We shall now discuss the impact of road accessibility on spatial distribution of rural population. It is instructive to visualise a system and hierarchy of communities from metropolis to villages. We find that every major city has a radius of satellite towns which in turn possess satellite villages. The pattern of this hierarchy would be influenced by the index of industrial development the degree of urbanisation and availability of road facilities. Our interest is confined to investigation of the impact of road accessibility upon size of the village free from the influence of industrial development. This prompts us to exclude the urban population and industrial centres from our analysis. The analysis has been confined to the rural population.

There is a possibility that the size of the village might have been influenced by the relative level road accessibility. The village acts as a centre of agro activities and residence of farmers. The economic distance may act as a limiting factor for growth of size of village. The poor road
facilities impose higher burden of economic distance and it restrains the growth of the villages. The farmer has to go to farm and come back. He has to sell his goods to the market in a nearby town and also buy as from it. The sphere of these interactions would be directly proportional to road accessibility as it reduces the economic distance. Thus it prompts us to say that assuming other things being equal, the population dispersion of a particular rural region would be an inverse function of road facilities. In the region having lower road density the relative size of the villages is expected to be lower owing to the same population tends to get dispersed in many villages centres as a result of attempt by villagers to minimize the economic distance. This implies the region having inadequate and inefficient road system could have greater proportion of small villages as compared to the region having adequate and efficient road system. This theoretical contention can be verified in the context of Marathwada and West Maharashtra as the former signifies the region with paucity of roads and the latter the opposite type. The following table reveals that the proportion of villages of smaller size is higher in Marathwada as compared to West Maharashtra.
<table>
<thead>
<tr>
<th>Population Size of Villages during 1999</th>
<th>No. of Villages Percentage</th>
<th>No. of Villages Percentage</th>
<th>No. of Villages Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 7</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>500 to 999</td>
<td>44%</td>
<td>44%</td>
<td>44%</td>
</tr>
<tr>
<td>999 to 1999</td>
<td>44%</td>
<td>44%</td>
<td>44%</td>
</tr>
<tr>
<td>2000 to 4999</td>
<td>44%</td>
<td>44%</td>
<td>44%</td>
</tr>
<tr>
<td>5000 to 9999</td>
<td>44%</td>
<td>44%</td>
<td>44%</td>
</tr>
<tr>
<td>10000 to 49999</td>
<td>44%</td>
<td>44%</td>
<td>44%</td>
</tr>
</tbody>
</table>

Table 8.1
The above table reveals that there is a relatively higher proportion of villages having a size of population less than 999 in Marathwada as compared to West Maharashtra. There were 77.33 per cent villages having this population range as against 60.49 per cent in West Maharashtra, also there were only 22.85 per cent villages having size of population from 1000 to 9999 in Marathwada as against 36.06 per cent in West Maharashtra.

The higher proportion of small sized villages in Marathwada as compared to West Maharashtra can be partly attributed to the relative paucity of roads in the region.

The influence of road accessibility in the size of the villages can be further substantiated by resorting to rank correlation analysis between average size of the village in the districts and road index; the hypothesis is that the average population size of the village would be directly proportional to the road density in the districts. The relative road density could be indicated by relative road index. The average size of the village is reflected by average population per unit in the district. We have taken 14 districts in
West Maharashtra and Marathwada including 9 from West Maharashtra and 5 of Marathwada, as shown in the table.

The estimated rank correlation co-efficient, between average population of village and road facilities index is found to be 0.63 which is statistically significant at .05 level of significance. The positive sign indicates that there is a possibility of positive impact of road facility on average size of the village, and thus it provides statistical support for our theoretical contention. If we take the regional basis, it has been found that the average rural population of the village was found only 781 in Marathwada, whereas it was 1168 in West Maharashtra. Further it was found that the number of rural towns having population within range of 5000 to 999 were very few in Marathwada as compared to West Maharashtra. This induces the further analysis indicating the rank correlation analysis between number of towns having population between 5000 to 999 and road facility index of the districts from West Maharashtra and Marathwada.

Road index, number of towns having population between 5000 to 9999 and their rank according to districts are given in Table A.8.1

The estimated rank correlation co-efficient is found equal to be 0.78 which is found statistically
significant at .01 level of significance. It indicates that the lesser number of towns with the population range between 5000 to 9999 in Marathwada can be attributed partly to the paucity of roads in the region. Thus both the average size of village and number of village towns within the given range provides statistical evidence for stimulating impact of road accessibility on pattern of spatial concentration of rural population.
Village isolation and road density.

The implication of very low density of population in Marathwada is very clear and it is that the majority of villages are not having roads. The percentage of inaccessible villages in Marathwada is very high as compared to West Maharashtra. The percentage of villages not on the main road in Maharashtra State in 1964 was 73.42 as against 87.39 per cent in Marathwada. The difference is very much glaring if we compare it with reference to the same in West Maharashtra. The percentage of villages not on the main road in West Maharashtra was only 70.8 as compared to 87.39 in the case of Marathwada. Further the glaring difference between the two regions was found in the case of villages having no main roads and approach roads. There were only 25.9 per cent villages having no roads in West Maharashtra but there were 68.3 per cent villages in Marathwada having no roads. Thus the proportion of villages having no roads in Marathwada was more than double as compared to West Maharashtra.

Let us analyse the implications of a very important fact that in Marathwada the proportion of villages having relatively less average population is very high as compared to West Maharashtra. According to 1961 census, there were 77.3 per cent villages having population less than 1000 as against 69.5 per cent in West Maharashtra.
This indicates the lower percentage of villages in Marathwada having population range of 1000 to 9999 and above as compared to West Maharashtra. 22.7 per cent villages in Marathwada has population of more than 9999 as against 30 per cent in West Maharashtra. Thus a greater proportion of rural population resides in smaller villages in Marathwada. Our interest lies in finding out whether there is any influence of this relatively greater proportion of the dispersion of population among very small villages in Marathwada upon road accessibility. The effect of road accessibility can be measured in terms of percentage of villages located on the road as an indicator of relative accessibility in the district. We can contemplate that the percentage of villages located on the roads in the district can be a function of two important variables namely, the road density in the district and average population size of the village in the district, implying that the greater the dispersion of the same population among the greater number of villages results into relatively lower average size of the villages. So the average size of the village can be taken as a proxy for the degree of dispersion of population among the number of villages. Owing to the possibilities of non-linear relationship we have resorted to following log linear form. So regression equation is as

\[ Y = a + b \ln(X) \]

\( Y \) represents the dependent variable, \( X \) represents the independent variable, and \( a \) and \( b \) are constants. The log transformation helps in reducing the skewness of the data and making the relationship linear. However, if the relationship is non-linear, other transformations might be necessary.

Table A 3.2
follows:

\[ Y = C x^a z^b \]

- \( Y \) = percentage of villages on the road as indicator of relative accessibility in the district.
- \( X \) = road density in per 100 Kms.
- \( Z \) = Average size of the village, in the district.
- \( a \) and \( b \) = exponential parameters
- \( c \) = constant.

\[ \log y = a \log x + b \log z + \log c. \]

The estimated regression equation is as follows.

\[ \log Y = 0.6112 \log X + .1834 \log Z + 0.0197 \]

\[ R^2 = 0.3217 \]

Regression co-efficient of road density emerged with positive sign and also found statistically significant at .01 level of significance indicating that the percentage of villages lying on the roads would be a direct function of road density in the district.

This does not require any elaborate explanation.

The regression co-efficient is less than one. It indicates that the road density has positive impact with diminishing rate. This indicates the possibility of overlapping as road density tends to increase.

The regression co-efficient of average size of the

It implies villages with more than one road.
village emerged with positive sign but not found statistically significant. It indicates that there is no influence of average size of the village upon the percentage of villages on the road. This no influence by size of the village is unanticipated but this can be explained in terms of joint accessibility. When the number of villages with the same population is more, the building of roads for two villages pass through the other villages in between the two villages. Thus there is every possibility of joint accessibility to other villages lying in between two villages and thus the average size of the village has no influence. The implication of this is very important indicating that the dispersion of population among many small villages may not require more capital expenditure for road construction owing to natural and inherent joint accessibility by additional roads.
8.2

Market Distance and Road Accessibility.

Let us analyse the issue of distance between villages and markets, that include regulated as well as weekly markets. The distance between village and market has an important bearing on the rural economy of Marathwada. The lower road density in Marathwada appeared to have caused slightly more average distance between village and market. The average distance between village and market was found to be equal to 4.32 miles as against 3.6 miles in West Maharashtra in 1963-64. It means the average distance between market and village was 20% more in Marathwada than in West Maharashtra. But the road density in Marathwada is only one third of that in West Maharashtra. Assuming that there is proportionate and direct impact of road density on market village distance, the average market distance should be more in Marathwada as compared to the same in West Maharashtra. Further, the average distance may not represent the magnitude of economic distance between the village and the market. It necessitates the construction of the market distance index of Marathwada and West Maharashtra. Taking into account average distance of the range of market village distance and proportion of villages within the same range in both regions, the equation for the said index is as follows:
Market distance index = 100 X 

average distance x proportion of villages corresponding to respective average distance in Marathwada.

average distance x proportion of villages corresponding to respective average distance in West Maharashtra.

The estimated market distance index for Marathwada is calculated in the Table No. 6.2

The estimated village market weighted index for Marathwada is found to be 101.6 against 100 for West Maharashtra. Thus it demonstrates that lower road density in Marathwada has not resulted in any significant difference between market distance in Marathwada and West Maharashtra. One probable explanation for this is that, owing to lack of road accessibility, the number of markets with given number of villages would be high as a natural tendency to reduce the economic distance. This contention gets support from the evidence available in 1961 census of weekly markets. According to the census, average number of villages per weekly markets in Marathwada in 1961 were only 6.7 as against 9.6 in West Maharashtra. It indicates that there are more weekly markets per hundred villages in Marathwada than in West Maharashtra. There were about 14 weekly markets for 100 villages in Marathwada as against 11 weekly markets in West Maharashtra. Thus the road inaccessibility might have created the forces
responsible for more marketing centres for a given number of villages. This particular possibility evidences the compensatory reaction to inaccessibility by road.¹

1. There are relatively more weekly markets in Marathwada but, the proportion of weekly markets connected by road was very low in 1961. As shown in the table there were 575 weekly markets in Marathwada, but only 139 were accessible by road. Only 23.5% of the total weekly markets in Marathwada was connected by road as against 51.6% of weekly markets accessible by road in Maharashtra State. Thus the proportion of weekly markets connected by road in Marathwada was less than a half that in Maharashtra State. The comparison between Marathwada and West Maharashtra would reveal even greater disparity. These 79.3% of weekly markets were connected by the road. Thus, as compared to West Maharashtra, only less than one fourth of the weekly markets were connected by road in Marathwada.
<table>
<thead>
<tr>
<th>Range of village-market distances in miles</th>
<th>Average distance</th>
<th>No. of villages</th>
<th>Percent age of villages</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>360</td>
<td>0</td>
<td>6.7</td>
</tr>
<tr>
<td>0.1 to 1</td>
<td>261</td>
<td>0.55</td>
<td>3.7</td>
</tr>
<tr>
<td>1.1 to 2.0</td>
<td>992</td>
<td>1.55</td>
<td>14.24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Range of village-market distances in miles</th>
<th>Average distance</th>
<th>No. of villages</th>
<th>Percent age of villages</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>360</td>
<td>0</td>
<td>8.1</td>
</tr>
<tr>
<td>0.1 to 1</td>
<td>652</td>
<td>0.55</td>
<td>6</td>
</tr>
<tr>
<td>1.1 to 2.0</td>
<td>1273</td>
<td>1.55</td>
<td>12</td>
</tr>
</tbody>
</table>
PART III - TOWARDS PLANNING FOR OPTIMISING HIGHWAY LAY-OUT.
form of reduction of operating cost of vehicles by improving the surface of the highways have been dealt with and the economic criteria for improving surface of roads have been identified in terms of vehicle density. The cost benefit analysis has been suggested for selecting the big road projects among the alternative road projects taken into consideration. The cost benefit analysis does take into account the distance saving effect on the combined cost but this approach has its own limitations. No one could claim that it is a method for optimising layout planning leading to optimum combined cost for inter-modal road transport. The cost benefit analysis helps us to select a particular road project out of alternative road projects. It lacks generalisation and so can not be accepted as a method for optimising combined cost for inter-modal road transport. In the context of India the cost benefit analysis is resorted to in exceptional cases and not as general rule to determine the layout of roads. In spite of all its deficiencies, its significance in layout planning can be admitted, but the application of cost benefit analysis must be taken as a supplementary tool in the optimising process of layout planning.

The reference to the transport problem and network flow problem analysed in the linear programming can not be avoided. But these problems assume the routes and network as predetermined and given.
Further, the responsibilities of providing highways and roads to the community lies with public authorities like Government and municipalities, but vehicles are partly owned by persons and different agencies. This dichotomy has resulted into lack of integrated approach taking into account combined cost to highway planning.

In the existing literature on the subject separate and distinguished analysis of cost function of the firms of road transport and motor vehicles has been conducted. The cost analysis of road constructions is also presented. But analysis of integrated cost function for inter-modal road transport is hardly attempted, its need in the layout planning is seldom felt and appreciated.

In the personal discussion with the engineers, it has been revealed that while deciding the location of road and highways the track cost is given major consideration on the basis of engineering criteria like the point density of vehicles and need of considering the operating cost for intermodal traffic as element for highway planning is not at all taken into account. The implication is that only point density of vehicles on the road used as the justification of new road to be constructed. But the vehicle intensity between the towns to be connected by the road and highway is not at all taken into consideration.
The objection against the sole consideration of track cost may not go unchallenged. The argument may be put forth justifying the present practice of minimizing track cost in highway planning in India on the basis of scarcity of capital in India. As minimizing length of new road to be constructed would require lesser capital investment. This would be consistent with investment criteria known as minimum capital output ratio that has been advocated in under-developed economies like India.

This ignores a very important aspect that road construction is labour intensive activity. On the basis of accounting prices of inputs of this capital asset the opportunity cost of the capital asset is significantly lesser than it appears on the basis of market rates of factor prices. Additional road construction on the basis of optimizing model reduces the distance to be travelled by the vehicles. This results into significant saving in operating cost especially owing to lesser consumption of petroleum products. The petroleum products and other components of operating cost have very high foreign exchange component. Thus additional road construction leading to saving in vehicular distance saves the highly scarce foreign exchange.
The investment needed is labour intensive, having very low opportunity cost owing to prevalence of idle labour power in India. In short the surplus labour is to be utilised for the saving of foreign exchange. The distance-saving road construction represents import substitution activity. It can be argued that in the future the possibility of surplus petroleum products cannot be denied, so the above said argument would not have relevance in future. Here we must pay attention to very important fact that surplus petroleum products can be exported and foreign exchange earnings would be increased. The surplus labour cannot be shifted to other countries. This import substitution or export promotion are to be considered on par in the light of the classification of the goods into shiftables and non-shiftable categories.

Besides petroleum resources are going to be exhausted in the long run; owing to perpetual wasteful use of petroleum resources future generation would be deprived of this important source of energy at an earlier stage.

There are so many significant indirect benefits of reduction in distance between urban centres and villages. The economic impact of urban poles is inversely proportional to the economic distance between two poles. Reduction in distance reduces this particular distance friction for spatial interactions between two nodes or two regions. Thus reduction in distance encourages the integration process of regional development. No doubt the quantification of these developmental benefits needs special treatment. This non-inclusion of indirect benefits as important limitations of this study.