure (Mohammed, 2015). And as an engineering network that secures the movement of vehicles and goods according to the design specifications.

Sustainability is an essential pillar of development and upgrading the policy of any city to improve the level, whether it existed before or not, to suit the requirements of the modern era. Therefore, it is necessary to pay attention to the concept of sustainable development in terms of the origins of planning science and build an accurate information base to ensure the rights of future generations. We see that this principle does not exist in a sense. The real thing is that most development projects focus on the present only, and there is no information about future problems or any solutions to future problems. We have not come up with a solution to our current issues, let alone thought about solving problems expected to occur in the distant future. There are many examples of this; most road networks don't have a pedestrian or bike path, so don't think about it in the past. It has many benefits in keeping people, and the road service may change for any reason. Suppose planning took from a distant perspective. In that case, it will not cause many problems, and these problems do not occur due to giving the economic aspect precedence over the environmental or social aspect, not only. But also because of the government's inability to read the future accurately (Swillem, 2008).

Sustainability has several principles, and what is essential in these principles is uniformity, meaning that all sustainability principles must fulfil to reach a sustainable urban road network (Al-Obaidi and Dabdoub, 2018).

1- Correlation

2- Accessibility
3- Diversity and multiple uses of the land
4- Attraction
5- Rest
6- Safety
7- A social environment
8- Vitality

The engineering planning dimension of sustainability: Sustainable engineering adopts a multidisciplinary approach and integrates all fields in its practices to improve the lifestyle, reduce energy consumption, and do not endanger the environment or deplete natural resources. Sustainable development through their experiences requires modern technologies to enable them to develop comprehensive planning and the right move towards engineering sustainability paths.

All sustainability categories include guidelines that help the urban designer achieve sustainable urban coordination for the urban road network, as shown in table (1), the best example of the British experience due to its importance in achieving sustainability. Its concept emerged theoretically in 1990 AD and entered the application framework in 2000 AD in several European and American cities. The application in Arab towns was limited or utterly non-existent because an urban design did not develop at the level of coordination (Lafah, Consulate and Hussein, 2014).

1-Green infrastructure (environmentally friendly)

2-Mobility

3-Social structure

4-Cost

Table 1. Sustainability dimensions, categories and indicators for the urban road network

Dimension of sustainability	The description	Main indicators	Secondary indicators	Impact
engineering	Preserving the road structure	Road network	Hierarchy	Integrated

4. Research Methodology

The analytical approach based on final, quantitative and qualitative data analysis methods using the statistical program according to the urban road network area represents the main factor in determining transport and urban development and a set of measurable indicators by obtaining the highest value for the hand-to-hand relationship. Transport adopt as an independent indicator (Y), and the geometric dimension indicators represented by the hierarchy of methods represent the variable indicators (X1, X2, X3 ....). For the analysis, the study area will be divided according to the neighbourhoods of the city of Ramadi, as it is the urban city centre in the governorate. The data was obtained by relying on the data of government departments and some variables obtained through the GIS program. The Ramadi Municipality Directorate provided us with a satellite image of the city of Ramadi for the year 2020.

The study hypothesis implies that the total area of the urban road network is directly related to the geometric dimension indicators since the full size of the urban road network is a kind of urban road and one of the components of urban area road design. The city, and since urban transport indicators support its sustainable development, we conclude that the total area of the urban road network, urban roads and related transport factors impact the sustainability that directly links it, and this will be analyzed and questioned. Use of multiple variables with what we want to obtain and demonstrate the accessibility of urban modelling to understand the interrelationship between the urban system structure and its environment. It is expressed in urban mobility, using the urban road network area model. And provide feedback to correct, improve or update urban models before moving to the construction phase, apply them now and predict the future.

After data collection and analysis using the multiple linear regression method in the SPSS statistical analysis software, four indicators were obtained as shown in the correlation table (4) and tested by the ANOVA method. What was confirmed was test by the T-test method. The calculated values of T are less than the probability value of T. Therefore, we accept the null hypothesis of sufficient claim. (Jibril, 2020).

5. Indicators of the Sustainable Engineering Planning Dimension

Engineering Dimension indicators are an integral concept involving all systems and connecting them to the components of sustainability while at the same time applying mathematical and scientific principles to use resources to enhance economic development efficiencies, environmental factors and the well-being of society. Importance for the profession of engineering and the world we live in "Engineers are still trying to understand how the concept of sustainability fits into our profession." From this saying, we can say that we can understand the engineering dimension through the development of equations, from which the current reality can improve according to planning standards. One of the essential engineering dimensions that we will address is one of the vital problems cities suffer from the hierarchy due to the increase in urban growth and the technological revolution that accompanies the transport sector.

Several systems followed classification roads differ from one country to another according to the location of the streets, ownership in some countries, and the network's topography. In the study area, the functional classification system was relied on according to road width, which is the most general classification. The unique design in this classification has its components, names and standards, as shown in tables (2) and (3). The road area index took length according to their category distributed over the neighbourhoods of the study area.

Table 2. criteria of road lengths according to a hierarchy (Al-Jameel and Abd Abas, 2017); (Meyer et al. l, 2016)

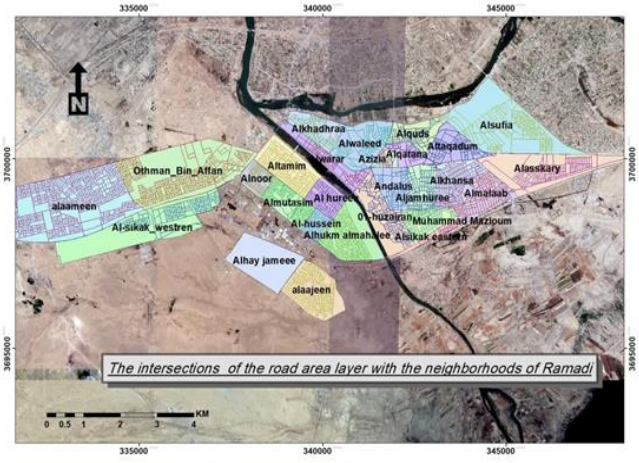
Road classification	The percentage of the length of the road
Major arterial routes	2 - 4%
Major arterial routes plus secondary	6 - 12%
Collective road system	20-25%
Local road system	65 - 75 %

Table 3. standards of The width of the road lane on urban roads according to road classification

Road classification	The width of the road lane on urban roads(m)	
	The lowest	Preferred value
Local road	2.75	3.6
Collective road	3.0	3.6
arterial road	3.0	3.6

6. Description of the study area

The location of Ramadi determine in the western part of Iraq at the intersection of longitude (43°-20'), (43°- 12') east and latitude (33°-27'),(33° – 23') north. The area of Ramadi is 318088 km2, while the borders of the urban neighbourhood locat in Ramadi (7375 hectares). The city locations are in the southeastern part of Anbar Governorate, and the Euphrates River passes through it. This city is an important administrative and urban centre for Anbar Governorate. It surrounds by Jazira in the north (Ramadi Island), Habbaniyah Lac to the south, Hasbah to the



east, and Rutba to the west. Baghdad, the capital of Iraq, is around 120 miles distant, Fallujah is 45 km, Heet 60 km, Haditha is about 160 km, and Al-Qaim is about 300 kilometres (Al-Issawi, 2019). The central and administrative importance of the city has become an important place for the circulation of activities between neighbourhoods and the gathering of many important government agencies. Institutions that gave it local importance directly contributed to the development and urban growth of the city as shows in Figure 1.

Figure 1. Spatial distribution of Ramadi neighbourhoods

7. Stages and steps of quantitative analysis

1- Data extraction by geographic information systems program
2- Obtaining data from government departments such as the satellite image for the year 2020 and the basic design of the port for the year 2019 as shows in Figure 2, and field surveys
3- Collecting data and extracting indicators according to scientific references, which numbered four indicators
4- Inserting data into the statistical program SPSS was in 6 stages.

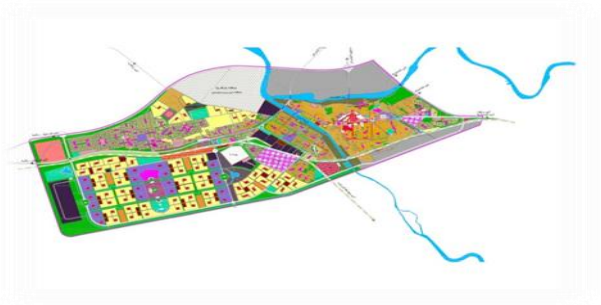


Figure 2. The basic design of Ramadi City,2019

7-1 The first stage

Entering the data and inserting it into the statistical program, we analyze and instruct the correlation to show the correlation value that 11 transportation indicators have been linked with the total road area indicator, as shown in the message's attachment.

7-2 The second stage

Please enter the data, insert it into the statistical program, and then analyze, and from there to the curve estimation, a list appears. We put the total path area in the y square and the x square. We start placing the variables one by one to obtain the variables associated with the independent variable y, which appeared in four indicators as shows in Table 4.

Table4 Correlation coefficient values

indicators	Correlation Coefficient R^2 Adjusted	The degree of correlation
The local road area index	.663	Medium correlation
The collective road	.617	Medium

area Index		correlation
The secondary road area indicator	.668	Medium correlation
The major road area	.851	Strong correlation

7-3 The third stage

After extracting the indicators related to the independent Variable, we make a statistical test for their importance to address the concept of decision-making based on the sample data by examining the T-test. After that, we perform the analysis and then the written instructions.

7-4 The fourth stage(t-test)

In this stage, a test of the relevant indicators is doing by statistical analysis of the T-test. As shown in the tables, the values of t computed are less than the value of probability t. Therefore, we accept the null hypothesis of sufficient claim. Each indicator has a table for the T-test, as described in the indicators section.

7-5 The fifth stage (Interpretation of results)

In this stage, the results are interpreting according to what appeared. We explained the details of each indicator in the previous, which indicates the existence of positive relationships and highly significant associations between the urban total area index. Road network and transportation indicators. Which four variables in terms of number.

The results will be interpreting by the measure of dispersion most used in statistics because it has very high precision in the lower the value of the standard deviation. The closer the data is to the expected value, the higher the normal deviation value, the more information is from the expected value. Table 5 below shows the standard deviation of the transport indicators.

Table5 descriptive Statistics

Hierarchy	Std. Deviation
Total road area	4.16071
Local road area	4.13703
Collective road area	4.30078
Secondary road area	5.68055
Main road area	6.20872

7-6 Sixth stage: building the model

After implementing the above five stages, road and transport engineers and urban planners tend to build and implement a spatial network model with high accuracy and conduct an evaluation to give positive results in sustainability to develop and improve the efficiency of the urban road network. After extracting the equations for each of the dimensions related to building the general model using multiple linear regression analysis in the SPSS program.

8. Results

8-1 The local road area index

The linear equation founded between the local road area index (V1) and the total road area (Y) and Table (6) (model summary) shows the correlation coefficient between them.

The dependent Variable (Y) and the independent Variable (V1) are equal to (R = 0.822). The square of the correlation coefficient (R2 = 0.676) the adjusted Square R = 0.663 and the analysis of variance to test the significance of the regression and the most significant value is (0.00) less than 0.05.

These indicate that the dependent Variable with the independent Variable has a statistically meaningful connection.

Table 6 model summary of the local road area index

R	R Square	Adjusted R Square	F	Sig.	Mean	Std. Deviation	Variance
.822	.676	.663	52.245	.000	3.7030	4.13703	17.115

8-2 The collective Road area Index

The linear equation founds between the collective road area index (V2) and the total road area index (Y) and Table (7) (model summary) shows the correlation coefficient between them.

The dependent Variable (Y) and the independent Variable (V2) equals (R = 0.795), and the square of the correlation coefficient (R2 = 0.631). The modified square R = 0.617 and illustrates the analysis of variance to test the significance of the

regression, and the essential value is Significant. It is (0.00) less than 0.05. These indicate that between the dependent Variable and the independent one, there is a statistically significant link.

Table 7 model summary of the collective road area index

R	R Square	Adjusted R Square	F	Sig.	Mean	Std. Deviation	Variance
.795	.631	.617	42.821	.000	3.7030	4.30078	18.497

8-3 The secondary road area index

The linear equation founds between the secondary road area index (V3) and the road network density for population (Y), and Table (8) (a summary of the model) shows the correlation coefficient between them.

The dependent Variable and the independent Variable are equal to (R = 0.825) and the square of the correlation coefficient (R2 = 0.681). The adjusted Square R = 0.668 and the analysis of variance to test the significance of the regression and the most significant value is Sig. It is (0.00) less than 0.05. These imply that the dependent and independent variables have a statistically significant connection.

Table 8 model summary of the secondary road area index

R	R Square	Adjusted R Square	F	Sig.	Mean	Std. Deviation	Variance
.825	.681	.668	53.426	.000	3.7041	5.68055	32.269

8-4 The Main road area indicator

The linear equation found between the main road area index (V4) and the total road area index (Y) and Table. (9) (model summary) shows the correlation coefficient between them.

The dependent Variable and the independent variable equals (R = 0.825) and the square of the correlation coefficient (R2 = 0.681). The modified square R = 0.668 and the analysis of variance to test the significance of the regression and the essential value is Significant. It is (0.00) less than 0.05. These denote that the dependent and independent variables have such a statistically significant connection.

Table 9 model summary of the main road area index

R	R Square	Adjusted R Square	F	Sig.	Mean	Std. Deviation	Variance
.926	.857	.851	149.679	.000	3.7026	6.20872	38.548

9. Building of the Model

After the indicators extract and the five stages of statistical analysis perform on them, we are now building a model of the engineering design dimension, and it appeared as follows.

The linear equation found between the engineering design dimension indicators (V1, V2, V3 and V4) and the total road area index (Y), and Table (18) (model summary) shows the correlation coefficient between them.

The dependent Variable and the independent variable equals (R = 0.998) and the square of the correlation coefficient (R2 = 0.995). The modified square R = 0.993 and the analysis of variance to test the significance of the regression and the essential value is significant (0.00) less than 0.05.

These mean a statistically significant relationship between the dependent Variable and the independent Variable, as shown in the tables below and Figures (3, 4, 5).

Table 10 model summary of the indicators

R	R Square	Adjusted R Square	F	Sig.
.822	.676	.663	52.245	.000

Through Table. (11) (coefficients), we note that the effect is proportional to the overall road area index

and the engineering design dimension indicators as shown in the regression line equation No.

Table 11 cofficient of the indicators

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.352	.117		3.015	.007
V1	.154	.045	.153	3.406	.003
V2	.172	.042	.178	4.079	.001
V3	.156	.028	.213	5.555	.000
V4	.378	.022	.564	17.304	.000

Therefore, the equation becomes

$$Y = 0.352 + 0.154V_1 + 0.172V_2 + 0.156V_3 + 0.378V_4$$

Figure (3) Normal P-P Plot of Regression Standardized Residual

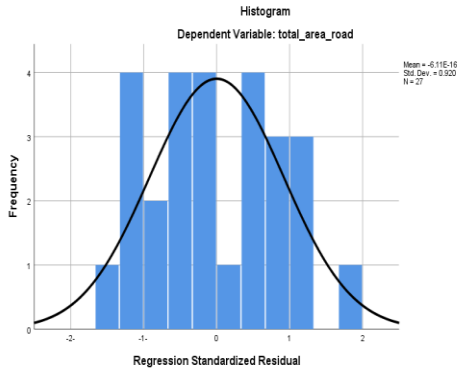


Figure (4) Regression Standardized Residual

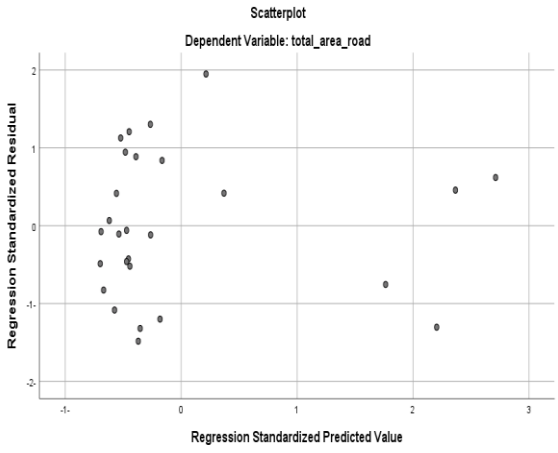
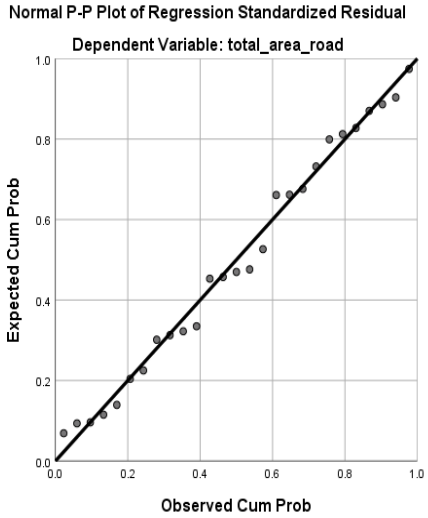


Figure (5) Scatter plot

These tables(10,11) and figures (3,4.5) contain the measures that appeared in the multiple linear regression analysis, and the estimated model calculates, and the evaluation performed through it.

An equation represents the linear relationship between the engineering planning dimension indicators that achieved a significant correlation in the first stage: four indicators and the total area of the urban road network.

1. The analysis of (multiple linear regression) and Table No. (11) shows that the coefficient of determination is an indicator of the validity and quality of the model and depends on the significant value if it is less than 0.005 and the most important value. Is significant = 0.000 (less than 0.005). The coefficient of determination for this relationship is equal to



(R = 0.998) and, in turn, indicates the validity and quality of the model

2. The multiple correlation coefficient indicates the strength of the relationship between the dependent and independent Variable, which in turn suggests the quality of the model, the square of the correlation coefficient (R2 = 0.995) and the square of the correlation coefficient for the rate R = (0.993), which in turn indicates the quality of the successful model.

3. The ANOVA table shows the analysis of variance for the most important regression test,

and the essential value is significant. = 0.000 (less than 0.005), Therefore, we will reject the null hypothesis and accept the alternative idea that the regression is essential and therefore, there is a significant relationship between the dependent Variable and the independent Variable

4. A t-test perform to confirm the hypothesis, and the calculated value of t appeared to be greater than the tabular value, and the significant significance value was greater than 5. Therefore, the null hypothesis was accepted and that the

average mean of the engineering planning dimension is sufficient for the claim .

10. Conclusions:

The study conclusions indicate that the engineering planning dimension significantly impacts the urban road network and contributes to sustainability.

And Ramadi is an urban city characterized by an urban road network, so it is possible to apply sustainability principles. The study proved a close correlation between the total area of the urban road network and the hierarchy. Although some neighbourhoods have achieved sustainability for the city by matching design standards, some parts of the city led to an imbalance in the transportation system and a loss of sustainability in parts of the road network Urban area.

11. Recommendations

To arrive at the most efficient, suitable, and suitable designs, it must provide access to sustainable engineering and a sustainable engineering road network; it is necessary to have specialists present to analyze and apply them in a manner that is appropriate for each case. These recommendations update to keep up with changes in development, social and environmental conditions, and planning requirements.

1- Commitment to developing a structural plan for the urban road network according to the hierarchy, taking into account the existing road network and securing permeable road network , interconnected and compatible with the topographical situation.

2- Developing traffic centres by linking them to mobile networks using fifth-generation technology and linking them to cameras to facilitate traffic, regulate traffic and reduce congestion.

3- . The integrated design of the movement network is required to enable flexibility and freedom of choice of modes of transportation, such as tuk-tuks or tripe in all nations represented, re-designing and enforcing the relevant regulations.

4- Preparing roads that need rehabilitation

5- Working with distance standards between services to reduce the volume of trips

6- Integrated planning through the uses of mixing to encourage walking and availability of services, reduce transportation, and provide a clean environment free from wear and tear and energy

7- Developing sustainable urban transport and energy systems, exemplified by public Transport and non-motorized Transport

8- Preferring public transportation to reach different areas with a paid system and providing stops on bus lines to encourage citizens to use public transportation

12- Allocating unique means of transportation for employees and workers in state departments

13- The use of economic standards by managing the demand for transportation systems through the charging of tolls on roads, parking lots and vehicles.

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