Transportation Planning Opportunities for Al-Jadriya Intersection through City Information Modelling Techniques

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Abstract

Particularly in the twenty-first century, it is imperative to stay up to date with the constant and rapid advancements in technology. City Planners can now make decisions more swiftly, precisely, and economically based on new technologies such as City Information Modeling. This technology makes it easier to quickly retrieve and integrate information, which improves the accuracy of the conclusions and reduces the level of errors and clashes between different planning specialties. This research examines the application of city information modeling technology in the transportation sector.

This research employs a case study: Al-Jadriya Intersection in Iraq. It carries out traffic surveys for data gathering. Data was gathered during official holidays, working hours, and different times of the day and night to identify periods of peak traffic. Afterwards, planning and traffic solutions were put into practice through simulations.

The solutions took many different forms. They indicate that governments should support contemporary transportation strategies, such as carpooling & ride sharing strategy, which encourages people to drive fewer personal vehicles. It should also develop areas for public transportation. It should also build more bridges and tunnels.

The study reveals that the best way to reduce traffic congestion is to immediately implement plans for public transportation. It also finds that widening streets, constructing bridges, and digging tunnels are only temporary fixes, with their effects remaining localized to the study area. These methods also make it more difficult to achieve new traffic nodes and transfer traffic congestion to neighboring areas. In addition, creating cutting-edge transportation solutions, such as ride sharing could help lessen traffic congestion on a regular basis.

Keywords: Transportation, Public Transportation, City Information Modeling, Mobility planning, Baghdad.

Introduction

In recent decade, transportation infrastructure improvements are essential to reduce traffic, increase productivity, reduce travel times, increase safety, and promote economic growth. Building strong, sustainable transportation networks capable of adapting to changing needs requires careful design, adequate financing, and ongoing maintenance. Through city information modeling technology, it is possible to achieve high efficiency in urban design and planning through collaboration between different disciplines

The capital of Iraq, Baghdad, has not witnessed improvements in the field of transportation infrastructure since the beginning of the twenty-first century, despite the continuous increase in the number of vehicles. The ongoing population inflation and the violations in land use have led to the formation of many traffic nodes, which places Baghdad in the lowest category in terms of classifications. Service in the world where Level of Service (LoS) is a vital measure to evaluate the performance of transportation networks, such as traffic flow, congestion rates, safety systems and accessibility of various modes of transportation.

Using city information modeling technology can be the only way to prevent wasting time and resources as well as making poor planning decisions at this point. This is because technology allows for a multi-aspect review of the design and the creation of a realistic simulation based on statistics that accurately reflect the situation. It allows the city to progressively include all the service infrastructure and architectural specialties

This research examines the capabilities of city information modeling technology in creating a realistic simulation by collecting traffic momentum information at the Jadriya intersection. It makes many design proposals to formulate design alternatives and choose the optimal alternative. Its aim is to investigate the extent to which establishing the good planning solutions can lessen traffic congestion. Its objectives are:

1. To ascertain the impact of the reduction of private transportation vehicles by using modern transportation techniques, such as Ride sharing
2. To identify how to implement the newest modes of public transportation gradually in order to attain the maximum percentage of public transportation
3. To evaluate the effectiveness of building tunnels and bridges in certain traffic hubs in Baghdad.

Theoretical Basis

Transport Planning

One of the main factors influencing the structure of an urban network and economy has always been traffic flows. Specifically, traffic patterns may affect where houses and businesses are located as well as how real estate develops. They influence how much property is worth, and how densely developed an area is. In this context, urban planning procedures may benefit from an understanding of the relationships between traffic flows and urban street networks (Zambrano-Martinez et al., 2020).

Complexity of urban traffic networks increases with the resurgence of urbanization and the sharp rise in traffic demand. There is a severe issue with traffic congestion in many cities during rush housr. The configuration of the metropolitan road network is one of the numerous elements that influence the emergence of such traffic congestion. Thus, a design of a road network may limit how the people choose their routes and traffic modes, which in turn can alter how traffic is distributed among the nodes and linkages. Transportation modes include the many methods of conveying people and goods using different types of vehicles. In fact, Castrogiovanni, et al. (2020) provides definitions and descriptions of several modes of transportation for cars.

Ride-sharing

The term "ride-sharing" lacks a universal meaning, since it varies based on the specific study being conducted. Carpooling and vanpooling are prevalent modes of ridesharing; however, the term does not imply a need to consistently use the same service on a daily basis or to exclusively engage in a certain service. Passengers have the option to use ridesharing services either for direct transportation between two points or as a supplementary mode of travel to complement public transportation, aiming to enhance the integration of public transportation within the overall multimodal transportation system. In this secondary context, ridesharing is striving to enhance the availability of public transportation services, optimize the use of multiple modes of transportation and immediate mobility to reduce single-passenger trips, and establish intelligent transportation zones in both urban and rural areas. The Code of Virginia in the United States offers a definition of "Ride-sharing" that can be applied to non-profit ride-sharing services. According to this definition, "Ride-sharing" refers to situations where the driver's main goal is not to earn a profit, but rather to reach a destination. The transportation of passengers is considered a secondary aspect of this objective (Shokoohyar et al., 2018).

Carpooling

Carpooling is the act of sharing automobile rides with others: usually, people who are going in the same way or towards the same place. Commuting via this method is both economically and environmentally good, since it decreases the number of automobiles on the road, alleviates traffic congestion, and cuts carbon emissions. The advantages of Carpooling are as follows.

1. Cost Savings: The act of sharing gasoline and maintenance expenses helps alleviate the financial strain on individual passengers.
2. Mitigated Traffic Congestion: The presence of fewer automobiles on the road may effectively ease traffic congestion, particularly during periods of high travel demand.
3. Environment Impact: Carpooling mitigates carbon emissions by decreasing the quantity of vehicles on the road, therefore, it is fostering a more pristine environment.
4. Social contact: Commuting offers a chance for individuals to engage in social contact and networking.
5. Decreased Parking Demand: A decrease in the number of automobiles results in a reduced need for parking spots, which may be advantageous in densely populated metropolitan regions.
6. Optimal Resource use: Optimizes the use of current transportation resources and infrastructure. (Berg. 2017)

Current and Future Roles of Urban Transportation

A key component of urban life, public transportation promotes a variety of activities and helps create an urban environment that is both ecologically and socially sustainable. A robust and attractive public transportation system is necessary for both a high standard of living and a city to be considered "livable." (Alkaissi et al.,2021)

In developed countries with high rates of automobile ownership, the importance and types of transportation vary significantly depending on the size and kind of city. In smaller cities, transportation largely helps those who don't drive or don't have access to automobiles; it doesn't really help with traffic congestion. However, in mid-sized cities, public transportation becomes an important part of offering a driving substitute that minimizes air pollution, traffic, the need for large parking lots and protects human-centered urban areas (Pangbourne, et al.,2018)

For cities and megacities with populations more than ten million, public transportation is the most efficient way to move huge numbers of people. Since traditional highways cannot handle the massive passenger loads, many cities suffer from chronic and debilitating street and highway congestions when there is little or no usage of transportation. When compared to private automobile travel, rapid transit in the main corridors of these big cities proves to be a more cost-effective, convenient, and comfortable choice for the passengers. Large parking lots are required by inadequate transportation networks, which displaces useful activities and lowers the general livability of places, especially city centers, making them dangerous and unwelcoming for the pedestrians (Zhu, et al.,2016).

Transport is much more vital in developing countries than in developed ones since it is economically efficient for a large portion of the population that does not own a private car. Its capability is also necessary to support rapidly growing, highly populated cities. As a result, cities in emerging nations must adopt transportation laws that guarantee the provision of dedicated transit lanes in conjunction with the construction of new highways. By creating such exclusive routes, it is possible to build autonomous, highly-capable transportation systems at affordable investment levels and include them into urban growth, preventing the appearance of severe street congestion, which would otherwise complicate and increase the cost of construction (May et al., 2013)

Level of Services (LOC)

The importance of Level of Service (LOS) in urban areas has a direct bearing on the efficiency, effectiveness, and general well-being of cities. LOS serves as a vital barometer for assessing the performance of transportation networks, taking into account critical factors like as traffic flow, rates of congestion, safety regulations, and accessibility for different modes of transportation. (Ahmed, et al,2023, p2)

Level of Service (LOS) is a qualitative metric used in transportation and urban planning to evaluate the efficacy and efficiency of transportation systems and infrastructure in particular locations, such as public transportation, highways, bike lanes, and pedestrian walkways. It assesses how well these networks are operating by taking into account variables including traffic volume, degrees of congestion, journey time, safety precautions, user comfort, and dependability (Ebraheem, al., 2020).

As a means of evaluating the caliber of services provided, LOS entails assigning numerical or alphabetical ratings to several facets of transportation performance. Planners, engineers, and legislators may better understand how effectively a transportation system meets the demands of its users and performs under various conditions with the help of these ratings (Gallin, et al., 2001).

Evaluating LOS makes it easier to plan, develop, and manage transportation systems with informed decisions. It aids in identifying areas that need improvement, directing the construction of infrastructure, assessing the success of initiatives or policies put into place, and guaranteeing that transportation networks suitably meet the changing needs of expanding urban populations while placing an emphasis on sustainability, efficiency, safety, and accessibility (Manual, et al., 2000)

Level of Services in Signalized Intersections

Level of Service (LOS) scores—which take into consideration motorized cars, pedestrians, bicycles, and transit—are used to evaluate signalized junctions. For motorized vehicles, the requirements are different and easier to quantify. Every approach, every lane group, and whole junctions may have their LOS assessed. The primary performance metrics taken into account for lane groups are volume-to-capacity ratio and control delay. Traveler perception is often used to assess LOS for bicycle, pedestrian, and transit modes, taking into account variables such crossing width and speed. Motorized vehicle LOS scores are categorized as follows: (Petritsch et al.,2005)

- **LOS A**: A volume-to-capacity ratio of no more than 1.0 and a control delay per vehicle not to exceed 10 seconds. It usually assigned when the cycle duration is extremely short or when the intersection progression is excellent with frequent green-light arrivals.
- **LOS B**: A volume-to-capacity ratio of no more than 1.0 with control delays per vehicle ranging from 10 to 20 seconds. It usually awarded when there is a noticeable cycle length or junction progression, but more cars need to halt than in LOS A.
- **LOS C**: With a volume-to-capacity ratio of no more than 1.0, control delays per vehicle should be between 20 and 35 seconds. It usually assigned in cases where the cycle duration is average or the intersection progression is respectable. Numerous cars come to a halt, and isolated cycle breakdowns might begin.
- **LOS D**: With a volume-to-capacity ratio of no more than 1.0, control delay per vehicle should be between 35 and 55 seconds. It assigned when there is insufficient effective progression or when the cycle duration is too long. A large number of cars break down, and single cycle failures increase in frequency.
- **LOS E**: With a volume-to-capacity ratio of no more than 1.0, control delay per vehicle should be between 55 and 80 seconds. It usually awarded when cycle length is extended and progression is not at its best. Individual cycle failures happen often.

LOS F: The volume-to-capacity ratio is more than 1.0, or the control delay exceeds 80 seconds per vehicle. It usually allocated when cycle duration is long and progression is very bad, meaning that most cycles cannot clear the queue (Zhang, et al.,2003).

Review of Literature

Numerous research has already been conducted on the connection between urban public transit and urban structure and transportation and the level of services. Filion et al. (2006) computes a service quality index, which takes service level into account, in order to measure how Toronto's density-distribution strategies affect the use of public transportation. According to them, policies that promote density alone are unlikely to increase transit use, even though densely populated areas are likely to see greater levels of transit use. The application of the service quality index to a single local system limits its usefulness in the field of transport research. Mees (2009) evaluates the association between urban density and the mode of transportation used to get to work in the US, Canada, and Australia after calculating urban densities for residential and non-residential property. Tsuji et al. (1999) focus just on Japanese cities with tramway systems, confirmed the link between compactness of cities and tramways, but did not examine the quality of service provided by such trams. Nakamichi et al. (2007) clarify the connection between private vehicle uses and LRT networks, on a nationwide basis. These three studies may have benefited from a more thorough examination of urban structure as they did not assess the levels of transportation services.

Currie et al. (2010) find that service level has a favorable impact on increasing transit use after analyzing the relationship between ridership, density, service level and a number of other important characteristics at the route level of systems in North America, Europe and Australia. This study is highly thorough, quantitative, and global in scope, yet it lacks important station level analysis. Werner et al. (2010) assess the walkability of Salt Lake City communities around LRT stations by contrasting interview responses with an objective walkability scale. They discover that residents of neighborhoods that were both objectively and subjectively considered con side red walkable had a higher likelihood of being transit users. The investigation might have benefited from a bigger, more varied data collection that included many cities, given its limitations to a single urban area. Jefferson (1996) shows to be most compatible with pedestrians in Europe, and as such, it should be a suitable foundation for the development of pedestrian areas. However, neither of this research includes a quantitative analysis like general reviews. Hass Klau and Crampton (2002) examine LRT-adopted cities in Europe and North America and determined success factors by examining the features of the cities and surrounding areas, including service frequencies during peak hours. Although it is a thorough analysis, its scope is restricted because it only looks at LRT systems.

Babalik-Sutcliffe (2002) determines the elements that contribute to the success of rail systems in US, UK, and Canadian cities, based on the anticipated effects of each system. The effects of land use differed from city to city, but they were generally determined by the state of the local economies and the existence of a robust central business district. Even though they were conducted internationally, the aforementioned studies only looked at a small sample of cities and did not take into account all cities with a population of more than a particular threshold. As was already indicated, the research that are now available do not fully clarify the connections between urban structure and urban public transit., Nagao et al. (2009, 2010) examine the connection between the people living in a 500 m radius and the service frequencies of trams and railroads, and concluded that higher service frequencies translate into a higher population in that area. This study, which comprehensively targeted all local cities with populations over 100,000, employed an international comparison of the relationship between urban structure and the service level of urban public transportation, including railways and tramways, among the local cities in Japan, France, and Germany. Its use of pedestrian spaces for analysis is another way that it varies from its predecessors. Wong and Yang (1997) add to the network traffic signal control problem the idea of network (reserve) capacity. When the multiplied O-D matrix is allocated to the network by some equilibrium model, the reserve capacity of a road network is determined by the maximum common multiplier that may be applied to a given O-D matrix, subject to the flow on each link not exceeding its capacity. Finding the best signal control pattern is the goal in order to optimize the network reserve capacity., Yang and Bell (1998) examine the integration of the network capacity concept into the design of road networks and demonstrate how adding a link to an already-existing road network or increasing the capacity of an already-existing link can actually lower the network's potential capacity or exacerbate the capacity flow pattern.

Table 1: Summary of studies
Source: Author

Source (Author, Year)	Summary
Filion et al. (2006)	measures how Toronto's density-distribution strategies affect the use of public transportation.
Mees (2009)	evaluates the association between urban density and the mode of transportation used to get to work after calculating urban densities for residential and non-residential property
Tsuji et al. (1999)	confirms the link between compactness of cities and tramways, but do not examine the quality of service provides by such trams
Nakamichi et al. (2007)	clarifies the connection between private vehicle use and LRT networks.
Currie et al. (2010)	finds that service level has a favorable impact on increasing transit use after analyzing the relationship between ridership, density, service level, and a number of other important characteristics
Werner et al. (2010)	assesses the walkability of Salt Lake City communities around LRT stations by contrasting interview responses with an objective walkability scale
Jefferson (1996)	shows to be most compatible with pedestrians, it must be a suitable foundation for the development of pedestrian areas.
Hass Klau and Crampton (2002)	examines LRT-adopted cities and determined success factors by examining the features of the cities and surrounding areas, including service frequencies during peak hours.
Babalik-Sutcliffe (2002)	determines the elements that contribute to the success of rail systems. The effects of land use different from city to city, but they were generally determined by the state of the local economies and the existence of a robust central business district.
Nagao et al. (2009, 2010)	examines the connection between the people living in a 500 m radius and the service frequencies of trams and railroads
Wong and Yang (1997)	Adds to the network traffic signal control problem the idea of network (reserve) capacity.
Yang and Bell (1998)	Examines the integration of the network capacity concept into the design of road networks

Research Methodology

This study analyzes the case of the Baghdad University intersection in Al-Jadriya and develop planning alternatives to overcome the crisis of traffic congestion there and compare them with each other to choose the best alternative, as this will be done in four stages.

1. Collecting data through field traffic surveys by calculating the number of actual vehicles at different times.
2. Conduct a simulation of the reality of the study area to illustrate the size of traffic congestion and the amount of delay and compare it with service level standards.
3. Proposing alternatives
4. Choose the best alternative

Al-Jadriya Intersection: Overview

The study area is close to the University of Baghdad. It is situated on the Rusafa side of the city of Baghdad. The Baghdad university traffic light intersection symbolizes it: four-way crossroads at the end of the Al-Jadriya highway that connects to the Al-Hassanin Bridge Square from the East and the next road from the North.

This road serves as the entrance for vehicles entering the University of Baghdad to transport faculty, students, staff, and reviewers. The area is close to the heart of Baghdad, and it is frequently used for residential, commercial, and administrative purposes in addition to government land usage. It is close to the

Green Zone, which serves as the focal point for most significant government agencies and ministries, as shown in Figure (No.1).

Fig. 1: The study area location
Source: Author

Data Collection

Many field surveys were conducted at the study site to obtain the following statistics:

1- The number of vehicles that entered the southern arm towards the University of Baghdad and the Ministry of Science and Technology is 5,268, more than 80% of which headed to the University of Baghdad. It is the most entering vehicle during rush hour because the percentage of vehicles entering the direction of the University of Baghdad is equivalent to 40% of the number of vehicles passing through the intersection.

2- The number of vehicles entering the western arm towards Al-Hassanin Square and the Karrada area outside is 4,614, which is the second largest entrance port for vehicles as they head to the city center.

3- The number of vehicles that entered the eastern arm to cross the Jadriya Bridge to the Karkh side is 2,264.

4- The number of vehicles that entered the northern arm towards the Babel Hotel and the Karrada Dakhil area is 366 vehicles.

5- The number of vehicles crossing the Al-Jadriya Bridge from Karkh to Al-Rusafa towards the intersection, represented by vehicles that exited from the western exit, is 6268. It represents the largest port through which vehicles flow to the intersection.

6- The number of vehicles that exited the eastern arm represented by vehicles coming from Baghdad city center is 3796 vehicles, and it is the second largest outlet through which vehicles flow to the intersection.

7- The number of vehicles that will cross the Al-Jadriya Bridge represented by the western arm from the Rusafa side exiting from the intersection to the Karkh side is 2264 vehicles, which constitute only 31% of the number of vehicles crossing the bridge in the opposite direction from the Karkh side to Al-Rusafa towards the intersection via the western arm (2737 vehicles).

8- The number of vehicles that crossed the Al-Jadriya Bridge and entered the intersection through the western exit in the direction of the southern exit towards the University of Baghdad is 2158 vehicles, which is equivalent to 30% of the total number of vehicles that crossed the Al-Jadriya Bridge (2737).

Fig. 2: Numbering the four entrances leading to the study area
Source: Author

Assessment of the Existing Neighborhood

Until recently, there was an excessive amount of construction on agricultural land, converting some of it to commercial and residential uses. Consequently, we anticipate an increase in take trips, which further complicates the situation and the study. Not only traffic congestion present in the research area, but new places of attraction have been established in the area that call for recalculations and spatial analysis to prevent traffic bottlenecks.

The following structures are these points of attraction:

1. The Central Bank of Iraq building, where the total internal building area is 90,000 square meters, which expects the number of employees and auditors to exceed 3,500 people.
2. Al-Jadriya Mall, with an area of 27,000 square meters, expects the number of employees and visitors to exceed 1,500 people.
3. The German Hospital, which can accommodate 220 beds, and it is expected that the number of patients and doctors will exceed 1,000 people.
4. Dijla Village Complex, which contains 224 apartments.
5. Al-Jadriya Residential Complex, the details of which have not yet been published.

The value of traffic statistics will increase by at least 5,000 trips if the future increases in trips due to land use change which is taken into account. If we apply ratio and proportion in the matrix, it will appear as below. (Alwan, et al,2021, p4)

Table 2 : Traffic surveys for the study area in peak hour if we increased it 5000 trips
Source: Author

	Zone 1	Zone 2	Zone 3	Zone 4	Total	Ratio
Zone 1	0	5351.52	2597.52	125.182	8074.22	0.51779
Zone 2	2311.05	0	2156.98	101.108	4569.13	0.29301
Zone 3	207.031	505.541	0	1611.71	2324.29	0.14905
Zone 4	349.064	84.2569	192.587	0	625.908	0.04014
Total					15593.5	

The Actual Situation

The traffic momentum matrix is entered into the Infraworks program to create and calculate the amount of delay, where the amount of delay that occurs is shown, which is estimated at 316 seconds. If we compare it to the service level standards, it will get a rank worse than (LOS F).

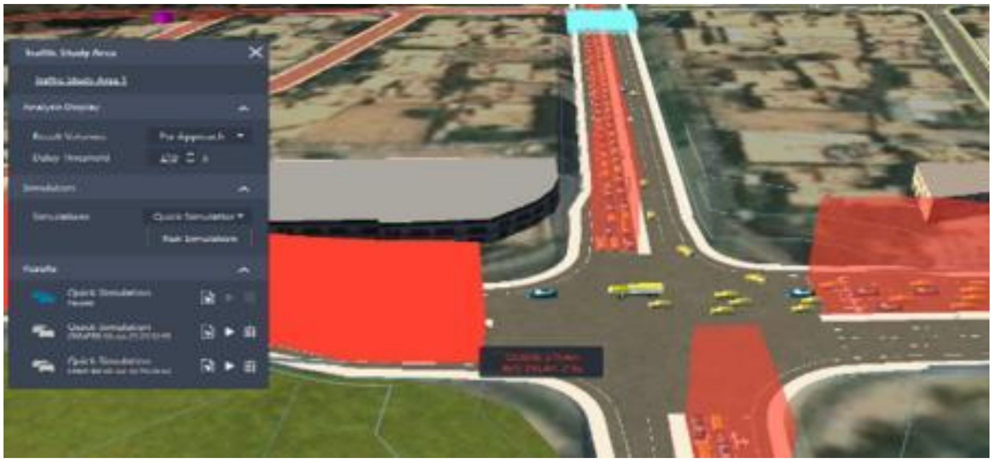

Fig. 3: Traffic simulation and delay results if land use take in to account
Source: Author

Proposing Design Alternatives

When the same recent data was placed, a tunnel was created that transports vehicles from the first feeder, represented by Al-Jadriya Bridge, to the second feeder, represented by Al-Hasanein Roundabout, and the process of analysis and simulation was conducted. In this case, the amount of delay for vehicles will be 70 seconds, meaning that it achieves level LOS E in the service level standard

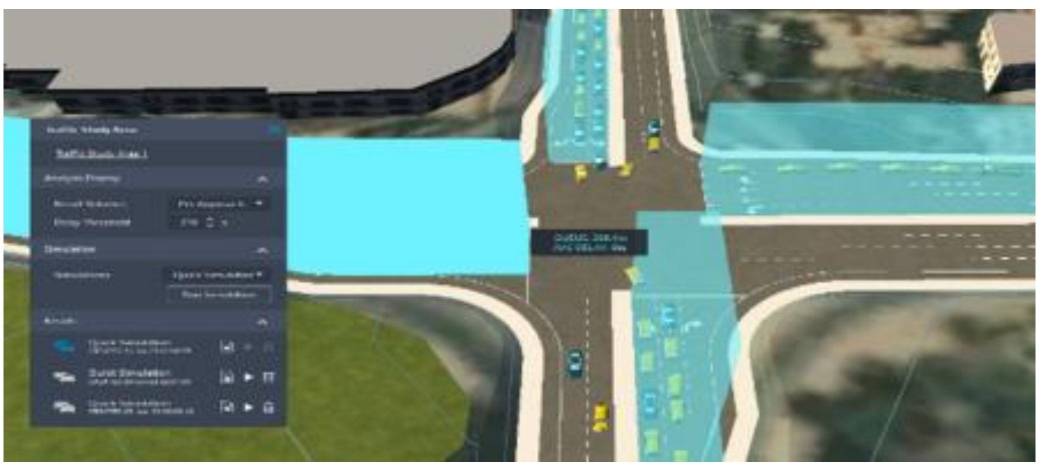

Fig. 4: Traffic simulation and delay results if we create a tunnel .
Source: Author

Based on a comprehensive field study conducted to ascertain the quantity of private and public automobiles and the corresponding number of passengers for each category, it was determined that private vehicles accounted for 95% of the overall vehicle count. Conversely, public vehicles constituted a mere 5% of the total. The data collection process involved doing the statistics several times and days to enhance the findings' accuracy. The statement above was made. The study involved quantifying the number of individuals present in various types of vehicles. Specifically, private transport cars accommodated an average of 1.6 individuals. In contrast, public transport vehicles, such as buses, have an average occupancy of 30 individuals, while smaller public transit vehicles have an average occupancy of 10 individuals. Thus, if public transportation was activated by 30%, that is, 25% of private transportation trips were transferred to public transportation. obtain the total number of trips after converting 30% of the number of trips to means of transportation, which will be 12,004 trips.

Table 3 : Traffic surveys for the study area in peak hours if 30% of the number will be transferred to public transportation
Source: Author

	Zone 1	Zone 2	Zone 3	Zone 4	Total	Ratio
Zone 1	0	4133.32	1996.53	96.2181	6206.068	0.517
Zone 2	1778.97	0	1660.37	77.8299	3517.172	0.293
Zone 3	159.316	389.027	0	1240.25	1788.596	0.149
Zone 4	274.476	66.2528	151.435	0	492.164	0.041
Total					12004	

According to the analysis and simulation results, the delay was reduced to 213 seconds from 316 seconds, as the service level rating is still within the category LOS F as is clear in the image below.

Fig. 5: Traffic simulation and delay results if 30% of the number is transferred to public transportation.
Source: Author

if public transportation capabilities are increased by only 25%, bringing the total percentage of public transportation to 30%, the delay will drop to 38 seconds. However, it has been demonstrated through international experiments that if cities improve their public transportation options, the average number of people using private vehicles will fall. Consequently, it is the authorities' responsibility to inform the public about modern transportation strategies, such as ride-sharing and carpooling, to decrease the use of public transportation and increase the number of passengers in private vehicles. For instance, assume that there will be an average of 1.8 passengers per private vehicle. As a result, altering the quantity of trips made by private transportation will alter the analysis's findings. The total number of trips will be 10791 and the trip matrix will look like this if we run the analysis:

Table 4: Traffic surveys for the study area at peak hour if the number of private transport passengers is transferred from 1.6 to 1.8
Source: Author

	Zone 1	Zone 2	Zone 3	Zone 4	Total	Ratio
Zone 1	0	3697.67	1794.78	86.4953	5578.947	0.517
Zone 2	1599.21	0	1492.59	69.9653	3161.763	0.293
Zone 3	143.217	349.716	0	1114.93	1607.859	0.149
Zone 4	246.74	59.558	136.133	0	442.431	0.041
Total					10791	

As is clear in the image below, the results showed a decrease in the amount of delay to 168 seconds from 213 seconds. However, it is still within the standards of service level within the category LOS F.

Fig. 6: Traffic simulation and delay results if the number of private transport passengers is transferred from 1.6 to 1.8
Source: Author

Finally, if 60% of trips are transferred to public transportation, the total number of trips becomes 6,454 trips. The form of the matrix will be as follows.

Table 5: Traffic surveys for the study area in peak hours if 60% of the number will be transferred to public transportation
Source: Author

	Zone 1	**Zone 2**	**Zone 3**	**Zone 4**	Total	Ratio
Zone 1	0	2211.55	1073.44	51.7321	3336.718	0.517
Zone 2	956.471	0	892.706	41.8456	1891.022	0.293
Zone 3	85.6567	209.162	0	666.828	961.646	0.149
Zone 4	147.573	35.6211	81.4197	0	264.614	0.041
Total					6454	

As seen in the image below, the results indicate that the delay was reduced from 168 to 74 seconds.

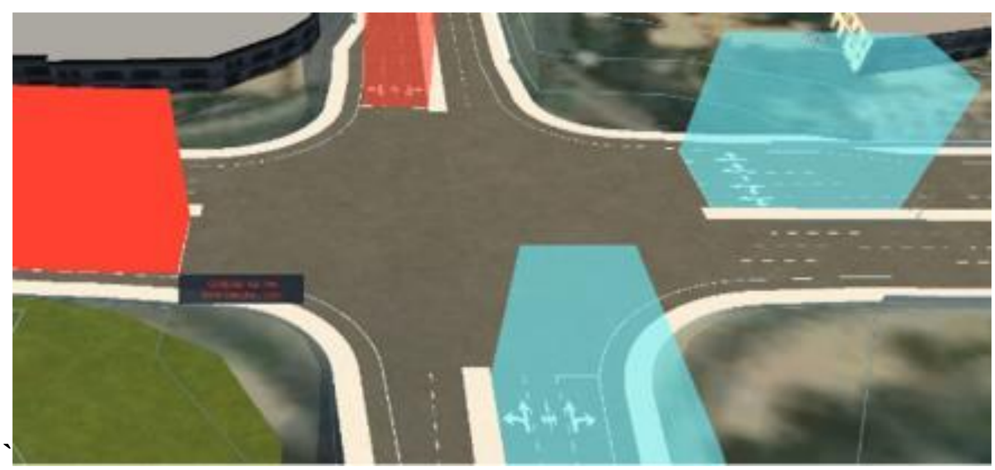

Fig. 7: Traffic simulation and delay results if ;60%of, the number will be transferred to public transportation
Source: Author

Ultimately, if public transport capacity were increased by just 55%, we would have a LOS E level of service.

Findings

In the case of the first alternative, which is constructing a tunnel, the positives of this proposal can be explained as follows

1. Obtaining outstanding results and reducing the volume of traffic delays by less than a quarter of the main delay
2. Ease of organizing traffic by obtaining a smooth movement of vehicles

The downsides of this proposal are as follows.

1. High cost of resolving traffic jams at one intersection
2. Traffic inflation at the intersections that follow the study area due to the smoothness in the influence of vehicles, as it is difficult to organize them within periods to coincide with other intersections.
3. It is considered a slow implementation solution

In the case of the second alternative, where work has been done to activate public transportation in the region, the positive aspects of this alternative are:

1. Fewer cars mean less traffic at all crossings, which lowers traffic density
2. Minimizing expenses while reducing delays at the intersection
3. Offering more affordable and efficient modes of transportation
4. The model has no drawbacks.

Conclusion

The results of the evaluation models conducted on the two alternatives indicate that the two alternatives rose in service level standards from the LOS F category to the LOS E category, which indicates the efficiency of the two alternatives in theory, but in terms of practical application, constructing bridges directly and taking the first alternative as an initial solution may lead to the formation of new irrigated nodes through traffic encroachment from one intersection to the next. As for the second alternative, which is activating public transportation capabilities and reducing the use of private transportation vehicles, it is free of defects. Therefore, this alternative can be considered as an initial solution, as the first alternative can be applied after that to enhance the level of traffic. The service will be better through the construction of the tunnel.

Therefore, it is expected that the level of service in the study area will rise to the LOS C category. This analysis was achieved through city information modeling technology and entering data into a three-dimensional work environment that enables the planner to extract the results of the analysis accurately and quickly. It can Governments can support and develop this technology to promote more efficient and sustainable cities

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