

IMPACT OF HEAVY VEHICLES ON THE AVERAGE SPEED AND AVERAGE TRAVEL TIME OF LIGHT VEHICLESWaheed Imran*¹Muhammad Alam²Muhammad Tariq Khan¹Waqas Ahmad Khan¹Daud Khan¹Samiullah Khan Babar³Ijaz Ahmad Khan³Waheed Imran*¹, Muhammad Tariq Khan¹, Waqas Ahmad Khan¹, Daud Khan¹

(National Institute of Urban Infrastructure Planning, UET, Peshawar)

Muhammad Alam² (Department of Civil Engineering, Abasyn University, Peshawar)Samiullah Khan Babar³, Ijaz Ahmad Khan³ (Department of Civil Engineering, UET, Peshawar)waheedemran@hotmail.com

+92 333 950 8530

ABSTRACT

Heavy vehicles have physical and psychological effects on the traffic flow in their vicinity. The presence of heavy vehicle in traffic flow results in speed drops and increased travel times. A pragmatic approach has been followed in this study to measure the impact of heavy vehicles on the speed drops and travel time of vehicles. Three different traffic conditions were considered, result show that the heavy vehicles affects the average speeds and travel times of light vehicles.

Keywords:

Light vehicles, Heavy vehicles, Speed drop, Travel time.

INTRODUCTION

Urban traffic congestion is one of the major problems of the traffic flow studies. In developing countries in general and particularly in Pakistan traffic congestion is increased due to the increase in population and rapid urbanization. Traffic congestion on urban roads is mainly because of the lack of planning and management of vehicles and road infrastructure. The presence of heavy vehicles (trucks of all types) on a road has greater effects than the small vehicles (cars, SUV's etc.) on the average speed and average travel time. The driving behavior of the heavy vehicles and the passenger cars are entirely different from one another [1,2,3]. The proportion of heavy vehicle in any traffic is comparatively less but the impact of the heavy vehicles on traffic flow is greater which contributes in urban traffic congestion [4].

Congestion due to heavy vehicles is the result of their physical characteristics (the dimensions of the heavy vehicle), heavy vehicles have physical and psychological effects on the surroundings, these impacts are studied in [5-8], and these effects on operational characteristics becomes more prominent under heavy traffic conditions. Despite all the effects on operational characteristics on traffic of heavy vehicles, it has received less attention. Previous studies shows that the drivers of the light vehicles avoid to be in the vicinity of the heavy vehicles, therefore they try to provide larger gaps between them or try to change their lane and accelerate, which results in drivers aggression [6, 9]. The frequent lane changing behavior of light vehicles potentially increases the risk of traffic accidents and reduces traffic safety.

In this study, a detailed examination of operational characteristics such as speed and travel time of the road is presented. The effect of heavy vehicles on the travel time and speed of light vehicles is calculated on National highway N-45 at Mardan, KPK, Pakistan. Section 2, presents the methodology of the study. The results of the study are provided Section 3, the conclusions are given in Section 4.

METHODOLOGY

A preliminary survey was done to identify the effects of heavy vehicles on the speed and travel time of light vehicles. National highway N-45 was identified where we can see frequent lane changing behavior due to the presence of heavy vehicles of the road and there are relatively high density of mix traffic. The light vehicles tries to accelerate and decelerate which results in traffic shockwaves.

Two video camera recorders were installed on a road section of 100 m to record the real traffic data which were used to calculate the speed and travel time of the heavy and light vehicles. Different traffic flow conditions were analyzed such that when there were only light vehicles of the road and when there were light vehicles on the road in the presence of light vehicles.

First Traffic condition:

First traffic condition was considered for the light vehicles when there were no heavy vehicles of the road. Total number of vehicles analyzed are 10 for 100 m long section of the road. The traffic data is given in Table 1.

Table 1: Speeds and travel times of vehicles for 100 m section of the road

Table 2: Speeds and travel times of vehicles for 100 m section of the road					
Sr No	Description	Travel Time (s)	Distance (m)	Speed (m/s)	Speed (km/hr)
1	Car	5.41	100	18.48429	66.54
2	Car	6		16.66667	60
3	Car	5.9		16.94915	61.02
4	Motor bike	6.1		16.39344	59.02
5	HiAce	6.35		15.74803	56.69
6	Car	5.82		17.18213	61.86
7	Motor bike	5.75		17.3913	62.61
8	Motorbike	6.102		16.38807	59.00
9	HiAce	7.58		13.19261	47.49
10	Pickup VAN	10.49		9.532888	34.32
Average Travel Time (s)					6.55
Average Free Flow Speed (km/hr.)					56.85

The average speed of the vehicles 56.85 km/hr. whereas, the average travel time is 6.55 s. The traffic flow is smooth, less lane changing behavior were observed.

Second Traffic condition:

In the second traffic condition light vehicles in the presence of 1 mini truck was considered. The traffic data for second traffic condition is given in Table 2.

Table 2: Speeds and travel times of vehicles for 100 m section of the road

Table IV: Speeds and travel times of vehicles for 100 m section of the road					
Sr No	Description	Travel Time (s)	Distance (m)	Speed (m/s)	Speed (km/hr)
1	Car	7.77	100	12.87001	46.33
2	Car	7.32		13.6612	49.9
3	SUV	5.26		19.01141	68.44
4	Car	5.25		19.04762	68.57
5	Mini truck	8.3		12.04819	43.37
6	Car	8.12		12.31527	44.33
7	Motor bike	8.39		11.91895	42.91
8	Car	8.14		12.28501	44.23
9	Motor bike	8.37		11.94743	43.01
10	HiAce	8.4		11.90476	42.86
Average Travel Time (s)					7.53
Average Free Flow Speed (km/hr.)					49.32

For the second traffic condition the average speed of the section is 49.32 km/hr. whereas, the average travel time recorded is 7.53 s.

Third Traffic condition:

Third traffic condition was considered for the heavy vehicles and the light vehicles. The traffic data of third traffic condition is given in Table 3.

Table 3: Speeds and travel times of vehicles for 100 m section of the road

Table 3: Speeds and travel times of vehicles for 100 m section of the road					
Sr No	Description	Travel Time (s)	Distance (m)	Speed (m/s)	Speed (km/hr)
1	Heavy truck	12.1	100	8.264463	29.75
2	Motor bike	8.35		11.97605	43.11377246
3	Car	9.41		10.62699	38.26
4	Car	9.49		10.53741	37.93
5	Heavy truck	13.27		7.535795	27.13
6	Car	12.13		8.244023	29.68
7	SUV	12.21		8.190008	29.48
8	Motor bike	12.39		8.071025	29.06
9	HiAce	12.27		8.149959	29.34
10	Car	12.269		8.150624	29.34
Average Travel Time (s)					11.39
Average Free Flow Speed (km/hr.)					32.31

The section average speed is 32.31 km/hr. and the average travel time is 11.39 s.

RESULTS

The impact of the heavy vehicles of the speed and travel time of light vehicles is studied. Heavy vehicles affect the behavior of driver and is characterized by the average speed and average travel time. In the first traffic condition there were only light vehicles on the road section. The results shows that there are less changes in the velocities as the density of the light vehicles increases. Figure 1 shows the travel time and the speed relationship.

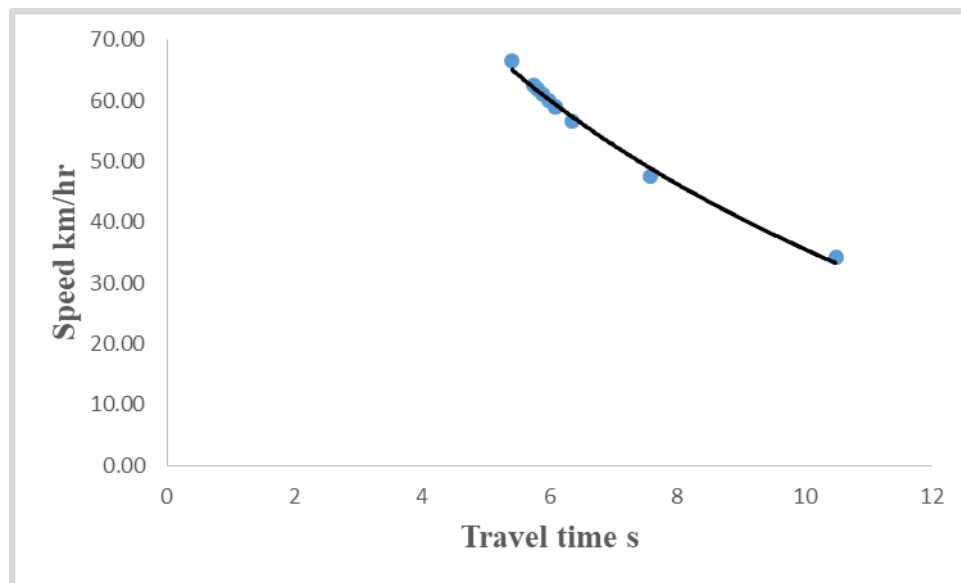


Figure 1: Speed and travel time relationship for 100 m road section

Results shows that when there are no heavy vehicles on the road, the drivers adjust their speeds freely without changing their respective lane. Most of the vehicles travel with desired speeds. Out of ten vehicles, the speeds of eight vehicles range between 59 to 66 km/hr.

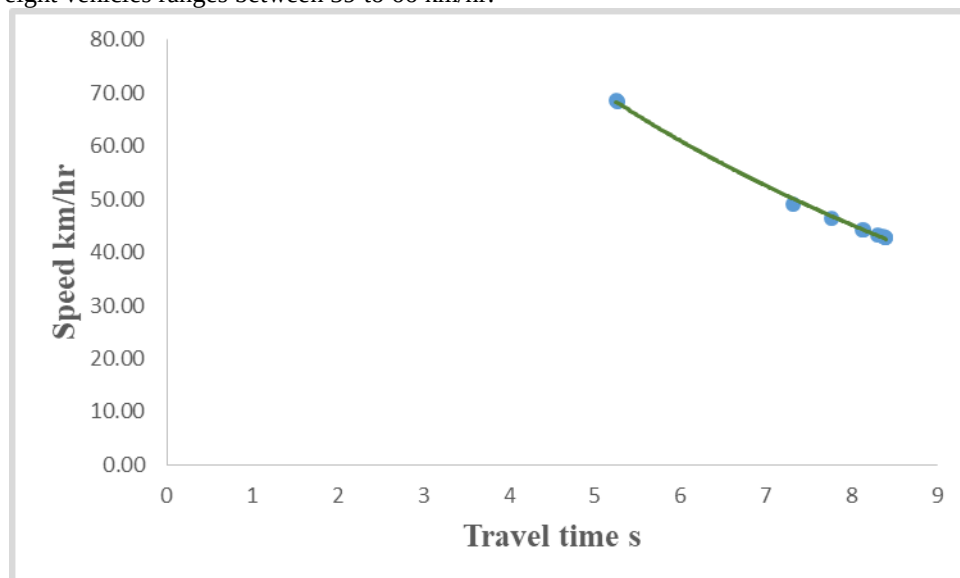


Figure 2: Speed and travel time relationship for 100 m road section

When a heavy vehicle was considered in the second traffic condition the average speed of section decreased and the average travel time increased. The average travel time increased by 0.98 s and average speed of the section decreased by 7.53 km/hr. Which is the result of single heavy vehicle

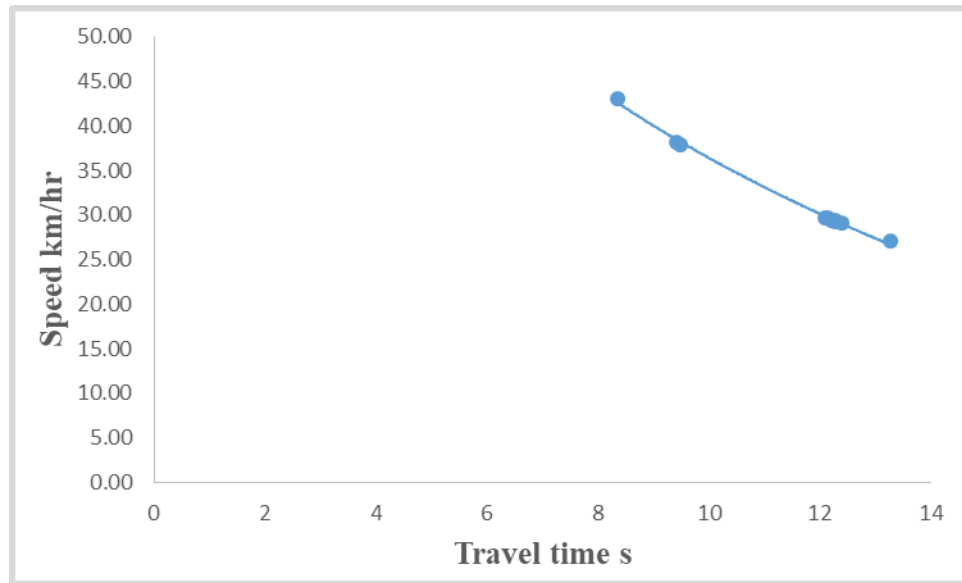


Figure 3: Speed and travel time relationship for 100 m road section

Third traffic condition is presented by Figure 3. When the density of heavy vehicles increased there are higher speed drops which shows the impact of heavy vehicles on the light vehicles. Third traffic condition is compared with first traffic condition, there is an increase of 4.84 s in average travel time of the section which results in the average speed drop which is 24.55 km/hr.

The travel times losses and speed drops experimentally observed for three different traffic conditions shows the impact of heavy vehicles of the light vehicles. It is essential to understand such traffic flows which are the causes of traffic congestion on urban roads. In this study we have proved that the heavy vehicles physically and psychologically affects the drivers of the light vehicles which is the cause of driver's aggression, results in traffic stop and go behavior and lane changing behavior, which decreases road safety and speed and increases travel time.

CONCLUSION

The average speeds and travel times of three different traffic conditions are analyzed and compared. Vehicular traffic is more influenced by the heavy vehicles as compared to the light vehicles. The presence of heavy vehicles results in higher speed drops, increased travel times and frequent lane changing behavior which causes traffic congestion as well as contributes in economic and societal losses.

REFERENCES

- [1] Moridpour S. Modelling heavy vehicle lane changing. Ph.D. Thesis, Monash University, Australia, 2010.
- [2] Moridpour S, Rose G, Sarvi M. The effect of surrounding traffic characteristics on lane changing behavior. Journal of Transportation Engineering 2010; 136(11):937–1055.
- [3] Moridpour S, Sarvi M, Rose G. Lane changing models: a critical review. Transportation Letters: The International. Journal of Transportation Research 2010; 2(3):157–173.
- [4] Al-kaisy AF, Hall FL, Reisman ES. Developing passenger car equivalents for heavy vehicles on freeways during queue discharge flow. Transportation Research A 2002; 36(8):725–742.
- [5] Uddin MS, Ardekani SA. An observational study of lane changing on basic freeway segment. Proceeding of the 81st Transportation Research Board Annual Meeting, Washington, D.C., CD-ROM, 2002.

- [6] Al-kaisy AF, Hall FL. Guidelines for estimating capacity at freeway reconstruction zones. Journal of Transportation Engineering 2003; 129(5):572–577.
- [7] Al-kaisy AF, Jung Y, Rakha H. Developing passenger car equivalency factors for heavy vehicles during congestion. Journal of Transportation Engineering 2005; 131(7):514–523.
- [8] Fwa TF, Ang BW, Goh TN. Characteristics of truck traffic in Singapore. Journal of Advanced Transportation 2010; 30(2):25–46.
- [9] Moridpour S, Sarvi M, Rose G. Modeling the lane changing execution of multi class vehicles under heavy traffic conditions. Transportation Research Record. Journal of the Transportation Research Board 2010; 2161:11–19.