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Variation of Passenger Car Unit with the Vehicle Speed under Mixed Traffic Condition: case study of Selected Intersections along Kathmandu Ring Road

Gobardhan Banskota[1], Thusitha Chandani Shahi[2]
[1]*Graduate Student,* [,2]*Associate Professor (Nepal Engineering College - Center for Postgraduate Studies, Nepal)*

Abstract:
Background: *Passenger Car Unit (PCU) is used for converting a mixed vehicle flow into an equivalent passenger car flow. PCU value for a vehicle is not constant but varies with traffic and roadway conditions. In this research, it was attempted to find the PCU value of different types of vehicles at selected intersections of Kathmandu Ring Road. These intersections are chosen based upon the significant queuing during peak hour and the manual traffic control by Traffic Police.*
Methods: *Traffic flow as the primary source of data was collected using videography during peak hour. Secondary data are vehicle dimensions, PCU value adopted by Nepal Road Standard (NRS) 2013 and study reports of Kathmandu Sustainable Urban Transport Project (KSUTP). Data processing was performed in VideoLAN Client (VLC) player and analyzed using Chandra method to calculate the PCU values.*
Results: *PCU values for different vehicle categories were found. The average PCU value obtained from calculation are Car: 1, Bike: 0.3 Truck: 3.32, Mini Truck: 1.84, Bus: 3.00, Micro-Bus: 1.29, Utility Vehicle: 1.32, and Tempo: 1.01. Statistical analysis (Z-test) shows that there is significant difference of PCU value for motorcycle and Truck from NRS 2013, whereas there is no significant difference in PCU value of remaining vehicle from NRS 2013. Similarly, there is no significant difference in PCU values for all type of vehicle with KSUTP.*
Conclusion: *It is also concluded that PCU values decrease for all type of vehicle by increasing the speed of vehicle.*
Key Word: *Passenger Car Unit, PCU, Highway Capacity, Chandra method*

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I. Introduction

Background

Nepal is a country in South Asia which is situated between two giant nations China and India. Nepal is spread within 147,516 square kilometers. Nepal has 12,493.04 km long Strategic Road Network (SRN) under Department of Roads and around 50,000 km of rural road (DoR, 2021). Further 19,57,849 number of registered vehicles like Bus, Minibus, Motorcycle, Van, Car, Tempo, Tractor etc. ply over the country with average of 13.8% increase in last 25 years (DoTM, 2016).

Two-lane highways represent the majority of road networks in the world. Most of the national highway and city roads in Nepal are of two lane with two-way mixed traffic condition and with very little lane discipline. Nepalese traffic streams consist of heterogeneous traffic which also includes non-standard vehicles. Heterogeneous traffic flow, characterized by a free inter-lane exchange, has become an important issue in addressing congestion in urban areas. New approaches to the heterogeneous non-lane-based flow have been proposed. However insufficient empirical verification has been made to estimate vehicle interaction, which is necessary for an accurate representation of mixed-flow conditions. (Ambarwati, et al., 2014). The traffic stream in Nepal has variety of vehicles like cars, heavy vehicles such as buses, trucks, light commercial vehicles, motorized two wheelers and three wheelers and non-motorized vehicles which comprise of wide range of static and dynamic characteristics. Hence a uniform measure of vehicles is thus necessary to estimate traffic volume and capacity of roads under mixed traffic flow. This is rather difficult to achieve unless the different vehicle types are stated in terms of a common standard vehicle unit. For this reasons, the concept of Passenger Car Unit (PCU) or Passenger Car Equivalent (PCE) was developed.

Traffic movement within urban area is very complex due to the heterogeneous traffic stream sharing the same carriageway. Highway Capacity Manual (HCM, 2000) and other works in developed country for PCU determination assume homogeneous and lane based traffic for analysis. There is notable lateral movement without following lane discipline at urban intersections and vehicles tend to use lateral gaps to reach the head of

the queue and overtake even during critical phase. Due to these fundamental differences, the standard western relationships for PCU factors are not appropriate for developing countries like Nepal. Transportation engineers and professionals in Nepal do not have local standards to use for PCU values. They currently use standards adopted by other countries without local validation. For correct signal design, capacity estimation, volume prediction & quantifying into the single unit these parameters should be estimated based on the local prevailing traffic conditions and hence requires a different approach of analysis. There is no such valid study for estimating PCU for non-lane based heterogeneous traffic conditions in case of Nepal.

Objectives of the Study: main objective of the study is to estimate the value of PCUs for mixed traffic condition of moving vehicle at urban intersections of Kathmandu Ring Road and comparison of those values with the values given by NRS 2013 and various other studies. Specifically, the study was aimed at the unveiling the influence of the speed on the values of PCU of respective type of vehicle.

II. Literature Review

Urban traffic movement in Kathmandu

Road transport is dominant mode in Kathmandu. Buses, cars and two wheelers are most common modes. Among the South Asian Countries, Nepal has a very low road density, not only in terms of serving the population but also in providing accessibility to various parts of the country. Although the strategic roads constitute about 20 percent of the National Road Network, it plays a very important role in terms of the movement of people and freight. The strategic roads have high traffic volume in comparison to district roads (Thapa, A.J., 2013).

As physical infrastructure has its constraint, managerial improvement thought to be more logical and sustainable. As road traffic was made up of a great variety of different types of vehicles – from large articulated lorries and busses, to minicars and bicycles, the different vehicle types have different characteristics – length, or typical speed, or rate of acceleration, and so they also have a different impact on road capacity etc. Rather than trying to deal with so many vehicle types, engineers came up with the idea of passenger car units (PCUs – sometimes also known as passenger car equivalents-PCEs) (Craus, et al., 1980).

In Nepal, four-wheeled vehicle constitutes about 20% of all registered vehicles with almost 22.2% of total travel mode distribution (JICA, 2012). Table 1 shows the details of mode of transportation in Nepal.

Table 1: Travel mode in Kathmandu

Mode of Transport	Percentage of People
Walking	39.7%
Bicycle	1.5%
Motorcycle	25.8%
Car	3.3%
Tempo	8.9%
Bus/Minibus	16.6%
Others	1.8%

Source: (JICA, 2012)

The government data shows that there has been impressive growth in registration under all segments of vehicles like bus, micro bus, car/jeep/van, motorcycle, among others, in recent years. Motorcycle registration has overtaken the registration of other vehicles.

Passenger Car Unit (PCU)

A Passenger Car Unit (PCU) is a method used in Transport modelling to allow for the different vehicle types within a traffic flow group to be assessed in a consistent manner (LEEDS, 2015). Highway Capacity Manual (HCM) paid special attention to passenger car equivalent factors (PCE). The recent edition of Highway Capacity Manual in 2010 defines PCE as "the number of passenger cars that will result in the same operational conditions as a single heavy vehicle of a particular type under specified roadway, traffic, and control conditions" (TRB, 2010). PCE values dependent on the traffic flow parameters, these values are subject to variations due to the factors influences the traffic flow parameters. Therefore it may not be precisely correct to adopt a constant set of PCE values under different roadway and traffic conditions (Justo & Tuladhar, 1984).

Methods of PCU determination

Several techniques are available in literature to calculate PCU values for different types of vehicle in traffic stream. Werner and Morall (1976) suggested a headway ratio method to determine PCU values at low levels of service. Krammes & Crowley (1986) analyzed a mixed traffic stream and developed an equation

considering headway differences between trucks and other vehicles, which can be applied at midblock section of a road segment for determination of PCU. Yagar and Aerde (1993) used speed parameters to estimate the PCU of trucks, recreational vehicles, and other vehicles on a two-lane highway. Thorne (1965) used a regression analysis technique to find the PCU for buses. Craus, et al. (1980) suggested another approach to determine the PCU of trucks on a two-lane highway by considering the actual delay caused by trucks and opposing traffic. Krammes and Crowley (1986) have indicated that the variables, which are used to define the LOS should be used to estimate the PCU values also. The LOS on a segment of highway is defined in terms of operating speed HCM (2000). Therefore, speed is considered a prime variable to determine the relative effect of individual vehicles on the traffic stream in terms of the PCU. In this study, the PCU of a vehicle type is taken as given by equation between speed and physical area of vehicle (Chandra & Sikdar, 2000).

$$PCU = \frac{Vc/Vi}{Ac/Ai} \qquad \text{(Equation 1)}$$

Where,

PCU = passenger car unit value of i^{th} type vehicle
Speed ratio of the car to the i^{th} vehicle = V_c/V_i
Space ratio of the car to the i^{th} vehicle = A_c/A_i
V_c = speed of car (km/h)
V_i = speed of i^{th} type vehicle (km/h)
Ac = static (projected rectangular) area of a car (m^2)
A_i = static (projected rectangular) area of i^{th} type of vehicle (m^2)

Beside that there is various other method for the calculation of PCU such as multiple regression method and density method for PCU calculation in pure homogeneous condition.

III. Methodology

Research design

First, the road sections with the significant amount of traffic was selected. Then the data was collected by classifying the data as primary and secondary data. After the collection of data, data was processed to obtain the speed of the vehicles and measurement of the PCU. Then the results were analyzed to reach conclusion.

Study Area

Since study approach is to determine the PCU of vehicle at selected intersections located along the Kathmandu Ring Road (one is Balkhu and another is Gaushala intersection). The selection of the intersections was based on the following criteria: High traffic volumes, significant queuing, no parking allowed at or close to the intersection and good mix of different vehicle types and presence of traffic police for regulating the flow. Balkhu intersection is staggered intersection and whereas Gaushala intersection is four legged intersections with directional indication as shown in Figure 1 and Figure 2. Detail of the location is shown in Table 2.

Table 2: Location detail

Location	Lane width	AADT in PCU	Type of Road
Balkhu	3.6 m	33,512	Two way
Gaushala	3.5 m	42,256	Two way

Source (DoR, 2017)

Study population

Study population is the number of through vehicle which crosses the Balkhu and Gaushala intersection. Minimum 30 numbers of vehicle of single category is needed to calculate the PCU of vehicle at desire section of roadway (Chandra & Sikdar, 2000). So 50 numbers of vehicle for each category is taken as the sample size in each intersection.

Data collection: Primary data

Time taken by the vehicle to travel 50m marked distance was noted from the video taken by Hand Camera (JVC Handycam) to calculate the speed of the vehicle. Data were collected in study intersection during morning peak hours. (9:00 AM to 11:30 AM) only on week days for a week from high raised building's roof nearby the intersection. The data is collected once in a single intersection and only until the desired sample size is obtained.

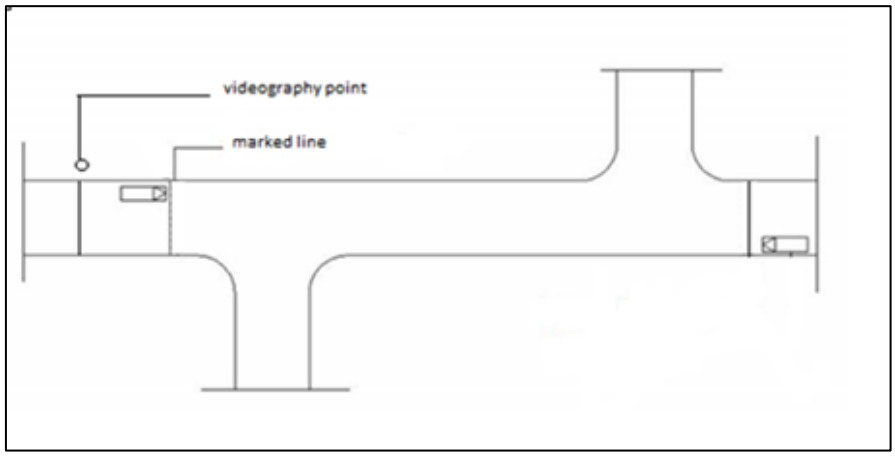

Figure 1: Sampling point for videography in Balkhu

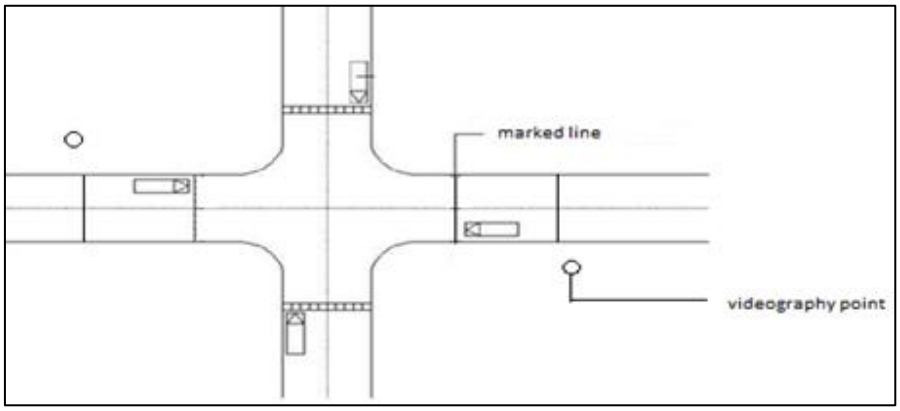

Figure 2: Sampling point for videography in Gaushala

Data Collection: Secondary data

Nepal Road Standard (2013) has also adopted PCU values also called equivalency factor stating that "different types of vehicles take up differing amounts of road space and have different speeds (For geometric design) and impose differing loads on the road structure(For structural design), as shown in Table 3.

Table 3: Vehicle Type and PCU as per NRS, 2013

Vehicle Type	PCU/ Equivalency factor
Car, Auto Rickshaw, SUV, Light Van and Pick Up	1
Light (Mini) Truck, Tractor, Rickshaw	1.5
Truck, Bus, Minibus, Tractor with trailer	3
Bicycle, Motorcycle	0.5
Non-motorized carts	6

(Source: NRS, 2013)

PCU values from various studies like Kathmandu Sustainable Urban Transportation Project (KSUTP) was compared with the PCU value obtained from the study. Calculated PCU values for different types of vehicle for proper development of roundabout and intersection design in various places in Kathmandu by KSUTP is shown in Table 4.

Table 4: Vehicle Type and PCU as per KSUTP, 2014

Vehicle Type	PCU/ Equivalency factor
Motorcycle	0.25
Car / 4WD	1
Utility vehicle	1
Bus / Minibus	3
Microbus	1.5
Multi axial Truck	3.5
3- wheeler	0.75

(Source: KSUTP, 2014)

The physical dimension of vehicle in single category is not uniform. Maruti Suzuki 800 DX is considered as a standard car for this study. Thus to maintain the standard, typical category of vehicle was taken as shown in Table 5 Dimension of all type of vehicle taken in this studies were taken from the respective automobile company webpage.

Table 5: Category and Dimension of Vehicle

SN	Type of Vehicle	Category	Dimension in meter	Projected Area (sq.m)
1	Car/taxi/Passenger car/van	Maruti Suzuki 800 DX	3.335 x 1.440	4.802
2	Motorbike	Pulsar AS 150 CC Honda Dio 100 CC Bullet Classic 350 Honda Shine 125	2.070 x 0.804 1.781 x 0.710 2.120 x 0.815 2.014 x 0.762	1.664 1.264 1.727 1.534
3	Bus Services	Sajha Bus/Mayur Nepal yatayat Kirtipur yatayat Mahanagar yatayat	7.000 x 2.140 5.690 x 2.100 6.020 x 2.120 7.000 x 2.140	14.98 11.949 12.762 14.98
4	Micro Bus	Jumbo Hiace Hiace Blue Micro	4.695 x 1.895 4.425 x 1520 3.450 x 1450	7.958 6.726 5.002
5	Truck	Tata 10 wheeler	7.240 x 2.220	16.072
6	Mini Truck	Tata 709	3.844 x 2.160	8.303
7	Utility Vehicle	Mahendra Bolero Tata Pickup Tata Ace	4.107 x 1.745 4.200 x 1.700 3.729 x 1.560	7.166 7.140 5.817
8	Tempo	Safa Tempo	2.635 x 1.300	3.425

(Source: internet web pages)

Data analysis

Speed and PCU: In this study, only Chandra Method is used for calculation of PCU. The different types of vehicle offer different degree of interference to other traffic and it is necessary to bring all types to a common unit adopted as the passenger Car Unit (PCU). To estimate the PCU values is that it is directly proportional to the ratio of clearing speed of vehicle, and inversely proportional to the space occupancy ratio of vehicle with respect to the standard Area of vehicle, i.e. a car, The PCU of a vehicle type is calculated by formula as mention in Equation 1. Speed of the vehicle (Vc and Vi) is calculated by using the formula:

$$Speed\ (V) = \frac{\text{Distance}}{\text{Time taken}} = \frac{50\ \text{m}}{t2-t1} \qquad \text{(Equation 2)}$$

Where, t_1 and t_2 denotes entry time and exit time for 50m marked distance.

Statistical Analysis of PCU Value

To statistically compare the PCU data in between the intersection using z test, the pre-requisite is that the PCU data of each vehicle's in all the intersection should be normally distributed. One- Sample Kolmogorov Smirnov test was performed to check normality of PCU data. For the 95% confidence interval, level of significance (α = .05).

The statistical comparison of the PCU of each vehicle type listed in table 4.4 among two intersections was done. If each category of vehicle is available in sufficient numbers in all two intersections, then one-way ANOVA test was done.

Secondly, the calculated average PCU value of eight vehicles as listed in Table 5 was compared to the PCU value of NRS 2013 and KSUTP using z statistics.

Finally, calculated speed and representative PCU value of each type of vehicle are plotted in the graph for graphical representation. Then the coefficient of determination, R^2, is used to analyze how differences in one variable can be explained by a difference in a second variable.

IV. Result and Discussion

Speed of Vehicle

In this study eight different types of vehicles were taken in account. As truck and mini truck weren't permitted to pass through the Gaushala intersection during peak hour, their data couldn't be collected. Similarly, there were no route of tempo from the Balkhu intersection.

The collected primary data (entry time and exit time) was noted and Speed of the vehicle to travel 50 m distance was calculated by using Equation 1 and Equation 2.

Table 6: Calculation of Speed

Name of Intersection: Balkhu				Name of Vehicle: Bike		
S.N	**Entry time (t1)**	**Exit Time(t2)**	**Difference (t)=t1-t2**	**decimal**	**Distance (d)**	**speed (d/t)**
1	9:10:00	9:10:05	0:00:05	5	50	10.00
2	9:10:17	9:11:24	0:00:07	7	50	7.14
3	9:10:30	9:10:36	0:00:06	6	50	8.33
…						
50						

PCU of Vehicle

PCU value of vehicle of (i) type was calculated using equation (Equation 1) as in Table 7. Similarly, PCU values of different vehicle at different intersections is shown in Table9.

Table 7: Calculation of PCU

Name of Intersection: Balkhu				Name of Vehicle: bike	
SN	**V_{car}**	**V_{bike}**	**A_{car}**	**A_{bike}**	**PCU**
1	7.09	10.00	4.802	1.664	0.24
2	7.09	7.14	4.802	1.264	0.18
3	7.09	8.33	4.802	1.664	0.29
…					
50					

Table 8: Calculated PCU of Vehicle

SN	**Type of Vehicle**	**PCU**		
		Balkhu	**Gaushala**	**Average**
1	Car/Taxi	1.01	1.00	1.00
2	Motorbike	0.31	0.29	0.30
3	Truck	3.32	-	3.32
4	Mini-Truck	1.84	-	1.84
5	Bus	2.98	3.03	3.00
6	Micro-Bus	1.40	1.29	1.34
7	Utility veh.	1.24	1.40	1.32
8	Tempo	-	1.01	1.01

Comparison of PCU values among two intersections is shown in Figure 3. To analyze the difference of PCU values among two intersections ANOVA test was conducted. Result of ANOVA test for different types of vehicle are discussed below.

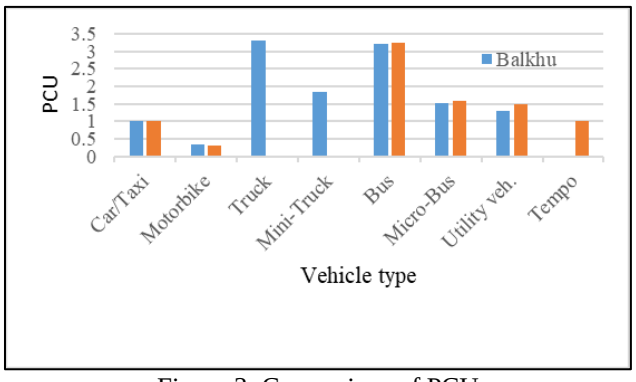

Figure 3: Comparison of PCU

PCU Comparison of Motorbike

Statistical result (as shown in Table 4.4): ANOVA test calculation from MS excel 2007 shows p -value of 4.99249, that is greater than the level of significance $\alpha = 0.05$. Which means it is possible to reject null

hypothesis. Thus there is no significant difference in PCU values for Motorbike among the intersections. The average PCU of Motorbike in two intersections is 0.30.

Table 9: ANOVA Test of Motorbike

SUMMARY						
Groups	Count	Sum	Average	Variance		
Balkhu	50.000	16.490	0.308	0.002		
Gaushala	50.000	14.840	0.303	0.001		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.030	1.000	0.030	23.594	4.992	3.947
Within Groups	0.113	90.000	0.001			
Total	0.142	91.000				

PCU Comparison of Bus

Statistical result (As shown in Table10): ANOVA test calculation from MS excel 2007 shows p-value of 0.495, that is greater than the level of significance $\alpha = 0.05$. Thus there is no significant difference in PCU values for Bus among the intersections. The average PCU value of Bus in two intersections is 3.0.

Table 10: ANOVA Test of Bus

SUMMARY						
Groups	Count	Sum	Average	Variance		
Balkhu	50.000	161.110	3.120	0.081		
Gaushala	50.000	162.850	2.980	0.048		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.030	1.000	0.030	0.468	0.495	3.938
Within Groups	6.337	98.000	0.065			
Total	6.367	99.000				

PCU Comparison of Micro Bus

Statistical result (As shown in Table 11): ANOVA test calculation from MS excel 2007 shows p-value of 0.640, that is greater than the level of significance $\alpha = 0.05$. Thus there is no significant difference in PCU values for Bus among the intersections. The average PCU value of Micro Bus in two intersections 1.34.

Table 11: ANOVA Test of Micro Bus

SUMMARY						
Groups	Count	Sum	Average	Variance		
Balkhu	31.000	46.121	1.402	0.094		
Gaushala	31.000	48.785	1.295	0.099		
ANOVA						
Source of	SS	df	MS	F	P-value	F
Between Groups	0.021	1.000	0.021	0.221	0.640	3.99
Within Groups	5.876	61.000	0.096			
Total	5.897	62.000				

PCU Comparison of Utility Vehicle

Statistical result (As shown in Table 12) :ANOVA test calculation from MS excel 2007 shows p-value of 0.0002, that is less than the level of significance $\alpha = 0.05$. Which means it is not possible to reject null hypothesis. Thus there is significant difference in PCU values for utility vehicle among the intersections. The average PCU of utility vehicle in two intersections is 1.32.

Table 12: ANOVA Test of Utility Vehicle

SUMMARY						
Groups	Count	Sum	Average	Variance		
Balkhu	50.000	65.680	1.414	0.043		
Gaushala	50.000	74.030	1.291	0.050		
ANOVA						
Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	0.697	1.000	0.697	14.911	0.0002	3.938
Within Groups	4.582	98.000	0.047			
Total	5.280	99.000				

PCU Comparison of Truck, Mini truck and Tempo

The average PCU of truck and mini truck in Balkhu is 3.32 and 1.84 respectively whereas PCU of tempo in Gaushala is 1.01. ANOVA test was not used to test the hypothesis as there is no any truck and mini truck in Gaushala. Also there is no any tempo in Balkhu.

Comparison of PCU with NRS (2013)

Comparison of average PCU value of eight vehicles with the PCU value as per Nepal Road Standard (NRS 2013) is shown in Table13.

Table 13: Comparison of PCU with respect to NRS (2013)

S.N.	Vehicle Type	PCU as per NRS 2013 (x)	PCU as per this Study (μ)	Standard deviation	z-calculated	z-tabulated
1	Car, SUV, Light Van	1.00	1	0.1183		1.96
2	Motorcycle	0.50	0.30	0.0387	31.061	1.96
3	Truck	3.00	3.32	0.6418	2.949	1.96
4	Mini Truck	1.50	1.84	0.1516	-15.858	1.96
5	Bus	3.00	3.00	0.2539	0	1.96
6	Micro Bus	-	1.34	0.1516	-	1.96
7	Utility Vehicle (Pick-up)	1.00	1.32	0.1884	-9.740	1.96
8	Tempo	1.00	1.01	0.1673	-0.422	1.96

Statistical analysis has shown that there is significant difference of PCU value for motorcycle and Truck among the present calculation and from NRS 2013. But it is found that, there is no significant difference in PCU value of mini truck, bus, utility vehicle and tempo among the present calculation and from NRS 2013.

Comparison of PCU with KSUTP

Comparison of average PCU value of eight vehicles with the PCU value as per KSUTP (2014) is shown in Table 14.

Table 14: Comparison of PCU with respect to KSUTP (2014)

Vehicle Type	PCU per KSUTP (x)	PCU as per this Study (μ)	Standard deviation	z-calculated	z-tabulated
Car, SUV, Light Van	1	1	0.1183		1.96
Motorcycle	0.25	0.30	0.0387	-14.617	1.96
Truck	3	3.32	0.6418	-2.949	1.96
Mini Truck	1.5	1.84	0.1516	-15.858	1.96
Bus	3	3.00	0.2539	0	1.96
Micro Bus	1.5	1.34	0.1516	-1.806	1.96
Utility Vehicle	1	1.32	0.1884	-9.740	1.96
Tempo	1	1.01	0.1673	-0.422	1.96

Statistical analysis has shown that there isn't significant difference in PCU value of motorcycle, truck, mini truck, bus, minibus, utility vehicle and tempo among the present calculation and from KSUTP studies.

Relationship between speed and PCU

Speed of the vehicle has direct relation with PCU value of vehicle plying in the road. The coefficient of determination, R^2, was used to analyze how differences in one variable can be explained by a difference in a second variable. Calculated speed and PCU values were plotted for the graphical representation of R-Squared and to derive their relation. Typical curves showing speed-PCU relationships are shown in Figure 4, Figure 5, Figure 6 and Figure 7.

Figure 4 shows that the PCU values of bike decreases in increasing the speed of bike. The $R^2 = 0.6009$ means 60.09 % of the variation of PCU value is explain by the speed of vehicle. Theoretically, the other 39.91 % is considered a random variation. It has been found that the maximum PCU value of bike is 0.39 at speed 22.5 km/h and minimum PCU value is 0.18 at 36 km/h.

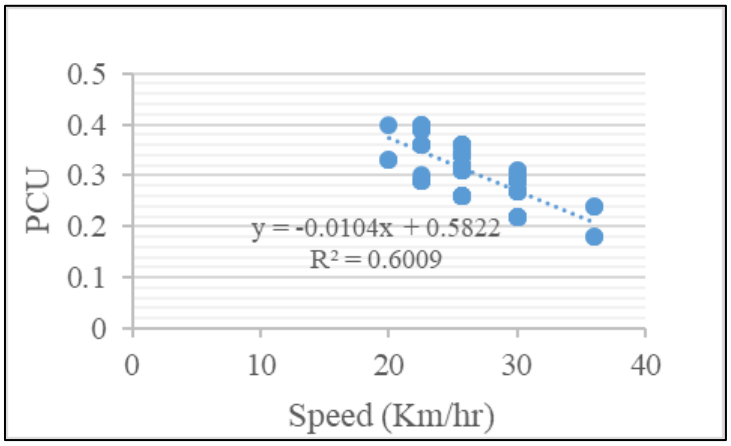

Figure 4: Speed vs PCU (Bike)

Figure 5 shows that the PCU values of utility vehicle decreases in increasing the speed of utility vehicle. The R^2 value for this case is 0.7833, which explains that the 78.33% of the variation of PCU value is explain by the speed of utility vehicles. Theoretically, the 21.67% is considered a random variation. The study found that maximum PCU value of utility vehicle is 1.68 at speed 22.5 km/h and minimum PCU value is 0.85 at 37 km/h.

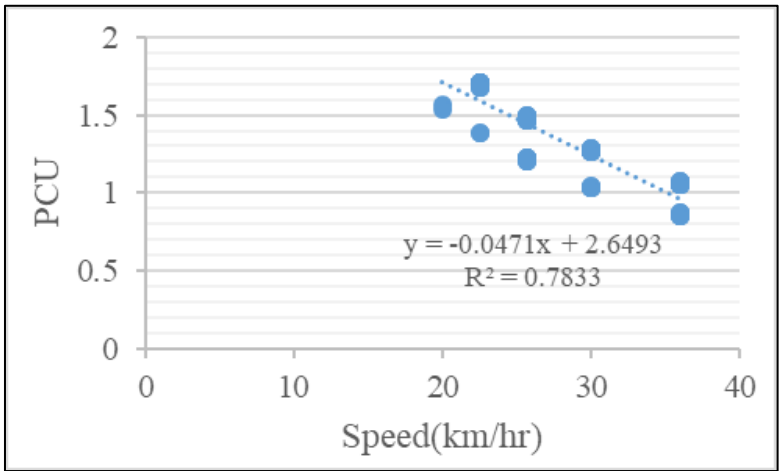

Figure 5: Speed vs PCU (Utility Vehicle)

Figure 6 shows that the PCU values of bus decreases in increasing the speed of bus. The R^2 value for this case was found as 0.6661. This is explained as the 66.61 % of the variation of PCU value is explain by the speed of vehicle. Theoretically, the other 33.39 % is considered a random variation. The study maximum indicates that the PCU value of bus is 3.98 at speed 19.98 km/h and minimum PCU value is 2.21 at 36 km/h.

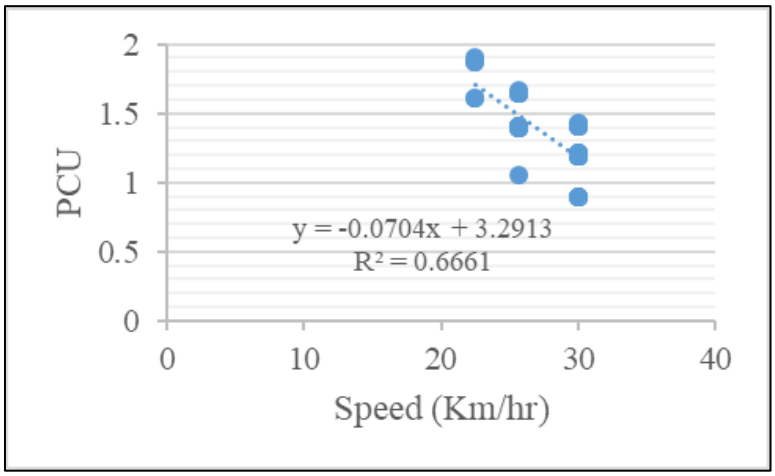

Figure 6: Speed vs PCU (Bus)

Figure 7 shows that the PCU values of micro bus decreases in increasing the speed. The R^2 value is found as 0.5418 means 54.18 % of the variation of PCU value is explain by its speed. Theoretically, the other 45.82 % is considered a random variation. The study determined the maximum PCU value of micro bus is 1.87 at speed 22.5 km/h and minimum PCU value is 0.90 at 29.98 km/h.

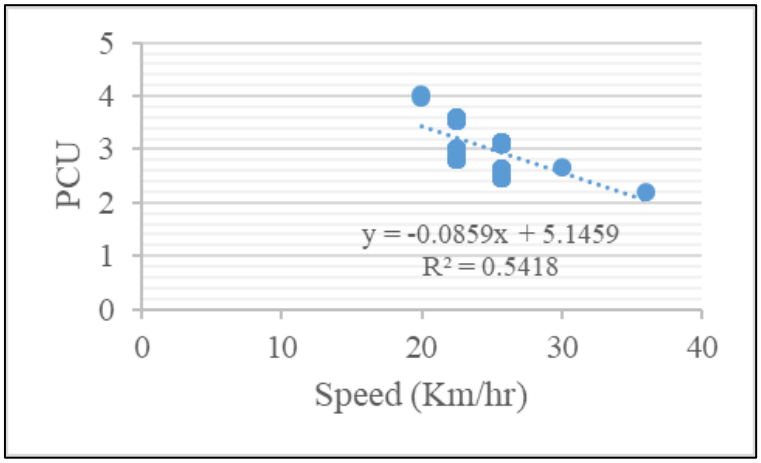

Figure 7: Speed vs PCU (Micro Bus)

Overall, the PCU values of the respective vehicle shows a decreasing trend with an increase in vehicle speed. The study shows that the change of the PCU value with respect to speed is higher in the case of bus; whereas, bike depicts minimum rate of dependency of PCU value to the speed.

In conclusion, for large vehicles like bus, increase in speed causes drastic decrease in PCU value. Whereas for small vehicle like bike increase in speed causes gentle decrease in PCU value. Since PCU is directly proportional to the area of individual vehicle (Ai) and inversely proportional to the speed of same vehicle (Vi), it is concluded that higher the area of vehicle higher will be the dependency of the PCU value to the vehicle speed.

V. Conclusion

From the study, it is found that there is very small variance of PCU value of individual vehicle within the selected intersection of Ring road in Kathmandu Metropolitan City namely Balkhu and Gaushala intersection. The PCU value obtained from calculation are Car: 1, Bike: 0.3 Truck: 3.32, Mini Truck: 1.84, Bus: 3.00, Micro-Bus: 1.29, Utility Vehicle: 1.32, and Tempo: 1.01. Using statistical Analysis of Variance (ANOVA) test it is found that there is no significant difference in PCU value among two intersections for all the vehicles except utility vehicle.

Statistical analysis (z-test) shows that there is significant difference of PCU value for motorcycle and Truck among the present calculation and from NRS 2013. But it is found that, there is no significant difference in PCU value of mini truck, bus, utility vehicle and tempo among the present calculation and from NRS 2013. Similarly, there is not any significant difference in PCU values for all type of vehicle with KSUTP studies.

Statistical comparison of calculation with PCU values from headway method shows that there is significant difference of PCU value for motorcycle. But it is found that, there is no significant difference in PCU values of truck, mini truck, bus, utility vehicle and tempo among the present calculation and calculation from headway method.

It is also concluded that PCU value is dependent upon the speed of the vehicle. PCU values decreases for all type of vehicle by increasing the speed of vehicle.

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