Developing Multidimensional Scale for Effective Measurement of Rural Leadership

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ABSTRACT

Many social researchers measure multidimensional variables, such as rural leadership, by aggregating the scores of individual dimensions / sub-dimensions. These dimensions / sub-dimensions are highly correlated and have inherent problem of multicolinearity which causes attenuation in measurement. In order to overcome this problem, the M-K-J-B-D method developed by a group of researchers, has been used to construct multidimensional scale of rural leadership. The advantage of multidimensional rural leadership scale is being demonstrated by comparing it with uni-dimensional scale in further statistical analysis. The present study is a blending of two research findings where the data on rural leadership have been collected from randomly selected 160 followers and 40 leaders from rural areas of Uttarakhand State of India and these have been tested through a method for developing a valid multidimensional scale with absolute reliability for effective measurement of rural leadership.

Key words : Multidimensional; Multicolinearity; Unidimensional; Leadership; Reliability;

The developing world, over the last few decades has been experimenting with various developmental projects aimed at bringing about sustainable rural development. Majority of such endeavours have one dimension in common viz., rural leadership. The paradigm of rural development has been a function of many factors in which rural leadership is of paramount importance. *Mlambiti et. al.(1999)* rightly emphasized that leadership is the focal point for the success of any developmental programme. In this context the importance of rural leadership was felt all around the globe. The success of rural development initiatives largely depends on the strategy for effectively mobilizing the grassroot level target groups for participatory development and empowering the beneficiaries to be the owners of their development (*Agunga, 1997*). Many extension researchers aim at measuring the rural leadership and evolving strategies to promote leadership in rural areas. It is felt that unlike many other variables, leadership is also inaccurately measured while conducting the researches. The conspicuous reason being, the way the scales are developed and the way these are used in the extension researches. In fact, rural leadership is a multi-dimensional variable whereas it is being measured as if it were a uni-dimensional variable.

It is common knowledge that most of the dimensions of a multidimensional variable are highly correlated. That means, there is a high covariance among the dimensions/ sub-dimensions of a multidimensional variable. While measuring the multidimensional variable many researchers do not eliminate the overlapping effect arising due to covariance among dimensions/ sub-dimensions and as a result get an inflated measurement of the variable in question. Subsequently, any further analysis using inflated measurement leads to inaccurate statistical results. So the present study, a blending of two research findings makes an attempt to measure the leadership as a multidimensional variable using a valid method (M-K-J-B-D) with a view to measure and analyse the rural leadership more accurately. The present study has the dual objectives of developing a multidimensional rural leadership scale and comparing the statistical results, correlation and regression, using multidimensional and uni-dimensional (conventional) rural leadership scales.

METHODOLOGY

A method developed by a team of researchers which is known as M-K-J-B-D (Maheshwari–Kumar–Jhamtani–Bhaskaran–Dandapani) method of multidimensional scale construction (*Kumar, 2006*) has been used to eliminate the overlapping effect of covariance among dimensions/sub-dimensions and calculate the scores more accurately. This method, which

is being used for this study, consists of a number of steps as follows:

Step 1: Identify dimensions / sub-dimensions / sub-sub-dimensions.

Step 2: Construct scale/ test/ index to measure individual indivisible dimensions, alternately use scale / test / index, if already available.

Step 3: Test the reliability of measurement of dimensions by eliminating items attenuating overall reliability of the scale/test (Not required, if scale is already standardized).

Step 4: Collect data for different dimensions through proper sampling method.

Step 5: Apply factor analysis to the individual dimensions of multidimensional variable.

Step 6: Eliminate dimensions, one by one, whose communality are found to be less than 0.6 (a thumb rule for factor analysis) and re-run it on the remaining indivisible dimensions.

Step 7: On the basis of scree plot, determine the number of components (Factors) to be kept in final factor analysis.

Step 8: Verify factor analysis model by using different methods of factor analysis e.g. Principal component method, Maximum likelihood method, Least square method.

Step 9: Compare, if the magnitude and direction of dimensions are similar for different methods of factor analysis.(optional)

Step 10: Compare residual plots of factor analysis for similarity.(optional)

Step 11: Finalise the factor analysis model if it is able to explain a large amount of variation in dimensions of multidimensional variable.

Step 12: Using MDS (Multidimensional Scaling), plot scatter diagram on 2-3 dimensions and compare the results with that of factor analysis (Optional).

Step 13: Using set of b (beta) values of each variable in different components, regress dimensions (variables) into factors (components). That is

$Y_1 = b_1*X_1 + b_2*X_2 + b_3*X_3\ldots$, $Y_2 = b_1*X_1 + b_2*X_2 + b_3*X_3\ldots$, $Y_3 = b_1*X_1 + b_2*X_2 + b_3*X_3\ldots$, $Y_4 = b_1*X_1 + b_2*X_2 + b_3*X_3\ldots$, and so on.

Step 14: Add Y_1, Y_2, Y_3, Y_4 …, which are uncorrelated to each other, to obtain overall score Y for individual respondents on the multidimensional scale of measurement. Thus, one can have the accurate and reliable score of individual respondents.

Data were collected from 160 followers and 40 leaders from rural areas of Uttarakhand State in India. The respondents were selected using simple random sampling method. A questionnaire was developed and pre-tested, and was finally used for data collection during 2004-05.

RESULTS AND DISSCUSSION

The results of the present study have been presented in the sequence in which M-K-J-B-D method was employed to develop multidimensional scale of rural leadership.

Dimensions of rural leadership (Step 1 & 2): Various dimensions of rural leadership as identified by *Mohanty, 2005* for the purpose of the study, were measured by using the following scales.

Dimensions	:	Scales
Achievement Motivation	:	Reddy (1978)
Power Orientation	:	Kipnis et al. (1980)
Decision Making Ability	:	Hage and Alken (1967)
Risk Orientation	:	Supe (1969)
Extension Agency Contact	:	Singh (1982)
Role Expectation	:	Rating developed
Information Processing Behaviour	:	Rating developed
Role Performance	:	Rating developed
Information Processing Behaviour	:	Rating developed
SES (Socio-economic status)	:	Mishra and Kaul (2000)
Information Sharing Behaviour	:	Rating developed
Social Participation	:	Trivedi and Pareek (1963)
Innovativeness	:	DasGupta (1989)
Social Progressiveness	:	Sinha (1963)
Mass Media Exposure	:	Kandpal (1984)

The Table No.1 shows the inter-correlation among various dimensions of rural leadership. From the table, it could be noted that there exists significant inter-correlation among many dimensions of leadership. Hence, it makes a right case to construct a multidimensional scale eliminating covariance effect in overall measurement of rural leadership.

Table 1. Inter-correlation among dimensions of rural leadership

Dimensions	SES	EAC	MME	ISB	IPB	IShB	SP	I	SPr	RE	RP	RO	AM	PO	DMA
SES	1														
EAC	.025	1													
MME	.177	.498**	1												
ISB	.554**	.098	.142	1											
IPB	.362*	.298	.207	.520**	1										
IShB	.376*	.116	.299	.687**	.537**	1									
SP	.437**	.361*	.175	.328*	.380*	.283	1								
I	.330*	.150	.375*	.301	.240	.349*	.220	1							
SPr	.505**	.132	.285	.697**	.517**	.417**	.172	.569**	1						
RE	.431**	.197	.168	.497**	.499**	.571**	.351*	.180	.398*	1					
RP	.368*	.160	.127	.302	.382*	.259	.222	.283	.295	.326*	1				
RO	.415**	.168	.122	.619**	.400*	.311	.173	.410**	.647**	.300	.415**	1			
AM	.344*	.414**	.208	.415**	.416**	.340*	.240	.470**	.478**	.323*	.540**	.622**	1		
PO	.373*	.205	.103	.698**	.539**	.602**	.282	.384*	.536**	.412**	.378*	.626**	.601**	1	
DMA	.127	.015	-.058	.560**	.575**	.473**	-.125	.193	.575**	.391*	.423**	.578**	.310	.568**	1

SES : Socio Economic Status
EAC : Extension Agency Contact
MME : Mass Media Exposure
ISB : Information Seeking Behaviour
IPB : Information Processing Behaviour
IShB : Information Sharing Behaviour
SP : Social Participation
I : Innovativeness
SPr : Social Progressiveness
RE : Role Expectation
RP : Role Performance
RO : Risk Orientation
AM : Achievement Motivation
PO : Power Orientation
DMA : Decision Making Ability

Factor analysis of collected data (Step 4, 5 & 6): After collection of data by using existing scales mentioned above, factor analysis was applied choosing principal component analysis for extraction and varimax method for rotation of the factors. The result of communalities as shown in Table No. 2 indicates that a high amount of variance for all the dimensions could be explained by the factor analysis model. As a thumb rule, communality more than 0.6 is considered as a sufficient condition to keep the dimension (variable) in the factor analysis model. Since all communality values were above 0.6, no dimension was dropped from the factor analysis model and was considered for next step i.e. deciding number of components in factor analysis model.

Scree plot and variation explained (Step 7): The scree plot as shown in Figure No. 1 depicts that after fifth component the line had become almost horizontal and Table No.3 shows that initial eigen values reduces to less than one after fifth component. Table No. 3 also confirms that five components (factors) could explain a total variance up to 75.72 per cent. The increment in total variation explained by subsequent components was marginal; hence, it was decided to restrict the components in factor analysis to five factors.

Table 2. Communalities of the dimensions of rural leadership

Dimensions of Rural Leadership	Initial	Extraction
Achievement Motivation	1.00	0.784
Decision Making Ability	1.00	0.891
Extension Agency Contact	1.00	0.836
Information Processing Behaviour	1.00	0.683
Information Seeking Behaviour	1.00	0.796
Information Sharing Behaviour	1.00	0.756
Innovativeness	1.00	0.733
Mass Media Exposure	1.00	0.811
Power Orientation	1.00	0.683
Risk Orientation	1.00	0.746
Role Expectation	1.00	0.637
Role Performance	1.00	0.629
SES	1.00	0.793
Social Participation	1.00	0.792
Social Progressiveness	1.00	0.786

Extraction Method : Principal Component Analysis.

Figure 1. Scree plot showing contributions of components w.r.t. eigenvalues

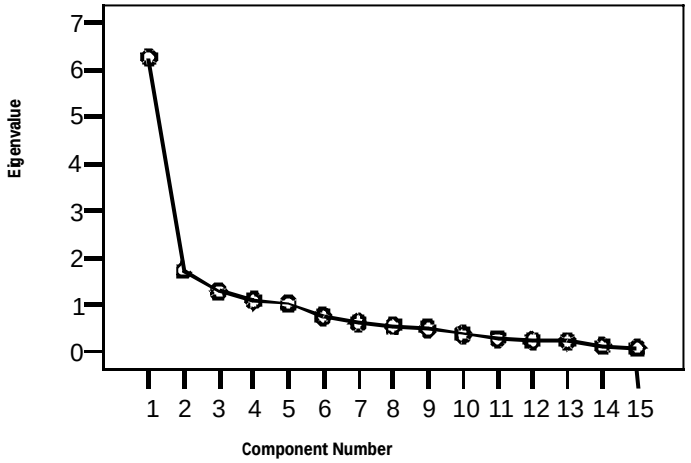

Table 3. Percentage of total variance by various components for initial eigenvalues, after extraction and after rotation

Component	Total	Initial Eigenvalues % of Variance	Cumulative %	Extraction Sums of Squared Loadings Total	% of Variance	Cumulative %	Rotation Sums of Squared Loadings Total	% of Variance	Cumulative %
1	6.252	41.677	41.677	6.252	41.677	41.677	3.642	24.277	24.277
2	1.727	11.514	53.191	1.727	11.514	53.191	2.412	16.083	40.360
3	1.277	8.517	61.708	1.277	8.517	61.708	2.074	13.825	54.186
4	1.080	7.199	68.907	1.080	7.199	68.907	1.645	10.964	65.150
5	1.022	6.816	75.722	1.022	6.816	75.722	1.586	10.572	75.722
6	.739	4.929	80.651						
7	.619	4.129	84.780	-	-	-	-	-	-
8	.541	3.609	88.389	-	-	-	-	-	
9	.475	3.165	91.554	-	-	-	-	-	-
10	.359	2.396	93.950	-	-	-	-	-	-
11	.270	1.801	95.751	-	-	-	-	-	-
12	.237	1.578	97.328	-	-	-	-	-	-
13	.216	1.440	98.768	-	-	-	-	-	-
14	.114	.762	99.530	-	-	-	-	-	-
15	.070	.470	100.000	-	-	-	-	-	-

Finalising factor analysis model (Step 8-11): After restricting the number of components to five, factor analysis was again employed to obtain the beta values for each dimension. The results were compared for consistency. The results of final components identified, which were uncorrelated to each other, are presented in Table No.4.

Comparison of factor analysis results with MDS plots (Step 12): Using the coordinates of the dimensions (X_1 to X_{15}), scatter diagrams have been plotted and rotated to identify and compare with the results (Components 1 to 5) of factor analysis. The same could also be obtained as part of output for factor analysis. The dimensions which have major contribution to a particular component have higher beta values than for other components. For example, X_1 has beta value 0.808 for component one but has lower beta values for remaining four components. On the basis of beta values of dimensions to a particular component (factor), the components are given a name to represent the group of dimensions that have major contribution to that particular component (factor). As per the Table No. 4, the first component (Y_1) has major contributions from dimensions - X_1: Information Sharing Behaviour, X_2: Information

Table 4. Rotated component matrix of the dimensions of rural leadership

Component	1 Information Behaviour	2 Urge for Excellence	3 Permissiveness	4 Information Source Exposure	5 Social Traits
X_1 : Information Sharing Behaviour,	0.808	-0.022	0.237	0.141	0.162
X_2 : Information Seeking Behaviour	0.738	0.219	0.385	-0.105	0.213
X_3 : Decision making ability	0.721	0.429	0.111	-0.147	-0.392
X_4 : Information Processing Behaviour	0.710	0.325	0.008	0.229	0.146
X_5 : Role expectation	0.696	0.121	-0.017	0.112	0.354
X_6 : Power Orientation	0.610	0.480	0.273	0.032	0.068
X_7 : Achievement Motivation	0.172	0.758	0.308	0.267	0.117
X_8 : Role performance	0.177	0.746	0.044	0.039	0.194
X_9 : Risk Orientation	0.344	0.638	0.466	-0.061	-0.016
X_{10} : Innovativeness	0.069	0.217	0.792	0.209	0.102
X_{11} : Social Progressiveness	0.499	0.283	0.675	0.009	0.019
X_{12} : Extension Contact	0.074	0.289	-0.078	0.854	0.107
X_{13} : Mass Media Exposure	0.108	-0.148	0.437	0.763	0.066
X_{14} : Social Participation	0.182	0.145	-0.021	0.256	0.820
X_{15} : SES	0.285	0.193	0.432	-0.169	0.678

Extraction Method : Principal Component Analysis. [a]Rotation converged in 7 iterations.

Rotation Method : Varimax with Kaiser Normalization

Seeking Behaviour, X_3: Decision Making Ability, X_4: Information Processing Behaviour, X_5: Role Expectation and X_6: Power Orientation. Broadly, Component 1 (Y_1) could be named as Information Behaviour. Figures No 2 & 3 confirm the result of factor analysis. The component 2 (Y_2) has major contribution from dimensions - X_7: Achievement Motivation, X_8: Role Performance and X_9: Risk Orientation. The Dimensions - X_{10}: Innovativeness and X_{11}: Social Progressiveness contribute mainly to Component 3 (Y_3), which could be named as Permissiveness. While X12: Extension Agency Contact and X_{13}: Mass Media Exposure contribute to Component 4 (Y_4), which can be termed as Information Source Exposure and Component 5 (Y_5) could be named as Social Traits, which has major contribution from X_{14}: Social Participation and X_{15}: SES.

Multidimensional scale of rural leadership (Step 13-14) : The components 1-5, i.e. Y_1, Y_2, Y_3, Y_4 and Y_5, are uncorrelated underlying factors among fifteen dimensions of rural leadership. Since these components are uncorrelated, there is no covariance hence no overlapping scores. Now, these components could be used to obtain scores of individual respondents. Mathematically, each factor could be regressed using ß (beta) values of the dimensions to obtain uncorrelated factor scores of individual respondents as shown below.

$$Y_1 = 0.808 * X_1 + 0.738 * X_2 + 0.721 * X_3 + 0.710 * X_4 + 0.696 * X_5 + 0.610 * X_6 + 0.172 * X_7 + 0.177 * X_8 + 0.344 * X_9 + 0.069 * X_{10} + 0.499 * X_{11} + 0.074 * X_{12} + 0.108 * X_{13} + 0.182 * X_{14} + 0.285 * X_{15}$$

$$Y_2 = -0.022 * X_1 + 0.219 * X_2 + 0.429 * X_3 + 0.325 * X_4 + 0.121 * X_5 + 0.480 * X_6 + 0.758 * X_7 + 0.746 * X_8 + 0.638 * X_9 + 0.217 * X_{10} + 0.283 * X_{11} + 0.289 * X_{12} - 0.148 * X_{13} + 0.145 * X_{14} + 0.193 * X_{15}$$

$$Y_3 = 0.237 * X_1 + 0.385 * X_2 + 0.111 * X_3 + 0.008 * X_4 - 0.017 * X_5 + 0.273 * X_6 + 0.308 * X_7 + 0.044 * X_8 + 0.466 * X_9 + 0.792 * X_{10} + 0.675 * X_{11} - 0.078 * X_{12} + 0.437 * X_{13} - 0.021 * X_{14} + 0.432 * X_{15}$$

$$Y_4 = 0.141 * X_1 - 0.105 * X_2 - 0.147 * X_3 + 0.229 * X_4 + 0.112 * X_5 + 0.032 * X_6 + 0.267 * X_7 + 0.039 * X_8 - 0.061 * X_9 + 0.209 * X_{10} + 0.009 * X_{11} + 0.854 * X_{12} + 0.763 * X_{13} + 0.256 * X_{14} - 0.169 * X_{15}$$

$$Y_5 = 0.162 * X_1 + 0.213 * X_2 - 0.392 * X_3 + 0.146 * X_4 + 0.354 * X_5 + 0.068 * X_6 + 0.117 * X_7 + 0.194 * X_8 - 0.016 * X_9 + 0.102 * X_{10} + 0.019 * X_{11} + 0.107 * X_{12} + 0.066 * X_{13} + 0.820 * X_{14} + 0.678 * X_{15}$$

After calculating the scores of individual respondents for Y_1, Y_2, Y_3, Y_4 and Y_5, the total score for rural leadership of each respondent could be obtained by adding the regressed value of Y_1, Y_2, Y_3, Y_4 and Y_5. Mathematically it could be represented as Total Multidimensional Score $(Y) = Y_1 + Y_2 + Y_3 + Y_4 + Y_5$.

The scores of individual respondents calculated using multidimensional scale of rural leadership could be used for further statistical treatment.

Reliability of multidimensional and uni-dimensional scales : The reliability score of the multidimensional scale of rural leadership using Cronbach's Alpha method was found to be 0.857. While, the reliability score calculated for uni-dimensional scale using Cronbach's Alpha method was found to be only 0.82. The same values of reliability were obtained using parallel form test of reliability. The uncorrected Gutman Split-half reliability coefficients were 0.703 and 0.659 for multidimensional scale and uni-dimensional scale respectively. This depicts that multidimensional scale is more accurate and error of measurement is less than that of uni-dimensional scale.

Relationship with independent variables: In accordance with the second objective of the present study, the scores obtained by using multidimensional scale and uni-dimensional scale were used to calculate correlation coefficients and regression with independent variables. In Table No. 5, the values of correlation coefficient between dependent variable calculated as multidimensional and uni-dimensional scales with independent variables show a high degree of difference. These differences could be attributed to the fact that the measurement by using multidimensional scale was more accurate than that of uni-dimensional scale.

Table 5. Correlation and Regression between rural ;eadership measured by multidimensional scale and uni-dimensional scale and independent variables

Independent Variables	Correlation Method	Multidimensional Rural Leadership Score	Uni-dimensional Rural Leadership Score
Age of the respondent	Pearson Correlation	-0.133	-0.096
Education of the Respondent	Pearson Correlation	0.644**	0.551**
Caste	Kendall's tau_b	-0.058	-0.041
Tenure status of land	Pearson Correlation	0.532**	0.479**
Family Size	Pearson Correlation	0.178	0.211
Family Type	Kendall's tau_b	0.188	0.207
Land holding	Pearson Correlation	0.383*	0.359*
Occupation	Kendall's tau_b	0.026	0.045
Annual Income	Pearson Correlation	0.575**	0.513**
Training Exposure	Kendall's tau_b	0.318*	0.248
Awareness of Development programmes	Pearson Correlation	0.539**	0.536**
Gender	Pearson Correlation	0.176	0.114
	Adjusted R Square	0.614#	0.505#
	F	32.041	20.854
	Sig.	0.000	0.000

#Predictors for regression analysis: (Constant), Education of the Respondent, Awareness of Development programmes

*Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

This fact was further reinforced by the results of regression analysis between dependent variable, Rural Leadership and independent variables. Table No. 5 shows the total change in dependent variable explained by independent variables, Education of respondent and Awareness about Developmental Programme. It could be observed that while 61.4 per cent change could be explained in case of dependent variable measured by multidimensional scale, only 50.5 per cent change could be explained when rural leadership was measured by uni-dimensional scale. This 11 per cent difference can be attributed to the overlapping effect arising due to the inter correlations amongst the dimensions of rural leadership, when measured using uni-dimensional scale. However, when multidimensional scale is used the attenuation due to measurement error is eliminated.

Hence, M-K-J-B-D method gains significant importance in research studies as it measures the multidimensional variable more accurately and reduces the attenuation in correlation and regression values caused due to error of measurement, thus helps in enhancing correlation coefficients and adjusting R square. It is further

revealed that the data on various dimensions of rural leadership evolved through research were valid enough to fit into the M-K-J-B-D method of multidimensional scale development.

CONCLUSION

The rural leadership scale developed by using multidimensional scaling technique (M-K-J-B-D method) provides accurate and reliable measurement than uni-dimensional scale. This was possible due to the fact that error in measuring rural leadership, a multidimensional variable, was reduced when measured using multidimensional scale. This multidimensional scale could be widely used in future researches for better accuracy and reliable results.

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