Physical Infrastructure Index for Govt. Schools of Odisha:

An Analysis using Principal Component Analysis

1. Introduction

Infrastructure is an important tool for facilitating quality education in Elementary education system. Realizing the importance of infrastructure, both the central and the state government have undertaken several schemes to improve physical infrastructure of government schools. Sarva Shiksha Abhiyan (SSA) is one of the flagship programs of Government of India, which has been implemented in all the 30 districts of Odisha since 2001 in order to achieve universal elementary education. SSA has been implemented in Odisha with objective to provide elementary education of satisfactory quality with focus on education for life.

Availability of physical Infrastructures are very crucial for providing satisfactory quality in elementary education. These physical infrastructures include provision of building, toilets, drinking water facility, electricity, computers, etc. In order to access the physical infrastructural development, it is important to take into account all the above stated infrastructure indicators separately. However, there is no particular indicator which will represent the infrastructure development of any school. **Realizing the importance of a particular indicator representing the overall development of the infrastructure, the present study attempted to construct a physical infrastructure index for government schools of Odisha using principal component analysis (PCA).**

2. Data and Methodology

All data are obtained from the secondary sources particularly from Management Information System (MIS) of OPEPA, Department of School and Mass Education, Government of Odisha. The present study used Principal Component Analysis (PCA) for the construction of a summary physical infrastructure index (INFI) for Government schools in elementary education of Odisha. The PCA was developed by Pearson (1901) and Hotelling (1933), while the best modern reference is Jolliffe (2002). To construct a summary physical infrastructure index (INFI) for Government schools of Odisha, present study takes into account various infrastructure indicators such as **number of schools with girl's toilet as percentage of total government schools (GT), number of schools with drinking water facility as percentage of total government schools (DW), number of schools with electricity as percentage of total government schools (ELEC), number of schools with building as percentage of total government schools (BUILD), number of schools with computers as percentage of total government schools (HCOMP).**

3. Analysis of Results

The PCA is a multivariate technique used to transform the original data consisting of a set of variables into a linear combination of a small set of variables known as principal components (PCs) so that the bulk of the variation in the original data is explained. These PCs are new entities and they are extracted from the original data set of variables after taking into account the correlation matrix. Among extracted PCs, the first PC would be best component as it explains greater variance than the rest of the PCs (Murthy, Patra & Samantaraya) (also see Fig.1). Linear combinations of each component's factor loading can be expressed as follows:

$$\text{INFI} = q_1 GT_t + q_2 DW_t + q_3 ELEC_t + q_4 BUILD_t + q_5 HCOMP_t \qquad (1)$$

In the above equation, q_1, q_2…….q_6 are weights of the components given by the respective eigenvector of the selected principal component. The eigenvalues and eigenvectors of the component matrix of INFI are as follows:

Table 1. Eigen values and Eigenvectors of the Component Matrix of Physical Infrastructure Components

Variables	Eigenvectors (PC$_k$)				
	PC$_1$	PC$_2$	PC$_3$	PC$_4$	PC$_5$
GT	0.440	0.641	0.043	-0.073	0.624
DW	0.444	-0.539	-0.300	0.561	0.327
ELEC	0.456	-0.207	-0.462	-0.714	-0.160
BUILD	0.441	-0.301	0.828	-0.150	-0.077
HCOMP	0.455	0.407	-0.089	0.384	-0.687
Eigen values (E$_k$)	4.61	0.26	0.11	0.01	0.00

The first principal component i.e. PC$_1$ captures the 92 per cent of the total variance (also see the Scree plot)[1]. All infrastructure indicators and substituting the respective eigenvalues for q_i's in equation (1):

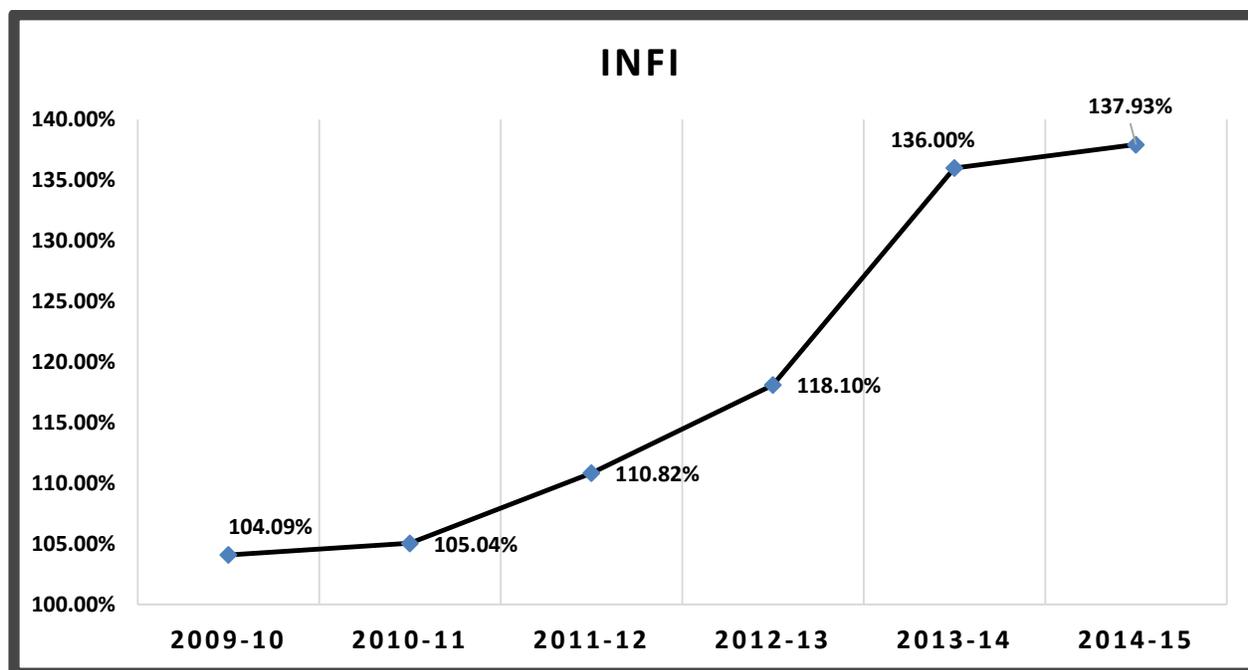INFI= (0.440) GT$_t$+ (0.444) DW$_t$+ (0.456) ELEC$_t$+(0.441) BUILD$_t$+(0.455) HCOMP$_t$(2)

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[1] $\sum E_k$ = 4.61+ 0.26 + 0.11+0.01+0.00 = 4.99. PC$_1$ = 4.61/4.99= 0.92

Fig.1: Scree Plot

The constructed civil infrastructure index for Government schools of Odisha is presented in the following Fig.2.

Fig.2: Trends in Physical Infrastructure Index

From the Fig.2 it is observed that the composite infrastructure for government schools of Odisha has increased over the period from 2009-10 to 2014-15.

4. **Findings**

The present study constructed a summary infrastructure index for government schools of Odisha using the Principal Component analysis (PCA) taking into account different infrastructure components such as building, toilet, computer, drinking water and electricity. The constructed composite infrastructure index reflected an asymptotically increasing trend from 2009-10 to 2014-15.

However, the increase in INFI has slowed down during FY 2013-14 to 2014-15 as compared to FY 2012-13 to 2013-14.

References:

HOTELLING, Harold, 1933. Analysis of a Complex of Statistical Variables into Principal Components. Journal of Educational Psychology, 24(6 & 7), 417–441 & 498–520.

JOLLIFFE, I. T., 2002. Principal Component Analysis. Second ed. Springer Series in Statistics. New York: Springer-Verlag New York.

Murthy, D.S., Patra, S.K. & Samantaraya, A. 2014.Trade Openness, Financial Development Index and Economic Growth: Evidence from India (1971-2012).Journal of Financial Economic Policy. Vol.6, ISS 4,pp.362-375,Emerald Publication.

PEARSON, Karl, 1901. On Lines and Planes of Closest Fit to Systems of Points in Space. Philosophical Magazine, Series 6, 2(11), 559–572.