A FUNCTIONAL ECOLOGICAL STUDY OF MUNICIPAL TOWNS IN NEPAL: *A FACTOR ANALYSIS APPROACH*

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ABSTRACT

In the present study, an attempt has been made towards the application of factor analytical approach in the urban ecological study of Nepalese municipal towns. The 13 selected variables representing the major activities of urban population: agriculture, livestock, poultry and small scale non agricultural economic activities of 58 municipal towns have been taken into consideration in order to investigate the most important functional ecological dimensions of towns. Trade/business, non-agricultural economic, and livestock/poultry are basic fundamental dimensions identified representing the functional ecological pattern of towns and together accounting for 90.2 (eigenvalue) percent of the total variance and more than 70.0 percent (communality) variance underlies in each selected variables except agriculture. The most pertinent functional dimension of Nepalese towns is trade/business which is highly associated to non-agricultural economic function accounting for 76.26 percent of common variance and similarly livestock/poultry is another, second important functional dimension accounting for 13.95 percent of common variance in rotated solution. Urban centers located in terai and inner terai geographical regions are characterized by livestock/poultry functional dimension whereas in the case of hill and mountain region, they are characterized by trade/business activities dimension as their basic function. Almost eighty percent of towns have been found without dominant and distinct functional dimension either in trade/business or livestock/poultry. It is so because of the fact that the functional aspect has not been taken into consideration while introducing the rural localities as Municipal Town that is essential or indispensable for development of functional bases of towns, level of urbanization and development of the country.

Key words: municipal towns, functional ecology, dimension rotated and unrotated, common factor, correlation, loading, Eligen value, communality, scree test, scatter plot.

INTRODUCTION

Nepal is newly urbanizing country with 58 urban centers occupying 3,359.14 km^2 (2.28% of country's total area), located in 44 out of country's total 75 districts including lowland and highland geographical areas and a population of 32,27,879, which makes about 13.9 percent and 16.2 percent of the country's total and rural population respectively (CBS, 2003). In modern high technical world, urban centers or municipal towns are considered as the engine of growth and therefore, the level of development of a country is associated with the level of urbanization. Over 50 percent of economically active population in municipal

areas has been involved in small scale non-agricultural economic activities for their livelihood. Almost 28 percent of economically active population in urban areas have agriculture as their major occupation, which varies in different geographical regions viz. Mountain/Hill (45.8%), Inner Terai (37.8%), Kathmandu Valley (12.8%) and almost equal in case of terai region (NC, 2003).

The term "Ecology" which has been widely overused as catchy word (Robson, 1969), was originally coined by biologists in order to describe the mutual relationship between organisms and their environment. Initially the concept of "Urban Ecology" was introduced by Park as formal discipline as early as 1915.

In geographical research, since mid 1960s, factor analysis has been gaining increasing importance as a useful technique for ecological study of cities and the fundamental dimensions of urban ecology had been identified and explained from factorial studies. Such studies carried out by geographer, were mainly concentrated on economic regionalization (Thompson, 1962), climatic regionalization (Steiner, 1965), classification of cities (Ahmad, 1965) and the analysis of commodity flow pattern (Berry, 1966). But it was very much limited in cities of western world and nominal in third world countries like Nepal.

The useful aspect of factor analysis approach is to study the differing urban ecology related to differing factor combinations that can be arranged along a scale of urban development from pre-to post-industrial forms (Berry & Rees, 1969). It is able to derive a few major dimensions of urban ecology from a large set of variables explaining significant relationships among them in each dimension. It has been christened quite aptly a *calculus* of the social sciences considered as an indispensable tool for structuring complicated real world situations into interpretable patterns and is leading major research thrust in geography under the *Factorial Ecology.*

Even though, the present research is a thrust towards the study of Factorial Ecology i.e., application of factor analytical approach in urban ecological studies, it is limited to the functional aspects of urban centers regarding the agricultural and non-agricultural economic activities rather than including all socio-economic and demographic aspect of people living in urban areas. Thus, in the present paper, an attempt has been made to identify and explain fundamental dimensions of selected economic activities of urban population in Nepal, to examine their characteristics and spatial pattern by employing *factor analysis approach.*

COUNTRY'S BACKGROUND

Nepal, a Himalayan country is located between 26° 22' - 30° 27' N latitudes to 80°4' - 88° 12' E longitudes, lying between China in the north and India in the east, south and west and having over east-west the average length of 885 km and north-south average width of 193 km. In country's total area of 1,47,181 sq.km., 83% is occupied by High Mountain and wavy hills and remaining 17% by flat lands of the Tarai.

Agriculture, livestock, poultry, manufacturing and trade etc. are major economic activities for Nepalese people. Agriculture is the predominant economic activity generating employments for 81 percent of the total economically active

population for their livelihood and the remaining 19 percent are engaged in manufacturing, trade/business, service and other non-agricultural activities.

The urban areas in Nepal is classified into 3 categories: *Mahanagarpalika* (Metropolitan city), *Upa-Mahanagarpalika* (Sub-Metropolitan) and *Nagarpalika* (Municipality) located in 5 development regions such as eastern, central, and western, mid-western and far-western and 3 geographical regions i.e., mountain, hill and Terai having VDCs and Municipalities of 3,194 and 58 respectively (NPC, 2002).

DATA SOURCE

Fifty-eight Nagarpalika (municipal localities) have been taken as observational units for the present investigation. These municipal areas have been redefined and classified by the Municipal Act of 1992 and Local Self-Governance Act 1999. Article 88(2) C of the Act considers *Mahanagarpalika* (Kathmandu) and *Upa-Mahanagarpalika* (Biratnagar, Lalitpur, Pokhara and Birganj) as *Urban Ares* and remaining 53 (*Nagarpalika*) as *Semi-urban areas.* Altogether eighteen (18) variables representing agriculture and non-agriculture economic activities for 58 municipal towns have been selected to explore the functional dimensions of urban centers and to examine their characteristics and spatial pattern. The primary numerical data of selected variables for each urban place has been obtained from Selected Urban Tables of Population Census 2001 which have produced a 58 × 18 data matrix.

CONCEPTUAL FRAMEWORK

The Principal Component and Common Factor Analytical Approach are basic models of statistical dimension reduction techniques that transforms a set of inter-correlated variables in a smaller number of basic dimensions called factors treated under the Factor Analysis. Even though the principal component analysis has been argued by many factor analysis methodologists as the unrealistic method for modeling the complicated real world situation due to not introducing the error term and having the assumption that all the variance is self-contained in the variables that is unlikely ever to occur in reality, the fact is that it has been widely used by geographers in their geographical researches. It may be the situation that depends upon the nature of correlation matrix. In the present research, Common Factor Model has been applied to explore the fundamental dimension of economic activities performed by municipal towns considering the fact that all the variance is explained by the variable themselves and some other factors. There are two basic components of Common (multiple) Factor Model: Common Factors derived from the correlated variables accounting for the explained proportion of the total variance of the data matrix and Unique Factors accounting for remaining variance representing unexplained proportion of total variance. The Unique Factor consists of two kinds of variance-they are due to the particular selection of variables in the investigation, and due to the unreliability of measurement. Mathematically Multiple factor Model has been used in its strict sense and the model for the 1th standardized variable is presented as:

$$X = A_{i1}F_1 + A_{i2}F_2 + ... + A_{ik}F_k + U_i$$

Where X_i is the standard score of the variable i, A's are the constants used to combine the k factors, the U is unique factors representing the part of the variable, i that cannot be explained by the common factors and the F's are the

common factors representing factor score in standardized form and their general expression for the estimate of the j^{th} factor F_i is:

$$F_j = \sum_{i-1}^{p} W_{ji} X_i$$

The W'_js are factor score coefficients (factor loadings), X_i is original data in standardized form and p is the number of variables.

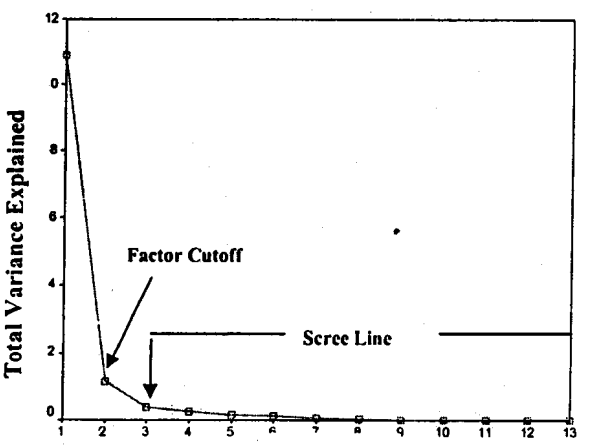
To explore the basic, most important and fundamental dimensions of functional activities of urban places of Nepal and to examine their characteristics, Factor Analysis Technique is employed by using 18 functional and related variables for 58 urban places of the country. The analysis was performed by using Statistical Software Package, SPSS version 11.5 and following procedures have been adopted in this study.

- The variables related to major activities of urban population, agriculture activities and small scale non-agricultural economic activities representing the basic and non basic functions of urban ecology have been selected (Table 1).
- The data of all selected variables for each urban place have disparity in units such as number of population and number of households. In order to solve this problem the variants has to be transformed into standardized score (Sneath & Sokal, 1973 as cited in Norusis, 1990). Thus, each and every original cell value of 58 × 18 data matrix is transformed into standardized score for making it scale free.
- The correlation coefficients have been computed from the standardized score matrix as an input data for the factor analysis.
- Concerning the suitability of the data for factor analysis, although it requires at least 300 cases for comfortable use, the relatively smaller size having the strong reliable correlations are also adequate (Tabachnick & Fidell, 1996). The sample size requirement advocated by researchers that have been reducing over the years (Stevens, 1996) is not matter of concern rather than the ratio of subjects to items (Nunnally, 1978). As the second issue related to inter correlations amongst the variables, an empirical test shows that the cases not less than 50 with their correlation coefficients above 0.3 are preferable for the use of factor analysis (Shenoy & Pant, 1994 ; Tabachnick & Fidell, 1996).
- As per the requirement of factor analysis, initial stage of sorting out the redundant variables has been made considering the correlation coefficient 10.31 as significant at 95% confidence level and thus 18 variables were reduced to 13 based on the rational basses mentioned above.
- Two statistical measures such as Bartlett's test of sphericity (Bartlett, 1954) and Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser, 1970, 1974) were also generated in order to assess the factorability of the data and their respective values: $p<0.05$ and 0.96 show more far than the minimum level for a factor analysis to be

considered appropriate (Tabchnick & Fidell, 1996). Anti-image correlation matrix generated for Measure of Sampling Adequacy (MSA) representing the negative partial correlation shows that the higher values (>0.5) of diagonal and smaller values (near to zero) of off diagonal elements qualify the variables to be included in the analysis.

- As concerning the factor extraction, several methods can be used in order to obtain the estimates of common factors based on differing criterion used to define *good fit.* In the present case, the most popular method used by many researchers (Schmid, C.F. & Tagshira, K., 1965 as cited in Taylor, 1977), *Principal Axis Factoring* has been selected to explore the basic functional dimension of economic activities performed In the urban centers. The selected method proceeds much as principal component analysis except that the diagonals of correlations matrix are replaced by estimates of communalities. At the first step, squared multiple correlation coefficient can be used as initial estimate of communalities. Based on these, the requisite number of factors is extracted. The communalities are reestimated from the factor loadings, and factors are again extracted, with the new communality estimates replacing the old by iteration. This step of iteration continues until negligible change occurs in the communality estimates (Norusis, 1990).

Fig.1: Selection of Best Number of Factors Based on Scree Test Criteria



- Both techniques Kaiser's Criterion and Scree Test have been used in order to assess in the determination concerning the number of factors to be calculated and used in the model. Although Kaiser's criterion technique that suggests the factors representing the variance greater than

1 (the eigen value>1) to be included, is most commonly used, is the default criterion in SPSS, and not always a good solution (Tucker, Koopman & Linn, 1969 as cited in Norusis, 1990). Cattell's scree test (1966) plots each of the eigen value of the factor pointing at which the shape of the curve changes direction and becomes horizontal (Fig. 1). He recommends retaining all factors above the *elbow* contributing the most to the explanation of the variance in the data set.

- Among the broad categories of rotational approaches: orthogonal and oblique, the orthogonal, most widely used approach, has been used to achieve *simple structure* (Thurstone, 1947 as cited in Taylor, 1977) by differentiating the factors distinctly. Among the variety of algorithms for orthogonal rotation, the most commonly used, varimax has been used to enhance the interpretability of factors by minimizing the variables having high loadings on a factor (Tabachnick & Fidell, 1996 & Tacq, 1997).
- At last, the scores of both Factor 1 and 2 for each municipal town have been computed by multiplying the standardized score values of variables by their corresponding regression factor score coefficients in which variance equal to squared multiple correlation between estimated factor score and the true factor values for analyzing their spatial pattern (Table 2).

RESULTS AND DISCUSSION

In this section, the functional ecology of municipal towns has been examined in terms of identification of fundamental functional dimensions, its functional structure, spatial pattern and factorial functional areas of urban centers in Nepal.

FUNCTIONAL ECOLOGY OF MUNICIPAL TOWNS

The correlation matrix has been used in order to extract basic factors, since the variance of variables ranges from 119.58 for poultry, to 20436.82 for students. Table 1 shows the common factor loadings (correlations of variables with the common factors) in both cases: unroated as well as the communalities and the percent of variance explained by each common factory. The factor loading matrix indicates that among all variables except agriculture, poultry and livestock in both solutions; unroated and rotated are Highly intercorrelated (above 0.80) with the first common factor. The patterns of elements of factor loadings clearly indicate two distinct clusters of activities/variables. The first cluster is grouping of non-agricultural economic activities which are highly associated with the common factor I. The second cluster including the agriculture related activities such as livestock and poultry is highly associated with the Common Factor II. These two clusters of variables suggest two *basic* and *fundamental* functional dimensions/factors that have been explored in order to examine the functional ecology of urban centers, by performing factor analytical approach considering 13 selected functional/occupational and agriculture/non-agriculture economic activity related variables for 58 municipal towns in Nepal. The first Two Common Factors have accounted for 90.2 percent common variance of total variance (Table 1). Putting it in slightly different terms, each unrotated and rotated solution suggest that the common variance which constitute 100 ($h^2/13$) = 90.2 percent of total variance can be summarized by the first two common

factors. The remaining eleven factors together accounted for only 9.8 percent of variance. Thus the model with two common factors seems to be most satisfactory to represent the urban community variables. The squared multiple correlation coefficients between a variable and all other variable are another indication of the strength of the linear association among the variables. These values are shown in the column labeled *Communality* in Table 1. The elements of communalities ranging from 0.988 to 0.670 indicates that all most maximum variance of non-agricultural activity variables are explained by two common factor model where as it is relatively less (only two-third) in case of agricultural activity. It further suggests that uniqueness of variables in agriculture related activities are more explained by unique factor rather than common factor.

On of the noticeable facts observed in Table 1 is that the factor loadings of Common Factor II in unroated solution have both positive (5) and negative signs (8) indicating the nature of relationship with that factor. This is also expected pattern of second and succeeding common factors if the first common factor has all positive correlations with the variables. The reason for this is that the first common factor must be orthogonal to all other remaining factors. In form of Two Common Factor Model, the Non-agricultural Functional Ecology of Urban Community (NAFEUC) can be expressed as:

$$NAFEUC - a\,(TBNAEA) + b\,(LVPT) + U_{NAFEUC}$$

TBNAEA and LVPT used in the equation are not single independent variables as usual in multiple regression. They are labels for the group of variables constituting the common factors that characterize the functional aspect of towns. Descriptive names or labels that have been assigned to these factors on the basis of the variables obtaining high factor loadings are as follows:

Factor I: Trade/Business-Non-agriculture economic activity Dimension

Factor II: Livestock-Poultry Dimension

Table 1: Factor Loadings (Unroated and Roated) and Estimated Communalities

Variables	Factor Loadings Unroated		Communalities	Factor Loadings Roated (Varimax)	
	1	2	h^2	1	2
ONAA	0.987	-0.116	0.988	0.976	0.188
JS	0.984	-0.045	0.970	0.951	0.255
TB	0.984	-0.132	0.985	0.978	0.171
HC	0.981	-0.011	0.963	0.938	0.286
SV	0.980	0.046	0.963	0.920	0.341
SW	0.976	-0.120	0.968	0.967	0.181
TR	0.966	0.167	0.961	0.870	0.451
ST	0.964	-0.182	0.962	0.974	0.118
EEA	0.933	0.086	0.878	0.863	0.364
MR	0.932	-0.152	0.892	0.934	0.137
ALO	0.812	-0.104	0.670	0.805	0.147
PTO	0.808	0.310	0.749	0.676	0.540
LVO	0.347	0.811	0.778	0.085	0.878
Eigen Values	**10.821**	**0.906**	**11.727**	**9.914**	**1.813**
Percentage of Total Variance	**83.240**	**6.967**	**90.208**	**76.262**	**13.946**

A. TRADE/BUSINESS-NON-AGRICULTURE ECONOMIC ACTIVITY DIMENSION (FACTOR I)

Factor Structure

Table 2 depicts the elements of dimensions in both solutions: unrotated and roated omitting the small loadings less than 0.3. It is convenient strategy to sort the factor-loading matrix so that variables having loadings on the same factor appear together for better interpretation of dimensions. The structure of elements of dimensions indicate that all non-agricultural economic activities including services, transportation manufacturing etc. are highly and positively associated (>0.90 for unroated and >0.85 for roated) with the Common Factor I.

In indicates that this factor is orthogonal to remaining factors and can be suggested that non-agriculture economic activities are major functions performed by urban population in municipal towns in which trade/business relatively predominate, thus the Common Factor I is labeled as trade/Business-Non-agriculture Economic Activity Dimension of functional aspect of urban ecology in Nepal. This is most dominant dimension accounting for 83.24 percent and 76.26 percent of the common variance on 13 variables for unroated and rotated solutions respectively. The remaining twelve factors together explain only 16.76 percent and 23.74 percent of variance for unroated and rotated solutions. This is the largest common factor and sometimes called a *size factor* and can be used as *single index* that *best* summarized functional variables (Dunteman, 1989). Although this dimension is highly loaded on trade/business, it is closely associated to the variables related to major non-agriculture economic activities and is found to be the most prominent functional ecological dimension of municipal towns. The highest communality element (0.988) among the basic variables of this dimension indicates that substantial amount of variance underlain in group of non-agriculture activities is highly and satisfactorily explained by Two-Common Factor Model. Thus trade/business non-agricultural economic activities based on highest factor loadings in rotated solution can be expressed as:

$$TBNAEA = 0.9789\ F1 + 0.171\ F_2$$

In this equation among the basic variables of this dimension, it is observed that Factor I is factor with largest loading for trade/business activity. It should be noted that most of the variance is explained by Common Factor I in unrotated solution rather than rotated. It is result of rotation that reduces the loadings with the Common Factor I except ST and MR variables where as it simplifies the structure and increases in case of Common Factor II. This dimension indicates that there is larger proportion of small-scale non-agriculture economic activities such as trade/business, salary/wage labor work, transportation etc. In these economic activities, person involved in job seeking and household chores that includes the household cooking, cleaning, shopping and caring infants and aged are also in larger proportion in municipal towns in Nepal. Extended economic activity that includes all activities involved in the production of goods consumed within the household is also one of major activities of urban centers.

B. LIVESTOCK/POULTRY DIMENSION (FACTOR II)

There is negative/positive pattern of loadings in unrotated solution and it becomes all positive due to the orthogonal varimax rotation. Common Factor II is the second most important functional dimension of urban ecology of Nepalese towns that accounts for 6.97 percent and 13.95 percent of total variance for unroated and rotated solution respectively. The basic variables of this dimension are livestock, poultry and agriculture. The livestock variable is highly, positively and significantly correlated with the common Factor II in both solutions: unrotated (0.811) and rotated (0.878) and less correlated with the Common Factor I. Where as agriculture is negatively weakly associated with this factor. Next to the livestock, poultry is also having high loading with the Factor II in both solutions: unroated and rotated as compared to Factor. I. Owing to high loadings, this dimension is labeled as Livestock/Poultry Dimension. It is also supported by higher communalities, 0.778 for livestock and 0.749 for poultry as compared to agriculture, 0.670 among the basic variables of this dimension. It should be noted that varimax rotation, maximize variance of the squared loadings for each variable and Common Factor II (Kim & Mueller, 1978). Although this factor accounted for the less proportion of the common variance, it could be considered important in revealing its meaningful interrelations with a number of variables. For example, its most basic variables, livestock is found to be significantly correlated with TR (0.451), EEA (0.364) and SV (0.341). Based on highest factor loadings of basic variables of this dimension in the rotated solution, livestock and poultry functional activities of urban community has been expressed as:

$$LVPT = 0.085\ F_1 + 0.878\ F_2$$

Table 2: Structure of Dimension: Trade/Business- Non-agriculture Activity (Factor I) and Livestock/Poultry- Agriculture related Activity (Factor II)

Variables	Factor I		Factor II	
	Unroated	Rotated	Unroated	Rotated
ONAA	0.987	0.976		
JS	0.984	0.951		
TB	0.984	0.978		
HC	0.981	0.938		
SV	0.980	0.920		0.341
SW	0.976	0.967		
TR	0.966	0.870		0.451
ST	0.964	0.974		
EEA	0.33	0.863		
MR	0.32	0.934		
ALO	0.812	0.805		
PTO	0.808	0.676	0.310	0.540
LVO			0.811	0.878

FACTORIAL FUNCTIONAL ECOLOGY OF NEPALESE TOWNS

Factor Analysis has found its most useful application in the area of urban research in geography. Since the ecological analysis is synonym of the analysis with the areal data. In the present study, Factorial Ecology has been perceived as the application of factor analysis in two dimensional space (spatial analysis) and factorial functional ecology has been interpreted as the adoption of factor analysis approach to the areal study of the functional pattern of municipal towns in Nepal.

Scatter Diagram (Fig. 2) has been formed using the standardized scores of both common factor I and II presented in Table 2. The areas so formed in the functional ecological study of urban centers are called functional areas that are considered to be very helpful in order to define the set of towns and to arrange them in meaningful typology. The Scatter Diagram is divided into a very general four quadrants indicating four broad types of urban communities called "factorial functional Areas" (a) towns of high trade/business and high livestock/poultry status; (b) towns of low trade/business and low livestock/poultry status; (c) towns of high trade/business and low livestock/poultry status; and (d) towns of low trade/business and high livestock/poultry status.

Fig. 2 provides the good summary pictures of broad types of urban localities in Nepal. In the scatter diagram it has been observed that almost eighty percent of the municipalities are concentrated around the origin of the plot having the relatively low scores in both dimension: trade/business and livestock/poultry indicating that they are not distinctly specialized in any functional dimensions. But one of the noticeable feature is clearly marked that the urban centers of terai and inner-terai are located almost near the horizontal axis where as towns belonging to mountain and hill are concentrated near to the vertical axis. Such spatial pattern concludes that terai and inner terai towns are more or less characterized by livestock/poultry dimension rather than trade/business of functional Ecology in which Dharan, Biratnagar, Birgunj Hetauda, and Butwal are important one in their order. Conversely all most all urban centers of mountain and hill ecological region except Pokhara are linearly distributed near to the vertical axis are characterized by trade/business non-agricultural economic function dimension in which all urban centers of Kathmandu valley such as Kathmandu, Lalitpur, Bhaktapur and Thimi except Kirtipur are dominant one as their order. Pokhara is one of peculiar among all urban centres located far from the both axis indicating that it is explained or characterized by both high trade/business and high livestock/poultry status dimension.

All the terai and inner-terai municipal towns were characterized by low trade/business status; but some of them revealed high livestock/poultry status. This factorial relation is clear indication of over livestock/poultry agriculture related activities in terai and inner-terai urban centers to meet the non-agricultural economic needs. Metropolitan city *Kathmandu* located at the end of vertical axis is markedly characterized by high trade/business function and marginally low livestock/poultry function. Fifty percent of Sub-metropolitan cities namely *Pokhara* and *Birganj* are characterized high trade/business status and high livestock/poultry status. Remaining *Lalitpur* is characterized by high

trade/business status but low livestock/poultry status where as *Biratnagar* is characterized by high livestock/poultry status but low trade/business status.

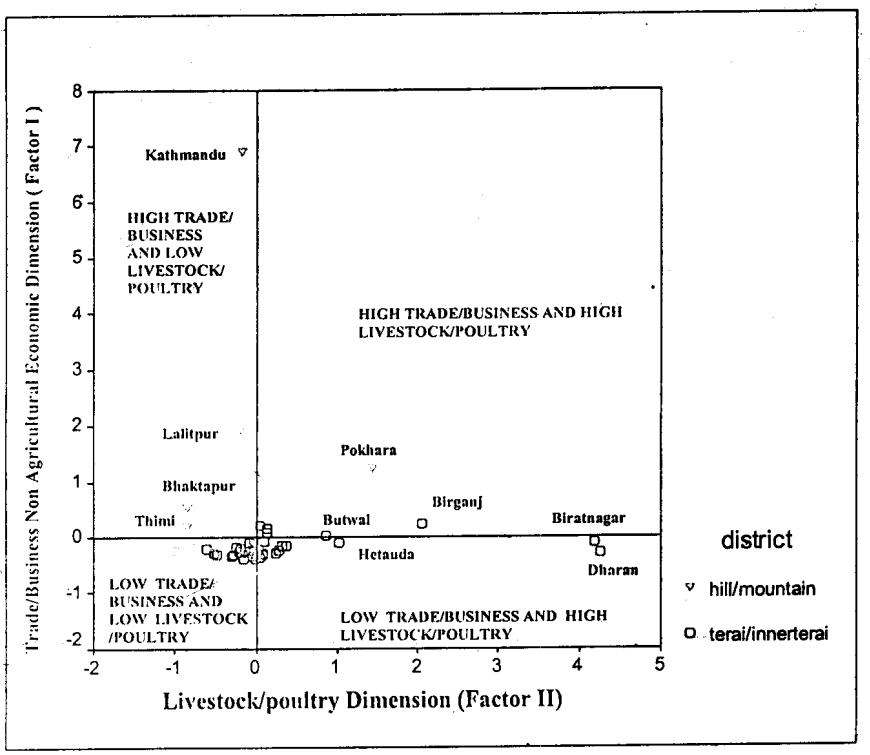


Fig. 2: Factorial Functional Areas of Municipal Towns

CONCLUSION

The present paper has made an attempt towards the application of factor analysis approach in the study of functional ecology of urban centers in the country like Nepal. All fifty-eight municipal towns are taken into consideration in order to obtain fundamental functional ecological dimensions of towns. Although eighteen variables are initially aggregated on 58 municipal towns, only 13 selected variables are used for the factor analysis because of elimination of redundant variables. Two common factors have been extracted together accounting for 90.2 percent of the total variance, and considered the most fundamental dimensions of functional ecology of Nepalese municipal towns. Fundamental dimensions of functional structure of cities have been identified and explained within the framework of two common factor model under the factor analysis. The most prominent dimension of functional ecology of towns in Nepal is trade/dimension which is highly associated with non-agricultural economic activities and account for 83.24 percent and 76.26 percent of the common

variance on 13 variables for unrotated and rotated solutions respectively. Similarly the second most important functional dimension of towns is found to be the Livestock/poultry dimension that is negatively associated with the agricultural activities and accounting for 13.95 percent of the common variance in rotated solution. With regard to planning implications, it has to be stated that most of urban centers located at the intersection point of scatter plot are characterized as diversified rather than dominance in terms of performing the functions distinctly. It indicates that there is lack of basic functions to be performed by the towns. It is so because of the haphazard declaration of small rural market as the municipal town without considering the basic functions. In this attempt, two common factor models has been regarded as useful too in explaining more than 70 percent underlying variance in the urban community variables and identifying the fundamental dimensions and reducing the large number of variables into small manageable number of factors.

WORKS CITED

AHMAD, Quazi (1965). *Indian Cities: Characteristics and Correlates.* Department of Geography Research Paper No. 102. Chicago: Department of Geography, University of Chicago.

BERRY, B.I.L. & Rees, P.H. (1969). "The Factorial Ecology of Calcutta." *American Journal of Sociology.* LXXIV.

BERRY, Brain I.L. (1966). *Essays on Commodity Flows and Spatial Structure of the Indian Economy.* Department of Geography Research Paper 111. Chicago: Department of Geography, University of Chicago.

CBS/HMG/N (2003). *Population Monograph of Nepal.* Vol. 1, Kathmandu: His Majesty's of Government, National Planning Commission.

KIM, JAE-OM & Mueller, Charles W. (1978). *Factor Analysis: Statistical Methods and Practical Issues,* USA: Sage Publication.

NORUSIS, Marija J. (1990). *SPSS/PC+ Statistics™ 4.0: for the IBM PC/XT/AT and PS/2.SPSS Inc.* 444 N. Chicago: Michigan Avenue. Illinois 60611.

NPC/HMG/N (2002). *Population of Nepal.* Village Development Committees/Municipalities, Population Census 2001, Kathmandu: HMG, National Planning Commission Secretariat, CBS in Collaboration with UNFPA.

ROBSON, B.T. (1969). *Urban Analysis: A Study of City Structure with Special reference to Sudnerland.* Cambridge: Cambridge University Press.

SHENOY, G.V. & Pant, M. (1994). *Statistical Methods in Business and Social Sciences.* New Delhi: S.G. Wasani Macmillan India Limited.

TEINER, Dieter (1965). I Multivariate Approach to Climatic Regionalizaiton and Classification *Tiidschrift van Het Koninkliik Nederel; andsch aard riikshundiggenootschap,* XXCII.

TABACHNICK, B.G. & Fidell, L.S. (1996). *Using multivariate statistics.* 3rd edition, New York: Harper Collins.

TACQ, Jacques (1997). *Multivariate Analysis Technique in Social Science Research:* From Problem to Analysis, Sage Publications. London: Thousand Oaks.

TAYLOR, Peter J. (1977). *Quantitative Methods in Geography: An Introduction to Spatial Analysis.* USA: Houghton Mifflin Company.

THOMPSON, I.H. (1992). Towards a Geography of Economic Health: The Case of New York *Annals of the Association of American Geographers.* LII.

ANNEX

Table 1: Variables of functional ecology of municipal towns

Municipalities	AOF	SW	ONAA	EEA	JS	HC	ST	ALO	LVO	PTO	LLV	LPT	LVPT	LLVPT	MR	TB	TR	SV
Ilam	2249	2424	1013	422	49	1752	4520	342	102	34	540	34	47	887	15	272	7	105
Bhadrapur	515	3861	1599	213	98	2915	3852	240	378	28	421	20	115	133	31	377	18	171
Damal	4199	4098	3378	909	304	4393	8039	506	895	54	1263	30	256	1224	139	1318	118	557
Mechinagar	4662	7817	4532	1191	360	6874	9731	739	960	153	1660	91	537	1752	201	1849	176	1271
Biratnagar	5310	30004	12777	2001	1876	32055	3419	2944	2365	393	2552	158	640	854	520	2691	514	4460
Dharan	2792	14601	8829	2723	1369	16301	22695	990	2422	275	925	81	1090	658	476	2919	717	3608
Inaruwa	1833	3005	1743	680	351	4058	4705	413	523	20	980	19	157	452	48	461	26	409
Itahari	3079	5850	3249	605	305	6994	9053	787	698	73	1218	54	468	1111	79	892	121	775
Dhankuta	4055	2329	1535	367	67	1751	5050	279	126	40	624	40	134	1487	41	622	9	212
Khadbari	5264	2114	800	721	112	1799	4778	264	98	24	815	47	93	2376	123	296	1	402
Tryiyauga	10438	5702	2096	1165	649	7083	10289	968	459	200	1309	245	473	4708	138	786	15	821
Rajbiraj	1042	3628	2880	181	216	6068	6514	750	224	50	812	32	61	155	84	728	60	936
Lahan	1493	3877	2889	158	165	5477	7305	399	380	82	818	18	112	236	172	955	87	217
Siraha	2513	2543	981	395	312	5266	3317	498	327	27	1730	20	37	132	88	245	17	90
Janakpur	2883	10065	6124	1245	572	13270	14799	1979	734	56	1559	19	118	168	145	1480	79	890
Jaleshwor	1600	3005	1481	141	237	5497	2907	630	360	28	928	17	39	104	108	447	23	296
Malangawa	794	2547	1213	555	187	3540	2777	459	193	23	573	14	26	63	93	341	44	157
Kamalamai	6243	3323	1352	916	328	4387	6139	544	143	27	1258	94	141	3095	57	600	35	321
Bhimeswor	4896	1952	1132	2090	210	800	4775	388	82	31	780	73	81	2578	75	298	7	281
Banepa	1725	2452	1912	145	86	2281	3272	957	42	19	494	55	8	120	117	556	52	204
Dulekhale	1820	1633	1138	266	75	1199	2195	487	34	16	530	80	15	412	40	336	19	266
Panuti	5285	3045	1671	176	214	2735	5430	923	82	28	2114	96	13	1053	116	489	20	456
Lalitpur	4342	33160	18913	2679	2052	29156	37067	4992	155	180	228	170	31	69	2327	5833	754	7441
Bhaktapur	11123	10684	7075	1095	706	8416	15363	5705	50	91	442	426	22	272	656	1910	211	1315
Madhyapur Thimi	5826	7544	4710	577	305	6651	11399	3675	36	52	508	266	9	151	381	1401	150	778
Kathmandu	9027	2E+05	75288	7629	7615	1E+05	2E+05	8396	614	595	833	367	197	282	3294	23774	1677	14535
Kirtipur	2233	9992	2086	340	302	6542	10896	3187	68	71	923	298	20	214	123	651	36	289
Bidur	3787	2317	1453	808	224	2357	4499	446	96	105	1010	91	103	1268	56	604	29	493
Hetauda	3977	12071	5520	705	864	11041	15356	2404	454	169	2676	249	131	659	165	2069	302	1202
Gaur	3224	2993	1202	120	416	5557	2931	856	277	18	1047	30	43	281	24	382	10	203
Kalaiya	204	4179	2149	319	286	7163	5099	1134	325	48	1063	44	55	131	66	442	22	208
Birgunj	2719	19388	11117	1930	820	22058	20335	2137	737	132	1070	62	123	136	364	3765	540	3166

Municipalities	AOF	SW	ONAA	EEA	JS	HC	ST	ALO	LVO	PTO	LLV	LPT	LVPT	LLVPT	MR	TB	TR	SV
Bharatpur	6391	13493	7652	1648	722	12991	21928	2860	816	79	4905	115	101	672	273	2561	208	933
Ratnanagar	5289	4620	2287	1295	307	4622	8558	1342	270	43	3104	100	63	839	104	868	77	398
Parithabi Narayan	6704	2126	1409	331	306	1551	6225	515	121	31	1404	85	67	1959	59	478	21	229
Byas	5599	2607	1748	595	199	1474	3047	729	102	27	981	89	49	2111	82	620	15	370
Putlibazar	7298	2717	1780	293	254	2086	6579	431	134	127	2292	80	63	1890	57	550	14	502
Waling	4719	1345	1326	507	68	1218	4684	320	84	30	1582	31	29	797	68	571	23	242
Lekhnath	7059	4183	2327	591	265	5022	9571	1323	226	148	3649	223	75	1545	121	776	103	459
Pokhara	7199	24830	16506	3071	1445	21611	38530	3682	714	558	3176	413	164	820	1156	5799	685	6062
Baglung	3555	2398	1662	212	131	2051	4958	502	84	47	1354	53	36	624	43	565	17	233
Tansen	1438	2781	1891	264	156	2820	5713	542	47	28	573	52	19	610	103	520	19	336
Ramgram	3766	2952	1307	297	67	3283	3486	572	118	32	1077	52	68	803	39	432	27	234
Butawal	2118	12010	7448	1390	722	12428	17191	1230	569	275	791	73	232	514	268	2363	354	1494
Siddharthnagar	2918	6619	4473	625	596	10862	10335	1442	177	188	1222	146	84	283	130	1142	75	556
Kaplbistu	4349	3275	2024	840	211	3925	3648	617	161	14	1561	30	31	172	75	612	64	357
Tribhuwan Nagar	4733	5212	3016	1917	172	6032	8989	1079	273	41	1812	77	92	1468	111	674	49	377
Tulsipur	4607	3366	2226	1144	155	4856	6880	877	191	46	1567	114	80	1709	88	83	118	320
Nepalgunj	1191	8236	6550	800	473	11827	11618	717	325	90	411	21	79	66	174	1818	151	1332
Gulariya	7444	5390	1550	902	145	7941	6325	1302	496	31	2792	108	117	1477	67	569	22	553
Birendranagar	2003	4454	2218	820	284	5140	6866	1624	207	35	1561	112	56	552	51	796	23	408
Narayan	4931	1348	739	467	343	1496	3498	288	75	18	1535	33	35	1123	23	340	2	107
Dipayal Silgadhi	5688	2598	875	828	298	1596	3113	363	98	44	2035	46	35	446	87	398	7	444
Dhangadhi	11758	6468	3475	629	306	1196	8979	1730	486	76	3280	141	108	2136	82	1218	164	924
Tikapur	7275	4049	1291	554	231	5048	7139	716	365	151	1134	206	353	2212	42	574	6	924
Mahendranagar	18371	5933	3123	1462	416	7367	18947	1099	634	22	7652	46	129	1549	61	1110	97	800
Amargadhi	5536	1147	908	178	28	836	3605	108	44	11	2601	9	8	134	170	286	13	136
Dasharathcanda	6008	1404	627	233	119	517	3857	136	62	6	2847	9	12	166	71	189	0	123

Table - 2: Explanation of Variables of Functional ecology in Municipalities

Explanation of Variables of Functional Ecology in Municipalities		
Major Activities of Urban Population	Agricultural Activities (No. of households)	Small Scale Non Agricultural Economic Activities (No. of households)
AOF = Agricultural own farm	ALO = Agricultural land only	MR = Manufacturing
SW = Salary/Wage	LVO = Livestock only	TB = Trade and Business
ONAA = Own non Agricultural activity	PTO = Poultry only	TR = Transport
EEA = Extended economic activity	LLV = Land and livestock	SV = Services
JS = Job seeking	LPT = Land and poultry	
HC = Households chores	LVPT = Livestock and poultry	
ST = Student	LLVPT = Land, Livestock and Poultry	

Municipalities	Factor I	Factor II	Municipalities	Factor I	Factor II
Ilam	-0.3007	-0.5882	Gaur	-0.3645	0.04854
Bhadrapur	-0.2947	-0.5201	Kalaiya	-0.2719	-0.2149
Damal	-0.2041	0.03394	Birgunj	0.24492	2.0558
Mechinagar	-0.1554	0.30741	Bharatpur	0.21529	0.04927
Biratnagar	-0.1108	4.19288	Ratnanagar	-0.2461	-0.0673
Dharan	-0.2735	4.26098	Parithabi narayan	-0.2186	-0.3944
Inaruwa	-0.314	0.08592	Byas	-0.1944	-0.4985
Itahari	-0.2319	0.28552	Putlibazar	-0.1843	-0.4418
Dhankuta	-0.223	-0.6934	Waling	-0.2332	-0.6116
Khadbari	-0.2782	-0.5758	Lekhnath	-0.2246	-0.179
Triyauga	-0.2897	0.2357	Pokhara	1.22000	.44246
Rajbiraj	-0.108	-0.086	Baglung	-0.202	-0.6149
Lahan	-0.2007	-0.6092	Tansen	-0.1493	-0.683
Siraha	-0.3975	-0.1531	Ramgram	-0.2998	-0.4755
Janakpur	0.07805	0.12733	Butawal	0.03022	0.85338
Jaleshwor	-0.3181	-0.2873	Siddharthnagar	-0.1911	-0.2476
Malangawa	-0.3488	-0.2935	Kapilbastu	-0.2727	-0.1402
Kamalamai	-0.335	-0.0471	Tribhuwan nagar	-0.1911	-0.2476
Bhimeswor	-0.3256	-0.1721	Tulsipur	-0.287	0.08665
Banepa	-0.1697	-0.7069	Nepalgunj	0.15212	0.13609
Dulekhale	-0.2587	-0.511	Gulariya	-0.3799	-0.0092
Panuti	-0.1598	-0.5635	Birendranagar	-0.2062	-0.1997
Lalitpur	1.953736	-0.1943	Narayan	-0.3325	-0.2164
Bhaktapur	0.55291	-0.8393	Dipayal Silgadhi	-0.3193	-0.2362
Madhyapur Thimi	0.20453	-0.8381	Dhangadhi	-0.0849	0.09715
Kathmandu	6.8979	-0.1805	Tikapur	-0.3191	0.00742
Kirtipur	-0.1743	-0.6897	Mahendranagar	-0.1631	0.37492
Bidur	-0.2822	-0.2133	Amargadhi	-0.2244	-1.0091
Hetauda	-0.1084	1.01932	Dasharathchandra	-0.2804	-0.6726