Estimation of Traffic Volumes Distribution of Urban Streets in Baghdad City

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Abstract

The aim of this research is to explore the time and space distribution of traffic volume demand and investigate its vehicle compositions. The four selected links presented the activity of transportation facilities and different congestion points according to directions. The study area belongs to Al-Rusafa sector in Baghdad city that exhibited higher rate of traffic congestions of working days at peak morning and evening periods due to the different mixed land uses. The obtained results showed that Link (1) from Medical city intersection to Sarafiya intersection, demonstrated the highest traffic volume in both peak time periods morning AM and afternoon PM where the demand exceeds the capacity along the link corridor. Also, higher values for Peak Hour Factor (PHF) were obtained for Link (1) range from (0.88 to 0.94) depending on different peak periods and traffic directions which indicated little flow variation and high traffic volumes. Lower values of PHF were obtained for link (4) (Kasra intersection to Anter square) range

from (0.77 to 0.89

Keywords:

Traffic Volume; Urban Streets; Vehicle Compositions; Peak Hour Factor; Volume Variations; Spatial Distribution.

تقدير توزيع الاحجام المرورية لشوارع حضرية في مدينة بغداد

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المستخلص

إن الهدف من هذا البحث هو التحري عن توزيع الأحجام المرورية مع المكان والزمن وحساب تصنيف المركبات. المقاطع الأربعة المختارة في هذه الدراسة تمثل مناطق مختلفة للازدحام المروري وحسب الاتجاه لمعظم فعاليات النقل. تعود منطقة الدراسة إلى قطاع الرصافة في مدينة بغداد والتي تمثل نسبة عالية من الازدحام المروري اليومي وعلى طول أيام العمل الأسبوعي خلال فترة ساعة الذروة الصباحية والمسائية وذلك لاختلاف استعمالات الأرض. إن النتائج المستحصلة بالنسبة للمقطع رقم 1 (من مدينة الطب الى تقاطع جسر الصرافية) يعطى أعلى قيم للأحجام المرورية في كلا ساعات الذروة الصباحية والمسائية ، حيث يزيد الطلب السعة الاستيعابية للمقاطع في منطقة الدراسة. كذلك تم الحصول على قيم معامل ساعة الذروة للمقطع رقم 1 والتي تتراوح من (0.88-0.94) اعتمادا على فترة الذروة والاتجاهات وهذا يدل على نسبة عالية من الأحجام المرورية ونسب قليلة لتغاير التدفق المروري. أيضا تم الحصول على نسبة منخفضة لقيم معامل ساعة الذروة للمقطع رقم 4 من تقاطع الكسرة إلى ساحة عنتر وتتراوح القيم من (0.77- 0.89) .

الكلمات المفتاحية :

الحجم المروري ، الشوارع الحضرية ، تصنيف المركبات ، معامل ساعة الذروة ، تغاير التدفق ، التوزيع المكاني.

1. Objective and Scope of Research

The congestion problems on most urban streets in the city of Baghdad have become of great concern due to the low efficiency of passenger traffic. This research aims to explore the time and space distribution of traffic volume demand and investigate its compositions. The location of selected study area for all segments; link (1), link (2), link (3) and link (4) show disturbance to traffic mobility which observed in terms of delay and queuing during the morning and evening peak hours of working days.

2. Introduction

The traffic flow analysis is essential for traffic engineering for improvement planning. (Jain et.al, 2016, p477) developed linear models of speed-density equation for traffic stream of six lane divided carriageways with different types of vehicle.

(Zhang et.al, 2017, p69) explored the relationship between traffic congestion and built environment during the 24 hr congestion pattern. It was found that the main congestion problems occur in the city center. Also different types of factors; such as type of the road, bus station, commercial land use, etc. had a significant effect on the formation of congestions.

(Pokulwar, et.al, 2016, p960) investigated the effect of heavy vehicles on disturbance of traffic stream in urban city. A methodology for lane changing decision focused on this impact and also detected the driving decisions of following car drivers under heterogeneous traffic condition.

(Al-Enazi, 2016, p7) applied the GIS functions in detecting the points of traffic congestions according to road direction during the working hours of day. This provides guide assistance for planner to reassigning roads and reduced the congestion points at network of Jeddah city.

(Yamuna, 2014, p41) studied the fundamental characteristics of flow and speed and the time headway distribution was also analyzed under urban heterogeneous traffic. The obtained results provided that, the headways

distribution of urban traffic can be modeled over a wide range of traffic flow levels.

(Alkaissi and Hussain, 2020, p1) estimated the total delay of signalized intersections in Baghdad city using Global Positioning System (GPS) that provide an opportunity to accurately measure intersection delay in terms of deceleration delay, stopped delay, and acceleration delay. The obtained results indicated that the stopping time for vehicles represents the major part of total control delay reaching about 88% of the control delay at some signalized intersections (Beirut and Bab Al Moatham intersections) at peak hours.

(Alkaissi, 2018, p9) investigated the distribution of time headway under heavy flow conditions. Collected field data for two links; Link (1) from Al-Mawal intersection to Bab AlMutham intersection 1.03 km length and link (2) from Zayona intersection to Mayslone intersection was obtained at two different time periods to conform the variation of time headway under congestion periods. The variation in time headway for Link (1) was reduced and more constant state was obtained due heavy flow conditions at congestion peak periods.

(Alkaissi, 2018, p8456) investigated the trend of traffic volume of urban street with different selected; Link (1) increased gradually with time periods from 4 p.m. and reach maximum flow at 9 p.m. and the traffic volume in south direction were greater than in the north direction. Link (2) demonstrated oscillate variation of traffic volume and achieved maximum hourly number of vehicle at 9 p.m. and the north direction displayed higher traffic volume of demand.

(Alkaissi et.al, 2020, p16) presented the analysis and modeling of discharge saturation headway at (3) surveyed signalized intersections in Baghdad city. Average discharge headway about (2.37 sec.), (1.872 sec.) and (2.43 sec.) for Al-Nakhala intersection, Al-Sakhara intersection and

Bairuit intersection respectively was obtained. This explored the traffic operation conditions with more heavy congested conditions for Al-Nakhala

intersection, Al-Sakhara intersection and Bairut intersection. A comparison of median and mean values of discharge saturation headway indicated that the median of (2.230) was less than the mean of (2.5272 sec.).

The collected traffic data can be efficiently represented using ArcGIS application. Maps and layers are important ways of organizing and displaying data in ArcGIS (Booth, B. and Mitchell, A., 2001, p21). In the street layer, the features are drawn with different line symbols according to the type of street that the lines represent (Booth, B. and Mitchell, A., 2001, p23).

3. Study Area and Collected Data

The recurrent traffic congestions of road segments and posterior congestions on urban network are increased rapidly with the overflowing number of vehicles in Baghdad city. Therefore, it is important to characterize the congested road corridor during the peak periods of working days which represents the critical time for higher delay and worst level of service. Figure (1) shows the study area which is obtained from Google maps. It is selected for this research compromised corridor roads of four links segments: link (1) , link (2) , link (3) , and link (4). The four selected links presented the activity of transportation facilities and different congestion points according to directions. The study area belongs to Al-Rusafa sector in Baghdad city that exhibited higher rate of traffic congestions of working days at peak morning and evening periods due to the different mixed land uses of governmental institutes, educational and residential that attracted higher number of daily trips. The study region is bounded by geographic latitudes (33º 20′ 40″ N – 33º 22′ 15″ N) and geographic longitudes (44º 21′ 20″ E – 44º 23′ 40″ E) .

The field data are collected for study corridors on Monday, Tuesday, and Wednesday in October 2016. Traffic volume counts were performed for four links segments as shown in Figure (1). The connected links are illustrated

in Table (1). Also, traffic volumes were observed during weekday peak hours periods at (7:00-8:00) AM and (2:00-3:00) PM.

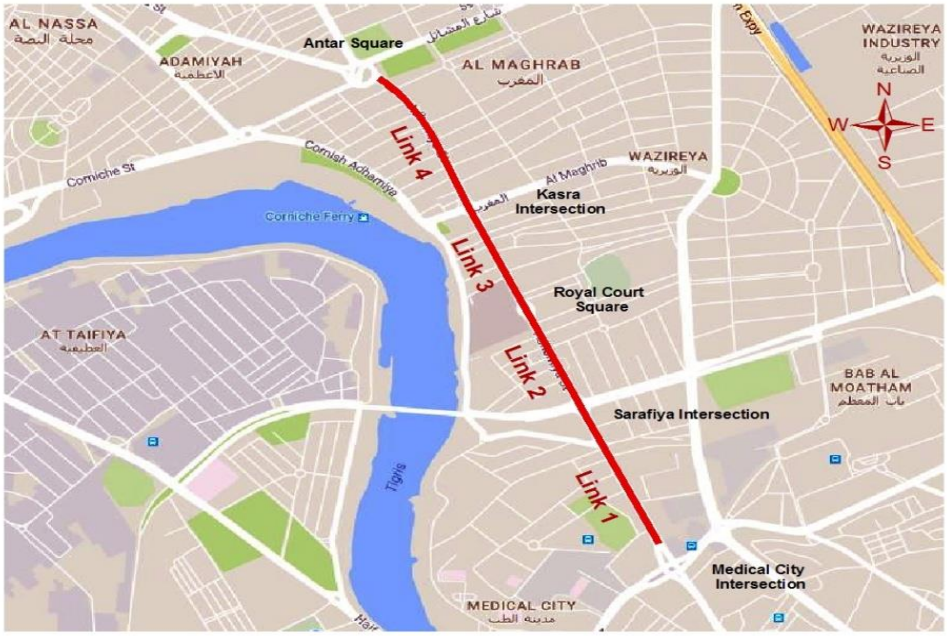


Figure 1: Study Area of Urban Corridors

Link	Connections
1	Medical city intersection –Sarafiya intersection
2	Sarafiya intersection – Royal Court Square
3	Royal court square –Kasra intersection
4	Kasra intersection –Anter square

Table 1: Locations of Selected Links

4. Results and Discussions

4.1. Spatial Traffic Volume Variation

The traffic volumes fluctuations are one of the most critical issues that should be considered to understand the occurrence and pattern of congestion state which is necessary for transportation policy and management plans. A segment of urban streets in the central portion of Baghdad city was considered in this research and divided into four links (1, 2, 3, and 4) as presented in Figure (1). The routes of the selected segments are represented as intercity roads in Baghdad, Al-Rusafa sector which show recurrent congestions that happen on regular daily basis during AM and PM peak hours. Figures (2) and (3) depict the spatial variation of traffic volume expressed in passenger car per hour for both north and south directions and AM and PM peak periods, respectively. Link (1) demonstrated the highest traffic volume in both peak time periods morning AM and afternoon PM where the demand exceeds the capacity along the link corridor. This may be attributed to the location of Link (1) in the study area near the center of Bab Al-Mutham region which attracted large crowds of daily educational and work trips, congestion state for Link (1) is shown in Plate (1).

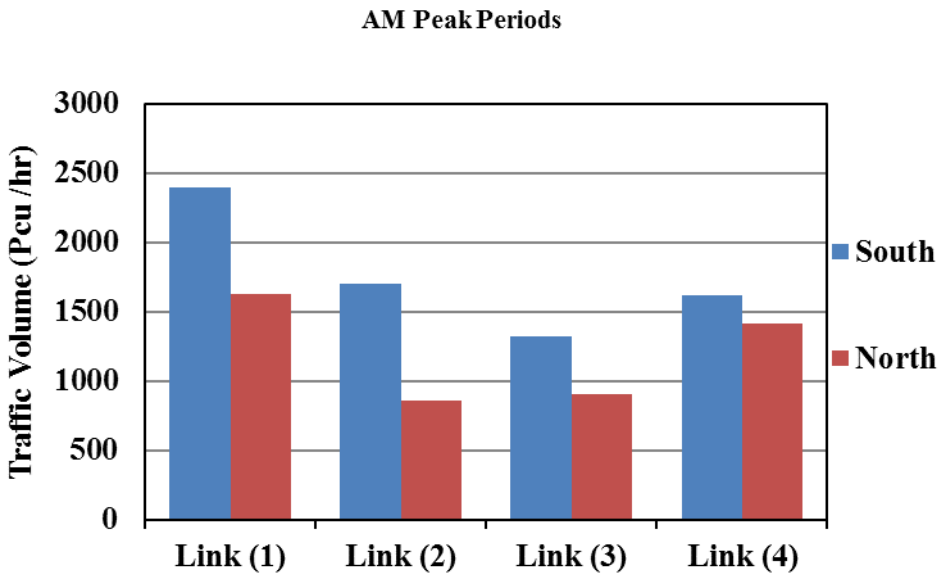


Figure 2: Spatial Traffic Volume Variation at AM Peak Period.

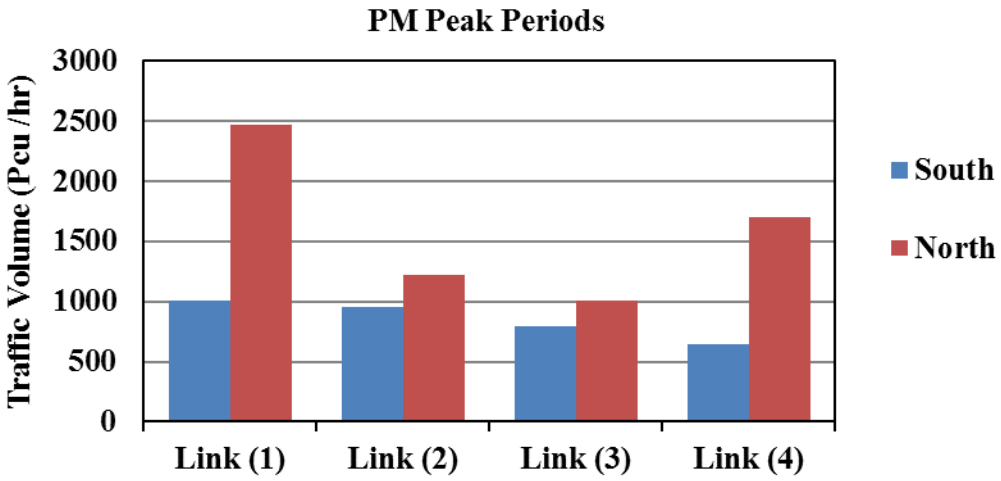


Figure 3: Spatial Traffic Volume Variation at PM Peak Period.

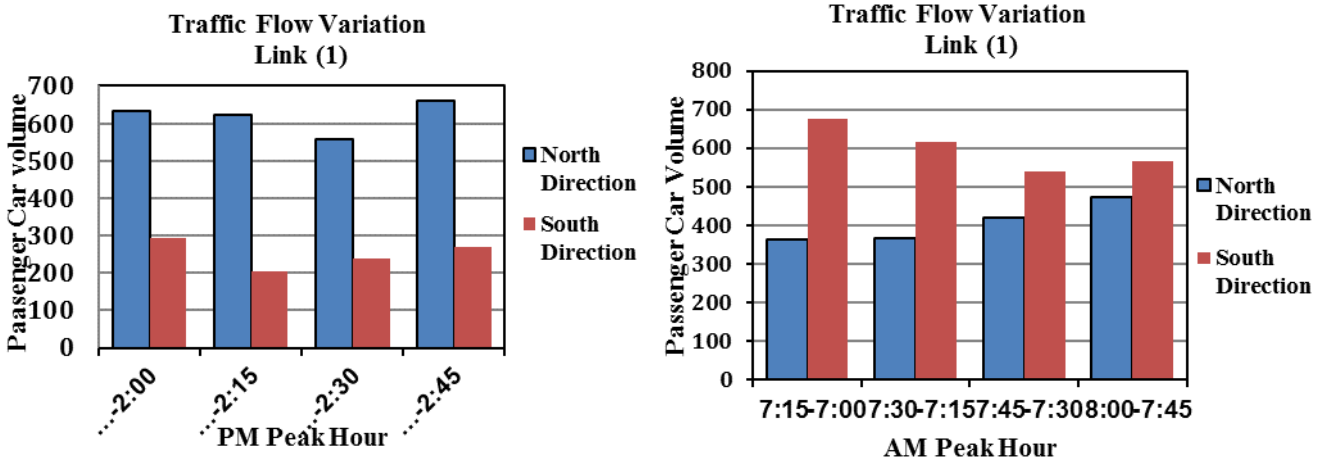
4.2 Hourly Traffic Volume Variation

Regarding the capacity consideration in the design of urban streets, the concentricity on peak hour of traffic volume since it represents the critical time period for operation of transportation facilities. Based on that, the traffic volume was counted for two peak period (7:00-8:00) AM and (2:00-3:00) PM as four 15 minute counts to simulate the rush hour variation. The peak volumes of passenger car are presented in Figure (4) to (7) for all studied links which represented the volume for higher capacity requirement. Small fluctuation in peak hour volumes for Link (1), (2) and (3) and approximately flat pattern was observed while Link (4) generates randomly variation in peak hour volumes.

The calculated peak hour factor (PHF) values for every 15 minutes count period are presented in Table 2 for all studied links in AM and PM peak periods for both south and north directions .

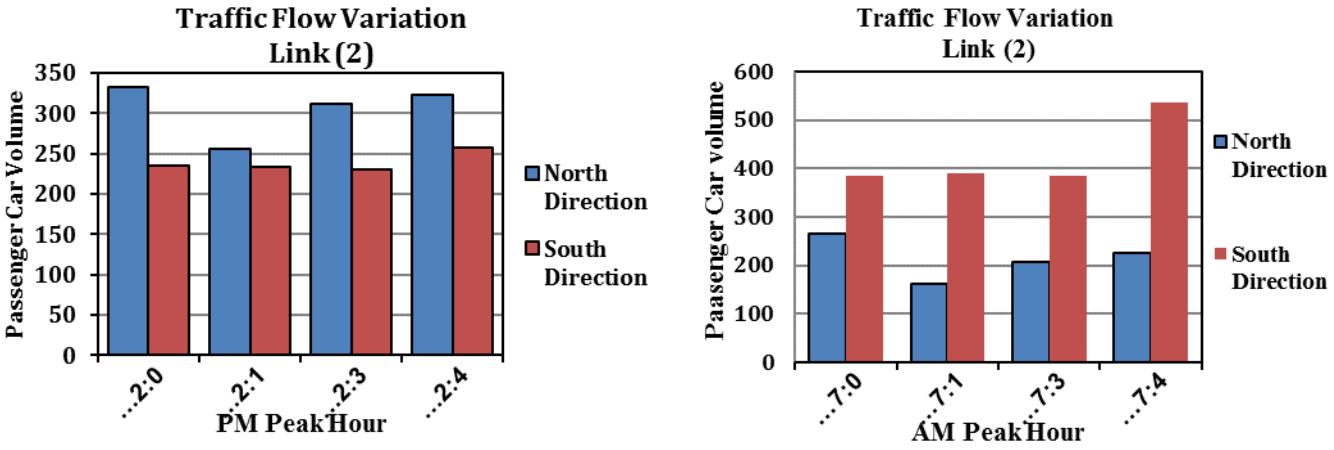
Also, Figure (8) and (9) illustrate the variation of PHF along the different selected sites (across different location for each link) .

Higher values for PHF are obtained for Link (1) range from (0.88 to 0.94) depending on different peak periods and traffic directions which indicated little flow variation and high traffic volumes. On the other hand, lower values of PHF were obtained for link (4) range from (0.77 to 0.89) that indicated a greater variability of peak traffic volume within rush hour for subjected link.



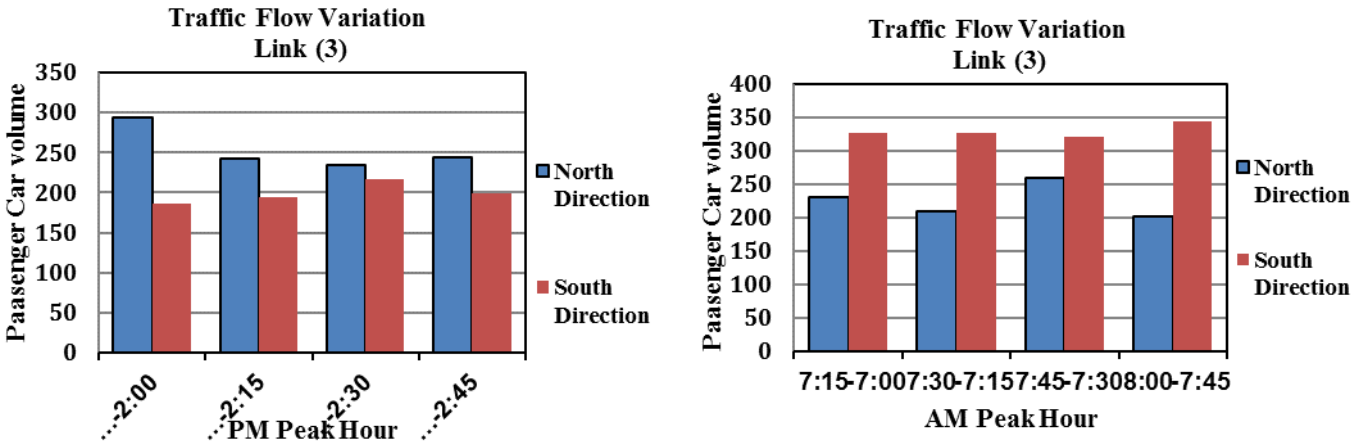
a- PM Peak Period. b- AM Peak Period.

Figure 4: Traffic Volume Variations for Link (1) at Peak Period.



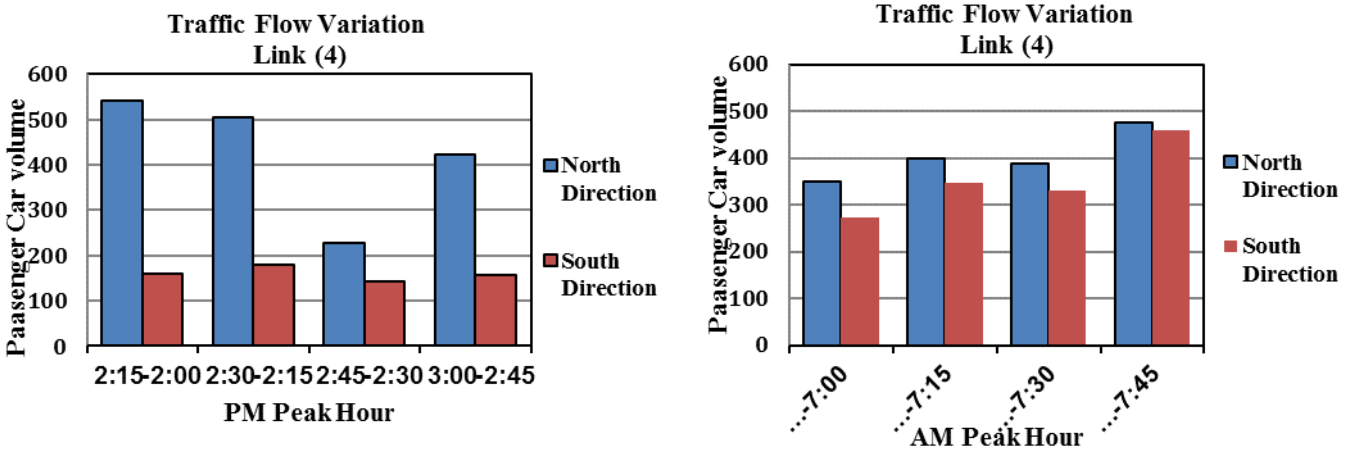
a- PM Peak Period. b- AM Peak Period.

Figure 5: Traffic Volume Variations for Link (2) at Peak Period.



a- PM Peak Period. b- AM Peak Period.

Figure 6: Traffic Volume Variations for Link (3) at Peak Period.



a- PM Peak Period. b- AM Peak Period.

Figure 7: Traffic Volume Variations for Link (4) at Peak Period.

Table 2: Peak Hour Factor Variations for all Links.

	PM	AM	PM	AM
Link (1)	0.94	0.86	0.93	0.88
Link (2)	0.92	0.81	0.93	0.79
Link (3)	0.86	0.87	0.92	0.96
Link (4)	0.78	0.85	0.89	0.77

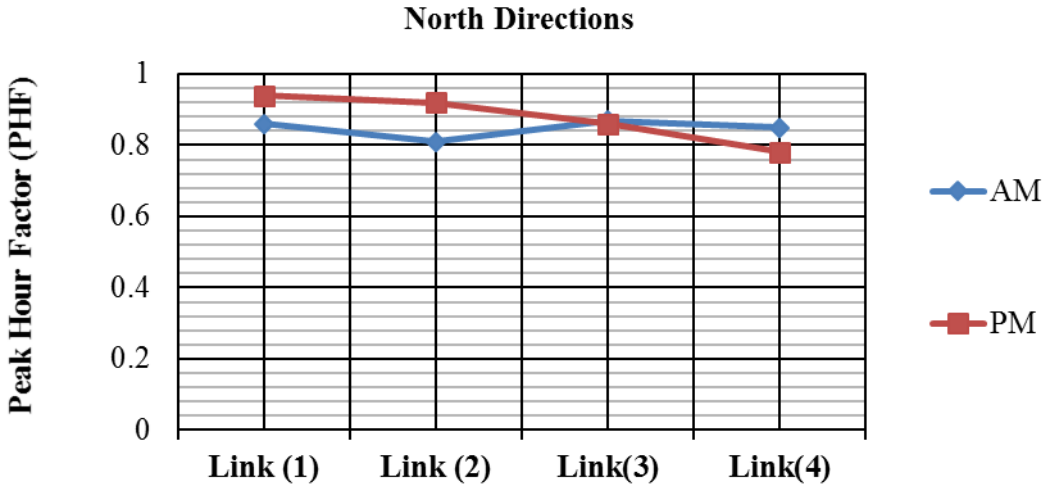


Figure 8: Peak Hour Factor Variations for all Links in North Direction

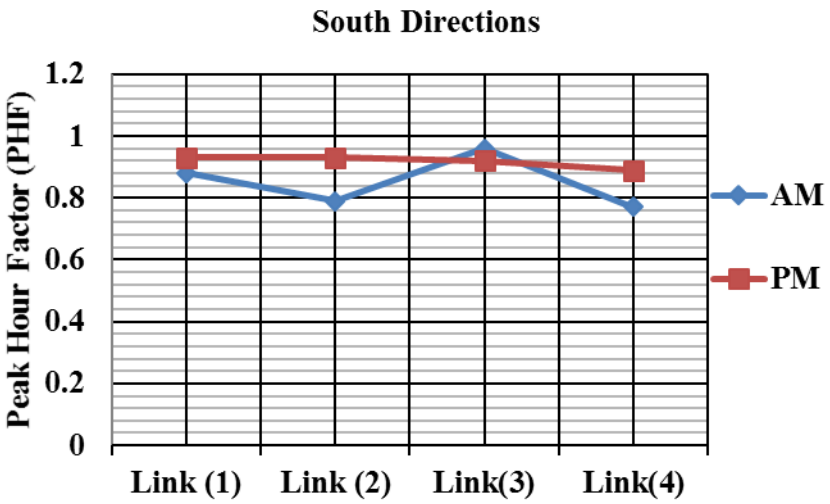
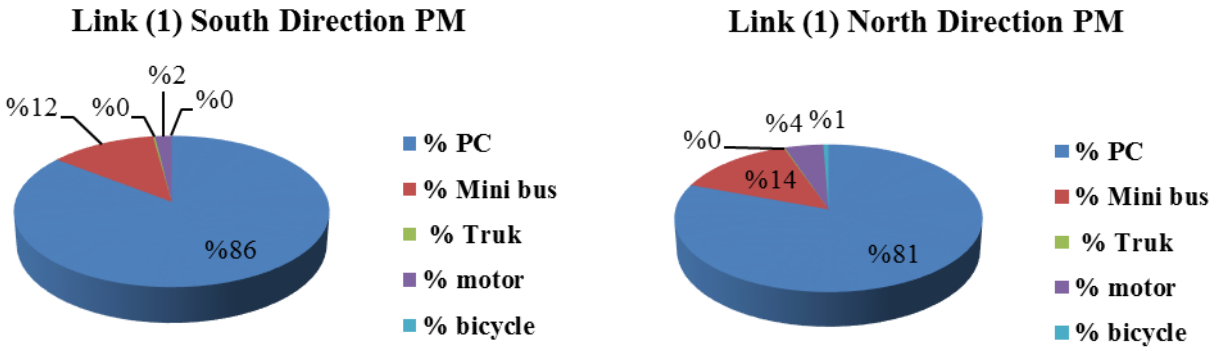


Figure 9: Peak Hour Factor Variations for all Links in South Direction.

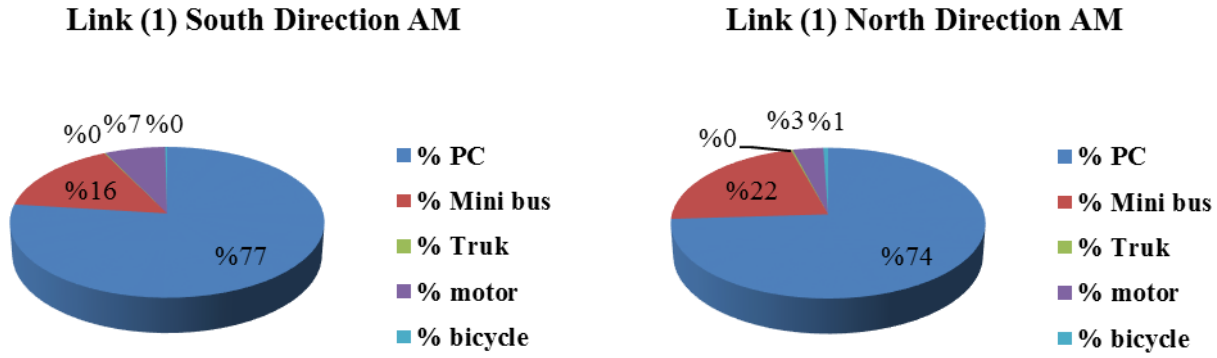
4.3 Traffic Volume Classification

Traffic flow compositions are considered as major factors that affect the operating capacity of urban streets. Different types of vehicle traveling having different capabilities of acceleration and deceleration. All types of local ehicles categories have been observed during this research period for all studied links (1), (2), (3) and (4) as illustrated in Figures (10) to (17). The different categories of travel vehicles affect on the capacity of urban streets. The observed field data of traffic volumes depicted that link (4) with north direction presents maximum percentage of mini bus vehicles about (19%) and (26%) in both peak periods (7:00-8:00) AM and (2:00-3:00) PM, respectively.



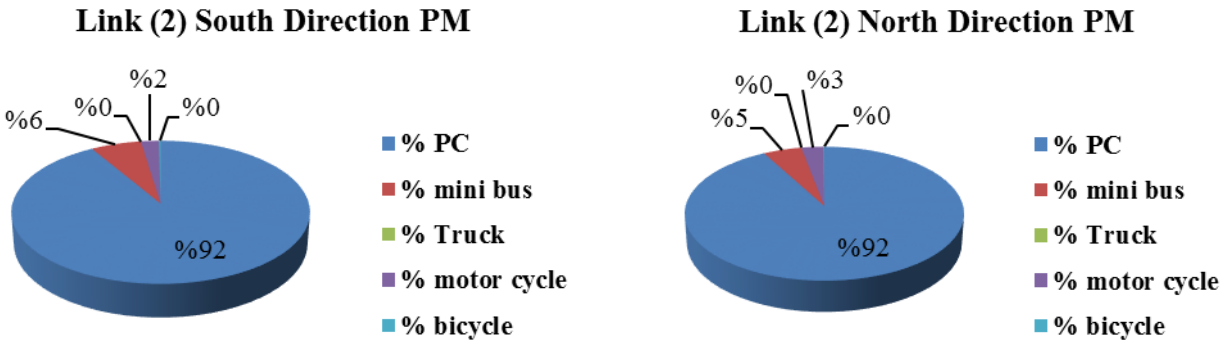
a- South Direction b- North Direction

Figure 10: Vehicle Classification for Link (1) at PM Peak Period.



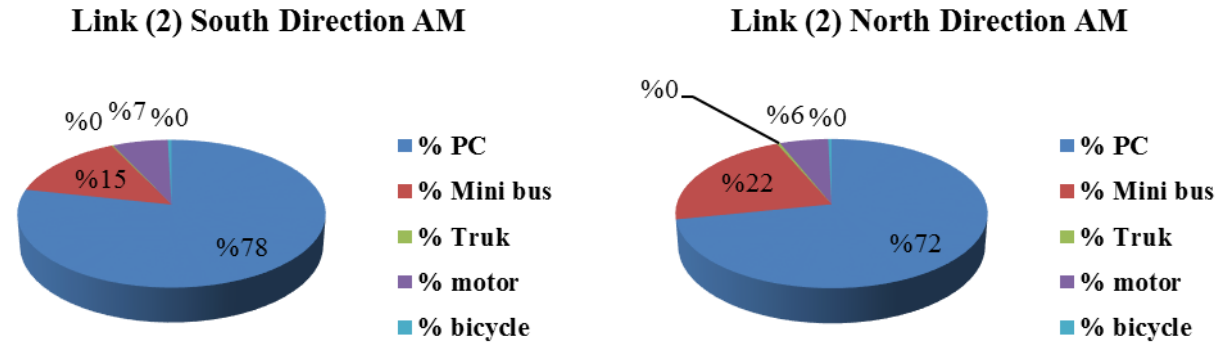
a- South Direction b- North Direction

Figure 11: Vehicle Classification for Link (1) at AM Peak Period.



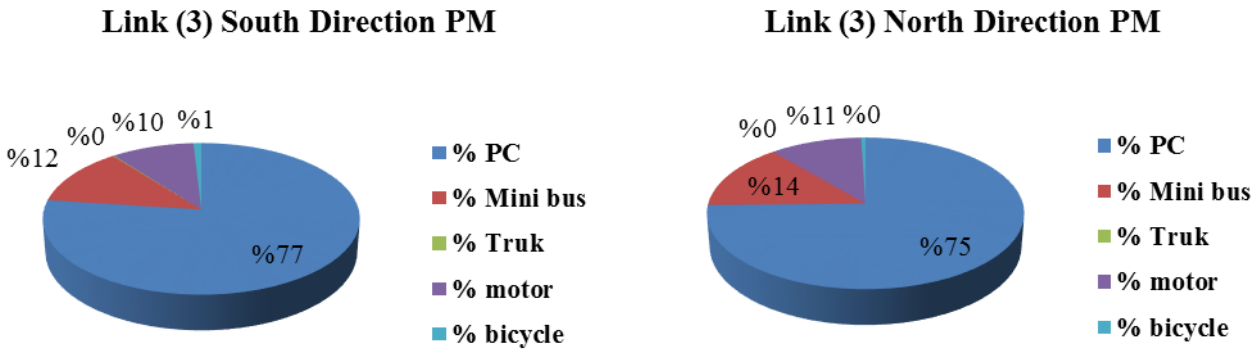
a- South Direction b- North Direction

Figure 12: Vehicle Classification for Link (2) at PM Peak Period.



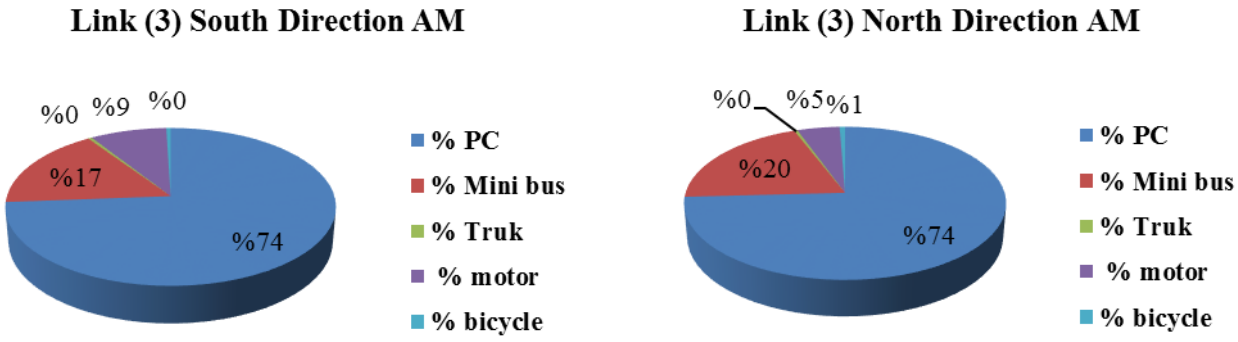
a- South Direction b- North Direction

Figure 13: Vehicle Classification for Link (2) at AM Peak Period.



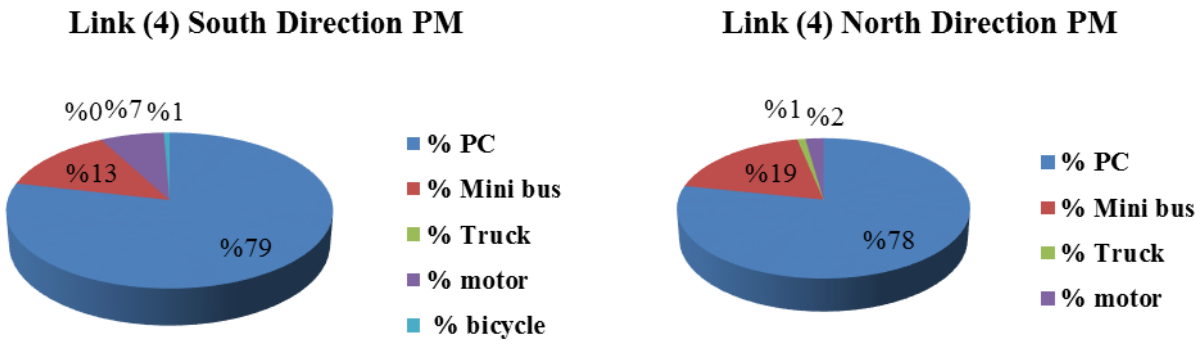
a- South Direction b- North Direction

Figure 14: Vehicle Classification for Link (3) at PM Peak Period.



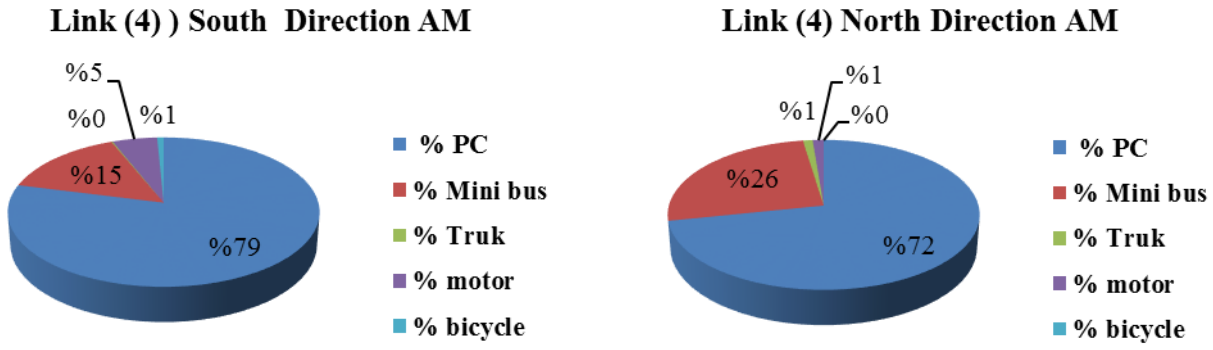
a- South Direction b- North Direction

Figure 15: Vehicle Classification for Link (3) at AM Peak Period.



a- South Direction b- North Direction

Figure 16: Vehicle Classification for Link (4) at PM Peak Period.



a- South Direction b- North Direction

Figure 17: Vehicle Classification for Link (4) at AM Peak Period.

4.4 Spatial Distribution of Traffic Volume for Study Area

The collected traffic data provide realization about spatial distribution of traffic volumes. In this research four segments of road corridors (Link 1) , (Link 2) , (Link 3) , and (Link 4) in Baghdad city Al-Rusafa sector were selected to study the spatial distribution of peak traffic volume using the google maps to establish their locations.

The distribution of traffic volumes were drawn using the symbology and layout of ArcGIS softeware. Figure (18) and Figure (19) clarify the spatial distribution of mid block traffic volume during the peak (7:00-8:00) AM and (2:00-3:00) PM periods. It can be visualized that the segment of Link (1) present the maximum peak traffic volume in both directions that lead to the high proability of congestion which may be expressed due to the connection of this segment to city center and Bab Al-Mutham station. Also , the mix land uses of the study area have a significant effect on the congestion rates. Link (1) segments of studied corridor connects the mix land uses of commercial land uses such as (Al-Shorja and Al-Jumhoria street) , and educational land uses such as (Campus of Bab Al-Mutham for Universities and Colleges), and Medical city.

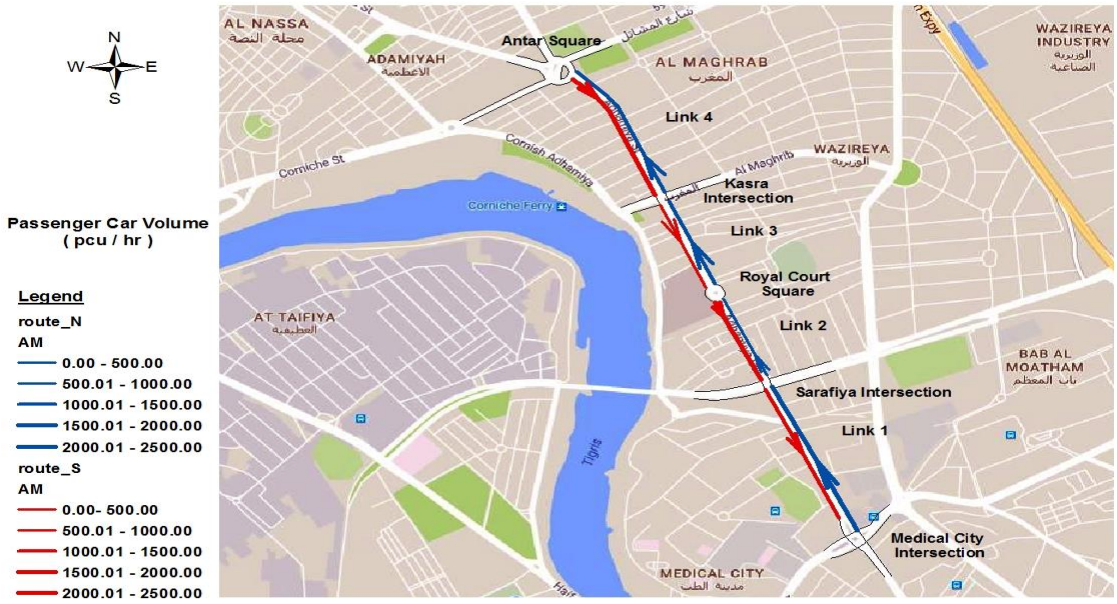


Figure 18: Traffic Volume Distribution for Studied Corridor at AM Peak Periods.

Figure 19: Traffic Volume Distribution for Studied Corridor at PM Peak Periods.

5. Conclusions

Based on the establised results , the following concluding remarks can be drawn out:

1. Link (1) from Medical city intersection to Sarafiya intersection , demonstrated the highest traffic volume in both peak time periods morning AM and afternoon PM where the demand exceeds the capacity along the link corridor. This may be attributed to the location of Link (1) in the study area near the center of Bab Al-Mutham region which attracted large crowds of daily educational and work trips.

2. Higher values for PHF are obtained for Link (1) (Medical city intersection to Sarafiya intersection) range from (0.88 to 0.94) depending on different peak periods and traffic directions which indicated little flow variation and high traffic volumes. On the other hand, lower values of PHF were obtained for link (4) (Kasra intersection to Anter square) range from (0.77 to 0.89) that indicated a greater variability of peak traffic volume within rush hour for subjected link.

3. The observed field data of traffic volumes depicted that link (4) with north direction presents maximum percentage of mini bus vehicles about (19%) and (26%) in both peak periods (7:00-8:00) AM and (2:00-3:00) PM, respectively.

4. It can be concluded that the segment of Link (1) present the maximum peak traffic volume in both directions that lead to the high proability of congestion which may be expressed due to the connection of this segment to city center and Bab Al-Mutham station.

5. Also , the mix land uses of the study area have a significant effect on the congestion rates. Link (1) segments of studied corridor connects the mix land uses of commercial land uses such as (Al-Shorja and Al-Jumhoria street) , and educational land uses such as (Campus of Bab Al-Mutham for Universities and Colleges) , and Medical city.

6. Recommendations

1. To better understanding the current and future state of traffic flow along arterial corridor, continuous station for data collection should be imposed.

2. Bicycles and motors should have specific lane beside the footpath for pedestrian walking and crossing.

3. This study focus on traffic volume variation during the peak hour which is useful for capacity estimation for future research.

Acknowledgements

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