

# Development of Road Connectivity In Nepal

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## 1.1 Introduction

Road connectivity may be defined as the degree to which the urban centres of a network are directly connected to each other. If it is required to compare the connectivity of two or more networks of roads, a connectivity index becomes useful.<sup>1</sup> Garrison<sup>2</sup> and Kansky<sup>3</sup> have devised a series of measures of network on the basis of graph theory. These measures allow accurate comparisons between the 'connectivity' and 'shape' of networks.<sup>4</sup> It is well demonstrated that these are very useful indices to show relationship between network geometry and the development of resource base at both national and regional levels.<sup>5</sup> In fact, road connectivity index measures the development of roadways with reference to socio-economic growth.

There are three useful indices of the road connectivity: (1) beta, (2) gamma, and 3) alpha. It is worth mentioning that these indices are applied without regard to distance and direction. This is one of the basic limitations of the road connectivity measure. The beta index measures the ratio of road links popularly expressed as 'edges' to urban centres which are presented as 'vertices'. This is derived by dividing the number of connections of road links by the number of towns. The gamma index expresses the number of actual road links in a network as a ratio of the maximum number of links possible. The alpha index is the measurement of circuits in a network. A circuit is a series of links that can be followed from one road to itself without retracing. These indices are thus derived from:

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1. R. Hammond and P.S. McCullagh, Quantitative Techniques In Geography, (Oxford: Clarendon, 1974), pp. 50-51.

2. W L. Garrison, "Connectivity of the Interstate highway system §", Regional Science Association, Papers and Proceedings, No 6, pp. 121-137.

3. K.J. Kansky § "Structure of Transport Networks: Relationship between network geometry and regional characteristics", University of Chicago, Department of Geography, Research Paper 84.

4. P. Hagget, Locational Analysis in Human Geography, (London: Arnold, 1969) p. 70.

5. Ibid.

$$\text{Beta} = \frac{R}{T}$$

$$\text{Gamma} = \frac{R}{3(T-2)}$$

$$\text{Alpha} = \frac{R-T+1}{2T-5}$$

Where R represents the number of road links among the towns, and T refers to the number of towns. The objective of the present article is to analyse the growth of the road connectivity in Nepal with reference to regional development pattern.

## 1.2 Recognition of Towns and Roads

It is implied that connectivity indices are directly related to traffic flow which is basically dependent on two elements, towns and roads. The connectivity index is a measure of relationship between these components. Therefore, the definition of towns and roads is an important step in the study of the road connectivity.

In the present study, all roads of different categories as recognised by the Department of Road, HMG, have been taken into account. The recognition of towns is a difficult task in the context of Nepal. Three different population censuses of the country do not provide identical definitions of urban settlements. According to 1952-54 and 1961 censuses, all settlements with a population of 5,000 and more are defined as towns, whereas the 1971 census considers only incorporated towns. This problem has been overcome by establishing comparable line of definition in the context of three censuses. All these settlements with a population of 5,000 and above and more than nine central functions have been taken as towns. 7

6. For further discussion on these indices see R. Stoddard "A Measure of Highway Expansion in Nepal" The Himalayan Review, Vol. VIII, 1976, pp. 1-9.

7. For information on application of the technique in recognising settlements with a population of 5 000 or more see C.B. Shrestha, "Urbanisation Trends and Emerging Pattern in Nepal," The Himalayan Review, Vol. VII, 1975, PP 1-13. For central functions see C.B. Shrestha, "The System of Central Places In the Arniko Rajmarga Area of Nepal", The Himalayan Review, Vol. VI, 1973-74. PP 19-39.

### 1.3 Growth of Connectivity Index

The increase in the index values of the road connectivity measures directly the progress in the development of roadways. To what extent changes in connectivity indices are related to economic development at both national and regional levels can be examined to express relationship between network system and economic growth.

In Nepal, there has been steady increase in the road connectivity index only during the last few decades. Prior to 1951 there were very few urban centres and roads in Nepal. According to 1952-54 census, there were 10 towns with a population of 5,000 and more and three road links (edges). Beta index was then 0.3, whereas gamma index represented a value of 0.13. Alpha index was zero. Table 1 shows that both beta and gamma indices have increased steadily during the succeeding decades. But alpha index showed zero value even in 1971. A circuit form in the road network developed only after 1971 as alpha index measured a value only in 1980. (Table 1). It is notable that even in 1980 the actual number of road links are extremely limited in relation to maximum possible road links (edges) measured in terms of gamma and alpha indices.

Regional changes in connectivity indices are the important aspects of a transportation system, which are of a matter of interest to geographers. Such changes may be usually reflections of the development of regional resources. According to 1952-54 census, the Kathmandu valley alone was associated with connectivity index (beta and gamma). Although there were 5 towns outside the Kathmandu valley, no other part of the country showed connectivity index.

There was no change in beta index in the Kathmandu Valley between 1952-54 and 1961. There was a slight decline in gamma index. This indicates that the growth of road links was behind the development of urban centres. By 1961 both beta and gamma indices measured values in the Eastern Terai. In both the indices, the values were higher than those of the Central Development Region where the road connectivity was still confined to the Kathmandu Valley. During the period from 1961 to 1971 connectivity index except for alpha value increased remarkably in both the Eastern and Central Development Regions. In the Central Development Region, connectivity index started to develop in both the Hills and the Tarai, whereas in the Eastern Development Region it was limited to the Tarai. Although urban centres existed in the Eastern Hill by 1971, there were no connecting road links between towns. The Far Western Development Region was still without any values in all three connectivity measures. This region showed connectivity values only in 1980. During the period from 1971 to 1980, there have been further-

Table 1

## Connectivity Index

Unit	1952-54			1961			1971			1980		
	Beta	Gamma	Alpha	B	G	A	B	G	A	B	G	A
Nepal	0.3	0.13	0	0.4	0.17	0	0.6	0.22	0	1.1	0.38	0.03
Eastern Development Region	—	—	—	0.7	0.67	0	0.8	0.84	0	0.9	0.30	0
Central Development Region	0.6	0.33	0	0.6	0.21	0	0.8	0.28	0	0.9	0.32	0
Western Development Region	—	—	—	—	—	—	0.6	0.25	0	0.6	0.25	0
Far Western Development Region	—	—	—	—	—	—	—	—	—	0.6	0.25	0

Source:— Nepal Sadakstithi, Department of Road, HMG, 1980, and Population censuses of 1952-54, 1961, 1971 and 1976 (Mid — Term Census).

some increases in beta and gamma indices in the Eastern and Central Development Regions, but no change has occurred in the Western Development Region. It is worth mentioning that notwithstanding the development of alpha value at national level in 1980, none of the sub-regions shows any value in this measure. In the Eastern and Central Development Regions, there have been increases of both the number of towns (vertices) and road links (edges) during the period from 1961 to 1980. In the Western Development Region, no change in the number of towns and road links has occurred during 1971-80. The connectivity value recorded in the Far Western Development Region in 1980 is significant as it did not have connectivity values in 1971.



Although connectivity indices are now represented in all development regions, there are still 4 Himalayan Sectors and 2 Hill sub-regions without connectivity values. All 4 Tarai sectors have now acquired values of beta and gamma indices. In the Hills, these indices are represented only in the central and western parts. The highest values exist in the Eastern and Central Development Regions. The number of urban centres (vertices) and the road links (edges) in different sub-regions, as existed in different periods, are presented in Table 2.

#### 1. 4 Relationship between Road Connectivity and Economic Growth

Connectivity index is usually taken as a reflection of a measure of economic growth. Positive changes in connectivity indices measure commercialization of a landscape. Therefore, the trend of mobilization of regional resources is markedly reflected in the regional variations of the changes that take place in the road connectivity index.

It is found that the rate of increase of road connectivity index measured particularly in terms of beta is closely related to the investment pattern in the country. During the period from 1971 to 1980 the increase of the annual budget of HMG and road connectivity index (beta) was nearly hundred percent. The similar positive relationship occurred during 1961 to 1971. Amounts of investment during successive periods in different regions were closely related to changes in beta index. In both these components, higher values were found in the Central and Eastern Development Regions. Investments were relatively low in the Western and Far Western Development Regions in conformity with low levels of connectivity indices.

Although both these parameters, annual budget and road connectivity, may be taken as indicators of economic growth, at both national and regional levels, they are not directly comparable. The increase of annual budget is not necessarily associated with increasing rate of economic growth, whereas rise in road connectivity index usually reflects progress in the mobilization of resources. Apparently, the better approach would be to relate road connectivity indices with mobilization of regional resource base. Detailed regional analysis along this line is not possible at present owing to paucity of data.

It is implied that connectivity index refers to trade flow as it is the measurement of

Table 2

## Connectivity Index with Number of Towns And Road Links

Region	1952--54			1961			1971			1980		
	B	G	A	B	G	A	B	G	A	B	G	A
1. E H	-	-	-	-	-	-	-	-	-	-	-	-
2. E h	-	-	-	0	0	-	0	-	-	0	-	-
				2	-	-	2	-	-	3	-	-
3. E T	0	-	-	2	2	0	10	10	0	12	12	0
	1	-	-	3	3	1	12	30	19	13	33	21
4. C H	-	-	-	-	-	-	-	-	-	-	-	-
5. C H	2	3	0	4	4	0	5	5	0	5	5	0
	5	9	5	6	12	7	7	15	9	7	15	9
6. C T	0	-	-	1	1	0	7	7	0	9	9	0
	3	-	-	4	6	3	10	24	15	10	24	15
7. W H	-	-	-	-	-	-	-	-	-	-	-	-
8. W h	-	-	-	0	-	-	2	2	0	3	3	0
				2	-	-	4	6	3	4	6	3
9. W T	-	-	-	-	-	-	0	-	-	1	1	-
							2	-	-	2	3	0
10. FWH	-	-	-	-	-	-	-	-	-	-	-	-
11. FWh	-	-	-	-	-	-	-	-	-	-	-	-
12. FWT	0	-	-	0	-	-	0	-	-	3	3	0
	1	-	-	1	-	-	4	-	-	5	9	5
Nepal	3	3	0	7	7	0	26	26	0	47	47	3
	10	24	15	16	42	27	41	117		43	123	81

Source: Ibid. Note:- E=Eastern, C=Central, W=Western F W=Far western, H=Himalayan, H=hills, T=Tarai, B=Beta G=Gamma, A=Alpha.

relation between roadways and urban centres. Indeed, roads and urban centres are the basis of trade flow. Nodal points and transferability (friction of distance) are the basic conditions under which trade interaction occurs.<sup>9</sup> Industrial development is usually the origin of trade, which in turn supports the development of roads and towns. In view of this, changes in road connectivity index could be linked with the regional variations in industrial developments. During the period from 1951 to 1971, relatively high levels of industrial development in the Central and Eastern Development Regions were associated with considerable increase in road connectivity (beta). The low level of industrial growth in the Western and Far Western Development Regions was connected with low connectivity values. The late industrial development that took place only during 1970s in the Far Western Development Region was in conformity with the late growth of road connectivity during the corresponding period. The present pattern of industrial concentration also substantiates the regional differences in road connectivity. High connectivity values (Table 1) in the Eastern and Central Development Regions were positively correlated with industrial activity with about 21 percent of the total industrial units in the former and about 25 percent in the latter.<sup>10</sup> The Far Western Development Region is far behind in the progress in both industrial development and road connectivity growth. The significant increase in the allocation of investment as well as relatively remarkable progress in the industrial development, that have taken place in the Far Western Development Region during the Fifth Plan period, can be taken as a supporting factor to explain the recent growth of connectivity in this Sector.<sup>11</sup>

### 1. 5. Analysis

There has been significant progress in the development of road connectivity in the country during the last few years. Although there has been good progress in the growth of both road links and the number of urban centres, gamma and alpha indices show that the road network is still highly inadequate in the context of maximum possible road links. Moreover, there are several parts which have either poor connectivity value or do not contain any

9 For detailed information on trade interaction see P.T. Taylor, *Quantitative Methods In Geography*, (London: Oxford University Press, 1974) p. 286-325.

10 Source:- National Planning Commission, HMG.

11 NPC, "Task Force Report on Regional Planning: Sixth Plan", 1979.

value at all. The regional disparity in connectivity indices is closely related to spatial pattern of socio-economic disparity. Table 2 shows that 6 sub-ecological belts do not have connectivity index of any measure. There are cases which, although associated with urban centres, are without road links.

A simple logic appears to make extension of roadways in regions without roads or having low connectivity values. Roadway expansion based on this too straitforward approach is not justifiable in several places. It is not illogical to assume that the opening of roadways implies the opening of new markets, and that the opening of new market means increased economic activity. But it is erroneous to presume that transport facilities alone will automatically induce economic progress in a backward country like Nepal.<sup>12</sup> There is usually a great time lag between the development of roadways and generation of supporting activities. In such cases, roads bear high economic costs. This is obviously undesirable in highly under-developed countries like Nepal. The Arniko Rajmarga and the Prithivi Rajmarga can be taken as such roads. In both cases, the highways are not justifiable in terms of connectivity index when related to their length. Long highways with poor connectivity imply low traffic, hence they are poorly used. It is a crucial problem in Nepal that the poor status of the resource base does not justify the construction of modern roadways in several places and resource mobilization in these areas is not possible without roads.<sup>13</sup> Therefore, it is highly unrealistic to plan the development of roadways in isolation. The vicious circle of 'no economic activity-no road-no economic activity' can be broken by a simultaneous action of roads construction and comprehensive planning of regional economic activities.<sup>14</sup> The development of roads should be preceded by comprehensive survey of regional resources at micro-regional level. The present need of the country is to improve connectivity index measured in beta so as to extend road links in remote areas with a micro-level development plan for different regions. The development of link' system with reference to gamma and alpha indices could be postponed. The present road construction policy lines should give priority to the gradual commercialization of more areas by developing bases which would give rise to urban centres with the progress in the development of road links.

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12 H. Gurung, *Regional Development Planning For Nepal*, (Kathmandu: National Planning Commission, 1969), P. 10.

13 Ibid.

14 Ibid.