

# Application of Sustainable Transport Tools in Central Area – Baghdad City

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**Abstract:** *To enable a sustainable transport system in a city, there are many tools used in transportation planning. The most common tools are used within the so-called Transport Demand Management (TDM) Strategy. Bab Al-Moatham represents the most important center of Baghdad city. It includes a variety of activities with a high population concentration. This research shows the possibility of applying sustainable transport tools in the study area by adopting planning tools for sustainable transport. SWOT analysis has been applied to identify internal and external environment measures of the study area. The main strength point of the study area is the geographical location as an economic, administrative and educational center, while the main weakness points are weak infrastructures and technology for the transport system in general and for the study area in particular, as well as the lack of a strategy for development of the area depending on sustainable transport. The opportunities available are the attractive environment for transport as a result of the existence of multiple events, while the most important risk is the lack of funding and investment in the transport sector and the absence of laws and regulations concerned with sustainable transport.*

**Keywords:** Sustainable Transport; Transport Demand Management; Traffic Intersections; SWOT analysis.

## 1. Introduction

To enable a sustainable transport system in a city, there are many tools used in transportation planning. These tools are used to suit each traffic problem, the area of study, potential, available resources, and other determinants and can be used individually or in combination with each other. The transport network represents the lifeblood of cities, where cities are the major sources of the national economic growth and any imbalance leads to different traffic problems such as overcrowding, environmental pollution and other urban problems that lead to a decrease in the level of service and thus a decrease in the quality of life of the society [1].

The globe is facing fast urbanization growth. The majority of this growth is appearing in developing countries, causing billions of new urban residents. To accommodate these new residents needs vast financial, social and environmental solutions. It is essential that urban growth plans increase the benefits and reduce the costs so as to keep a sustainable legacy for upcoming generations [2].

Boosting the sustainability of metropolitan transport systems is an essential goal of all considered strategies. Several plans and measures could be implemented to advance the productivity of transport systems, in accordance with a considerable number of features that can influence the effects of the applied measures [3]. The problem of this research is that the low level of service in the transport network and traffic intersections, especially in a central area in Baghdad city like Fine Arts Faculty intersection in Bab-Al-Muadham sector. The research has been conducted so as to outline a practice capable of describing applicable and effective approaches and measures, permitting to boost the

sustainability level. Therefore, the main objective of this research is to improve the level of service in the transport network and traffic junctions using sustainable transport tools. The research assumes that the use of sustainable transport tools that reduce the use of private cars and the focus on sustainable transport can improve the level of service of the transport network and traffic intersections.

## 2. Transportation Demand Management

It is a strategy aims to maximize the efficiency of the urban transport system throughout more efficient, healthier and environmentally friendly transport such as public transport and non-motorized means of transport (Broaddus et al, 2009) [4]. Rules and arrangements systems proposed to boost transport system productivity are termed *Transportation Demand Management (TDM)*, as reviewed in Table 1 [2].

Demand management strategies may be classified into two main categories: mandatory and voluntary. Mandatory type pursues to run demand for highway use over a set of policies or discouragements. Voluntary strategies might be economical, willingly executable congestion lessening strategies that managed to be seen more encouragingly by the public than the mandatory strategies [5].

**Table 1:** Transportation demand management strategies [6]

<i>Improve Transport Option</i>	<i>Efficient Option incentives</i>	<i>Land Use Policies</i>	<i>Programs</i>
Walking and cycling improvements	Efficient road and parking pricing	Smart Growth policies	Commute trip reduction
Public transit improvement	Roadway management	Transit-oriented development	School transport

	that favours resources-efficient modes		management
Car- and bike-sharing	Mobility management marketing	Efficient parking management and pricing	Transportation management associations

## 2.2 Transportation demand management strategy application tools

The most important tools to implement the demand management strategy in transport are as follows in Table 2:

### 2.1 Demand Management Strategy application steps

There are several steps to implement the strategy [4], [7]:

- 1) The policy and planning improvement: increasing funding for alternative means, increasing support for transport demand management programs, changes in land use planning practices, etc.
- 2) Improving walking and cycling conditions, improving transport services and public transport services, increasing integration and development of mixed land uses, increasing road and parking fees, reducing transit prices, etc.
- 3) Mobility changes: shifts in travel time, route, position, destination and frequency.

The expected results of implementing the demand management strategy are as follows:

- Lowering traffic congestion.
- Cost savings for road and parking.
- Reducing accidents.
- Energy saving.
- Reducing pollution emissions.
- Improving mobility for non-drivers, and others.

### 3. Study Area

Bab al-Mu'adham is one of the most important areas in the city of Baghdad. It consists of a number of intersections, the most important of which is the intersection of the Faculty of Fine Arts, as shown in Figure 1, which is characterized by high traffic volumes in most working hours, and suffer from traffic congestions especially at peak hours. Therefore, it is worth to be studied trying to override this problem.

The study area (Bab al-Mu'adham and the intersection of the Faculty of Fine Arts) is distinguished by the use of many different overlapping lands, including educational institutions, commercial centers, light industries, residential areas, and administrative and health institutions.

The intersection of the Faculty of Fine Arts connects a number of main streets in Bab al-Mu'adham area as shown in Figure 2:

- The street connects with Palestine Street: connects the area of Bab al-Mu'adham in the eastern areas of Baghdad such as Palestine Street, Sadr City and others. The most important landmarks near the intersection is the Turkish Embassy.



**Figure 1:** Study area (Faculty of Fine Arts intersection).

**Table 2:** Transportation demand management strategies [4], [8]

No.	The main tools	The sub-tools	The implementation policies
1	Planning instruments-land use planning (master plan)	<ul style="list-style-type: none"> <li>•To bring the population closer to the activities they need to reach.</li> <li>•Establishment of parking around cities.</li> <li>•Encouraging employers' programs, which contribute to the establishment of mobility patterns, as they can affect the factors that support</li> </ul>	<ul style="list-style-type: none"> <li>•Intelligent growth, new urbanization, and complex uses.</li> <li>•Reducing traffic congestion within cities and encouraging the use of public transport.</li> <li>•Reduction of parking spaces, especially in the center of the city or increase the cost of using the position (different costs depending on the number of passengers, free cancellation,</li> </ul>

		<p>the use of the vehicle</p> <ul style="list-style-type: none"> <li>•Transport-oriented development: A combination of residential, commercial, office, open areas and public use in an integrated pedestrian environment, making it convenient for residents and employees to travel by public transport, bike, foot or car.</li> </ul>	<p>and impose a fee on parking).</p> <ul style="list-style-type: none"> <li>•Offer parking spaces for workers' vehicles. Employers can also help solve congestion problems by influencing work conditions (work schedules, work programs) that define the demand for transportation and reduce individual mobility in private, work-oriented vehicles such as the joint car program.</li> </ul>
2	Regulatory instruments-standards	<ul style="list-style-type: none"> <li>•Includes local international standard.</li> <li>•Traffic movement regulation.</li> <li>•Regulatory measures are used to limit the use of certain motor vehicles, affect the types of vehicles used and specifications that must restrict or require the performance of vehicles and the regulation of roads.</li> <li>•The allocation of roads throughout the separation of public transport routes to avoid traffic congestion by specifying a section of public roads for their own use to ensure a certain speed and regulation of transport without the need for more traffic and movement.</li> </ul>	<ul style="list-style-type: none"> <li>•includes emission determinants and safety.</li> <li>•speed limits, parking, and allocation of road areas).</li> <li>•Exclusive lanes: Part of the road is allocated by means of street signs for the passage of public transport, as it can be open to buses, taxis, ambulances, other buses and others.</li> <li>•Special track: where the lane is separated from the rest of the road.</li> <li>•The allocation of mixed roads: where the general traffic is prohibited by regulatory standards and allocates only to pedestrians and means of transport that travel at a specified speed (and is given priority except at the level of the pedestrian passage), increasing the size of the sidewalks to provide the largest pedestrian areas.</li> </ul>
3	Economic instruments	<p>- Includes fuel tax or fees, road tolls, subsidies, purchase taxes, fees and levies, and emissions costs.</p>	<ul style="list-style-type: none"> <li>•Financing fee: the purpose is to finance the infrastructure of roads or public transport.</li> <li>•Regulatory fee: to regulate traffic and improves traffic by changing the behaviour of the driver.</li> <li>•Environmental fee: to reduce environmental damage (such as pollution, noise). This fee is used to improve the infrastructure and public transport network.</li> <li>•Taxes: A tax on fuel, for example.</li> </ul>
4	Information instruments	<ul style="list-style-type: none"> <li>•Includes public awareness campaigns.</li> <li>•Management of mobility and marketing plans or regulations.</li> <li>•Environmental driving regulations.</li> </ul>	<ul style="list-style-type: none"> <li>•Providing information in a readily accessible manner that can increase awareness of transport alternatives and lead to shifting to walking and cycling, and will provide everything related to improving driving and mobility behaviour.</li> </ul>
5	Technological instruments	<p>Includes improved fuel, clean technologies, and end-of-pipe technology. When mobility or so-called automatic mobility is necessary, technology becomes useful to reduce the effects of carbon emissions, by developing clean fuel and improving the efficiency of vehicles.</p>	



Figure 2: The Main Streets Connected to the Study Area. Searchers

- The next street from Al-Sarafiya bridge: connects Bab Al-Mu'adham area by Al-Karkh areas, such as Al-Ataifiya, Mansour and others.
- The street coming from the Khulafaa intersection: connects Bab al-Mu'adham area by Al-Shorjah and Bab Al-Sharqi.
- The street coming from Al-Nida'a mosque and extended in the area of Al-Waziriyah and reaching to the area of Bab al-Mu'adham.

#### 4. Data collection of the traffic volumes

This research is based on the traffic volumes of the intersection of the Faculty of Fine Arts as follows:

- The survey time was (7:00 am - 5:00 pm) during official working hours of the week (Table 2).
- Calculating traffic volumes using the manual counting of the various vehicles classified into passenger cars, public transport vehicles, and a few heavy vehicles that were converted to passenger cars by multiplying them with the factor Passenger Car (2.0).
- The highest traffic volume in this intersection was adopted in the analysis process, which was 5843 vehicles per hour for the period from 9 am - 8 am, is the peak period for this intersection as shown in Table 3.
- Highway Capacity Software (HCS) was used to calculate the level of service at this intersection and according to traffic surveys.

Table 4 shows the level of service (LOS) at the intersection of the College of Fine Arts with the adoption of the HCS program. The level of service of the intersection, in general, was at level F, the two approaches extending from Palestine street and from Al-Sarafiyah Bridge were the worst in terms of LOS (LOS F), while the LOS was (E) in the path extending from Al-Waziriyah towards the study area. The

level of service in the path coming from the intersection of Al-Khulafa'a intersection to the study area was (D).

#### 5. The extent of the application of control devices

##### 5.1 Planning tools

Are done through the following:

- Bringing the population closer to the activities in the area of Bab Al-Mu'adham: Bab al-Mu'adham is the center of the city of Baghdad. It includes multiple activities with high building density.

**Table 3:** Traffic volumes for each hour in the study area

Time	Pc %	Taxi %	Minibus %	Bus %	Truck %	Traffic volumes Pc/h
7:00-8:00 am	26	30	29	3	3	5718
8:00-9:00	35	30	33	2	0	5843
9:00-10:00	35	35	29	1	0	3859
10:00-11:00	40	33	26	1	0	2752
11:00-12:00	39	32	28	1	0	2982
12:00-1:00 pm	36	30	33	1	0	2940
1:00-2:00	35	32	30	2	1	3832
2:00-3:00	36	30	30	3	1	5706
3:00-4:00	40	31	24	1	4	2716
4:00-5:00	48	40	20	1	1	2655

**Table 4:** Level of service in the study area

Approach	Lane width	No. of lane	Movement	Saturation flow rate (vph)	Average delay sec/veh.	LOS
From Turkish embassy	12	4	TH	3234	233.2	F
	12	4	L	3130		
From al-Sarafiya intersection	12	4	TH	3150	188	F
	12	4	L	4025		
From al-wazirya intersection	12	4	TH	3200	61.8	E
	12	4	L	1612		
From al-kolafaa intersection	12	4	TH	4298	41.9	D
	12	4	L	3088		
Average intersection delay					164.8	F

This activity can be done by adopting expansion policies such as smart growth, new urbanization and increasing integrity within the region, however, its application needs a high financial budget to acquire the main sites, as well as organization and planning in line with the idea of bringing the population closer to the events.

- Establishing parking spaces around the city of Baghdad: it is needed to transfer Bab al-Mu'adham area to a public transport center, which includes multiple means of transport such as a metro and large public transport vehicle, as well as connecting them with the main positions at the entrances of the city of Baghdad, as shown in Figure 3.
- The development oriented towards Transportation: Bab Al-Mu'adham is a suitable environment to be developed towards a public-transport-oriented zone due to the existence of multiple activities that can be organized by adopting walking zones which are compatible with public transport throughout preventing private cars from entering the area and by establishing a parking area for public transport vehicles near the educational and health complex of the faculties and the Ministry of Health, as well as the

existing Bab al-Mu'adham car park, which serves a numerous colleges and business activities in the region, along with the walking routes to the enclosed parking areas (Figure 4). The pedestrian corridors are organized and planned to provide a comfortable and convenient environment for pedestrians with all the required facilities.

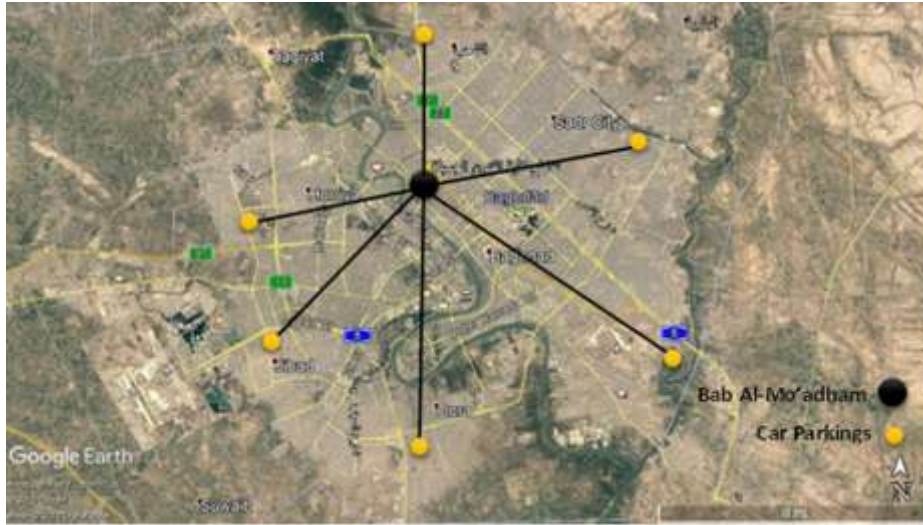
##### 5.2 Organizational tools

- The study area is suffering from the lack of regulatory tools such as the determinants of emission, speed, or the quality and age of vehicles.
- There are no separated public transportation routes that give priority to public transport.
- There are no determinants for the quality and quantity of public transport in order to achieve a level of user satisfaction required to encourage them to shift to public transport, although the area is known to have a large public transportation garage.
- Traffic regulation by the concerned authorities is very weak, therefore there is an overlap in the movement of vehicles in a confusing way for the drivers. This may

increase the possibility of traffic accidents.

- There are using what so-called (car sharing) in this area enables students to transport to their educational institutions in the region. The study area is characterized by the existence of educational institutions and some

integrated educational complexes. This is a positive indicator, but it lacks regulation and the establishment of some limitations to the entry of private vehicles that do not follow the principle of sharing.



**Figure 3:** The Main Parking Sights in Baghdad City.



**Figure 4:** The Suggested Development Oriented Towards Transportation

### 5.3 Economical tools

Generally, these tools are very limited in the country except for the private garages that receive only the car parking fees.

### 5.4 Information tools

- There is a lack of knowledge about the importance of public awareness campaigns, mobility management and marketing plans or regulations that encourage the development of alternatives to environmentally friendly modes of transport. There are no cooperation agreements with regard to goods related to the transport sector, reducing the use of private vehicles or improving the level of transport. Moreover, there are no environmental driving regulations.
- It is difficult to provide easily accessible information.

- Lack of awareness of transport alternatives and encouragement of shifting to walking and cycling, because of the lack of an environment conducive to the transformation of these alternatives, as well as their poor infrastructure.
- There is no involvement in providing everything related to improving driving and mobility behaviour, thus reducing fuel consumption.

### 5.5 Technological tools:

The country is still far from modern technologies of improving fuel, renewable or environmentally friendly fuel alternatives, or other technology uses that reduce traffic congestion.

The application of sustainable transport tools in the study

area will reduce the number of private car trips and increase public and sustainable transport and thus improve the level of service at the intersection of the Faculty of Fine Arts and Bab Al-Mu'adham area in general.

### 6. SWOT analysis for the study area

The study area is analyzed according to the SWOT analysis to an internal environment that shows strengths (S) and weaknesses (W), as well as the external environment of opportunities (O) and expected risks (T) in the study area and as in Table 5.

The SWOT analysis shows that sustainable transport tools can be applied in the study area because of many strengths and opportunities, at the same time, vulnerability and risk factors need to be addressed through:

- Developing a strategic plan for the sustainable transport of Baghdad in general and Bab Al Mu'adham in particular, which aims to implement sustainable transport tools for the purpose of reducing congestion and pollution resulting from vehicles.
- The need to put laws and legislation for the plan of sustainable transport and encourage the use of means that reduce the use of the private car.
- Preparing of a local framework for sustainable transport in Iraq in general.
- Allocating a special financial budget that includes the government and private sectors to promote sustainable transport.
- Prepare sustainable plans in the transport sector put by specialists in the academic and technical sector of the Iraqi transport sector.

**Table 5: SWOT analysis for the study area**

<i>Internal environment</i>	
<i>Strengths</i>	<i>Weaknesses</i>
<ul style="list-style-type: none"> <li>• The good geographical location of the study area.</li> <li>• The existence of Bab Al-Mu'adham for public transport.</li> <li>• The multiple land activities and uses.</li> <li>• The availability of specialized technical and scientific staff to prepare future plans for sustainable transport.</li> <li>• The low cost for public transport services (passenger pricing).</li> <li>• Developing the transportation system for the city of Baghdad towards sustainable transport.</li> <li>• A commercial, educational, health and administrative environment.</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of modern and sophisticated infrastructure and technology.</li> <li>• Lack of a strategic plan to develop the study area.</li> <li>• there is only one public transport method in Baghdad (minibuses).</li> <li>• Poor transport and traffic network in the study area.</li> <li>• Lack of coordination between the various institutions concerned with transport (Municipality of Baghdad and traffic management).</li> <li>• Lack of traffic management systems as an intelligent system.</li> <li>• Lack of traffic signs.</li> <li>• There are no corridors designated for public transport.</li> <li>• Weak public transport services and lack of integration.</li> <li>• There is no parking policy in the study area.</li> <li>• Lack of involvement of the owners of scientific knowledge (universities) in the preparation of transport plans, especially sustainable ones.</li> <li>• Lack of training programs for staffs planned in government transport departments and the difficulty of adapting employees with sustainable planning.</li> </ul>
<i>External environment</i>	
<i>Opportunities</i>	<i>Threats</i>
<ul style="list-style-type: none"> <li>• The possibility of modernizing the transport system to attract public transport with modern technologies.</li> <li>• The possibility of applying strict traffic laws.</li> <li>• Development of areas surrounding the study area.</li> <li>• An attractive environment for public transportation in the study area.</li> <li>• Increasing the demand for transportation in the study area.</li> <li>• Global trends in sustainability and sustainable transport.</li> <li>• Developments and updates in the field of information and technology in the transport sector.</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of an institutional framework for sustainable transport.</li> <li>• Poor funding for the transport sector.</li> <li>• Non-investment of the private sector in the transport sector.</li> <li>• The fluctuation of political stability and weak security and stability.</li> <li>• The financial crisis.</li> <li>• Lack of government funding to address congestion and pollution.</li> <li>• The difficulty of acquiring land in the study area.</li> <li>• Lack of deterrent penalties for violators of traffic laws.</li> <li>• the increasing demand for transport in the study area using private cars.</li> <li>• The weakness of the laws and regulations of the public transport sector.</li> </ul>

### 7. Conclusions

The entire research is aimed to outline a set of measures that, assembled in a logical way, allowing considerable development in planning and in the sustainability of urban transport systems of Baghdad City. According to the analysis of the above data and results, the following conclusions can be drawn:

- 1) The low efficiency of the transport network and the level of service in most of the roads and intersections of

Baghdad city. The level of service in the path extending from the University of Mustansiriya towards the intersection of the Faculty of Fine Arts (level F), the path extending from Al-Sarafia bridge towards the same intersection was (F), the path extending from Al-Waziria was (E), and the path extending from A-Kholafa'a intersection was (D). This indicates the amount of traffic pressure on Bab Al-Mu'adham area and the intersection of the Faculty of Fine Arts.

- 2) The existence of tools to improve the level of service in

the transport network that is related to the achievement of sustainability, including planning, regulatory, economic, information and technological tools.

- 3) Iraq is lacking in a strategy, plan and framework for sustainable transport that works on solving traffic problems in modern and sophisticated ways.
- 4) The possibility of applying sustainable transport tools at the intersection of the Faculty of Fine Arts and Bab Al-Mu'adham area in a comprehensive manner, however, this needs for preparing of laws, legislation, financial budgets and strategic plans.

This research concluded that the utilization of sustainable transport measures that decrease the use of private vehicles and the emphasis on sustainable transport can boost the level of service of the transport network and traffic intersections. These outcomes verify the statement that shared transport is of great sustainability amongst urban transport means. Thus, the increase of such transportation mode, in addition to bicycle and pedestrian, can assure an advance in the level of overall sustainability.

## 8. Recommendations

- 1) The development of the Iraqi transport system towards a sustainable multi-modal transport that provides convenient and safe public transport services throughout the development of a comprehensive and integrated sustainable transport strategy and plans with a local framework.
- 2) The establishment of an independent institute for sustainable transport that includes transportation experts from academics and technicians of all universities and government institutions to prepare sustainable plans.
- 3) The progressive application of sustainable transport tools at the intersection of Fine Arts in Bab Al-Mu'adham, such as the regulatory and economic instruments that require procedures and orders from the Municipality of Baghdad, which can be prepared in a simplified manner.

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