

Characteristics of Parking Garages within Multi-story Building in Duhok CBD Area

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Abstract

In this study, four multi-story building parking garages located within the CBD area of Dohuk city had investigated for different characteristics of parking behavior for user. Parking accumulation, volume, walking distance to destination point, turnover, duration, and mode of travel were investigated within the duration from 9:30 a.m. up to 4:30 p.m. Trip purpose were introduced within a special interview form used to collect the necessary parking data from each facility users. Figures, and tables presented out of this study demonstrate that the amount of spaces provided on the three parking facilities were about 717 spaces with peak demand already taking place at mid-noon. Average walking distance concluded was 155m and four hours as an average parker duration. Average turnover obtained out of the data analysis was 1.09 vehicles /one space.

دراسة لمواقف المركبات متعددة الطوابق الواقعة في مركز المدينة

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الخلاصة

في هذه الدراسة، تم إجراء التحريات لثلاثة أبنية متعددة الطوابق لمواقف المركبات والواقعة ضمن الرقعة الجغرافية في المركز التجاري لمدينة دهوك لدراسة مختلف الخواص الهندسية لها والمتأثرة بطبيعة تصرف السواق المستخدمين. تم جمع بيانات حول تراكم وقوف المركبات، حجوم التوقف، مسافة السير إلى منطقة الهدف، عدد مرات تبادل نفس الموقف، الفترة الزمنية للوقوف، وأنواع المركبات المتوقفة ما بين 9:30 صباحا و 4:30 مساء. الغرض من الرحلة والذي تم التعرف عليه من خلال استبيان خاص تم القيام به باستخدام استمارة خاصة بذلك لكل من المستخدمين للمواقف. النتائج والجداول المستحصلة والمعروضة في هذه الدراسة توضح بأن عدد المواقف المتوفرة للأبنية المتعددة الطوابق الثلاثة كانت 717 موقفا وأن ساعة الذروة للازدحام هي في منتصف النهار. معدل مسافة المشي المستنتجة من هذه الدراسة هي 155 متر تقريبا ومعدل فترة التوقف أربع ساعات. معدل عدد تبديل المواقع التي تم الحصول عليها من تحليل البيانات كانت 1.09 مركبة لكل محل وقوف.

Received: 9 – 1 - 2011

Accepted: 1 – 8 - 2011

General

Multi-story parking building garages have been constructed in many urban, and suburban locations where land values are high, and in areas where land is in short supply that permit a more intensive use of space. There are three important factors to be considered when designing a multi-story car park (Davis, 1968)

- 1-parking demand that, must be curtailed locally;
- 2-simplicity, and short time in parking and un-parking; and
- 3-constuction and parking operating cost.

However, construction, maintenance, and operating costs will be significantly greater with single- level parking garage, improved security, and better quality facilities are also seen as more important than the cost of parking itself. The majority of multi-story parking garage users would be willing to pay up to 10 percent more for parking if site owners, in turn, installed improved staff, (Morgan,1999),(IHT,1987). Thorough examination of the Dohuk City Central Business District (CBD), especially on multi-story building parker characteristics such as, dominant trip purpose to look for a parking space, origin of trip maker as it is related to trip distance, parking duration which is affecting positively the mount of parking load, and walking distance to the destination points which is the most important parameter in selecting the parking lot or garage to hide his or/her car, are the most important factors to be considered in locating new parking facilities. Usage of existing facilities as measured by the accumulation, and turnover of parked vehicles, are considered as a good indicators on the amount of demand for parking space. Dohuk city has experienced an extremely high growth population as well as vehicles during the last decade. Also, it has a special distinct geographical location, which caused a lot of transportation to be executed through the city and the occurrence of high density business opportunities in the city center. To perform this study, the CBD area located within Dohuk city was investigated as it contains four main multi-story garages. The CBD area is containing adversity of commercial activities, and different land uses, in addition to many important offices, and governmental buildings, that attract a large numbers of vehicle trips causing traffic jam within the CBD road network curbs, lots, and garages, and relationship between these characteristics as well.

Problem Definition

As the city of Dohuk is going to grow, competition about the land use has increased at a rapid rate as well as the increase in land cost located in the CBD creating a major problem to build a multi-story parks to accommodate the shortage in parking spaces. This study was planned to understand the main physical characteristics of the CBD area multistory parking garages, such as rare parking spaces with no real program for regulation, and efficiency in parking spaces utilization is handled as well. Effect of parking characteristics on the general performance of parkers, their habits, and desire to park at certain location whether multi-story parking garage or a lot off-street parking, can be understood out of this study too.

Study Area

The study area selected for conducting this parking study includes three zones (1,2, and 3), and a part of zone (6) out of the twenty five zones of Dohuk city master plan shown in Figure (1), (DMD,2010). Study area was divided into (9) sectors as illustrated in Figure (2), enclosed by according to the Duhok Municipality district distribution within the city master plan (DMD, 2010). Gully Dohuk rotary from the north east, Ahmady-Khany intersection from the north west. Shimik-Zara interchange is bounding the study area from the south east, and Showrash rotary from the south west. All parking studies considered CBD of cities and

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district centers as characterized by dense development , tall building, central governmental function rising land values ,and parking facilities cost (Taha,1983).

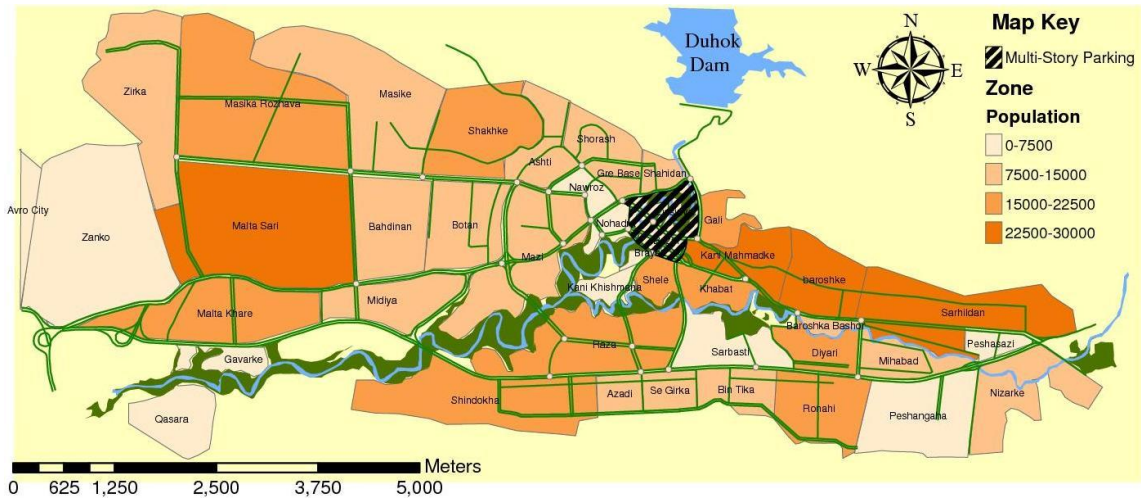


Figure (1): Duhok City Layout Map Showing the Study Area(2010) [10]



Figure (2): Locations of the Selected Multi-Story Parking Facilities within CBD Area in Duhok City(2010)⁽¹⁰⁾

Method of Study

This parking study is conducted in order to accumulate essential information in developing a view about parking problems and to establish parking requirements through determining major multi-story parking characteristics in Dohuk City center.

Four types surveys were carried out in the period between November 2007, and January 2008. These surveys included parking inventories, accumulation counts, license plate surveys, and interview survey. Study area was divided into (9) sectors, and code identifies each sector as shown in Figure (2).

Data Collection

To conduct a parking inventory, a certain form was prepared and used to cover multi-story parking facilities located within the study area. The form contained information about the location, name of facility type, payment and other relevant questionnaire.

Dimensions of each facility measured and used to determine the plan dimensions, and area of each facility. Facility (1, 2, and 3), were only investigated in this study, but facility (4), could not be investigated as its owner was not cooperative with the inventory team. Table (1), shows the calculated capacity area, and average parking space dimensions of each multi-story parking facility.

Table (1): Calculated Capacity of the Selected Multi-Story Parking Facility Within Study Area (Dohuk 2008)

Facility No.	Facility Name	Total Parking Area (m ²)	Number of Spaces	Parking/One Space Dimension
1	Bra	5148	312	5.0x3.3m
2	Dohuk	2154.6	105	5.4x3.8m
3	Zozan	4500	300	5.0x3.0m

Parking accumulation is the number of parked vehicles in an area at any specified moment. It can be divided into journey purpose categories i.e., shopping, work, business, etc. (Pegnatrio, 1973). Manual count of all vehicles parked conducted in the three facilities. An observer covered each location, and counts started from 9:30 a.m., up to 4:30 p.m., at half hour intervals as this duration of the day is representing the major parking activities period in the city as mentioned by Nahla A. (9, 2004)

License plate survey was conducted in order to measure time length vehicles parked and rate of usage of space in each facility. This survey was implemented for (7) hours between 9:30 a.m., and 4:30 p.m. due to the same above reason, too. Last four license numbers were recorded by two observers stationed at the entrance of each facility, one recorded license number with time of arrival of vehicles to the park, and the other recorded the license number with the time departure from each facility. Two forms of data survey were used for this purpose (ITE, 1984). Matching of the two forms was undertaken to obtain parking duration for each vehicle parked.

Interview survey was made in order to obtain the distance that a vehicle occupants walk from their origins up to their parking space destinations, or from destinations up to their trip origins. The purpose of each trip collected and the origins and next destinations of each trip maker obtained by one interviewer for every 10 spaces (Kadiyali, 1999). Interviewers asked politely parkers about their origin, destination, and trip purpose, vehicle classification (i.e., private, taxi, pick-up), and recording vehicle license number. This survey was conducted within the same (7) hours of license plate survey discussed above. From the total number of

parkers (782) obtained, only (102) parkers of them (i.e., 13.04 percent of the total), were interviewed. Some people refused to read or answer the asked questions.

Data Analysis and Results

Multi-Story Supply

Parking inventory for the existing parking supply carried out on the three multi-story parking facilities revealed that, the total spaces provided were equal to (717) spaces. Total spaces provided are including (105) spaces in Dohuk ,(300) spaces in Zozan ,and (312) spaces in Bra/ multi-story parking. Zozan parking facility , which is privately owned ,publicly used ,operated by attendant ,opened along 24 hours of the day ,and parking fees of I.D.,1000 per one parking space .Dohuk ,and Bra parking facilities which along 24 hours of the day ,and the parkers charged with fees of I.D.,1000 per one parking space ,and I.D.,50,000 per one month. The percent of total number of spaces available, and practical capacity of each facility shown in Table (2). It can be noticed that, the available capacity is much more than the practical capacity, and this means that there is under loading with vehicles using the multi-story parking buildings.

Table (2): Available and Practical Capacity for the Selected Multi-Story Parking Facility (Dohuk 2008)

Facility Name	Facility No.	Available Capacity in spaces	Percentage of Total Spaces	Operational Capacity Surveyed in (pcu)
Bra	1	312	43.52	148
Dohuk	2	105	14.64	111
Zozan	3	300	41.84	90

Parking Characteristics

Information on parking characteristics is necessary in the formulation of parking programs, to provide basic data for the planning, and design of parking facilities. Some items related to parking characteristics are (Nahla, 2004):

1- Parking Accumulation

Accumulation data for total parking facilities study is summarized in Figure(3). The figure shows that, Bra facility accumulates the highest number of vehicles during the period of study from 9:30 a.m., and 4:30 p.m., the three facilities are accepting an increasing number of vehicles are going to accumulate. Peak p.m., periods are showing peak accumulation too, which the second is p.m., peak period of loading happen during 4:30 p.m. hour of accumulation.

Table (3), shows the parking index (i.e., parking efficiency factor).Dohuk facility is showing the highest efficiency of accepting parkers, especially during the Noon period from (11:00-12:00) a.m., The other two facilities (i.e., Bra, and Zozan) are showing less efficiency in accepting parkers trying to park on their spaces.

Parking indices at p.m., periods between (3:30 -4:30) p.m. hours are higher for Dohuk than other two facilities due to higher vehicle accumulation on it.

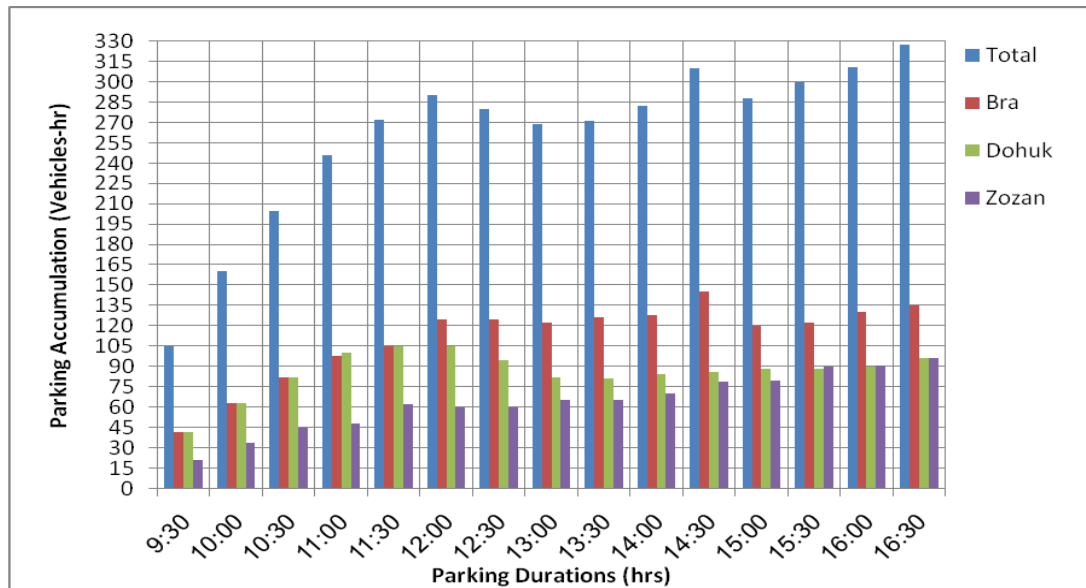


Figure (3): Parking Accumulation of Vehicles on the Selected Multi-Story Parking Facility Within Study Area(Dohuk 2008)

Table (3): Parking Index Values on the Selected Multi-Story Parking Garages Facility(Dohuk 2008)

Time	Parking Index			
Facility Name	Bra	Dohuk	Zozan	Total
9:30 a.m.	14.74	39.05	8.00	15.48
10:00	20.83	64.76	12.33	23.71
10:30	27.24	79.05	15.33	29.85
11:00	32.37	100.00	18.67	36.54
11:30	36.54	105.71	21.00	40.17
12:00	43.59	104.76	20.33	42.82
12:30 p.m.	41.35	96.19	19.67	40.31
1:00	41.03	78.10	22.00	38.49
1:30	40.06	70.48	20.00	36.12
2:00	41.03	70.48	23.67	38.08
2:30	44.23	79.05	25.33	41.42
3:00	47.12	83.81	25.67	43.51
3:30	43.59	94.29	30.00	45.33
4:00	45.83	88.57	30.00	45.47
4:30	47.44	101.9	27.00	46.47

2-Parking Volume

Parking volume is defined as the total number of vehicles parking in the selected study area over a given period of time (Pegnatario, 1973). Total number of vehicles parked at the three multi-story facilities counted by license plate survey equal to (275) parkers in Dohuk, (186) parkers in Zozan, (321) parkers in Bra facility .This means that, the total parking volume was (782) parkers during (7) hours .

3-Space-Hour Usage

It means one parking space for one hour. Space-hour usage, and percentages of parkers using multi-story parking spaces for different duration are shown in Table (4). Maximum values of space-hour usage were obtained at (5.5) hours parking duration for the three parking garages. Bra facility is attracting the highest number of parkers traveling to downtown traffic zones as shown in table (4). It can be noticed that, there is a significant increase in space-hour percentages as parking duration increase.

Table (4): Percentage of Parkers and Their Space-Hour Usage at Different Durations for the Selected Parking Facility(Dohuk 2008)

Duration (hr)	Bra		Dohuk		Zozan		Total	
	Parkers	Space-Hour	Parkers	Space-Hour	Parkers	Space-Hour	Parkers	Space-Hour
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
0.5	0.93	0.17	5.82	0.93	1.61	0.27	2.81	0.48
1.0	19.31	7.07	10.18	3.25	9.68	3.19	13.81	4.69
1.5	22.74	12.49	8.0	3.83	22.04	10.90	17.39	8.86
2.0	9.97	7.30	8.36	5.34	10.22	6.74	9.46	6.43
2.5	7.17	6.56	11.27	9.00	8.60	7.09	8.95	7.60
3.0	4.98	5.48	10.18	9.75	7.53	7.45	7.42	7.56
3.5	6.45	8.39	12.0	13.41	5.91	6.83	8.31	9.88
4.0	4.98	7.30	6.18	7.89	6.99	9.22	5.88	7.99
4.5	3.12	5.13	5.82	8.36	1.61	2.39	3.71	5.67
5.0	3.74	6.85	4.36	6.96	5.38	8.87	4.35	7.38
> 5	16.51	33.26	17.82	31.28	20.43	37.06	17.90	33.45
Total	100	100	100	100	100	100	100	100

4-Parking Turnover

It is a rate of use of parking spaces, and obtained by dividing parking volume by the number of parking spaces for a specified time period (Pegnatario, 1973). Table (5), is showing parking turnover obtained for the different multi-story parking facilities. Parking turnover is going to affect by trip purpose executed by parkers. Table (6) is showing the type of each facility, and turnovers obtained for different trip purposes. Shopping trip purpose has the highest turnover rate, especially at Dohuk garage. Table (7), is describing the variation of parking duration, and turnover experienced at the three parking facilities. The table shows that, after 1.5 hours of parking period, highest turnover was happened at Bra, and Zozan parking garages, meanwhile Dohuk garage is showing the highest turnover after 2.5 hours of parking duration. This phenomenon is mostly due to the location of the facilities, and how much they are accessible by parkers arriving to CBD area.

Table (5): Parking Turnover in Each Multi-Story Facility (Dohuk 2008)

Facility Name	No. of Spaces	No .of Parkers	Turnover(Vehicle-Space)
Bra	312	321	1.03
Dohuk	105	275	2.62
Zozan	300	186	0.62
Total	717	782	1.09

Table (6): Parking Turnover With Respect to Trip Purpose for Each Multi-Story Parking Facility (Dohuk 2008)

Trip Purpose	Facility Name	Number of Parkers	Turnover (Vehicles/Spaces)
H.B.*	Bra	0	NA"
	Dohuk	0	NA"
	Zozan	0	NA"
Work	Bra	31	0.73
	Dohuk	11	1.26
	Zozan	30	0.63
Shopping	Bra	13	0.3
	Dohuk	12	1.36
	Zozan	3	0.05
Business	Bra	0	NA"
	Dohuk	0	NA"
	Zozan	2	0.04
Other	Bra	0	NA"
	Dohuk	2	NA"
	Zozan	0	NA"
Total	Bra	44	1.03
	Dohuk	23	2.62
	Zozan	35	0.62

*Home-based trips

N.A" Not Available

Table (7): Parking Turnover for Different Values of Duration in Selected Multi-Story Facility(Dohuk 2008)

Duration (hr)	Bra		Dohuk		Zozan		Total	
	No. of Parkers	Turnover (Vehicle/Space)	No. of Parkers	Turnover (Vehicle/Space)	No. of Parkers	Turnover (Vehicle/Space)	No. of Parkers	Turnover (Vehicle/Space)
0.5	3	0.01	16	0.15	3	0.01	22	0.03
1.0	62	0.20	28	0.27	18	0.06	108	0.15
1.5	73	0.23	22	0.21	41	0.14	136	0.19
2.0	32	0.10	23	0.22	19	0.06	74	0.10
2.5	23	0.07	31	0.30	16	0.05	70	0.10
3.0	16	0.05	28	0.27	14	0.05	58	0.08
3.5	21	0.07	33	0.31	11	0.04	65	0.09
4.00	16	0.05	17	0.16	13	0.04	46	0.06
4.5	10	0.03	16	0.15	3	0.01	29	0.04
5.0	12	0.04	12	0.11	10	0.03	34	0.05
< 5.0	53	0.17	49	0.47	38	0.13	140	0.20
Total	321	1.03	275	2.62	186	0.62	782	1.09

5-Parked Vehicle Class

Class of vehicles on each facility has been considered such classes are private car, taxi, and pick-up. Table (8), shows the number, and percentage of different cars parked on their three studied facilities during the period from 9:30 a.m., up to 4:30 p.m. Trips are mostly executed by private cars are going to terminate their trips on Zozan, and Bra garages, more than the trips ended at Dohuk garage. Table (9), shows parkers frequency, and percentages at three garages according to trip purpose. Work trips are highly going to terminate at Zozan parking garage, as it is the most near parking location to drivers coming from dense populated corridors in Dohuk City, especially Baroshki residential corridor area

Table (8): Number and Percentage by Type of Vehicle in Selected Multi-Story Parking Facility (Dohuk 2008)

Type Of Vehicle	Number and Percentage of Each Type of vehicle at Certain Facility							
	Bra		Dohuk		Zozan		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Private	35	79.54	16	69.56	28	80	79	77.45
Taxi	2	4.55	1	4.35	2	5.71	5	4.9
Pick up	7	15.91	6	26.09	5	14.29	18	17.65
Total	44	100	23	100	35	100	102	100

Table (9): Number and Percentage of Parkers by Trip Purpose in Selected Multi-Story Parking Garages in CBD Area in Dohuk City (Dohuk 2008)

Trip Purpose	Number and percentage of Parkers							
	Bra		Dohuk		Zozan		Total	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
H.B.*	N.A."	N.A."	N.A."	N.A."	N.A."	N.A."	N.A."	N.A."
Work	31	70.45	11	47.82	30	85.71	72	70.59
Shopping	13	29.55	12	52.18	3	8.57	28	27.45
Business	N.A."	N.A."	N.A."	N.A."	2	5.72	2	1.96
Others	N.A."	N.A."	N.A."	N.A."	N.A."	N.A."	N.A."	N.A."
Total	44	100	23	100	35	100	102	100

* Home-based N.A." Not Available

6-Walking Distance

Parkers are usually preferred to park where there is shortest distance to walk. Average parking distance obtained from interview was 155m. Bra, Dohuk, and Zozan parkers are walking average distance of 83, 168, and 212m respectively to arrive to their destinations. This result shown in Figure (4), which demonstrates that, Bra garage is attracting most of the parkers, than the other two facilities as the parkers are going to walk (51-100) m only. Major part of the work trips was accumulated on Bra and Zozan garages as walking distance is less than 50m for the former, and less than 300m only for the latter. This result is shown in Table (10).

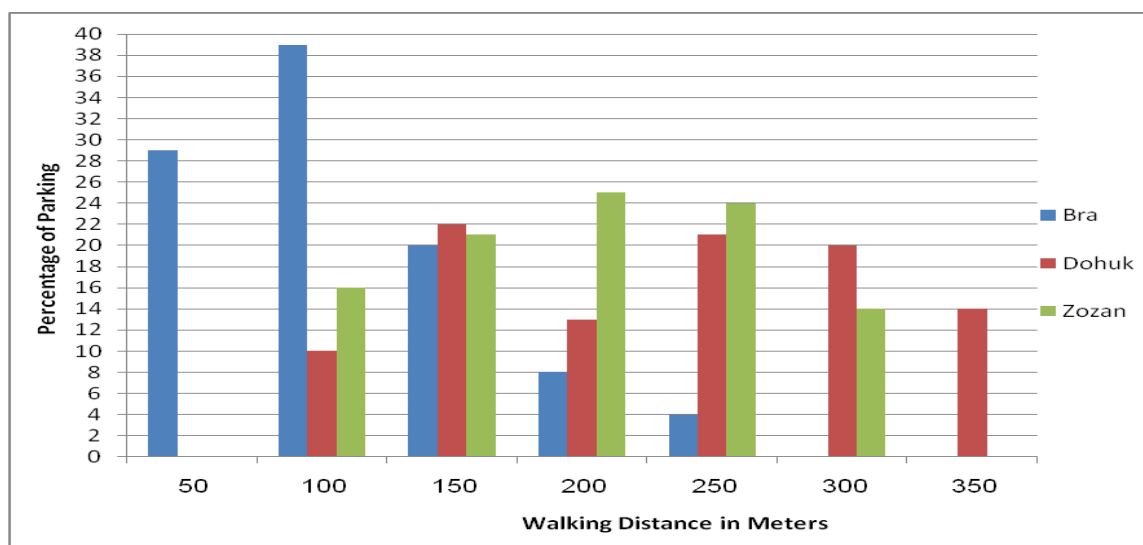


Figure (4): Distribution of Parkers According to Walking Distance for Multi-Story Parking Facility (Dohuk 2008)

Table (10): Percentage of Parkers by Type of Facility, Purpose, and Walking Distance in Selected Multi-Story Facility

Trip Purpose	Facility Type	Percentage of Parkers Walking a Certain Distance in Meters						
		<=50	51-100	101-150	151-200	201-250	251-300	> 300
		Percent	Percent	Percent	Percent	Percent	Percent	Percent
H.B.*	Bra	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
	Dohuk	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
	Zozan	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
Work	Bra	92.3	70.58	77.77	66.67	N.A"	N.A"	N.A"
	Dohuk	N.A"	100	40.00	25	60	85.71	83.33
	Zozan	N.A"	66.67	85.71	100	87.5	85.71	83.33
Shopping	Bra	7.7	29.42	22.23	33.33	100	N.A"	N.A"
	Dohuk	N.A"	N.A"	60.00	75	40	N.A"	N.A"
	Zozan	N.A"	33.33	14.29	N.A"	N.A"	N.A"	16.67
Business	Bra	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
	Dohuk	N.A"	N.A"	N.A"	N.A"	N.A"	14.29	16.67
	Zozan	N.A"	N.A"	N.A"	N.A"	12.5	14.29	N.A"
Other	Bra	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
	Dohuk	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
	Zozan	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
Total	Bra	100	100	100	100	100	N.A"	N.A"
	Dohuk	0	100	100	100	100	100	100
	Zozan	0	100	100	100	100	100	100

*Home-based trips N.A." Not Available

7-Parking Duration

Table (11), represents the relationship between parking duration on each facility, and purpose of each trip to destination. Parkers coming for work to the CBD are originating the highest percentage of trips, especially for duration of 1.0hours, and more. Dohuk and Zozan garages are going to accept all parkers within (2:00-3:00) p.m., hour duration period. Parkers coming for shopping are remaining shorter period of time less than half an hour. In general, Zozan garage is able to accept parkers for longer period of time than 5:00 hours especially, those going for work.

Table (11): Percentage of Parkers by Trip, Purpose, and Parking Duration in Selected Multi-Story Facility (Dohuk 2008)

Trip Purpose	Facility Type	Number and Percentage of Parkers by Duration in Hours						
		< 00:30	0.5-1.0	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	>5.0
		Percent	Percent	Percent	Percent	Percent	Percent	Percent
H.B.*	Bra	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
	Dohuk	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
	Zozan	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
Work	Bra	N.A"	100	83.33	66.67	66.67	100	63.63
	Dohuk	N.A"	50	42.86	100	60	N.A"	25
	Zozan	N.A"	50	71.42	100	N.A"	100	90.9
Shopping	Bra	N.A"	N.A"	16.67	33.33	33.33	N.A"	36.37
	Dohuk	100	50	57.14	N.A"	40	N.A"	75
	Zozan	N.A"	50	14.29	N.A"	N.A"	N.A"	4.55
Business	Bra	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
	Dohuk	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
	Zozan	N.A"	N.A"	14.29	N.A"	N.A"	N.A"	4.55
Other	Bra	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
	Dohuk	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
	Zozan	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"	N.A"
Total	Bra	N.A"	100	100	100	100	100	100
	Dohuk	100	100	100	100	100	N.A"	100
	Zozan	N.A"	100	100	100	N.A"	100	100

N.A" Not Available H.B.* Home-based trips

8-Parking Usage -Supply Relationship

Parking supply is usually expressed in space-hours for particular facility, this term is the product of the number of parking spaces in each facility, and the duration of parking study in hours. This theoretical space –hour supply will be in reality never be fully utilized due to the time lost during parking, and un-parking of vehicles. There fore, the practical supply as shown in Table (12), has been derived by applying an efficiency factor of (0.487) to the theoretical parking supply. The efficiency factor has been determined by averaging the three facility-parking indexes according to the method recommended by the Manual of Comprehensive Parking Study (NCUT, 1957). Figure (5), shows the practical supply , and usage on each facility with average deficiency ratio of more than 25 percent in both Dohuk, and Zozan facilities, meanwhile usage , and supply are about the same in Bra facility. The figure shows also that, net deficiency are 299 space-hours for the three parking facilities.

Table (12): Summary of Space-Hours Supply and Usage for the Selected Multi-Story Facility (Dohuk 2008)

Facility Name	Supply or Usage in Space-Hours				
	Theoretical Supply	Practical Supply	Usage	Usage/ Supply Ratio	Difference
Bra	1824	888	877	0.988	+11
Dohuk	1364	664	862	1.298	-198
Zozan	990	482	594	1.232	-112
Total					-310+11= -299

Deficiency ,+ Surplus -

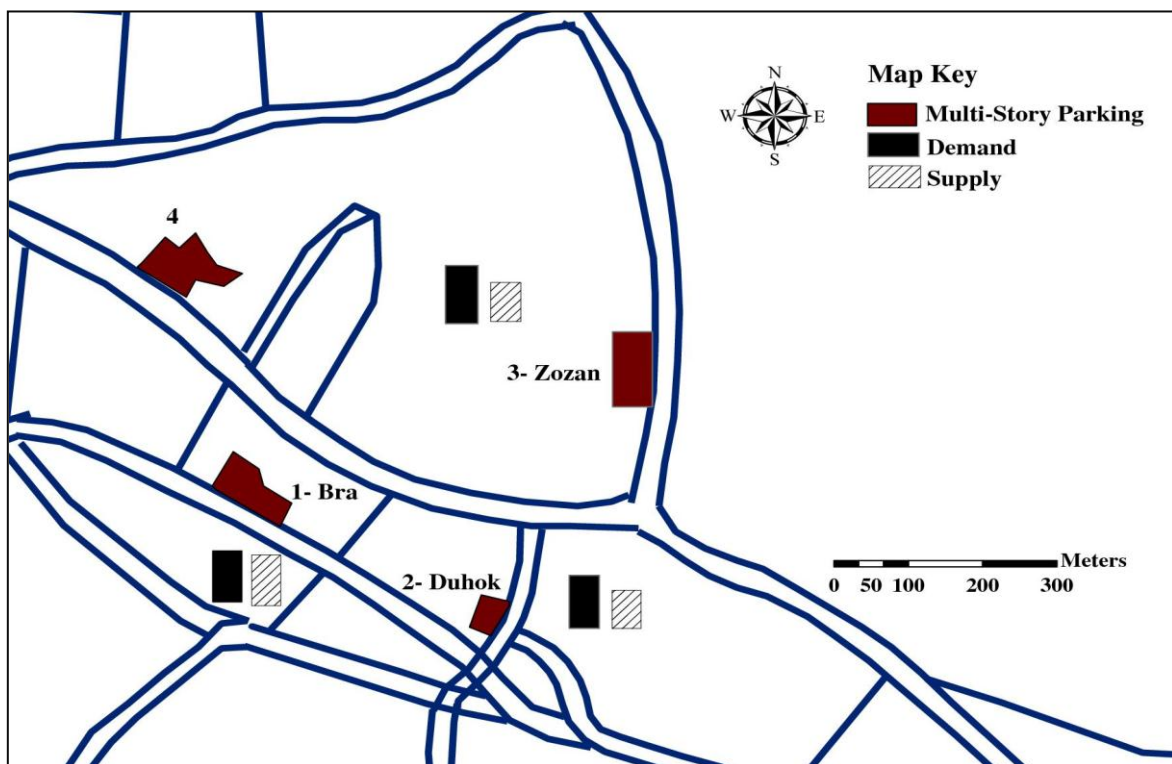


Figure (5): Existing Space-Hour Demand and Supply between 9:30a.m., and, 4:30 p.m., During an Average Weekday in Duhok City CBD Study Area

Conclusions

The main and important findings drawn out of this study can be summarized as follows:
1-There are 717 as a total existing parking spaces found in the selected three multi-stories investigated.

2-Peak parking accumulation loads is usually going to occur between 12:00 a.m., and 4:30 p.m., during which (307), and (336) vehicles are coming to park respectively.

3- Maximum parking index is reaching 46.86 percent ,which usually occurring at 4:30 p.m.

4-Parking due to working trips are constituting 70.59 percent , shopping trips are 17.45 percent, business trips are only 1.96 percent, from the total and there is no home, or other trips.

5-Average walking distance surveyed is (155) m for most of the parkers going to CBD for different purposes.

6-Average parking duration investigated for all parkers is (4) hours .

7-Total parkers volume accumulated during (7) hours of the day is (782) only, coming to CBD, for different purposes.

8-Average turnover taking place during (7) hours of survey is found to be (1.09) vehicles/space only.

9-Deficiency analysis revealed that, there are (299) space-hours shortage in the usage at the three parking facilities with balance number of supply, and usage .

Recommendations

From the conclusions referred above, it can recommended that,

1- Control system is needed to be applied by imposing time limits or by charges.

2-Parking demand forecasting for multi-story parking garages is needed due to the large increase in car ownership registered in Dohuk city of about (10-15) percent, annually.

3- Land-use pattern changes or new master plan for Dohuk city is actually needed to release the large parking demand imposed by different off-street parking facilities.

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The work was carried out at the college of Engineering. University of Dohuk