

## **A Study Of Traffic Flow On Siddartha And Prithvi Highway**

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### **INTRODUCTION:**

The road system develops in response to demands for movement of people and of goods and services within or among the regions.<sup>1</sup> The origin of their movement between the places is conditioned mainly by areal differentiation. Some other factors such as supply and demand<sup>2</sup>, distant apart and the number of intervening opportunities,<sup>3</sup> desirable-undesirable and abundances-scarcity<sup>4</sup> are also important to create their movement between the places. Such movement along the highway linking different geographical regions and the places is known as 'highway traffic flow.'

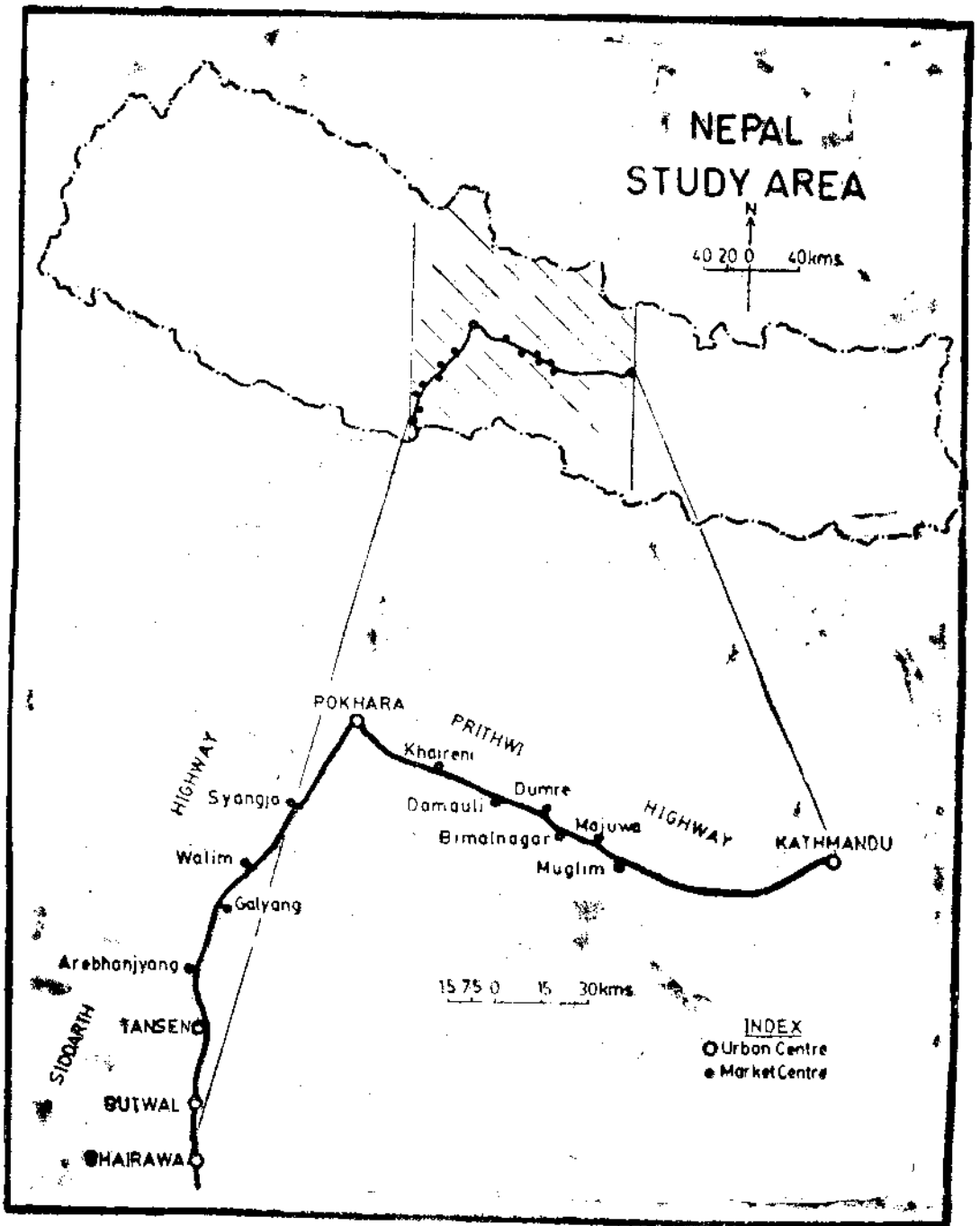
An introduction to the origin of traffic flow system along the long route, particularly the modern highway, corresponds to the development

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1. Harold M. Mayer, 'Making a Living in Cities: The Urban 'Economic Base', *The Journal of Geography*, vol. 48 (1969), p. 75.
2. R. Abler, Adams and P. Gould, *Spatial Organisation; The Geographer's View of The World* (London: Prentice Hall International Editions, Inc., 1977), p. 196.
3. G. O. Ewing, 'Gravity and Linear Regression Models of Spatial Interaction: A Cautionary Note', *Economic Geography*, Vol. 50 (1974), p. 84.
4. E. Ullman, *Man's Role In Changing The Face of The Earth*, in W. L. Thomas (Ed. f, Chicago (1956), pp. 862-80.



of modern highway in Nepal.<sup>5</sup> Since the construction of Siddhartha Highway<sup>6</sup> and Prithvi Highway,<sup>7</sup> it is seen that there has been an increase in the number of visitors and public vehicle flow and a change in travelling nature of the people of the western and the central parts of the kingdom. The traffic was opened to public in these highways in 1968 and 1969<sup>8</sup> respectively. Siddhartha highway, the north-south aligned road, joins two distinct geographical regions - Tarai and Hill<sup>9</sup> while Prithvi highway, extending east west completely lies in the hill region. These highways joining three urban centers - Bhairawa, Pokhara and Kathmandu<sup>10</sup> and also many small market centers<sup>11</sup> - create movement of traffic flows among themselves and with other centers. The present paper is an attempt to study the number and intensity of traffic flow with respect to population size of the centers located along Siddhartha and Prithvi highways.

#### OBJECTIVES OF THE STUDY:

The main purposes of this study are two fold: to examine the number and the intensity of vehicle and passenger flows between the interacting points of origins and destinations.

5. Tribhuvan Rajpath with 190 km long is the first highway constructed in 1956.
6. It is 184 km long completed in 1972. It connects two zones - Gandaki and Lumbini and four districts - Kaski, Syangja, Palpa and Rupandehi.
7. The highway passes through three zones - Bagmati, Narayani and Gandaki, and six districts - Nuwakot, Dhading, Chitwan, Gorkha, Tanahu and Kaski. It is 176 km long up to Naubise and was completed in 1973.
8. M.C.W. Crocder and Daniel G. Sisler, **The Impact of Sonauli-Pokhara Highway on the Regional Income and Agricultural Production of Pokhara Valley, Nepal**, Occasional paper No. 32 (Cornell University, USAID, Price Research, 1972), p. 1.
9. Tarai, the low level flat land with fertile alluvial soil, occupies about 16 percent of the country's total land. Hill region is composed of rugged terrain and valleys covering about 84 percent of the country's total lands.
10. Bhairawa is an urban center of the western Tarai region and also an important commercial as well as agricultural production center. - Pokhara is an urban center of the western hill region with plenty of natural sceneries. Kathmandu is the capital city of Nepal.
11. These market centers offer varieties of functional services including marketing and district level administrative facilities.

**STUDY AREA:**

The study area is located within the central-west Nepal (Fig. 1). Siddartha and Prithvi highways are only the paved motorable roads of this region.

**SOURCE OF DATA:**

The data for this study were obtained through the recorded sources of the concerned offices. The data for vehicle flow were taken for 15 days each of the two months- Jestha (May/June; the beginning month of rainy season) and Shrawan (July/August; the slack season of summer). These were collected from the selected points such as Manigram, Pardi, Walim, Bijayapur and Khairani.<sup>12</sup>

The passenger study consists of two kinds: **express service** and **local service**.<sup>13</sup> The data for this study were collected for 7 days and 3 days for these services respectively. Eight centers<sup>14</sup> for each of the highways have been taken for an origin and destination survey. This study is concerned with the passengers served by buses regulated under the syndicate system of the highways. It does not consider the passenger flow served by locally conducted bus services.

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12. Among the survey points Pardi and Walim keep the record of vehicle flow between Pokhara and Bhairawa while Manigram from Bhairawa to Pokhara. The rest Bijayapur and Khairani take the record of vehicle flow from Kathmandu to Pokhara and from Pokhara to Kathmandu respectively. The Pardi and Manigram points lie at the western end of the Pokhara valley and the north-western end of Bhairawa respectively while Walim is located on the mid-way of these two centers. The last two Bijayapur and Khairani points are located at near east and east of the Pokhara valley.
  13. The express service allows commuters to get down and on only at major bus-stopages while the local services includes service for both major and minor bus stopages.
  14. They are Pokhara, Syangja, Walim, Galyang, Arebhanjyang, Tansen, Butwal and Bhairawa along Siddartha Highway and Pokhara, Khairani, Damauli, Dumre, Bimalnagar, Majura, Muglim and Kathmandu along Prithivi highway,

**METHOD OF ANALYSIS:**

The employed analytical techniques in this study are Regression analysis<sup>15</sup> and the Interaction models.<sup>16</sup>

Regression analysis simply describes the functional relationship between two variables along a line. It is used in this study for the task of prediction of annual revenues derived from passing vehicles. The year [time] and the revenues are independent and dependent variables.

The interaction model attempts to explain the reciprocal activity between two places. The gravity and the potential models are other forms of interaction model. The model postulates that in a system of flows the flow level between an origin and destination varies directly according to the product of their mass and inversely with the distance between them. The interaction model is often used to study the flow system mainly on linear interaction linking pairs of points. The gravity model, which is employed to describe spatial interaction, is a function of two general variables, viz, mass and distance.<sup>17</sup> The mass component is a measure of trip-generating or trip attracting character of a location. The population size as a mass is often

15. The formula for this statistic is  $Y = a + bx$ , where 'Y' predicts the value for the future expectation, 'a' is the Y intercept i. e.

$$a = \frac{\sum Y - b \sum X}{n}$$

and 'b' is the slope of regression line, i. e.

$$b = \frac{n \sum XY - (\sum X)(\sum Y)}{n \sum X^2 - (\sum X)^2}$$

It shows the relationship between two variables. Year and revenues are replaced by X and Y for the calculation in this study.

16. John W. Alexander, *Economic Geography* (New Jersey: Prentice Hall Inc, 1973), p. 624. The formula for the model is

$$I = \frac{P_i P_j}{P_j d_{ij}}$$

where I is the interaction,  $P_i$  population of one of the places,  $P_j$  population of other place and  $d_{ij}$  - distance between i and j.

17. David L. Huff and Georg E. Jenks, 'A Graphic Interpretation of the Friction of Distance in Gravity Models' *Annals of the Association of American Geographers*, vol. 48 (1958), p. 814.

used in many gravity studies because it is convenient and readily available. For the distance component the more conventional measure is simply distance between two points.<sup>18</sup>

The potential model is used to examine the volume of passenger interaction that would flow between the places. Potential at a point is simply an aggregate measure of the influence of all distant places on that point. In the computation of potential model for each center the mass (population size) remains the same but distances are recomputed. The distance for the center itself or 'i' is considered the half of the distance from its nearest neighbour center.

### DATA ANALYSIS

#### Vehicle Traffic flow

Table 1 shows the number of vehicle flow of 15 days for the months—Jestha and Shrawan. A greater number of vehicle flow was observed in the

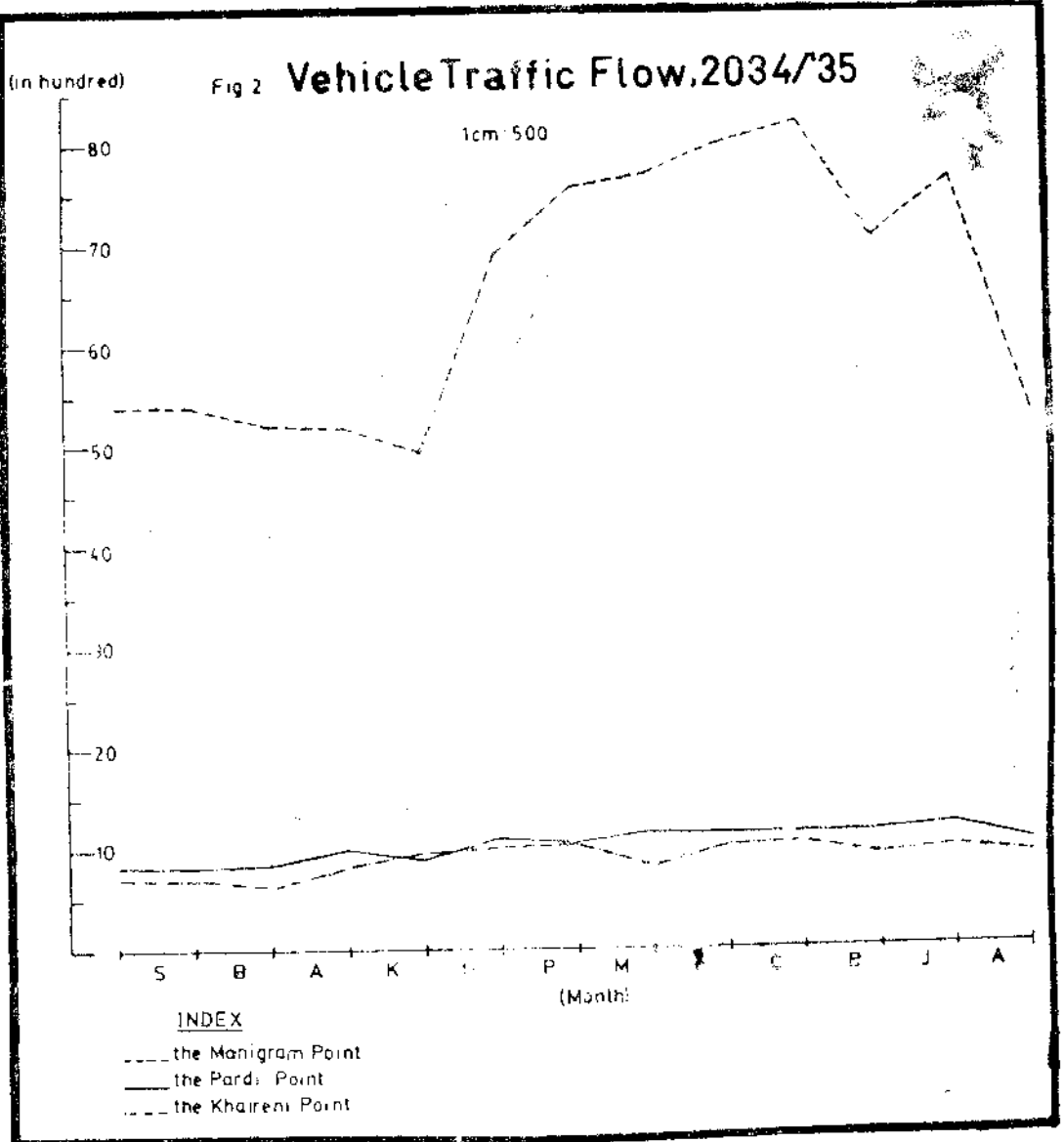
Table 1: Number of Vehicle Flow

Survey points	Jestha	Shrawan	Total
The Manigram Point	3680	1862	5542
The Pardi Point	526	420	946
Total (Siddartha Highway)	4206	2282	6488
The Bijayapur Point	499	430	929
The Khaireni Point	470	346	816
Total (Prithvi Highway)	969	776	1745

month of Jestha (63 percent) than in Shrawan (37 percent). The Manigram point recorded the highest number of flow (i. e. 67 percent) of the total vehicle flow while the Khaireni point the lowest (10 percent; Tab. 1). The flow from Bhairawa and Kathmandu to Pokhara exceeded over the flow from Pokhara to Bhairawa (southward) and Kathmandu (eastward). The Manigram and Bijayapur points recorded the greater number of flow than the points Pardi and Khaireni. Siddartha highway comprised more than 3 times (or 79 percent) the vehicle flow of Prithvi highway (21 percent).

Figure 2 shows the monthly recorded vehicle flow during the year 2034/35. In this year the peak point occurred in the months from Falgun to

18. P. Hagget Andre D. Cliff and Allan Frey, *Locational Analysis in Human Geography* (London: Edward Arnold Ltd., 1977) vol. 1, p. 31.



12/10/11

Jestha. Among the recorded vehicle at the three points the Manigram point recorded more than 6 times (i. e. 79050) the flow recorded at the Pardi point (12636) and 7 times the flow recorded at the Khaireni point (10905). This figure was not available in the record of the Bijayapur point.

The actual interaction of vehicle flow between Pokhara and Bhairawa showed near about 10 times and more than 5 times the interaction between Pokhara and Kathmandu for Jestha and Shrawan months respectively (Tab. 1 and Fig. 3) In the case of expected interaction the model predicts that the flow between Pokhara and Kathmandu would 5 times the interaction between Pokhara and Bhairawa. The actual interaction of vehicle flow between these pairs of points did not show the correlation with their expected interaction. This was also not significant correlated with the population size between Pokhara and Kathmandu.

On the basis of available data the yearly collected revenues were computed by means of regression analysis for different years for the points-Manigram, Khaireni and Pardi (Tab. 2).

**Table 2: The Predicted Revenues**

Survey points	Predicted Revenues (Rs.)	Years
Manigram	14,54,313.0	2036/37
Khaireni	10,77,435.5	2037/38
Pardi	8,13,276.6	2039/40

This analysis predicted the highest revenues for the Manigram point with the rate of highest value as compare with the values of other two points (Tab. 2) for the coming years.<sup>19</sup> If this rate of predicted value continues the Manigram point, undoubtly will provide the highest amount of revenues for each year. However, Siddartha highway displayed a significant contribution to add annual revenues derived from the public vehicles.

The variation in the volume of traffic flow from place to place reflects spatial differences in populations, settlements, and economic activities of the area.<sup>20</sup> Bhairawa is a commercial center which supplies most of the goods for the towns and villages located north of it. Three relatively large settle-

19. See detail; Pushkar K. Pradhan, **Highway Traffic Flow and Market Centers**, an unpublished Master's dissertation submitted to Geography Instruction Committee, Tribhuvan University, Kirtipur, 1979.

20. William, H. Wallace, 'Railroad Traffic Densities and Pattern', **Annals of the Association of American Geographers** vol. 48 (1958), p. 352.



ments such as Butwal, Tansen and Khasyauli along Siddartha Highway are located very close to Bhairawa and as a result, many local trips connected among them. It was observed that almost all trucks carried loads through the Manigram point while those passing through the Pardi point were seldom loaded because of few goods found to be exported from Pokhara to Bhairawa. Similarly, trucks flow observed from Kathmandu, Birgunj, Hetauda and Narayanghat were loaded. The least number of flow in Shrawan was because of heavy rainfall.

#### PASSENGER TRAFFIC FLOW

Table 3 shows the number of passenger flow served by express bus service. The flow was greater in number between Kathmandu-

Table 3: Passenger Flow

Origin Destination	No. of Passenger flow		
	Jestha	Shrawan	Total
1. Pokhara-Bhairawa	972	796	1768
2. Bhairawa-Pokhara	1050	857	1907
3. Kathmandu-Pokhara	2531	1607	4138
4. Pokhara-Kathmandu	2931	2154	5085
Total	7484	5414	12898

Pokhara-Kathmandu than between Bhairawa-Pokhara-Bhairawa. Prithvi highway comprised near about 3 times (71.5 percent) the passenger flow of Siddartha highway (28.5 percent; Tab. 3). This flow in Jestha exceeded (by 16 percent) over the flow in Shrawan. The flow from Pokhara to Kathmandu and Bhairawa exceeded over the flow from Kathmandu and Bhairawa to Pokhara. This flow was greater (by 10 percent) from Pokhara to Kathmandu than from Kathmandu to Pokhara and this from Bhairawa to Pokhara was greater (by 4 percent) than from Pokhara to Bhairawa.

In local passenger service the three days survey showed a total of 4428 passenger being travelled among eight origin and destination pairs through Siddarth highway and that encountered 5802 through Prithvi highway. Table 4 shows one day passenger number. The total number of 708

**Table 4: Matrix of Passenger Number ( Siddartha Highway )**

From / To	A	B	C	D	E	F	G	H	Total
A	0	28	9	7	3	28	96	122	293
B	40	0	14	6	2	12	21	21	116
C	15	19	0	21	4	13	22	1	115
D	11	14	23	0	5	17	27	21	118
E	5	6	8	13	0	21	14	10	77
F	38	13	11	23	15	0	47	41	188
G	101	20	13	20	8	49	0	55	266
H	125	28	19	14	9	45	63	0	303
Total	335	128	97	104	46	185	290	291	1476

Note. A-Pokhara, B-Syangja, C-Walim, D-Galyang, E-Arebhanjyang  
F-Tansen, G-Butwal, H-Bhairawa.

above zero and of 768 below zero indicates the passengers being travelled southward (Bhairawa) and northward (Pokhara) from each of the centers in a day of Jestha month (Tab. 4). Similarly, the total number of 912 above zero and of 1022 below zero indicates that the passengers travelled towards east (Kathmandu) and west (Pokhara) respectively from each center (Tab. 5). In Shrawan month the one day passenger numbers were 1073 and 1556 for Siddartha and Prithvi highways, respectively.

**Table 5: Matrix of Passenger Number ( Prithvi Highway )**

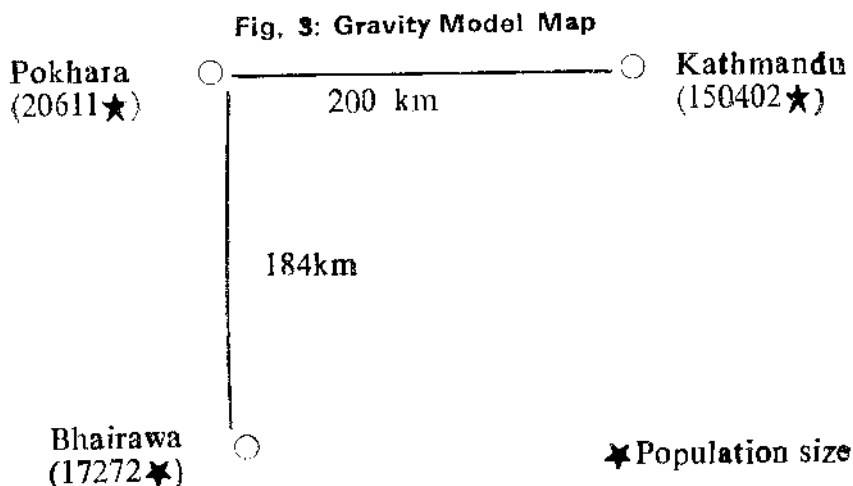
From / To	A	B	C	D	E	F	G	H	Total
A	0	23	31	14	14	10	9	451	552
B	37	0	29	13	8	8	5	16	116
C	42	27	0	33	16	10	6	19	153
D	25	11	25	0	28	14	9	19	131
E	21	12	32	41	0	27	13	18	164
F	21	12	21	32	42	0	22	30	180
G	21	10	16	23	26	23	0	17	136
H	356	17	33	23	18	40	15	0	502
Total-	523	112	187	179	152	132	79	570	1934

Note: A-Pokhara, B-Khaireni, C-Damauli, D-Dumre, E-Bimalnagar,  
F-Majuwa, G-Muglin, H-Kathmandu

Among the bus systems, the study revealed that the local bus system played greater role in term of passenger flow among the places than the express bus system. The study observed that the number of passenger was

not correlated with the number of buses<sup>21</sup> conducted over the highway but rather it was correlated with the size of population of the centers.

The gravity model predicts that the highest volume of interaction in the system would flow between Pokhara and Kathmandu than between Pokhara and Bhairawa [Fig. 3] The actual volume of passenger interaction was



greater between Pokhara and Kathmandu than between Pokhara and Bhairawa. In both cases, there is a significant correlation between flow of passenger and the population size of the centers. The result shows that as the distance from one center to other center increased the interaction between them decreased and the gravity of passenger flow is increased as the population of them increased (see Tabs. 4 and 5 for passenger value and Tabs. 6 and 7 for distance and population size).

In the computation of potential model figures 4 and 5 explain that the greater the population of the centers the larger their potential for passenger interaction which is inversely related with road distance between them. Figure 4 shows that the passenger potential from Damauli to Muglin is increased even though the population of the centers is not constantly increased. It is mainly because of the attraction of greater gravitation force of the biggest population size of Kathmandu city. Of all the centers, Kathmandu, therefore, will have the largest passenger potential followed by Pokhara. The passenger potential also is increased towards south from

21. 30 buses out of 81 permitted buses for Siddhartha Highway and 20 buses out of 52 permitted buses for Prithvi Highway were conducted by the Private Bus Syndicate System.

# Passenger Potential

1cm : 250

Fig 4 PRITHWI HIGHWAY

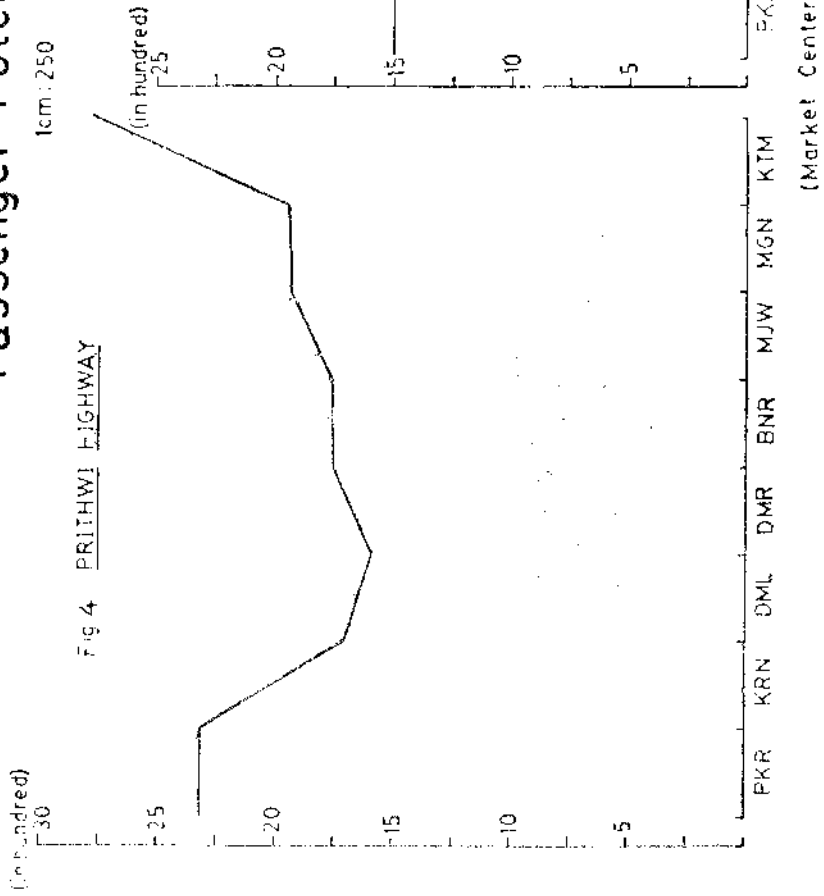
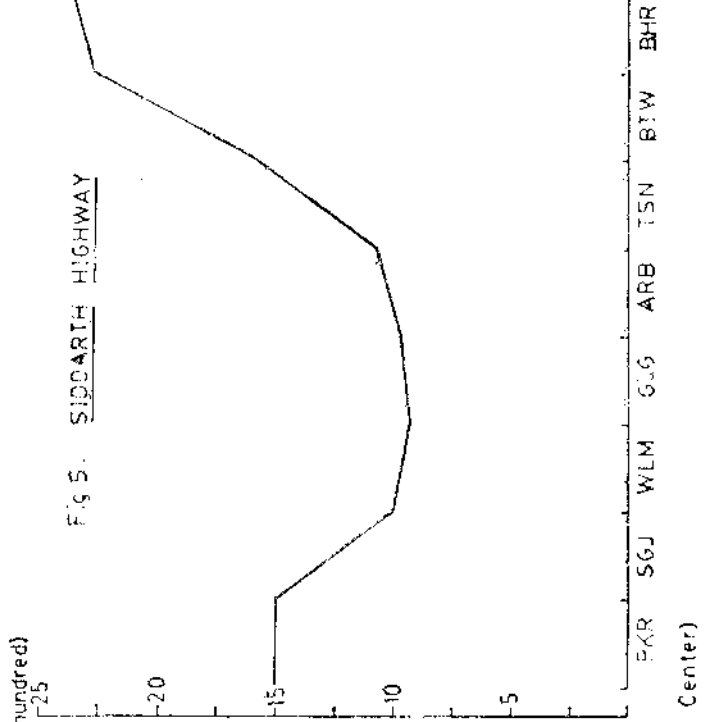


Fig 5. SIDDARTH HIGHWAY



Pokhara (mainly from Walim to Arebhanjyang it is gently upward and from there towards south is steep upward; fig. 5). The reason is only because there are three urban centers with large population size such as Bhairawa, Butwal and Tansen. Both figures however reveals that the gravity of passenger potential will increase from Pokhara to eastward and southward.

The intensity of passenger flow on these highways is determined by many factors.<sup>22</sup> Some of them are: the population density of the areas served, distribution of population relative to highway, the level of the size of the market centers, traditional Hindu ceremonies and fairs and seasons of the year. Siddartha highway found to be used mainly for business purpose as well as for military purpose (pension or leave) while Prithvi Highway for administrative and tourist reasons.<sup>23</sup> Physical uniqueness of the Pokhara valley and the socio-economic and historical uniqueness of the Kathmandu valley are also dominant features for attracting greater number of passengers. In addition, many important historical and religious centers like Gorkha (Mankamana) located on the side of Prithvi Highway are also attracting features for people. This highway consists of a larger number of market centers in a relatively short distance than the Siddartha highway. Prithvi highway serves larger area than Siddartha highway since it runs through many districts. In case of Siddartha highway Lumbini and Tansen attract many visitors.

**Table 6: Distance (km) and Population Size (Siddartha Highway)**

From / To	A	B	C	D	E	F	G	H	Population Size
A	0	34	60	78	105	123	158	184	20611*
B		0	26	44	71	89	124	140	709
C			0	18	45	63	98	114	785
D				0	27	45	80	96	231
E					0	18	53	69	295
F						0	35	51	6434*
G							0	16	12815*
H								0	17272*

22. *Ibid.*, P. 359.

23. P. Blaikie, J. Cameron and D. Seddon, *The Effects of Roads in West Central Nepal*, part 3 (U. K.: University of East Anglia, 1977), pp. 6-9.

**Table 7: Distance (Km) and Population Size (Prithvi Highway)**

From / To	A	B	C	D	E	F	G	H	Pop. Size
A	0	27	48	66	70	84	90	200	20611*
B		0	21	39	43	57	63	173	245
C			0	18	22	36	42	152	1072
D				0	4	18	24	14	400
E					0	14	20	130	245
F						0	6	116	533
G							0	110	333
H								0	150402*

Note: \*indicates the population size according to 1971 Census and others the field survey.

### CONCLUSION

The present study an attempt to show the number and distribution pattern of vehicle and passenger traffic flows in respect with the population size of the centers along the highways. The degree of agreement between the number of passenger flow and population size is found significant. But it is not true in the case of vehicle flow. The fact is that the economic exchange between Bhairawa and Pokhara is larger than between Kathmandu and Pokhara since the former two centers lie in two distinct geographical regions. Recently these flows are being increased on the Prithvi highway since the completion of Gorkha-Narayanghat road in 1981. The study showed the increasing trend of both traffic flows. These were evident from the yields by regression analysis and potential model. However, the volume of these flows were lower than the potential flows of the centers. The degree of relationship of the traffic flows along the highways may differ with functional services offered by the market centers. This aspect should be of interest to future researchers.