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QUALITY OF LIFE IN LUCKNOW: A PRINCIPAL COMPONENT ANALYSIS

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Abstract

The main objective of this paper is to find out the key factors that determine the quality of life in Lucknow. The study is based on a survey of objective as well as subjective questions that are seen as indicators of quality of life. The people of Lucknow were asked to put their opinion on different measures of quality of life. The collected sample of over 300 responses on a questionnaire was subjected to principal component analysis, a statistical technique for dimensionality reduction of the dataset. The dimensionality reduction technique revealed seven underlying factors / components as the key determinants of the quality of life in Lucknow. Out of these seven components, personal, social and economic wellbeing is found to be the most important one followed by ambient environment, transport infrastructure and police services, housing facilities, social infrastructure, utility services, and social environment. This shows that the state government of Uttar Pradesh and municipal government of Lucknow needs to focus on improving the infrastructure, both physical as well as social infrastructure, and police services in the city to improve the quality of life of people in Lucknow.

Keywords: *Quality of life, Infrastructure, Principal Component Analysis*

JEL Classification: *I31, R20, C81*

1. INTRODUCTION

Quality of life is a holistic approach that not only emphasizes on individuals' physical, psychological, and spiritual functioning but also their connection with their environment and opportunities for maintaining and enhancing skills (Marya *et al.*, 2012).Theoretical definition of quality of life can be made from many perspectives. The definition of this complex concept, which goes beyond a single discipline, is not uniform. The quality of life can be defined in terms of psychology, sociology, economics, and also politics. In general, quality of life can be defined as a product of the cooperation of social, health, economic,and environmental conditions affecting the development of people (Payne *et al.*, 2005). In other words, quality of life is the

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degree to which the experience of an individual's life satisfies that individual's wants and needs, both physical and psychological.

Measurement of quality of life is based on many different models and approaches. Accurate, reliable, and theoretically satisfactory measurement of quality of life which is agreed by most experts does not exist. This is mainly due to the two relatively separated components by which the quality of life is made of. They are objective and subjective (Jindrova and Polackova, 2012). The objective quality of life can be defined as the degree to which specified standards of living are met by the objectively verifiable conditions, activities, and activity consequences of an individual's life. On the other hand, subjective quality of life is a person's sense of well-being, his satisfaction or dissatisfaction with life, or his happiness or unhappiness (Kerce, 1992).

The main aim of this study is to identify the important factors which affect the quality of life of people in Lucknow. Lucknow is the capital city of the state of Uttar Pradesh. It is the second largest city of northern India after New Delhi and the eleventh largest city of India. It is also the most populated city of Uttar Pradesh with a population of 2.82 million of which 1.47 million are male while females constitute 1.35 million of the population. Lucknow is experiencing rapid growth in its population; its population increased from 2.25 million in 2001 to 2.82 million in 2011. Changes in population and its structure will have several implications oneconomy, infrastructure, environment, society, family life and consequently, quality of life of people in the city. This study tries to identify the factors affecting the quality of life of people in Lucknow using a survey of objective as well as subjective questions. The collected sample of over 300 responses on a questionnaire was subjected to Principal Component Analysis (PCA), a statistical technique for dimensionality reduction of the dataset. Statistical Analysis Software (SAS) is used to evaluate the survey data by the PCA.

The study is organized into the following sections. Section 1 presents the brief introduction about the study. Data and specification of methods are described in section 2 and 3, respectively. Section 4 presents the main results of the study. Last section concludes the paper.

2. DATA

The data was collected from 302 respondents of Lucknow city during the period December, 2013 to February, 2014. All the respondents have been living in the city at least for last one year. The sample data constitute 53 per cent male and 47 per cent female. Average age of the respondents is 34 years, with minimum age being 18 years and maximum age being 75 years. Most of them have some level of formal education. Most of the respondents are married; they constitute 62.5per cent of the sample. Never married people constitute 35.8 per cent while widowed/divorced comprise 1.7 per cent of the respondents. The sample has people with varied employment status; 21.8 per cent of them are employed in the public sector, 32.1

per cent in the private sector (13.6 per cent in organized private sector and 18.5 per cent in unorganized private sector), and 12.6 per cent are self-employed. Besides employed people, sample also constitutes people who are not in the work force (26.5 per cent including 14.2 per cent students), who are unemployed (5.3 per cent), and pensioners (1.7 per cent). Employment status of female respondents is not very impressive in comparison to their male counterparts; only 50.35 per cent females are employed whereas the corresponding figure for males in the sample is 80.75 per cent. People from different income groups are part of the dataset; 86 out of 302 respondents had no individual income, 72 had income up to Rs. 100,000, 111 had income between Rs. 100,000and Rs. 500,000, and rest 33 had income above Rs. 500,000. Most of the respondents have 4-5 members in their household. However, 20.5 per cent respondents have less than four members whereas 24.5 per cent have more than 5 members in their family. Most of the respondents have been living in the city for more than 10 years. In fact, 40.7 per cent respondents have been living in the city for more than 20 years.

A self-rated questionnaire was used to collect the data for this study. Questionnaire was divided into two parts: first part comprised socio-economic background of the respondents such as age, gender, marital status, education, employment status, income, family size, etc. whereas second part dealt with respondents' rating about quality of life in Lucknow and the factors affecting the same. Respondents were asked to rate their overall satisfaction and factors that influence their satisfaction such as infrastructure and government services, social, economic and environmental issues, and residential and personal issues. A seven point Likert type scale with "Delighted" equal 7, "Pleased" equal 6, "Mostly Satisfied" equal 5, "Neither Satisfied nor Dissatisfied (Neutral)" equal 4, "Mostly Dissatisfied" equal 3, "Unhappy" equal 2, and "Terrible" equal 1 was used to rate the satisfaction level.

3. METHOD

To determine the key factors affecting the quality of life in Lucknow, dimensionality reduction techniques can be used. The main aim of the dimensionality reduction techniques is to obtain a compact and accurate representation of the data that reduces or eliminates statistically redundant components. Factor analysis (FA) and principal component analysis (PCA) are the two most widely used techniques for dimensionality reduction. These techniques are usually used when variables are highly correlated. The factor analysis estimates factors, which influence responses on observed variables. The factors account for common variance in a dataset. In the FA, observed variables are a linear combination of the underlying factors (estimated factor and a unique factor). Squared multiplecorrelations are used as communality estimated on the diagonals. Communality is the variance in observed variables accounted for by a common factor. Large communality is strongly influenced by an underlying construct. If communalities are large, close to 1.00, the results of PCA and FA could be similar (for detail on this, see, Suhr, 2005 and

Meloun and Militky, 2006). Researchers use factor analysis when they believe that certain latent factors exist that exert causal influence on the observed variables.

In contrast, principal component analysis makes no assumption about an underlying causal model. Principal component analysis is simply a variable reduction procedure that typically results in a relatively small number of components that account for most of the variance in a set of observed variables. It minimizes the sum of the squared perpendicular distances to the axis of the principal component. By reducing a data set from a group of related variables into a smaller set of components, the PCA achieves parsimony by explaining the maximum amount of common variance using the smallest number of explanatory concepts (for detail on this, see, Field, 2005).

This study uses the principal component analysis to find out the key factors affecting the quality of life in Lucknow. Statistical Analysis Software (SAS) is used to evaluate the survey data by PCA. In general, principal component analysis is undertaken in cases where there is sufficient correlation among the original variables to warrant the factor/component representation. Also,PCA requires sample size to be greater than 100 or at least 5 times the number of variables.It is used for large multivariate datasets where it is often desirable to reduce their dimensionality. The first component extracted in a principal component analysis accounts for a maximal amount of total variance in the observed variables. Each succeeding component will account for progressively smaller amount of variance in the dataset and are uncorrelated to all previous components.

In PCA, most commonly used criterion to retain number of components/factors is the eigenvalue-one criterion, also known as Kaiser criterion (Kaiser, 1960). The eigenvalues are representations of the variance variables share. With eigenvalue-one criterion, components with eigenvalues greater than 1 are retained. However, there is a considerable chance that too many components are retained (Costello and Osborne, 2005 and Zwick and Velicer, 1986). So, it is important to consider other criteria as well for component retention before drawing any conclusion.With the scree test (Cattell, 1966), the eigenvalues associated with each component is plotted.A "break" between the components with relatively large eigenvalues and those with small eigenvalues is found. Factor loadings above 0.40 are relevant and can be included in the result (Hair *et al*., 1998). Moreover, a minimum of at least three significant loadings are required for factor identification (Zwick and Velice, 1986). The retained components/factors can be interpreted on the basis of the variables that they load upon significantly and may be named accordingly. The retained factors/components are rotated orthogonally to make it easier to interpret the retained components.

The rotated PCA methods rotate the PCA eigenvectors, so they point closer to the local clusters of data points. There are several analytical choices of rotation that were proposed in the past. One of them is the varimax method of orthogonal rotation. The varimax rotation criterion maximizes the sum of the variances of the

squared coefficients within each eigenvector, and the rotated axes remain orthogonal (Lin and Altman, 2004). This study uses varimax method of orthogonal rotation for rotated principal component analysis.

4. RESULTS AND DISCUSSION

Studies on quality of life employ both subjective as well as objective indicators. Most of the research studies emphasize that the quality of life is very much connected to the perceptions, feelings, and subjective values of the persons. Satisfaction and happiness indicators are accepted to be the most important criterion in measuring the subjective values. The people of Lucknow were asked to put their opinion on different measures of quality of life. These measures were based on the following indicators - infrastructure and government services, social and economic issues, environmental issues, residential issues, and personal issues.

Infrastructure and government services include availability and adequacy of power supply (X_1), water supply (X_2), sanitation facilities (X_3), transport services (X_4), traffic and road infrastructure facilities (X_5), infrastructural facilities for pedestrian and cyclist (X_6), parking facilities (X_7), internet services (X_8), health services (X_9), quality of education services (X_{10}), recreational facilities (sports, entertainment, etc.) (X_{11}), level of crowding in public places (X_{12}), and adequacy and effectiveness of police services (for personal and property safety) (X_{13}).

Social and economic issues include cooperation among neighbours (i.e., social cohesion) (X_{14}), degree of cultural integration (X_{15}), sense of community (feeling that one is part of a larger dependable and stable structure) (X_{16}), availability of employment opportunities (X_{17}), and satisfaction with financial situation of household (X_{18}). Environmental issues include air quality (X_{19}), noise level (X_{20}), cleanliness (X_{21}), and green spaces (parks, gardens, etc.) (X_{22}). Residential issues include availability and affordability of housing (X_{23}), satisfaction with overall physical condition of residence (X_{24}), satisfaction with crime and fire safety in residence (X_{25}), satisfaction with outdoor activity area (X_{26}), and availability of parking facility in and around residence (X_{27}). Personal issues include satisfaction with work and work environment (X_{28}), relationship with friends, relatives and family members (X_{29}), own health and health of family members (X_{30}), food intake (X_{31}), clothing (X_{32}), household items including vehicles (X_{33}), and achievement in life (X_{34}).

As discussed in the previous section, we have used PCA to identify the most important factors/components that influence the quality of life in Lucknow. With eigenvalue-one criterion, components with eigenvalues greater than 1 are retained. With this criterion,eight components are retained. However, there is a chance that too many components are retained. Using a combination of eigenvalue-one criterion, the scree test, the proportion of variance explained criterion and the interpretability criteria, a total of seven factors are retained. The retained factors/components are rotated orthogonally to make it easier to interpret the retained components.The

results of the analysis of the varimax rotated components are presented in Table 1, which succeeded in reducing the 34 variables to 7 components.The 7 components together explained 63 per cent of the total variance. All the seven components have positive loadings on their respective significant variables.

First component accounts for 12.8 per cent of the total variance. This component has high positive loadings on financial situation of household (X_{18}), work and work environment (X_{28}), relationship with friends, relatives and family members (X_{29}), own health and health of family members (X_{30}), food intake (X_{31}), clothing (X_{32}), household items including vehicles (X_{33}) and achievement in life (X_{34}).These variables describe standard of living, personal and professional relationship, and personal achievement of individual. Thus, this component can be called as "personal, social and economic wellbeing".

Second component explains 9.6 per cent of the total variance. This component has high positive loadings on air quality (X_{19}), noise pollution (X_{20}),and cleanliness in the city (X_{21}). These variables are related to environmental factors and thus, can be called as "ambient environment".

Third component extracted from the analysis includes availability and adequacy of traffic and road infrastructure facilities (X_5), infrastructural facilities for pedestrian and cyclist (X_6), parking facilities (X_7), level of crowding in public places (X_{12}), and adequacy and effectiveness of police services (for personal and property safety) (X_{13}). This component accounts for 9.6 per cent of the total variance. It mainly describes the status of transport and police services in the city. Thus, this component can be called as "transport infrastructure and police services".

Fourth component accounts for 8.1 per cent of the total variance.This component includes availability and affordability of housing (X_{23}), crime and fire safety in residence (X_{25}), outdoor activity area (X_{26}), and parking facility in and around residence (X_{27}).These variables are related to housing and facilities available in and around houses in the city. Thus, this component can be called as "housing facilities".

Fifth component extracted from the analysis includes availability and quality of internet services (X_8), adequacy of health services (X_9), quality of education services (X_{10}), and availability of recreational facilities (sports, entertainment, etc.) (X_{11}). This component accounts for 7.8 per cent of the total variance. It mainly describes availability and adequacy of social infrastructure in the city. Thus, this component can be called as "social infrastructure services".

Sixth component includes availability of power (X_1), water (X_2), and sanitation facilities (X_3) in the city. These variables are related to utility services and thus, this component can be called as "utility services".It explains 7.6 per cent of the total variance.

Seventh component accounts for 7.5 per cent of total variance. This component has high positive loadings on cooperation among neighbours (i.e., social cohesion)

(X_{14}), degree of cultural integration (X_{15}), and sense of community (feeling that one is part of a larger dependable and stable structure) (X_{16}). These variables describe the social relationship of the individual. Thus, this component can be called as "social environment".

There is another component which has eigenvalue more than 1, but this component is not presented in Table 1 because it doesn't contain more than two variables having loadings greater than 0.40. It is important to note that the variables which have significant loadings on more than one component are dropped because they are not pure measures of any one construct (for detail on scratching out any variable that loads on more than one component, see, Rourke *et al.*, 2005). Due to this, availability and adequacy of transport services (X_4), availability of employment opportunities (X_{17}), availability of green spaces (parks, gardens, etc.) (X_{22}), and overall physical condition of residence (X_{24}) are excluded from the interpretation.

Table 1
Total Variance Explained by Different Components

Component	*Initial Eigenvalues*			*Rotation Sums of Squared Loadings*		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	9.685	28.5	28.5	4.366	12.8	12.8
2	3.453	10.2	38.7	3.255	9.6	22.4
3	2.306	6.8	45.5	3.248	9.6	32.0
4	1.972	5.8	51.3	2.738	8.1	40.1
5	1.514	4.5	55.8	2.643	7.8	47.9
6	1.383	4.1	59.9	2.590	7.6	55.5
7	1.068	3.1	63.0	2.539	7.5	63.0

5. CONCLUSION

The main aim of this paper is to identify the important factors which affect the quality of life of people in Lucknow. We used principal component analysis for the same. The principal component analysis reduced the 34 variables in 7 principal components. The 7 components together explained 63 per cent of the total variance in quality of life in Lucknow. All the seven components have positive loadings on their respective significant variables. Out of these seven components, "personal, social and economic wellbeing" is the most important one; it explains the highest variance (12.8 per cent). Other important components are "ambient environment" (9.6 per cent) followed by "transport infrastructure and police services" (9.6 per cent), "housing facilities" (8.1 per cent), "social infrastructure services" (7.8 per cent), "utility services" (7.6 per cent), and "social environment" (7.5 per cent). Although, in general, issues related to individuals are beyond the control of the government, government can improve the quality of life of people by improving the transport infrastructure, social infrastructure, utility services, ambient

environment, housing facilities, and police services. Therefore, state government of Uttar Pradesh and municipal government of Lucknow needs to focus on improving the infrastructure, both physical as well as social infrastructure, and police services in the city to improve the quality of life of people in Lucknow.

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