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Feasibility Study for Ring Roads in the Southern Part of Najaf Governorate

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Abstract

The main justifications for the research are related to solving the traffic congestion in the city due to the increasing number of cars, the natural annual growth, and the great importance of the city of Najaf as a city of tourist attraction. Therefore, it has become necessary to study the feasibility of establishing multiple projects for ring roads, this research aims to evaluate the traffic characteristics of the ring roads and the main road network associated with it and to propose the construction of new ring roads according to the city's need to address traffic congestion within the scope of sustainability in the city of Najaf.

The research reached a set of conclusions, the most important of which was that establishing allied roads in the city of Najaf achieves economic feasibility, as the criteria used in the evaluation achieved good results, such as the payback period, net present value, and payback period. As for the most important recommendations, they were: the researchers recommend that the concerned authorities, especially the Civil Administration of Najaf Governorate, the Roads and Bridges Directorate in the city, and the Traffic Directorate, develop a five-year plan that includes the construction of new bridges to achieve the goal of reaching thirty ring roads during this period in addition to the current roads.

Keywords: Feasibility Studies, Project Evaluation, Ring Roads, Road engineering.

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1. Introduction

The urban traffic system is a fundamental component of the urban socio-economic system, and its sustainable development is a crucial prerequisite for supporting sustainable urban development. Sustainable development encompasses all aspects of planning, constructing, operating, and managing the urban traffic system [1]. Urbanization emerged as a significant economic and social phenomenon during the 20th century. The urban population worldwide

has grown substantially since 1950, doubling in size to approximately 4.2 billion individuals by 2018. This represents about 55.2% of the global population [2]. The ongoing transformation is expected to continue into the latter part of the 21st century, as evidenced by the increasing size of urban areas and the rising percentage of individuals residing in urban regions. It is projected that by 2050, approximately 70% of the world's population will move to urban areas, resulting in an urban population of around 6.4 billion individuals. Cities play a significant role in shaping national economic output, serving as primary centers for production, distribution, and consumption activities [2].

There has been considerable expansion in the road network over the past two decades. The total road network in Iraq, including main and secondary paved and unpaved roads, as well as all other paved roads in the country, reached 58,592 square kilometers in 2018, according to the latest report from the Iraqi Ministry of Planning and the Central Statistical Organization (2022). Additionally, with the expansion of the road network, the number of vehicles has significantly increased. In Iraq, according to the Central Statistical Organization, the total number of cars was 6,110,859 in 2016 and 7,026,106 vehicles in 2020. However, transportation does not always have a positive impact; it can also have negative effects, leading to traffic congestion, increased travel time, and financial and environmental impacts such as vehicle emissions and noise [3].

Recurrent congestion refers to traffic congestion that arises due to reduced street capacity during periods of high demand, typically during peak hours. Conversely, non-recurrent congestion usually results from unexpected events such as adverse weather conditions or road repairs and can even be attributed to vehicle accidents [4]. This reflects adaptation to the demands of contemporary life. Studying urban street networks and aligning them with current and future human needs is vital. Effective integration between various functional areas within a modern urban environment requires appropriate connectivity between residential, commercial, and service areas. This includes the use of advanced transportation systems that are compatible with the demands of current lifestyles and existing networks [4].

On the other hand, cities today face heavy traffic. The city of Najaf al-Ashraf suffers from traffic congestion in several parts of its road network, and ring roads help alleviate traffic congestion in urban centers by providing alternative routes for vehicles. Additionally, ring roads redirect unwanted traffic, such as through goods, away from the city center to reduce congestion. Ring roads significantly impact urban planning by encouraging urban sprawl and facilitating expansion. Therefore [5], many local city administrations seek to study the feasibility of constructing ring roads and the economic benefits they could provide to the local government and road users alike [6].

2. Related Literature

2.1. Ring road

Constructing ring roads is a conventional method to alleviate urban traffic congestion and improve road capacity. Nevertheless, this method tends to be inefficient in the long run because of induced traffic, which refers to the additional traffic volume created by constructing new ring roads. These newly built roads become appealing to drivers, leading to a progressive rise

in traffic congestion on them over time. The primary objective of several global solutions to alleviate traffic congestion is to minimize the duration of a motorist's travel time. As to traffic experts, the approach to ease traffic congestion involves enhancing the capacity of highways via the construction of ring roads and the expansion of existing roadways. Constructing or expanding ring road networks is an often-used approach to mitigate the issue of traffic congestion.

The implementation of ring roads is a commonly used strategy for reducing traffic congestion in urban regions by increasing road capacity [7]. Urban ring roads belong into the classification of roads that are particularly susceptible to congestion phenomena due to the limited financial capacity of public governments to undertake the necessary development and construction of new highways. Hence, it is imperative to implement interventions that improve the capacity of current infrastructures while minimizing costs [8]. The construction of a ring road has a direct influence on the development of new residential complexes. The building of new housing complexes can have different effects. The lack of proper spatial planning in the layout of urban areas can lead to an increase in the road network load within housing complexes in major cities [9].

2.2. The importance of the ring road

Several factors make ring roads clearly important in improving the urban road network in cities [10], as explained below.

- **Traffic management**

Ring roads help in diverting through-traffic away from the city center, reducing congestion in the urban core. This improves overall traffic flow and reduces the time commuters spend in traffic jams.

- **Connectivity**

Ring roads connect different parts of the city, making it easier for people to travel between neighborhoods and districts. This improved connectivity enhances accessibility and fosters economic and social interactions.

- **Bypass for through-traffic**

Ring roads act as a bypass for vehicles not intending to stop in the city. This reduces the number of vehicles passing through the central business district, leading to less congestion, improved air quality, and a more pedestrian-friendly city center.

- **Cargo transportation**

Ring roads are often designed to accommodate heavy vehicles, facilitating the efficient movement of goods and cargo around the city. This is essential for supporting economic activities and ensuring the timely delivery of goods.

- **Emergency services access**

Ring roads provide emergency services, such as ambulances and fire trucks, with quicker and unobstructed access to various parts of the city. This is critical for responding promptly to

emergencies.

- **Facilitation of urban expansion**

Ring roads can serve as a boundary for urban expansion. They help manage and guide the growth of the city, preventing unchecked sprawl and ensuring a more organized development pattern.

- **Reduction of local traffic**

By offering an alternative route for through-traffic, ring roads help decrease congestion on local roads within neighborhoods. This contributes to a quieter and safer environment for residents.

- **Improvement of public transport efficiency**

Ring roads can enhance the efficiency of public transportation by providing express bus services or dedicated lanes, allowing faster movement of buses through the city.

- **Enhancement of property values**

Well-designed ring roads can contribute to increased property values in certain areas by improving accessibility and reducing commute times, making those neighborhoods more attractive to residents and businesses.

- **Tourism and commerce**

Ring roads that connect key tourist destinations or commercial areas can boost local tourism and commerce by making it easier for visitors to navigate the city and access various attractions.

2.3. Challenges of ring roads

Among the most prominent challenges facing the implementation and expansion of ring roads are described below [9]:

1- The issue of designing and building ring roads. The primary obstacle faced in the design and construction of ring roads is the issue of acquiring land. Concurrently, the land acquisition procedure cannot be completed due to the government's inadequate financial assistance. Therefore, the process happens simultaneously with the expansion of the town. As a result, there are still several incomplete ring road connections and development projects. A further difficulty comes while constructing a section of the new ring road in heavily populated areas. Upgrading the current roads to satisfy the specifications of the proposed ring road in this scenario poses a significant challenge.

2- One issue that arises is the need for more adherence and consistent implementation of rules. The leading cause of several issues on the ring road is the failure to comply with established regulations. The construction of the ring road should be implemented as a toll road, given its paramount importance as the main thoroughfare, even though this is not the prevailing practice in most localities. The toll-free circular highway poses several issues due to its direct linkage with residential complexes and communities. Moreover, the rapid expansion of

housing complexes and communities will lead to a rise in roadside barriers and infringements of territorial borders.

3- The subject of urban expansion and spatial arrangement. Suburban residential developments often arise after the installation of ring roads. At times, the unanticipated expansion of residential areas conflicts with spatial planning and local development goals. Many newly constructed residential areas are far from The Regional Activity Centre (RAC/PKW). This might lead to elevated transit fees and eventually result in gridlock on the ring road.

4- The issue of housing growth and the accompanying facilities. After the new ring road placement plan was widely distributed, developers enthusiastically took advantage of the chance to purchase property along the new ring road. This circumstance could influence the expansion of metropolitan areas and the development of dwellings without proper regulations. The lack of sufficient urban planning and uncontrolled growth of residential construction has resulted in the inefficiency of public facilities. Furthermore, it has been shown that several developers are obligated to provide public amenities as stipulated by settlement laws. Moreover, studies have shown that several residential structures near ring roads either need additional road access or, while already there, want further enhancements.

5- The challenge of attaining simultaneous collaboration between institutions and regulations. Inadequate cooperation across organizations and entities might result in complications when providing building permits. There are several persistent issues with the authorization for constructing the ring road at different locations. The process of acquiring land for a ring road is made more complex due to the need to obtain a building permit, also known as an IMB. It has been determined that the network of roadways overlaps many administrative boundaries. Local authorities must cooperate to meet this requirement. It is recommended to align development regulations with a particular focus on enforcing uniform space restrictions in areas bordering the ring road.

6- One environmental challenge of combining a ring road with expanding communities is the impact on the ecosystem. The presence of ring roads and the nearby towns might adversely affect the ecosystem. When formulating a strategy for a circular itinerary, it is crucial to consider this circumstance from the outset. Efficient urban planning is essential for the growth of residential areas to guarantee a pleasant and suitable living environment. At times, slum settlements may be seen around ring roads, which reduces the attractiveness of the surrounding region. Urgent measures need to be implemented to stop the expansion of slum communities, and the surrounding area should be reorganized.

2.4. Description of the study area

Najaf is a governorate located in central Iraq. It is located 161 kilometers southwest of Baghdad, the capital of Iraq. Najaf is located on the edge of the western plateau. It is located 50 meters above sea level. It is about 80 km from Karbala and adjacent to the Bahr al-Najaf depression from the north and northeast, respectively. The city's coordinates lie between latitude 32° 01' 33.38" north and longitude 44° 20' 46.50" east, City population (2019 estimate): 795,700; Population of the governorate: 1,510,338. It is also a flat area extending from the

Euphrates River in the northeast to the Saudi border in the southwest. Desert dominates the terrain, especially near and towards the Saudi border, except in areas near the river [11]. Religious, social, and economic activities, such as holy shrines, places of worship, cemeteries, shopping malls, schools, and universities, have significantly increased traffic demand and thus affected traffic flow, especially during peak hours. The subject of this research relates to the main ring road that starts from Abu Al-Fadl (Al-Radawiya) Bridges, the connecting point between the city of Najaf and the southern governorates, passing through Al-Diwaniyah Governorate and Al-Manathira Street - Najaf. It extends towards the northern direction of the town. It ultimately intersects with the Najaf-Karbala highway at the Shuhada Bridge, the connecting point between the city of Najaf and the governorates of the north. This part represents the eastern axis of the road and then connects to the western axis, which begins with the Shuhada Bridge and ends with the Abu Al-Fadl Bridges. The study area also includes the main and arterial roads linked to the ring road within the urban road network in Najaf, Table (1) comprehensively describes the methods used, including specific details. The study area, represented by the main ring road with its eastern and western parts and the 10 main arterial roads connected to it in the urban area, embodies the data collection.

Table (1) Details of urban roads in the study area.

No.	Name of street	Length (km)
1	Eastern Ring Road	16.8
2	Western Ring Road	29.37
3	Al - Manathira Street	5.8
4	Najaf- Karbala Street	18
5	Najaf-Kufa Street	8.5
6	Al-Hizam Street	3.9
7	Najaf-Baghdad Street	6.7
8	Al-Zaytoon Street	2.06
9	Al-Matar Street	4
10	Emad Sekr Complex Street	3.5
11	Al-Kafeel University Street	5
12	Al-Mujamaat Street	4.7

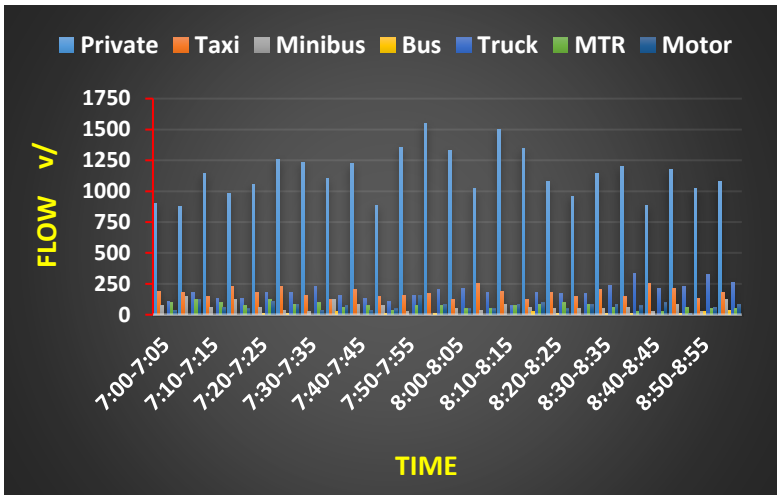
2.5. Ring Road users in Najaf

- Eastern Ring Road

The Eastern Ring Road extends from the Abu Al-Fadl Bridge (Al-Radawiya) to the Al-Shuhada Bridge. It passes through areas designated for educational, health, cultural and commercial activities, and Najaf International Airport at the station (3.35 km). Traffic flow rate data for the

directions of Street No. **1** were measured on Tuesday morning, corresponding to (12/12/2023) from (7:00 AM) to (9:00 AM), as shown in Figure (1).

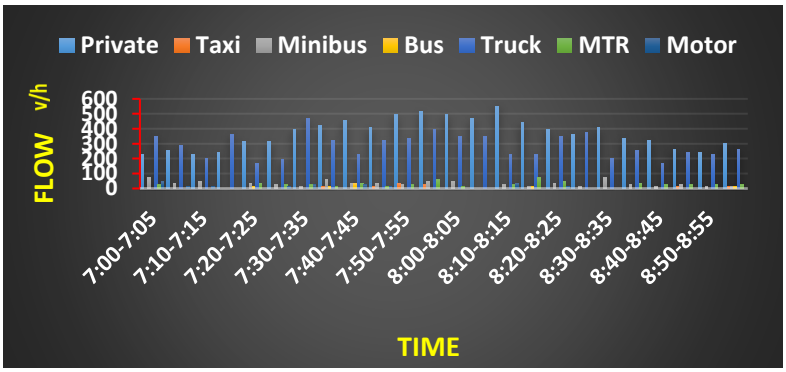
Figure (1) The flow rate for Eastern Ring Road (towards Al-Shuhada Bridge).



- Western Ring Road

The Western Ring Road extends from the Al-Shuhada Bridge to the Abu Al-Fadl Bridges (Al-Radawiyah) and extends along the Tar Al-Najaf area and the model cemetery in Wadi Al-Salam. Traffic flow rate data for the directions of Street No. **2** were measured on the morning of Tuesday (16/1/2024) from (7:00 AM) to (9:00 AM), as shown in Figure (2).

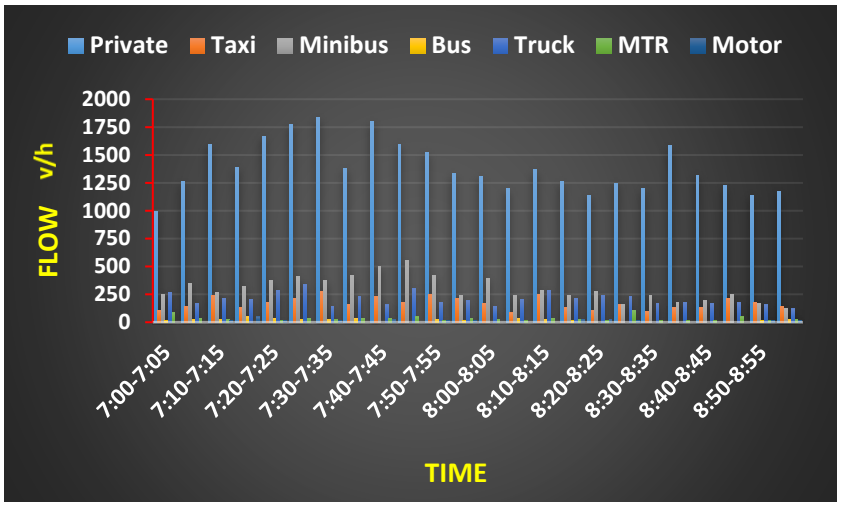
Figure (2) The flow rate for Western Ring Road (towards Abu Al-Fadl Bridges).



- Al - Manahira Street

Data were collected for Al - Manathira Street in the median area of the street Opposite Dar Al Samah gas station. The morning time was used to measure on Wednesday, January 17, 2024, starting from 7:00 until 9:00 A.M. Figure (3) show the traffic flow rate data for the directions of Street No.

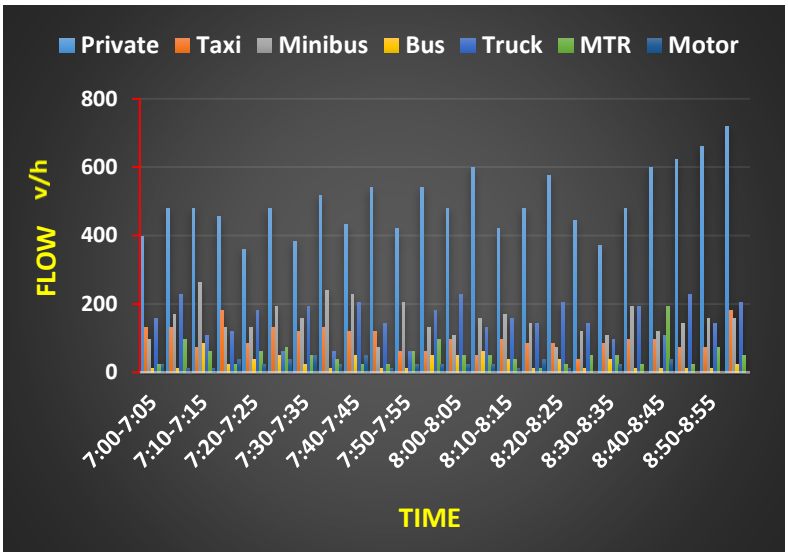
Figure (3) The flow rate for Al - Manathira Street (towards Al-Najaf).



- Najaf – Karbala Street

Collected from the median area of the street next to the Al-Shuhada Bridge. Comprehensive traffic flow rate data for Street No. **4**. The measurement was conducted on Thursday morning (18/1/2024) from 7:00 am to 9:00 A.M. As shown in Figure (4).

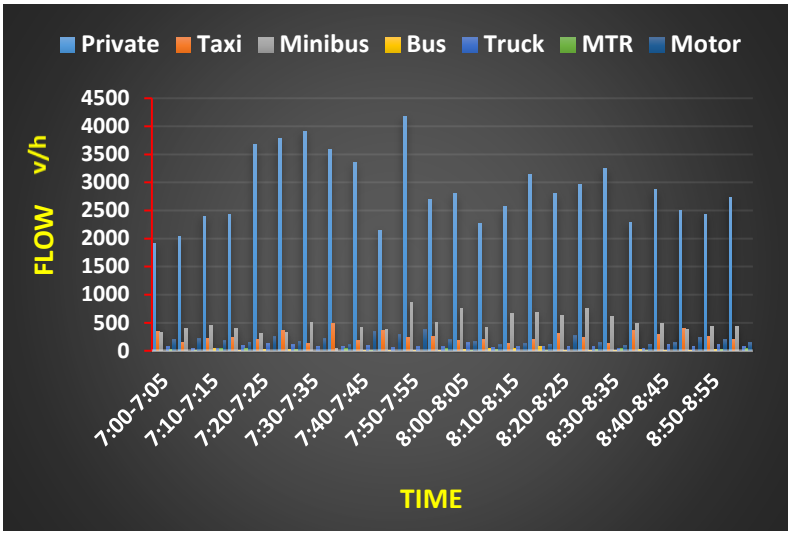
Figure (4) The flow rate for Najaf – Karbala Street (towards Al-Najaf).



- Najaf -Kufa Street

The road section within the study area begins at the Al-Sadr Roundabout and ends with the Al-Sadr Hospital Bridge, also known as the Kufa-Najaf Bridge. The measurement was conducted on Tuesday, January 19, 2024, during the first hours of the day, specifically from 7:00 A.M to 9:00 A.M. Figure (5) shows the total traffic flow rate data for Street No. **5**.

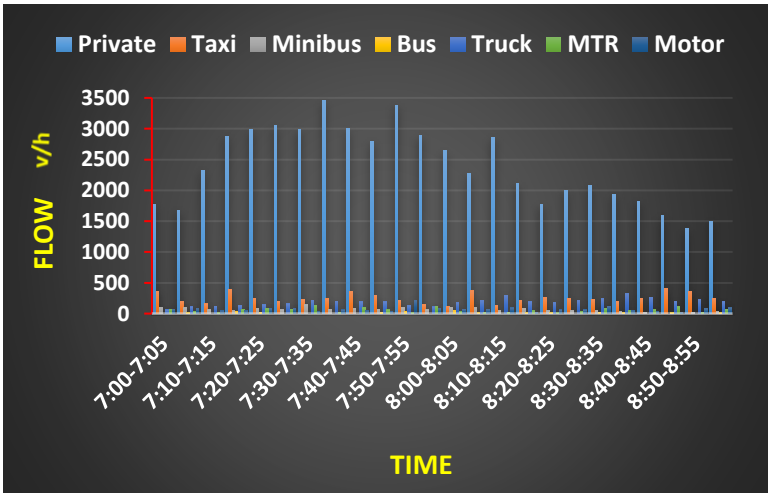
Figure (5) The flow rate for Najaf -Kufa Street.



- Al-Hizam Street

The data was measured on Wednesday, January 20, 2024, during the morning peak hours, specifically from 7.00 A.M to 9.00 A.M, extending from the A-l Easkariu tunnel towards the Eastern Ring Road. Figure (6) shows the total traffic flow rate data for Street No. **6**.

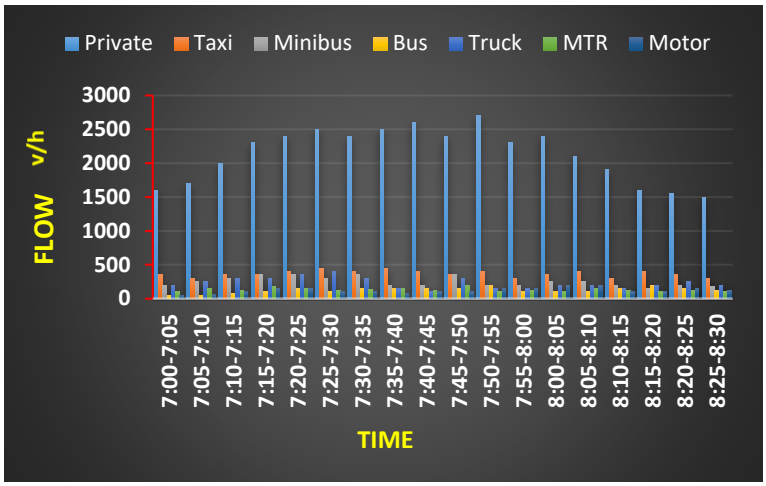
Figure (6) The flow rate for Al-Hizam Street.



- Najaf-Baghdad Street

Figure (7) represents the traffic volumes for the road section from the Al-Mukhtar Tunnel to the Al-Zahra Bridges. The measurement was conducted for the first section on 1/21/2024 and the second section on 1/22/2024 at the morning peak time for the two sections from 7.00 to 8.30 A.M.

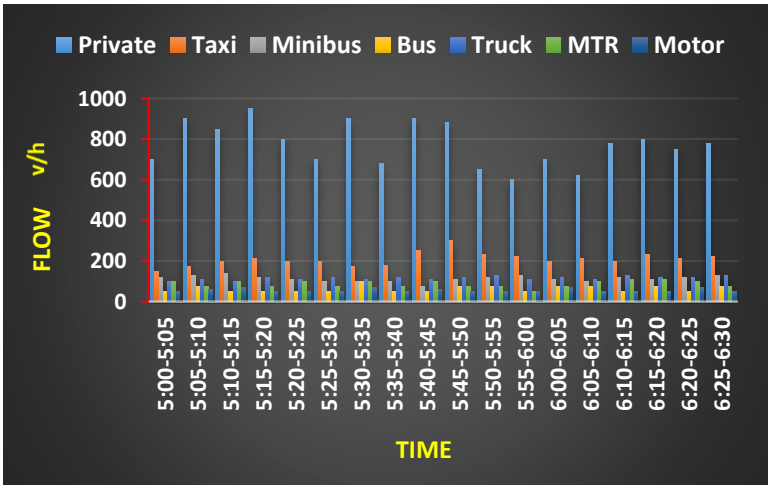
Figure (7) The flow rate for Najaf-Baghdad Street (Sec 1).



- Al-Zaytoon Street

The area in question extends from the Karama neighborhood on the Najaf-Karbala road to the military neighborhood to the eastern ring road, and the Al-Ghadeer residential complex and Crete Mall are on the opposite side. The study was conducted on Sunday, January 28, 2024, between 5:00 and 6:30 P.M because the peak time for the street is in the evening, according to daily traffic observations .As shown in Figure (8).

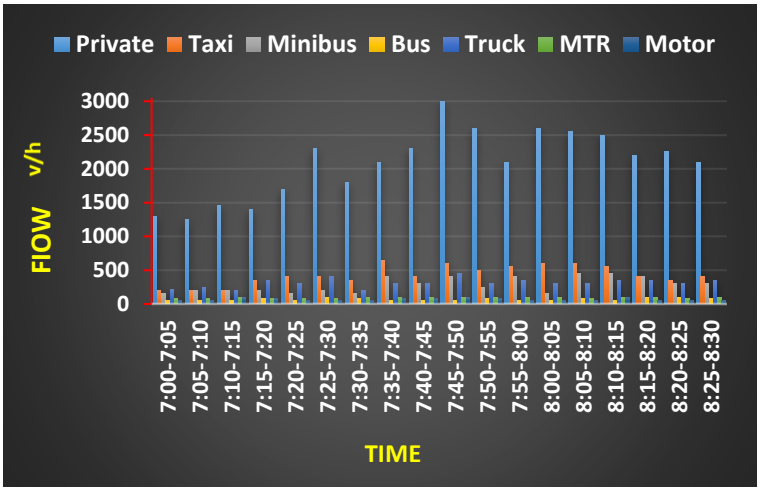
Figure (8) The flow rate for Al-Zaytoon Street.



- Al-Matar Street

The main road contains areas designated for industrial and commercial activities, and it starts from Al-Ma'mal Street and eventually leads to Najaf International Airport on the Eastern Ring Road. The measurement was performed on Monday, January 26, 2024, from 7:00 to 8:30 A.M. Figure (9) shows traffic flow rate data for Street No. **9**.

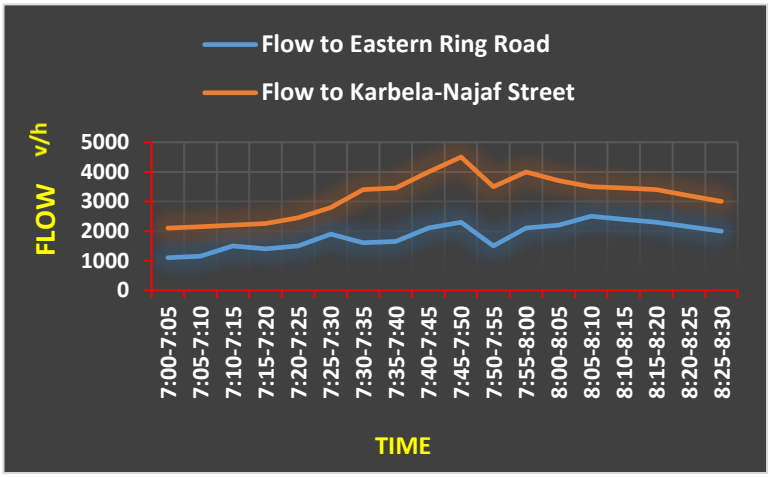
Figure (9) The flow rate for Al-Matar Street.



Emad Sekr Complex Street

Street No. **10** extends from Karbala-Najaf Road to the Eastern Ring Road at the Airport Roundabout. Traffic volumes were measured for the directions of the street on Sunday, corresponding to (2/4/2024) in the morning from 7:00 to 8:30 A.M, as shown in Figure (10).

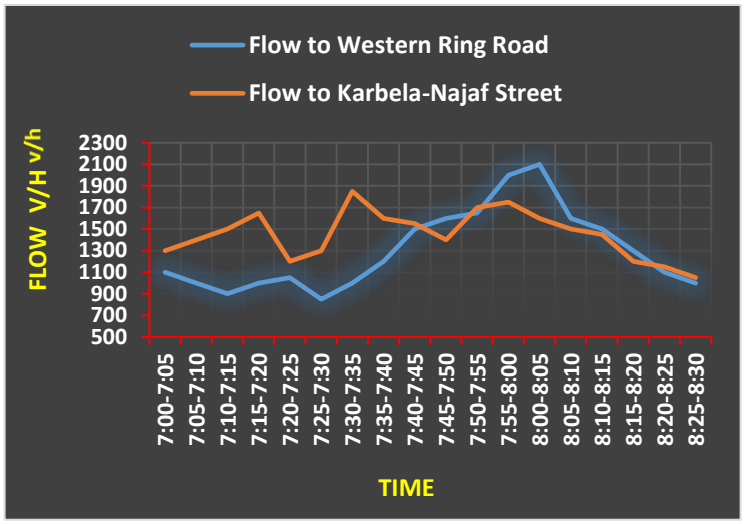
Figure (10) The flow rate for Emad Sekr Complex Street.



- Al-Kafeel University Street

Traffic volume data were measured on Sunday, February 11, 2024. The data collection site is located close to Mikal Shopping Center. The study was conducted during the early hours of the day, specifically from 7:00 to 8:30 A.M. Figure (11) shows traffic flow rate data for the Street No. **11** directions.

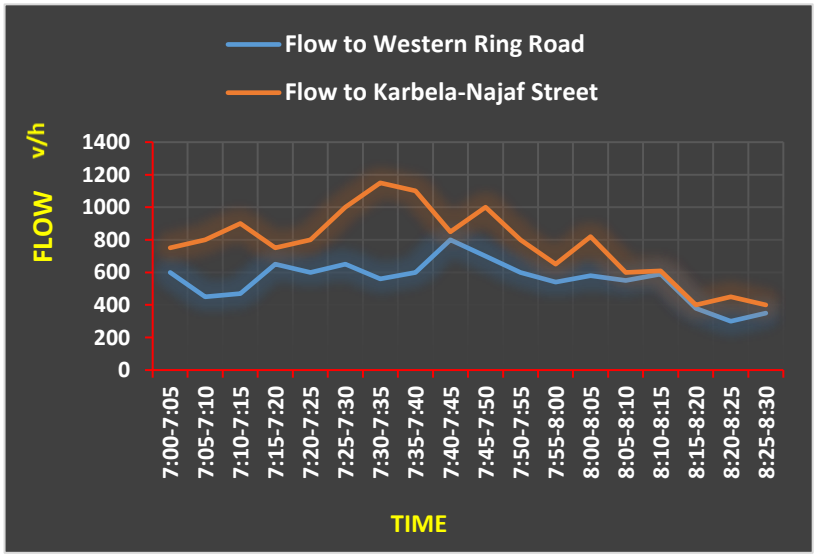
Figure (11) The flow rate for Al-Kafeel University Street.



- Al-Mujamaat Street

The measurement was conducted on Sunday, February 25, 2024. The data was collected from a site opposite the marketing center of the Princesses Residential Complex during the early hours of the day, specifically from 7:00 to 8:30 in the morning. Figure (12) shows traffic flow rate data for the directions of Street No. **12**.

Figure (12) The flow rate for Al-Mujamaat Street.



2.6. Ring Roads improvements

The Eastern Ring Road and the Western Ring Road in the city of Najaf suffer from various problems, the most prominent of which is congestion. This congestion arises from the large

traffic flow during the morning and evening peak hours on the Eastern Ring Road, especially towards the Abu Al-Fadl Bridges, and at times of visiting cemeteries regarding the Western Ring Road, leading to high noise levels and increased pollution indicators as highlighted this in Chapter Three. Therefore, multiple proposals were presented to improve these roads to raise the level of service, traffic performance, and classification. In addition, intelligent management strategies can be implemented for these road systems. Image indicates the most critical areas of congestion on the Eastern Ring Road during the morning peak period.

5.3.1 Improve the traffic flow problem

A. Eastern Ring Road

Many important proposals will fundamentally transform this street. These proposals include creating an alternative bridge for the current Airport Roundabout, as shown in Image, the proposed bridge in front of Al-Hizam Street, a proposal to build a bridge in front of Al-Zaytoon Street, and a proposal to cancel U-turns or modify the design of some of them, which cannot be canceled at present in order to achieve traffic flow, as the volume of traffic is expected to increase. It drops off significantly when the road turns from a major arterial to an expressway. This shift is characterized by one direction of traffic with three lanes, each lane having the capacity to accommodate 2000 veh. /hr/lane. Thus, the total capacity of this direction is 6000 veh. /hr/lane. The map shown in Figure (13) shows the bridges proposed to be implemented on the Eastern Ring Road. These proposed bridges have the potential to effectively mitigate congestion and traffic-related issues, especially when combined with intelligent sensor technology.

HCS 2000 software analyzed the road, specifically as an expressway. This analysis determined that with a speed limit of 110 km/h, assuming the improvements above were made, the service level for this road was classified as LOS **C** after the service level was **F** before the road improvements were made.

Figure (13) proposed bridges for Eastern Ring Road.

B. Western Ring Road

The western ring road is considered complementary to the Eastern Ring Road, which together form the main ring road of the holy city of Najaf. It originates from the Al-Shuhada Bridge along the road leading to Najaf-Karbala Street. It extends through the area leading to the residential complexes and the model cemetery, the Wadi al-Salam cemetery, and the shrine of Imam Ali. These prominent landmarks that pass through the road give it great importance and are widely visited, especially on religious occasions. The road ends at Abu Al-Fadl Bridges, along the road leading to Al-Manathira Street, the southern entrance to the holy city of Najaf. This street plays a vital role in alleviating traffic congestion for the reasons mentioned above. It is essential to address locations with high traffic volume and low flow speed, as problem areas on the road were previously identified in this research. Therefore, we propose replacing the Muzaffar roundabout with a bridge and proposing a bridge opposite Al-Kafeel University Street. Figure (14) shows the proposed bridges that can reduce congestion by connecting The street above Najaf-Karbala Street and the Eastern Ring Road.

Figure (14) proposed bridges for Western Ring Road.

HCS 2000 software analyzed the road, specifically as an expressway. This analysis determined that with a speed limit of 110 km/h, assuming the improvements above were made, the service level for this road was classified as LOS **A** after the service level was **B** before the road improvements were made.

- One of the improvements that can be made to the Eastern Ring Road, as it is a road that passes through residential areas and important economic centers, is to divert heavy vehicles and trucks towards the Southern Ring Road, which is designed in two directions, three lanes in each direction and a middle area according to Figure (14), which is in progress and extends From Al-Radawiya Bridges all the way to Al-Qadisiyah district, and from there to the international highway that connects the southern governorates to Al-Najaf Al-Ashraf Governorate. We propose to complete the road and connect it to the Western Ring Road via a bridge to facilitate the passage of heavy vehicles coming from the southern part of Al-Najaf Al-Ashraf Governorate without passing through the Eastern Ring Road or Al-Manathira Street. It is shown in Figures, which represents a proposed map of the ring roads and the main roads associated with them in the holy city of Najaf.

- One of the improvements that can be made on the Eastern Ring Road and the Western Ring Road is to divert heavy vehicles and trucks towards the Al-Siyahiu Ring Road, which extends from the Al-Shuhada Bridge to the Ghamas Intersection south of the city of Najaf, provided that the current road is improved by making it two-way, as in the proposed design shown in Figures, and redesign the Ghamas Interchange according to the proposal shown in Figures. It is also expected that when trucks are diverted towards the Al-Siyahiu Ring Road, traffic congestion on the main roads associated with it, namely Najaf-Kufa Street, Najaf-Baghdad Street, Najaf-Karbala Street, and Al- Manathira Street will be reduced.

3. Research Methodology

3.1. The problem statement

Among the important investigations into the roads of Najaf [12]. As a result, the rapid expansion of commercial and social activities and the increase in car ownership in Najaf, especially in recent years, affects the capacity of ring roads without traffic management and regulation. It is important to study traffic conditions and monitor environmental factors to evaluate the impact of transportation on living spaces and establish a healthy and sustainable lifestyle. Moreover, the limited research that addressed sustainability indicators related to ring roads, main streets, and the need for highways in Najaf constitutes another motivation for this research, Therefore, the construction of ring roads has become a necessity to solve traffic problems. The most important question remains: Is it possible to build these roads to achieve financial and economic feasibility and achieve financial benefits and revenues that cover construction costs and ensure future development?

3.2. Objectives

This research aims to evaluate the traffic characteristics of the ring roads and the main road network associated with it and to propose the construction of new ring roads according to the city's need to address traffic congestion within the scope of sustainability in the city of Najaf.

The objectives of the study can be summarized as follows:

1. Determine the classification of the main ring road and the main road network connected to it in the Holy City of Najaf according to the Highway Capacity Guide [7].
2. Evaluate the LOS of the roads in the study area using field traffic surveys.
3. Determining the economic and financial feasibility of the ring roads in the city of Najaf according to the standards used in Iraq.

4. Feasibility study

The economic feasibility of the ring road project includes several stages. The first stage is estimating the investment costs in its two parts: estimating fixed capital and working capital. The second stage is estimating the operating costs in its two parts: estimating the fixed costs and the variable costs. The third stage is estimating the project revenues, and finally extracting the financial ratios and determining the project feasibility.

4.1. Estimating Investment Costs & Operation Costs

Table (2) Estimating Fixed Capital

Details	Amount
Establishment Expenses	312,500
Land	58,750
Buildings, Facilities and Services	32,756,000
Other Service Facilities	123,368
Water, Electricity and Support Services	351,000
Diesel/Heavy Cars and Engines	364,000
Cars and Engines/Light	153,000
Office Furniture and Equipment	96,000
Basic Machines and Equipment	8,838,000
Secondary Equipment and Supplies	230,000
Total Fixed Capital	**43,282,618**

Table No. (2) includes an estimate of fixed capital [14] based on several axes, but the main axis is the estimate of the costs of the ring roads currently constructed and those proposed to be constructed over the next six years. The cost of the ring roads, which total about 30 ring roads in the city of Najaf, was estimated based on the engineering estimate prepared by specialized engineers.

Table (3) Estimating Working Capital for an Operating Cycle

Estimating Working Capital for an Operating Cycle			
Annual Fixed Costs	**Duration/Working Day**	**Total Amount**	**Required Amount**
Management Services, Fuel and Spare Parts	2,190	72,250	433,500
Administrative Expenses	2,190	319,350	1,916,100
Marketing Expenses	2,190	146,500	879,000
Interests and Fees	2,190	100,000	600,000
Depreciation	2,190	4,152,265	24,913,592
Obsolescence	2,190	912,847	5,477,084
Amortization of Start-Up Expenses	2,190	62,500	375,000
Amortization of Trial Operating Costs	2,190	600	3,600
Salaries and Wages for Administrators	2,190	604,800	3,628,800
			38,226,676
Annual Variable Costs	**Duration/Working Day**	**Total Amount**	**Required Amount**
Raw Materials		120,000	120,000
Production Services, Fuel and Spare Parts	2,190	161,900	1,013,031
General Production Expenses	2,190	228,450	1,429,444
Salaries and Wages/Production	2,190	1,371,600	8,582,297
			11,144,773
	Total Working Capital		**49,371,449**
	Total Investment Costs		**92,654,067**

4.2. Estimating Revenues

The revenue calculation for the project was based on the laws and instructions of the Republic of Iraq, specifically those related to government fees paid by the people to the government as a result of the transfer of ownership of cars, as these instructions stipulate the necessity of paying fees by one of the parties to the process of buying and selling cars of all types [15]. These fees are allocated as revenues for the state as a result of its construction of roads and bridges. These fees include the costs of construction, maintenance, rehabilitation, upkeep, safety measures, traffic signs and other services. The share of ring roads constitutes (3%) of all road and bridge fees imposed on the transfer of ownership of cars. Ring road fees vary according to the type of vehicle, as the fees for (Private cars) amount to approximately (0.6) dollars for each transfer of ownership, (Public cars for four people) the fees for this type of car are (1.2) dollars, (Public cars from seven to eighteen people) the fees for this type of car are (1.5) dollars, (Public vehicles more than eighteen people) the fees for this type of car are (2.1) dollars [15].

Table (4) Estimating Revenues

Estimating Revenues			
Income	**Fees per sale**	**Annual number of cars**	**Total Amount**
Private cars	0.60	19,698,000	11,818,800
Public cars for four people	1.20	4,924,500	5,909,400
Public cars from seven to eighteen people	1.50	6,566,000	9,849,000
Public vehicles more than eighteen people	2.10	1,641,500	3,447,150
			31,024,350

4.3. Income Statement and Cash Flows

Table (5) Income Statement

Income Statement					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Growth Rate %	**0.35**	**0.50**	**0.60**	**0.75**	**0.85**
Sales	10,858,523	15,512,175	18,614,610	23,268,263	26,370,698
Sales Returns	0	0	0	0	0
Net Sales	10,858,523	15,512,175	18,614,610	23,268,263	26,370,698

Cost of Sales	658,683	940,975	1,129,170	1,411,463	1,599,658
Total Operating Income	10,199,840	14,571,200	17,485,440	21,856,800	24,771,040
Fixed Costs	1,306,000	1,306,000	1,306,000	1,306,000	1,306,000
Net Operating Income	8,893,840	13,265,200	16,179,440	20,550,800	23,465,040
All other Revenues	0	0	0	0	0
Net Income before Tax	8,893,840	13,265,200	16,179,440	20,550,800	23,465,040
Tax	0	0	0	0	0
Net Income after Tax	**8,893,840**	**13,265,200**	**16,179,440**	**20,550,800**	**23,465,040**

Table (6) Cash Flows

Sales	10,858,523	15,512,175	18,614,610	23,268,263	26,370,698
Cost of Sales	658,683	940,975	1,129,170	1,411,463	1,599,658
Total Operating Income	10,199,840	14,571,200	17,485,440	21,856,800	24,771,040
Extinctions	6,371,113	6,371,113	6,371,113	6,371,113	6,371,113
Earnings before Interest and Taxes	3,828,727	8,200,087	11,114,327	15,485,687	18,399,927
Benefits	100,000	90,000	81,000	72,900	65,610
Taxable Profit	3,728,727	8,110,087	11,033,327	15,412,787	18,334,317
Tax	0	0	0	0	0
Profit after Tax	3,728,727	8,110,087	11,033,327	15,412,787	18,334,317
Net Cash Flow	**10,199,840**	**14,571,200**	**17,485,440**	**21,856,800**	**24,771,040**

4.4. Financial Indicators

Table (7) Financial Indicators

Payback Period		3.87	Year
The number of years needed to cover the amount in the project when the annual net flow is constant			
Operational Cost Coverage Rate		3.76	Once
Using revenues to cover operating costs			
Interest Coverage Ratio		88.94	Once
Using project revenues to cover interest costs			
Return on Investment		0.26	%
The project's profitability is measured by the total investments			

Breakeven		12.8	%
The point at which a project's sales revenues equal its total production costs			
Liquidity Ratio		18.31	More then 1
Measuring the rapid ability to pay obligations			
Turnover Ratio		18.73	More then 1
The amount of assets covering liabilities			
Asset Turnover Rate		0.25	More then 1
The project's ability to exploit available resources			
Working Capital Turnover Rate		0.22	More then 1
Management efficiency in using working capital			
Return on Equity		0.10	%
Ratio of return to owned capital			
Profitability Index (PI)		15.46	More then 1
A relative indicator of the project's profitability			

4.5. Results Analysis

The payback period of the project was approximately four years, the project's ability to pay its short-term obligations was approximately (18) times more than required, the project's ability to exploit available resources was approximately (25%) of what was required, the project management was highly efficient in using working capital, estimated at (22%) of what was required, the standard for using revenues to cover operating costs was a good result estimated at (89) times more than what was required approximately, the project's profitability to total investments was approximately (26%), the project is not sensitive to increases in costs and decreases in revenues [16].

The project creates new job opportunities and can be acquired with sufficient skills and experience easily and without additional costs. The project serves a good number of categories and segments of society and cities. All production elements are available in the project. The localization level is (0.22), and thus the project area is considered an attractive and encouraging area for establishing the project in it. The cost saving criterion was excellent in all its sub-criteria. At the level of descriptive criteria, we mention the most important of them, as the project evaluation was encouraging with regard to the per capita rate and human development indicators, the development of technical knowledge and the increase in the experience curve [17].

Conclusions

1. Maximum traffic flow rate in the study area reached its capacity of 4800 veh. /hr. at Najaf -Kufa street with average travel speed of 52 km/hr. followed by gradual reduction

in traffic speed.

2. It was observed that there was a clear variation in traffic volumes, speed, and travel time during and outside peak hours, sometimes reaching nearly half in some locations.

3. The frequency of U-turns on roadways has a significant impact on travel times, causing a reduction in the average speed of vehicles and leading to heightened levels of congestion and traffic.

4. By analyzing the volume of traffic on the ring roads and the main streets connected to them in the study area in the holy city of Najaf, the results show that the private car represents the main means chosen by a large number of individuals for transportation in the city, at a rate of 63%. Heavy reliance on cars leads to increased demand on all highways and thus increased traffic congestion.

5. More public transportation in the study area is needed, which has negative impacts on travel time, vehicle operating costs, driver inconvenience, air quality, and others. The maximum percentage of buses was 1%, and that of minibuses was 8% during the analysis of data collection during the peak hour period.

6. The current ring road projects are not sufficient for the city of Najaf because they cover almost a third of the city, and the required number for the year 2030 is thirty ring roads to relieve traffic congestion.

7. After estimating the investment and operational costs of the ring road projects in Najaf, which number thirty projects for the next five years, and estimating the revenues generated from these roads based on the database of the Traffic Directorate in the city of Najaf, and after extracting the financial ratios, we arrived at a set of financial ratios that show the economic feasibility of this type of project.

Recommendations

In terms of the conclusions and findings that are arrived in this work, the following are recommended:

1. It is recommended to encourage the implementation of urban transportation laws and policies to develop a sustainable transportation system.
2. Moving towards an intelligent transportation system to increase traffic management efficiency, reduce pollution, provide information, save time and effort, and maintain safety.
3. Excessive use of private cars can be reduced through improved means of public transport and development directed towards these means.
4. To better understand the lane changing, simulation tools are recommended to model the impacts and solutions.
5. After verifying the economic feasibility of the ring road projects, the researchers recommend that the concerned authorities, especially the Civil Administration of Najaf Governorate, the Roads and Bridges Directorate in the city, and the Traffic Directorate, develop a five-year plan that includes the construction of new bridges to achieve the goal of reaching thirty ring roads during this period in addition to the current roads.

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