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Compliance of Access Management Techniques on Urban Arterial in Nablus City

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Abstract: - Due to the increasing limitation of spaces and resources in most cities, there has been a growing trend in the management of the existing traffic system rather than building new facilities. Traffic management is a low cost improvement while constructing new facilities is capital-intensive and may be faced with the limitations of space and financial resources. The main objectives of this paper are to evaluate and explore the various measures of access management, to evaluate the applicability and effectiveness of some of these measures on one studied arterial. And to get a general idea of how the public will react to applying such measures using field interviews with drivers, pedestrians, and business owners on the studied arterial. After the discussion of the applicability of access management strategies, a set of access management criteria were adopted to be applied on the arterial. It is concluded that some of these measures can be easily applied on certain arterials, others can be applied with limited geometric improvements, and some measures could not be applied because they need large space. The interview results indicates that pedestrian recommendations conform to the main objectives of this study, drivers' indications did not conform to the main goals of this study, since they are local drivers and need a high level of accessibility. Business owners' indications did not conform to the main goals of this study also; they are concerned that changes in direct access to their property, such as closing driveways or installing raised medians, will lead to declines in sales.

Keywords: - *Traffic Management, Access Management, Medians, Driveways, Public Acceptance.*

I. INTRODUCTION

In the past, road improvements were frequently made on an ad hoc basis. They were based on predicted future traffic growth and looked at one problem area rather than the whole route. This piecemeal approach can have the effect of shunting traffic problems further along a road corridor. Transportation management focuses on reducing corridor congestion and improving overall mobility on the existing facility. This alternative includes an integrated package of transportation management strategies that maximize the operational efficiency and person-moving capacity of the corridor by better balancing the demand for travel with the capacity to handle travel demand. Many of these strategies rely heavily on public- private partnerships to achieve desired results.

Transportation management strategies generally exclude extensive infrastructure investments aimed at expanding roadway capacity. Instead, these strategies focus: first, on management of travel demand to reduce the severity and duration of circumstances where travel demand exceeds existing roadway capacity. Modifications to travel demand can include adjustments to travel time (by time-of-day and/or day-of-week), travel route, trip distance (through changes in trip origins and destinations), and vehicle occupancy. Second, management of existing corridor capacity to address locations where relatively minor improvements to the roadway network or highway operations will help address temporary or long-term capacity bottlenecks. Temporary bottlenecks include those caused by incidents, weather, and construction factors.

The traffic management can be divided into two main scales: streets and intersection control. This study discusses traffic management in terms of use of streets especially arterials and major corridors. This embraces solutions for existing arterials. New developments can also be part of this category; however, the focus should be on low cost improvements. Highway functional classification means classifying highways with respect to the amount of access or movement they are to provide, and then designing and managing each facility to perform that function. There are no definite dividing lines between each of the classes or rigid rules defining what makes a street a local, collector, or arterial. The three basic functional classes represent a continuum of facilities that range from unrestricted access to complete access control.

II. DEFINITION OF ACCESS MANAGEMENT

Development of any country now is related to the strength of the transportation sector. Although the level of technology in transportation varies and the needs and demands are expressed differently, the movement of people and goods is essential for human activities and production. Living in any place without streets that connect cities with other cities or villages is impossible. Use of any transportation modes is necessary to

facilitate the accessibility. Therefore, transportation has to be treated as an integral and basic component of any comprehensive development plan.

Access management is a key element in any development plan. There are no international standards to be adopted in any access management project. Historically, some of such projects are done in many countries, and each project is differing from the other according to many factors such as the topography of the area, traffic volume, turning traffic, and public acceptance. In the following sections, brief historical explanations of some access management measures are presented.

Access is the ability to enter or leave a public street from or at an adjacent driveway or another public street. Access management is defined as "the process that provides access to land development while simultaneously preserving the flow of traffic on the surrounding system in terms of safety, capacity, and speed". It is desired to restrict access on rural roads, but when these roads pass through cities, the municipalities must agree to allow access to a business or residence. The application of access management treatments may be long-term when planning or designing the facility, or short-term when evaluating operation and control strategies.

III. STUDY AREA

Palestine is a typical developing country located in a central location in the Middle East. Its significance is represented by its geographic location. Nablus is a major city located in the northern part of the West Bank. Faisal Street is the street that this study will apply the concepts of access management on. This street is divided into two sections. One section extends from the intersection of Tunis Street and Haifa Street in the west to Al-Salam Intersection in the east. The other section extends from Al-Salam Intersection in the west to the office of the Ministry of Education in the east. Faisal Street is a major urban arterial street in Nablus City. It connects the city with cities and villages around it.

IV. ACCESS MANAGEMENT TECHNIQUES

A set of the most important access management measures are explored in the next sections. A final conclusion for adoption of each technique is also identified at the end of each section.

4.1 Traffic Signal Spacing and Coordination

Traffic signal coordination is one of the most widely used traffic management measures. The signals at two or more adjacent junctions are coordinated (linked) on a common cycle time and the relative timings set so that the traffic that leaves one junction arrives at the downstream junction when the signals are green. For a well-designed coordinated signal system, vehicles flow without having to stop at every intersection. MUTCD, 2000 recommends that signals within 0.5 mile (0.8Km) of each other be coordinated on major streets. Intersection spacing is an important measure of access management. As the number of intersections per mile increases, the opportunity for crashes increases. The existence of too many intersections per mile also increases delay and congestion. Colorado and Florida states considered that intersection spacing along major (arterial) urban and suburban streets should follow the pattern ranges from 0.5 to 2 miles (City of Florida and Colorado Regional Government, 1996). Same as the MUTCD (2000), 0.5 mile (0.8Km) between successive signals will be adopted for coordination.

4.2 Corner Clearance

Corner clearance distance is the minimum distance required between an intersection and an adjacent driveway along an arterial road or collector street (see Figure 1).

Figure 1 Corner Clearance

Corner clearance standards vary greatly from city to city and from one street to another, it also depends on the speed limit on that arterial. For instance, the standard in Florida State ranges from 75 feet (23m) (about five car lengths) to 250 feet (76m) (about 16 car lengths) in urban areas. The 250-feet correspond to the minimum distance required to stop a car traveling 35 miles per hour (56kph) (Williams, Kristine M., and

Marshall, Margaret A. 1996). Since corner clearance depends on speed limit, and the speed limit on the studied arterial is 50mph (80kph), so the minimum distance required to stop a car traveling at this speed is 422-feet (130m).

4.3 Raised Medians at Intersections

The adopted standards for medians are based on AASHTO (2001), were median width should be (0.5-9.0m). The width of the deceleration lane should keep storage for one vehicle, this width should be at least 3m, and desirably should equal that of the through lanes. Deceleration length depends or (taper length and turning lane pocket length) is the distance required to stop the vehicle from the deceleration speed 20mph (32kph), which is 111-feet (34m). This length is equal to six vehicles lengths, which is approximately the maximum number of vehicles waiting to turn left or right in the studied street. The width of median nose should be at least 1.2m, a width of 1.8-2.4m is preferable, to provide excellent visibility.

4.4 Continuous Raised Medians and Median Opening

Continuous raised medians with well-designed median openings are among the most important features for managing access to create a safe and efficient highway system. Physical medians prevent accidents caused by crossover traffic, reduce headlight glare distraction, reduce fuel consumption, and separate left-turning traffic from through lanes when combined with left-turn lanes. The raised median prohibits left turns into and out of driveways that may be located too close to the functional area of the intersection. A study was conducted in San Francisco, showed that accidents at four intersections in this city dropped 52 to 38 percent after turn restrictions were implemented (Jonathan Reid, 2000).

Because of such limitations, businesses and land owners oppose a raised median project if they believe it will limit access to their property, especially if they perceive it will block customers trying to make left turns into their property. Florida Department of Transportation (1997) recommended one-half mile (0.8Km) spacing between full median openings and one-quarter mile (0.4Km) spacing between directional median openings on major arterials.

The adopted standards for median openings along the studied street will be based on AASHTO standards presented on (Table 1). A separate minimum width of each opening will be adopted according to the width of the median and the shape of the median end.

Table 1 Minimum Median Opening Length

Metric			US Customary		
M Width of median (m)	L = Minimum length of median opening (m)		M Width of median (ft)	L = Minimum length of median opening (ft)	
	Semicircular	Bullet nose		Semicircular	Bullet nose
1.2	28.8	28.8	4	96	96
1.8	28.2	22.8	6	94	76
2.4	27.6	20.4	8	92	68
3.0	27.0	18.6	10	90	62
3.6	26.4	17.4	12	88	58
4.2	25.8	15.9	14	86	53
4.8	25.2	15.0	16	84	50
6.0	24.0	13.2	20	80	44
7.2	22.8	12.0 min	24	76	40 min
8.4	21.6	12.0 min	28	72	40 min
9.6	20.4	12.0 min	32	68	40 min
10.8	19.2	12.0 min	36	64	40 min
12.0	18.0	12.0 min	40	60	40 min
15.0	15.0	12.0 min	50	50	40 min
18.0	12.0 min	12.0 min	60	40 min	40 min
21.0	12.0 min	12.0 min	70	40 min	40 min

Source: AASHTO, 2001

Notes:

- There is no difference between opening at intersection or for U-turn. Openings for one-way driveways should be more than half the above values.
- For medians about 1.2m wide there is no difference between the two forms of median end. For median width of 3.0m or more the bullet nose is superior to the semicircular end.

4.5 Driveway Turn Radius

Driveway entrances with longer turn radii help slower, turning traffic move off the arterial more quickly. They also help traffic leaving a driveway turn and enter the stream of traffic more efficiently.

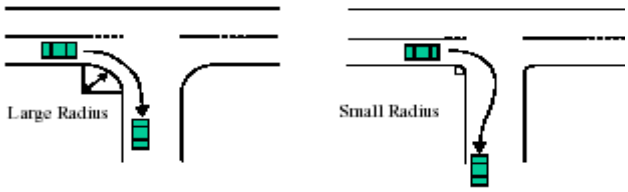

Figure 2 Large and Small Turning Radiuses

It is recommended a minimum 25 feet (7.6m) turn radius in urban areas, although a 35 feet (10.7m) radius may be needed to accommodate buses and single unit trucks. In most suburban settings, 25-50 feet (7.6-15.2m) radii are desirable. A minimum 15 feet (4.6m) radius is recommended in areas of heavy pedestrian traffic such as business districts and school crossings. (Oregon State University, 1998). Proper turning radii should be designed to accommodate the largest vehicle generally expected to use the driveway. The design vehicles that use the studied driveways are single unit trucks with 15m turning radii.

4.6 Driveway Grade and Driveway Width

Driveway grade is important because it affects speed differential. The steeper the driveway, the greater the reduction in speed required to prevent "bottoming out." (Table 2) shows typical driveway entry speeds for varying degrees of driveway grade.

Table 2 Variation of Driveway Entry Speed with Its Grade

Driveway Grade Change (percent)	**Typical Driveway Entry Speed (mph)**
Greater than 15	Less than 8
14-15	8
12-13	9
10-11	10
8-9	11
6-7	12
4-5	13
2-3	14
0-2	Approximately 15

Source: Oregon State University, 1998.

The (ITE Guidelines for Driveway Location and Design, 1987) recommends the following initial driveway grade angles (Table 3), these grades were all chosen to keep the speed differential at or below 20 miles per hour (32kph).

Table 3 Change of Grade According to Roadway Type

Roadway Classification	Desirable Change in Grade (percent)	Maximum Change in Grade (percent)
Major Arterial	Less than 3	5
Minor Arterial	Less than 4	5
Collector	Less than 5	6
Local	Less than 6	8

Source: ITE Guidelines for Driveway Location and Design, 1987.

Vehicles must slow to a greater extent to negotiate narrower driveways than wider driveways. The optimal width for a one-way in or out driveway is 14- 16 feet (4.3-4.8m). (National Cooperative Highway Research Program (NCHRP), 1987). Very gentle driveway grades should be selected, with maximum change in grade of less than four for minor arterials, to keep smooth entrance to the arterial and for drainage (ITE, 1987). A proper driveway width should be designed, neither narrow nor too wide. Driveways may vary in size depending on the number of lanes needed. Driveways in the studied street can be either one-way in or out with optimal width of 14-16 feet (4.3-4.8m), or two-ways with one lane per direction, with each lane being at least 11 feet (3.3m) wide.

4.7 Driveway spacing

Maintaining an adequate spacing between commercial driveways is one of the most critical aspects of access management. Motorists turn left and right into and out of driveways when permitted. Traffic turning into and out of driveways moves more slowly than through traffic. This speed difference produces conflicts that may lead to broadside and rear-end collisions between vehicles. It is known that roadways with a large number of closely spaced driveways are always less safe than similar roads where driveway access is more limited.
There are no hard and fast guidelines for driveway spacing, and spacing requirements vary considerably from place to place. However, Table (4) is used by two local governments in Florida and Ohio (Tallahassee, and Cincinnati Regional Governments, 1996). As the posted speed limit rises, the recommended spacing between driveways increases, and the number of driveways per mile or block falls to accommodate the increased spacing.

Table 4 Florida and Ohio Standards for Driveway Spacing of the Highway Systems

Posted Speed on Arterial Street (mph)	Centerline to Centerline Driveway Spacing (feet)	Approximate Number of Driveways per 500-foot Block Face
20	85	About 6
25	105	5
30	125	4
35	150	3
40	185	3
45	230	2
50	275	Fewer than 2

Source: City of Tallahassee, Florida (1996), and OKI Regional Government, Cincinnati, Ohio (1996).

Minimum stopping sight distance can be used to determine the spacing between driveways. Based on minimum stopping sight distance with 50mph (80kph) design speed on the studied street, the adopted minimum driveway spacing is 422ft (130m). Comparing this result with the USA standards mentioned before, this value is appropriate and can be adopted.

V. COMPLIANCE WITH ACCESS MANAGEMENT TECHNIQUES ON THE STUDIED STREET

The compliance with the following access management measures on the studied arterial will be evaluated:

- Medians at Intersections
- Median Opening
- Driveway Spacing

5.1 Medians at Intersections

Along Faisal Street, the continuous median in the first section has a width ranges from (0.5-5m). The raised median at intersections has (15-23m); deceleration lane length; these lengths are smaller than the standard length, except for one location in the west of Al-Salam intersection (# 10 in Figure 3), which has a length of (40m). The deceleration lane is (2m) width; this width is smaller than the standard width, but it can be increased easily.

5.2 Median Opening

In the studied streets, median opening satisfied the basic guidelines for median opening placement principles, median breaks are provided at some road intersections, and there are few driveways that median do not have a break. Tables (5) present the width of median opening along the studied street. Note that minimum length of opening depends on the width of the median (m) and the shape of median end either semicircular (S.C) or bullet nose (B.N); the locations of medians opening are numbered according to Figure 3.

5.3 Driveway Spacing

The spacing between the adjacent driveways and the distances between the intersections and the next driveways are listed in Table (6). Along Faisal Street, distances between driveways are greater than the minimum spacing between driveways 422ft (130m), distances between driveways 10/11 and 11/12 are less than the standard, and driveway number 11 can be closed easily.

Table 5 Median Opening on Faisal Street

Opening	Median	End	Minim. Required	Existing Opening	Compliance

#	Width	Shape[a]	Opening Width (m)	Width (m)	
1	2.0	B.N	21.0	23.0	Yes
2	2.5	S.C	13.7	9.0	No
3	3.0	S.C	13.5	10.0	No
4	3.0	B.N	18.6	15.0	No
5	2.5	B.N	10.0	7.0	No
6	3.0	B.N	18.6	25.0	Yes
7	2.8	B.N	9.0	6.0	No
8	4.5	S.C	7.7	21.0	Yes
9	5.0	B.N	14.5	15.0	Yes
10	2.0	B.N	21.0	30.0	Yes
11	1.0	B.N	14.4	15.7	Yes
12	1.0	B.N	14.4	14.0	No
13	1.0	B.N	28.8	13.0	No
14	2.0	----	For Pedestrian	5.0	Yes
15	20.0	B.N	12.0	14.0	Yes
16	20.0	B.N	12.0	18.5	Yes
17	20.0	B.N	6.0	12.3	Yes
18	20.0	B.N	6.0	7.5	Yes
19	20.0	B.N	6.0	11.3	Yes
20	20.0	B.N	6.0	9.3	Yes
21	20.0	B.N	6.0	9.5	Yes
22	20.0	B.N	6.0	10.5	Yes

[a] B.N: Bullet Nose; and S.C: Semicircular

Table 6 Driveway Spacing on Faisal Street

Driveway Number	Spacing (m)	Compliance	Driveway Number	Spacing (m)	Compliance
1-2	385.0	Yes	9-10	290.0	Yes
2-3	253.0	Yes	10-11	120.0	No
3-4	310.0	Yes	11-12	90.0	No
4-5	162.0	Yes	12-13	160.0	Yes
5-6	392.0	Yes	13-14	170.0	Yes
6-7	180.0	Yes	14-15	230.0	Yes
7-8	140.0	Yes	15-16	200.0	Yes
8-9	220.0	Yes	16-17	290.0	Yes

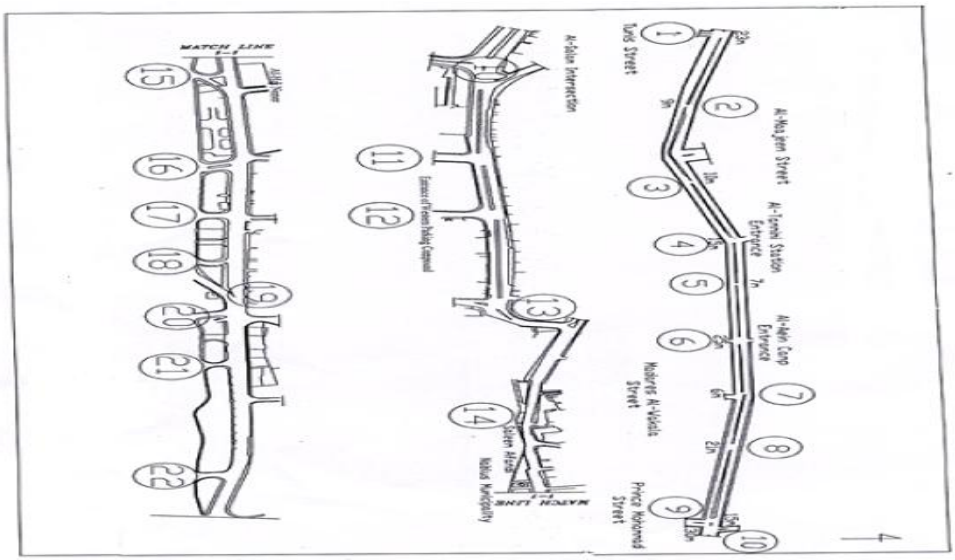

Figure 3 Median Opening on Faisal Street

VI. SURVEY OF USERS' PERSPECTIVES

This survey was done to present users' trends about the subject of this study, and not to reach to final conclusions, since the sample size is not statistically representative. Therefore, it is intended only to get a general idea of how the public will react to applying such measures. The form was prepared to measure people's perspective about access management measures. A sample size of 100 person was taken, and the form was distributed to drivers, pedestrians, and business owners on the studied arterial.

Drivers at some taxi/bus garages were asked about their perspectives. Some forms were distributed to private vehicle drivers who were parking their vehicles near commercial centers. Pedestrians walking along the streets were asked about their opinions. Interviews were done with some business owners, whose business is near the studied street. The interviews were done face-to-face with these groups; an Arabic clarification about these measures and the main goals of this study was explained, because it is not easy for the public to understand the form requirement. The results of the drivers, pedestrians, and business owners are shown in Tables (7,8,9) respectively.

Table 7 Drivers Trends towards Access Management

#	Access Management Measure	Condition			
		Appropriate	Need Adjustment	Not Appropriate	Don't Know
1	Location of Median Opening	24%	34%	42%	0%
2	Width of Median Opening	82%	13%	0%	5%
3	Driveways Spacing	36%	20%	30%	14%
4	Continuous Raised Medians	56%	26%	13%	5%
5	Pedestrian Safety Aspects	12%	32%	56%	0%
6	Parking Availability	13%	56%	21%	0%
7	Sidewalks Continuity	13%	67%	20%	0%

*Sample size=40 drivers

From Table (7) and based on the interviews, drivers suggest to increase the number of median opening, not closing any of the driveways at the street, and increase on-street parking. Drivers indicate that sidewalks need adjustment and pedestrian safety aspects are not appropriate.

Table 8 Pedestrian Trends towards Access Management

#	Access Management Measure	Condition			
		Appropriate	Need Adjustment	Not Appropriate	Don't Know
1	Location of Median Opening	69%	31%	0%	0%
2	Width of Median Opening	44%	37%	13%	6%
3	Driveways Spacing	19%	75%	0%	6%
4	Continuous Raised Medians	56%	19%	19%	6%
5	Pedestrian Safety Aspects	13%	81%	6%	0%
6	Parking Availability	13%	37%	50%	0%
7	Sidewalks Continuity	25%	44%	19%	12%

*Sample size=30 pedestrians

Table 9 Business Owners Trends towards Access Management

#	Access Management Measure	Condition			
		Appropriate	Need Adjustment	Not Appropriate	Don't Know
1	Location of Median Opening	86%	14%	0%	0%
2	Width of Median Opening	82%	18%	0%	0%
3	Driveways Spacing	55%	32%	13%	0%
4	Continuous Raised Medians	27%	55%	9%	9%
5	Pedestrian Safety Aspects	9%	59%	32%	0%
6	Parking Availability	59%	27%	14%	0%
7	Sidewalks Continuity	5%	59%	36%	0%

*Sample size=30 business owners

From Table (8) and based on the interviews, pedestrians suggest increasing driveway spacing, limiting median opening, increasing safety measures for them and for the drivers, enhancing sidewalks continuity, and

increasing sidewalk clear width. From Table (9) and based on the interviews, business owners preferred to break the median in front of their shops and increase parking spaces. They indicated that median opening locations and widths are good. They also suggest enhancing sidewalks continuity and increasing safety measures for pedestrians.

Some public recommendations conform to the main objectives of this study, especially the pedestrian indications. Drivers' indications did not conform to the main goals of this study, since they are local drivers and need a high level of accessibility. Business owners' indications did not conform to the main goals of this study also; they are concerned that changes in direct access to their property, such as closing driveways or installing raised medians, will lead to declines in sales. The limited education and knowledge of the benefits of some access management measures is expected to be the main reasons of drivers and business owners' indications.

VII. CONCLUSION

Based on the analysis presented in the study, several conclusions were reached. The conclusions are:

- There are no specific guidelines or standards that are universally adopted for some access management measures. Therefore, it was necessary to adopt criteria for the studied arterials to evaluate their compliance with access management.
- The level of compliance of the studied arterial with access management measures are relatively acceptable, as median opening, width and location, and driveway spacing conform to adopted standards.
- Access management measures can be applied on the studied street, some measures are easily applied (such as driveway spacing and median opening), others can be applied with little geometric improvements (such as driveway related issues), and some measures could not be applied (such as frontage and backage roads) because they need large space.
- It is difficult to apply access management measures on urban arterials, especially near the CBD area, where space is limited and the need for accessibility is high, while it is much easier on rural arterials.

As a result, the following recommendations were depicted:

- It is concluded that the proposed improvements produced good results on the network level, therefore, it is recommended to adopt these improvements and apply them to the actual network.
- There is a lack of knowledge among public in the road sector about access management and its applications. Therefore, it is recommended that these officials consider the access management techniques listed in this study and evaluate it in other cities.
- The access management measures standards should be adopted by the Municipalities when constructing new arterials or evaluating the existing streets, considering the effect of the related variables.
- Since this study focused on the general concepts of access management, it is recommended for other studies to discuss specific measures of access management in details and to explore establishing standards that is appropriate for an city conditions.
- It is recommended to conduct traffic impact studies for future land developments including access management's projects, to mitigate resulted traffic impacts.
- It is recommended to conduct a comprehensive study about the public opinions and acceptance of applying access management techniques on urban arterials in the cities.
- Public involvement should be seriously considered when applying access management because they are impacted by these measures. Therefore, it is important to obtain their support in order for the project to succeed.

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