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A META-REVIEW OF EXPLORATORY FACTOR ANALYSIS IN LEADERSHIP RESEARCH

Admin Sciences

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ABSTRACT

The wide use of EFA as a method for understanding the dimensional structure of constructs is confronted with its common misuse while analyzing the relevant data. The decisions made whilst conducting different EFA procedures are observed to be defective, which may lead to serious theoretical consequences. The paper reviews 30 studies using EFA for exposing leadership related constructs with the help of major designs and important issues. Results show that, like in other disciplines as examined by reviewers so far, the leadership studies are also burdened with the same inaccuracies. Reasons for misuse are discussed and guidelines for future research are submitted.

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It is the glory of God to conceal a thing:
But the honor of kings is to search out a matter"
–Proverbs 25:2

"Man, biologically denied the ordering mechanisms
with which the other animals are endowed, is compelled
to impose his own order upon experience."
–Peter L. Berger, The Sacred Canopy:
Elements of a Sociological Theory of Religion

All scientists, and more often the social scientists, have to examine, test, and make attempts in proving their theories on the 'orderness' of the universe through postulating constructs (variables), and finding relationships amongst them. However, these subjective 'ordered' universe. Their pursuit of discovering underlying dimensions of such constructs is facilitated by a number of inductive and deductive

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methods, and amongst them most 'scientific' is probably the tool of factor analysis, which like all other 'objective' scientific tools is not itself free human assumptions. The underlying assumption of factor analysis is that there exist a number of unobserved latent variables (or 'factors') that account for the correlations among observed variables, such that if the latent variables are held constant, the partial correlations among the observed variables become zero. In its simple form this assumption suggests: latent variable ('factor') determines the value of observed variables.

Introduction: What is Factor Analysis?

Hair et al. (2006) define factor analysis as "an interdependence technique.......... whose *primary purpose is to define the underlying structure among the variables in the analysis.*" (Italics are from the original text) (p.104). Still earlier, Stewart (1981) observed that factor analysis is concerned with the identification of structure ('order') within a set of observed variables. According to him the proper use of factor analysis involves the study of interrelationships among variables in an effort to find a new set of variables, fewer in number than the original variables, expressing which is common among the original variables. Russell (2002) reports from his review of 320 empirical articles published in *Personality and Social Psychology Bulletin* that 27% of these articles have used factor analysis: either exploratory factor analysis, principal component analysis, or confirmatory analysis. Low & Gardner (2000) have found that during the first decade of *Leadership Quarterly* (1990-1999) out of 78 articles based on quantitative methods in 42% authors used factor analysis among them in 28% exploratory factor analysis is used.

Regarding the purpose of factor analysis, Russell (2002) reports that his review has found that 51% of factor analysis was performed for data reduction (reducing a set of items to a smaller set of more reliable measures), 39% was used for testing a hypothesized factor structure for a set of measure of a construct, and the remaining factor analysis were conducted to test a measurement model associated with a structural equation modeling analysis, using confirmatory factor analysis software. Other uses can be evaluation of redundancy among a set of items in a measure, and a replication of results from a prior factor analysis. **Conway & Huffcutt (2003)** while reviewing the practices of exploratory factory analysis (EFA) in the three organizational journals (*Journal of Applied Psychology. Personal Psychology, and Organizational Behavior and Human Decision Processes)* during 1985-1999 codified the purpose of EFA into (i) data reduction, (ii) assessing unidimensionality of existing measures, (iii) assessing the unidimentionality of new or *ad hoc* measures, (iv) preliminary evaluation of existing measure, (v) preliminary evaluation of new or *ad hoc* measure, (vi) *Post hoc* exploration of correlations, (vii) development of a new measure, (viii) hypothesis testing, and others. Nevertheless, the majority of exploratory factor analysis has been found to be a assessment, evaluation, and development of construct measures.

The objectives of this paper are to study in depth one of the multivariate analytical techniques (and in this case it is exploratory factor analysis –EFA) after reviewing at least 30 articles published in research journals on a specific topic (leadership, in this case) and after reviewing the use of EFA to discuss how investigators are using these techniques, practically and what improvements are required, ideally. In order to achieve these objectives next I will discuss the nature of factor analysis, specifically the EFA and the key issues related to it. The subsequent sections of this paper consists of review of articles from leadership scholars i.e findings of this study, guidelines for future research using EFA, and lastly, based on the review findings the conclusions of this study.

Exploratory Factor Analysis: Nature and Key Issues Related to its Application

Nature of EFA: Authors have classified factor analysis into more than one major streams / perspectives. Hair et al. (2006) classify it into *exploratory factor analysis (EFA)* and *confirmatory factor analysis (CFA)*. According to them these perspectives distinguish the appropriate role of factor analysis: EFA is considered for data reduction and/or for searching a structure among a set of variables (phrased as 'take what data give you'), on the other hand, CFA males an assessment of how the data meet the *a priori* structure, which can be phrased as 'judge on how data fits you'. Furthermore, they make a distinction between *component analysis (*also known as *principle component analysis* –PCA) and *common factor analysis* within EFA perspective. Merenda (1997) classifications is similar to this; however, he considers PCA as predominantly exploratory, CFA predominantly confirmatory, and common FA as potentially confirmatory. Conway & Huffcutt (2003) give a more detailed classification schema. Their review of 371 articles has found that authors use four types of factor extraction models (EFA): PCA, common FA, principal axis method, and maximum likelihood. Russell (2002), besides CFA, considers two other types of factor analysis, which are exploratory in their nature: PCA and principle axis factoring. Podsakoff et el. (2003) have identified four types of measurement models: exploratory (reflective) that is common factor model, and confirmatory (formative) that is composite latent variable model. This taxonomy is based on (i) whether the model is exploratory or confirmatory, and (ii) whether the measurements are reflections of the underlying latent factor or are its determinants. An earlier study by Stewart (1981) identifies six models of factor analysis used in marketing research: O,P,Q,R,S,T on the basis of whether the factors are loaded by variables, persons or occasions; the indices of association computed on these three 'things'; and whether the data are collected on one occasion, one person, or one variable. Since the space of this paper does not permit to explain these categories individually, I will rely on the main line of distinction between EFA and CFA drawn by Hair et al. (2006), and will use the codification of factor extraction models used by Conway & Huffcutt (2003) in my review of EFA use in leadership literature.

EFA is mostly used as a contributory technique for preparation and refinement of data for more robust statistical operations towards testing of hypothesis that are generally the main target of a study. This role of EFA is demonstrated when, for example, validity of an existing well-established measurement scale is studied in a different situation before start of the large scale study or a preliminary evaluation of a new instrument of items is done. However, EFA may become the central technique in a study some times. For example, if a new scale development is the purpose of a study the rule of EFA becomes critical and fundamental. Some researchers, even, use it for hypotheses testing (for example, Khatri, Ng & Lee, 2001; Godwin & Neck, 1998). However, Merenda (1997) opines that common FA and PCA (both EFA) are not methods of statistical analysis, therefore, cannot be used in testing the null hypothesis. Anyhow, if the purpose of study is to see whether the factors/dimensions of a construct changes with the change of environment (e.g national culture, organizational context, income level, etc.), EFA can be used for hypothesis testing.

Key Issues: It is observed that despite its wide use in social science research, exploratory factor analysis has been exploited within a inaccuracy in application and reporting **(Russell, 2002; Podsakoff et al. 2003; Stewart, 1981; Conway & Huffcutt, 2003)**. In the following paragraph, I will discuss very briefly the issues that are important in use and reporting of exploratory factor analysis. The structure of issue identification, logically, will serve as a framework for the review of articles conducted for this study and putting in place the prevalent misapplications of exploratory factor analysis in leadership studies.

Sample Size: Like any scientific modeling, the search for an underlying structure (concept/construct) is also subject to the principles of parsimony and rigor. In a context of the size of sample for conducting an

EFA the former demands a reasonably manageable-not-too-large sample of participants (cases), while the later requires that the sample size should be firmly acceptable-not-too-small to lose its scientific features. Hair et al. (2006) informs the generally the researchers would not do the factor analysis of a sample with size of fewer then 50 observations. Preference is given to a sample of 100 or large cases. However, as observed by Conway & Huffcutt (2003), the adequate sample size is a relatively complex issue. Researchers have their own reasons while deciding the size of samples. Nevertheless, it is agreed that small sample size (n), particularly when it is accompanied with over-extraction, is likely to lead to a low saturation (loading of items /variables) and poor identification of factors/component. In such an event the sample structure /pattern is not likely to represent the population structure/pattern **(Merenda 1997)**. In contrast to these aspects, Hogarty et al. (2005) have found that when communalities are high, sample size tended to have less influence on the quality of factor solutions then when communalities are low. But, most of the authors do not provide any information on the communalities associated with the measures; therefore, one is compelled to make judgments on the appropriateness of sample size used for EFA. In this regard *n:p ratio* (ratio between number of cases and number of measures/items/variables) may help to determine the suitability. Even, on the size of n:p ratio difference of opinion exist. Merenda (1997) quotes three versions: (i) 20:1 for PCA when p is reasonably small compared to n, (ii) 10:1, and (iii) 3:1 as a minimum when p is rather large for a PCA used for construction of an instrument.

Number of Retained Factors: In EFA the number of factors retained can be one or more than one depending fulfillment of one or the combination of criteria that I will discuss below. However, it is pertinent to note that a good factorial structure is one that consists of good individual factors/components. A good factor is that that contributes well in total variance (about total variance contribution, I will talk later). SPSS, by default, retains factors with *eigenvalues* ≥ 1.0 (equal are greater than one). This criterion is also called Kaiser Criterion and latent root criterion (Hair et al., (2006). Eigenvalues explain the amount of variance contributed by factor to the total variance and can be calculated by squaring the loadings on a factor and summing them up. SPSS uses this rule no matter which method is used for factor extraction. Russell (2002) suggests that Kaiser Criterion *should only* be used when PCA with communalities fixed at 1.0 is chosen for factor extraction. Despite its inaccurate results, this rule is most often used as it is provided conveniently in the statistical softwares like SPSS, SAS and BMDP. Sufficient research shows that it tends to generate too many factors, i.e., it leads to over-factorization **(Russell, 2002; Merenda, 1997; Conway & Huffcutt, 2003; Fabrigar et al., 1999).** Russell (2002) informs that his review has found that 52% of the studies mentioning the factor extraction criteria have used eigenvalues ≥ 1.0 rule. Nearly 60% of these studies have used it correctly, i.e. in case of PCA, while the remaining 40% used it inconsistently with the required factor extracting procedure. Another widely used criterion for extracting good factor is with the help of *scree test,* which is used to extract optimum number of factors. The criterion suggests that factor extraction should be stopped at the point at which the "elbow" occurs in the plot of successive eigenvalues. This criterion is criticized for its subjectivity–a plot of eigenvalues may emerge without any break in its linearity ('elbowness') or more than one 'elbows', both clear and vague, may emerge. The third important rule that is applied in factor extraction is the percentage of variance criterion. According to Hair et al. (2006), in social science research it is common to extract factors that contribute 60% (or even less) in total variance. Other criteria are parallel analysis, *a priori* theory, sample homogeneity-heterogeneity criteria, and Minimum Average Partial (MAP). Most of the reviewers of factor analysis suggest that a combination of the criterion may be helpful in extracting the appropriate number of factors **(Fabrigar et al., 1999; Conway & Huffcutt, 2003).**

Variable–Factor Ratio: Russell (2002) suggests that a factor model can be well explained when the factors extracted are loaded with an appropriate number of variables/measures. The measures help in identification of a factor that in turn operationalize a concept/construct. He recommends that at least three items/measures are required for identification of a factor. More items loaded on a factor leads to over-identification. However, Fabrigar et al. (1999) recommend that four or more items per factor lead to adequate identification for the factor extracted. In practice, however it is found that researchers extract factors with less number of items are extracted. Russell (2002) informs that in his reviews 25% of EFA reported in *Personality and Social Psychology Bulletin (PSPB)* included three or fewer items per factors. Another relevant question is to know how a measure belongs to a factor? Merenda (1997) founds from general literature in social sciences that .09(0.30) is the minimum value of a squared loading commonly accepted a measure as belonged to a factor. According to him this is not a convention, but a practice–and an ineffective one.

Factor Rotation: Factor rotation is carried out in EFA in order to improve the interpretability of the results. Hair et al. (2006) indicate three major steps in interpretation of results: estimating the initial (unrotated) factor matrix containing *factor loadings**, factor rotation for achieving a simple structure with a meaningful factor solution, and factor interpretation once the factor model is 're-specified'. The need for factor rotation emerges when more than one factor (and this occurs most often) are produced. Resultantly, the factor model will have more than one solution. Here, the critical task for the factor analyzer is to select a factor solution among several solutions having a *simple structure*†. This is done by rotating the factors in the multi-dimension space in order to achieve the objectives the most appropriated interpretation of the results. Researchers conduct two types of factor rotations: *orthogonal* and *oblique* rotations. Orthogonal rotation functions under an assumption, as explained by the Merenda (1997), that the unexplored underlying (or the accepted and generally accepted) model/concept is multidimentional and its dimensions (factors) are mutually orthogonal (statistically independent/unrelated) i.e. they are positioned at right angles to each other.

On the other hand the assumption under oblique rotation is that the factors/dimensions are related to each other (nonzero correlations). The correlations are either positive separated by an acute angle (angles between 90° and 180°), or are negative separated by an obtuse angle (angles less than 90°), that is they are separated with non-right angles. The most commonly used orthogonal rotation in the VARIMAX. Others are QUARTMAX, EQUIMAX, and PARSIMAX. In case of oblique rotations OBLIMIN (provided in SPSS) is the most preferred one. Other such rotations are PROMAX and ORTHOBLIQUE in SAS, and DQUART, DOBLIMIN, and ORTHOBLIQUE in BMDP. Regarding the preference for the type of rotation method authors differ in their recommendations. For example Conway & Huffcutt (2003), Russell (2002), and Fabrigar et al. (1999) recommend that with the help of oblique rotation such as PROMAX a factor can be interpreted in a meaningful way. On the other hand others (for example hair et al., 2006) suggest that there are no compelling reasons for favouring one method over the other. Nunnally (1978) once suggested that orthogonal rotation is more useful because of its simplicity and conceptual clarity. Since

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* *Factor loadings* are defined as correlation of each variable and the factor on which they are loaded and indicate degree of correspondence between them. They are the means of interpreting the role each variable plays in defining the factors produced (Hair et al., 2006).

† A *simple structure* means that each factor has a subset of variables with high loadings and rest with low loadings, and that each variable has high loadings on only some of the factors and low on the rest (Fabrigar et.al, 1999).

most of the statistical software packages have VARIMAX in their default position, this method is widely used. Fabrigar et al. (1999) have given three reasons for favoring an oblique method over an orthogonal rotation. They are (i) in psychology (in fact almost in all social science disciplines) majority of concepts are considered, and empirically found, to be correlated, therefore, the need for uncorrelated factor restriction is unwarranted; (ii) in case when the true underlying factor structure is based on correlated factors then a rotation requiring only orientation at 90° may produce a poorer simple structure, and (iii) oblique rotations provide more information on interpretability than orthogonal rotations, for example, estimates of the correlations amoung common factors. in practice, the factor analysts prefer VERIMAX and this has been found in review of EFA. For example Conway & Huffcutt (2003) report that in their review of 371 articles on organizational research 41% researchers were found using orthogonal rotation (38% using VARIMAX) and only 18% used oblique rotations. The remaining either did not rotate (extracting only one factor) (23%), or contained no information on the rotation (18%). Russell (2002) indicates another common error in the process of factor interpretation stating that the researchers do not report the variance explained by the factors before and after rotation.

The above overview provides a structure for study of the current practices in use of EFA in leadership studies, which follows the next.

Methodology of the Current Study

Sample: The above review provides sufficient grounds and evidences that the researches in organizational context using EFA are likely to confront intricacies in deciding possibly options and criteria for application of the analysis. Furthermore, there choices possibly may lead to dubious interpretation of concept explored. To my knowledge, after a brief search of exiting literature, no endeavor is so far made specifically to examine the use and misuse of EFA leadership research. In broader frameworks Lowe & Gardner (2000) and Podsakoff et al. (2003) have reviewed the literature published in *Leadership Quarterly* during 1990-1999 and 1990-2002, respectively. Both the reviews have selected the year 1990 being the first year of *LQ*, which is the only general specifically dedicated to leadership research. The former have a review of all the articles published in *LQ* during the period focusing on main themes and issues concerning the topic, including the analytical methods used in 118 empirical papers with a brief mention of the use of EFA. The second review capture the task of examining use of measurement models (both exploratory and confirmatory in nature) in leadership studies in three leading journals: *LQ*, *Journal of Applied Psychology*, and *Academy of Management Journal*. Logically, the current study is designed first to explore the articles published in *LQ* after 2002 in which authors have used EFA. In this way 10 articles were identified and included in the review. Since the author of the current study was required to review at least 31 articles, the reminders were selected randomly from electronic databases of research journals. Summary of the articles reviewed is shown in Table.

Table: 1 Summary of leadership articles used EFA with source of publication

Sr. No	Title of Journal	Years	Numbers of Studies	Percentage
1	LQ	2003-2007	10	32
2	LODJ	1997,2002,03,04	04	13
3	APJM	2001,03	02	06
4	AP-IR	2001	02	06
5	EJWOP	1997, 2003	02	06
6	Other Journals	1998. 2000-5	08	26
7	Others	1994, 1998, 2004	03	10
		Total	31	100

[1]One article each was selected from *International Journal of Cross Culture Management (IJCCM), International Journal of Human Resources Management (IJHRM),International Journal of organizational Theory and Behavior (IJOTB), Journal of Business and Psychology (JBP), Journal of Management Studies (JMS), Journal of Occupational Psychology (JOP), Management International Review (MIR),* and *Public Administration Review (PAR).*

[2]These include *Academy of Management Best Paper (AMBP) Proceedings, Asia Academy of Management (AAM) Proceedings,* and *Rensselar Working Papers in Economics (RWPE).*

Selection of above articles was done manually with care after viewing each article published in LQ during 2003-2007 and those available with the author in electronic or paper form. Thus, only those articles were included in which EFA is used with a significant role and explained comparatively well.

Coding: On the basis of findings on key issues that are critical in use of EFA coding was done on variables, including the measured construct, sample size, purpose of conducting EFA, factor extraction model used, decision criteria with number of factors retained, rotation method used, reporting information (correlation matrix, factor loading matrix, percentage of variance accounted for, Cornbach's alpha, and descriptive statistics), and n:p and p:f ratios. Due to time limitation the codes were, however, not processed for reliability and instead the patterns of Conway & Huffcutt (2003) were adapted with slight changes depending on the stuff that I had for the review.

Results of the Study:

The overall findings of current study are transformed in Annexure A in which coded data extracted from each article were summarized separately and placed in the relevant column. These details facilitated in generation of frequency table (Table-2), which summarizes the result for meaningful discussion and conclusions. The coded characteristics (variables) of EFA included in the table are: the leadership construct used, sample size, p:f ratio, n:p ratio, purpose of conducting EFA, factor extraction model, decision criteria for factor retention, and the rotation method used by the analyst. Furthermore, additional information that is considered as important and indicator of the quality of EFA, is included in the last section of Table-2. Two columns of the table show the number of analysis and the corresponding percentage of total number of analysis relevant to each variable under the specific category (code). A better analysis of these variables can be done through application of some statistical test (for example, chi square test) and other procedures for assessing the quality of EFA decisions-making* reflected in the data set of the current study, but due to limited scope of the assignment this aspect is not explored.

Table 2: Frequency of EFA variables (N=46)

Variables	n	%
Leadership construct explored		
– transformational leadership	13	28.26
– charismatic leadership	05	10.87
– vision and charisma	02	04.35
– country specific leadership profile	06	13.04
– leaders' skills	01	02.17
– leadership outcomes	14	30.43
– other leadership behaviors	05	10.87

*The methods adopted by Conway & Huffcutt (2003) and Fabrigar et al. (1999) can be suitable to follow in this regard.

	Sample size		
–	1-100	04	08.70
–	101-200	11	23.91
–	201-300	09	19.57
–	301-400	06	13.04
–	401-500	06	13.04
–	501-600	06	13.04
–	≥ 601	04	08.70
	Ratio of number of variables to number of factors (p:f ratio)		
–	≤ 3:1	00	00.00
–	3:1	02	04.35
–	4:1 – 6:1	22	48.83
–	7:1 – 9:1	06	13.04
–	≥ 10:1	05	10.87
–	No information	11	23.91
	Purpose of conducting EFA		
–	New measurement development	23	50.00
–	Evaluation of an existing measure	22	47.83
–	Mix of both	01	02.17
–	Hypothesis testing	13	28.26
–	Item reduction	02	04.35
	Factor extraction model used		
–	Principal component analysis (PCA)	34	73.91
–	Maximum likelihood	05	10.87
–	Principal axis factoring	01	02.17
–	Common FA	01	02.17
–	EFA (unspecified)	01	02.17
–	No information	04	08.70
	Decision criteria for factor retention		
–	Eigen value ≥ 1.0 (Kaiser criterion) (a)	30	62.22
–	Maximum percentage variance accounted for	01	02.17
–	Scree plot test (b)	09	19.57
–	Discontinuity test	02	04.35

– Factor loading criterion (e.g >0.4)	14	30.43
– Factor interpretability clarity	03	06.52
– No information	07	15.22
- Single criterion	20	43.48
- Multiple criteria	19	41.30
Rotation method used		
– VARIMAX	34	73.91
– OBLIMIN	02	04.35
– Oblique (unspecified)	01	02.17
– No information	09	19.57
Other information reported		
– Factor loading matrix	41	89.13
– Correlation matrix	06	13.04
– Percentage of variance accounted for	34	73.91
– Reliability estimates (e.g Cornbach's alpha)	09	19.57
– Descriptive statistics	03	06.52

(a) = including 13 cases where combined with other criteria
(b) = all combined with Kaiser criterion

Thirty research articles explored under this study contain in all 46 EFAs for examining different constructs related to leadership process. The first section of Table 2 shows such constructs. It is found that the attention of the majority of researchers has been looking at leadership out comes (34.43%), transformational leadership (28.26%), cross-cultural leadership (13.04%), and charismatic leadership (10.87%). This pattern is not different from the actual current trends in leadership studies (see Lowe & Gardner, 2000 in this regard). Therefore, one may argue that the quality of analytical techniques used (for example the use of EFA) can be one of the critical determinants for the legitimacy of leadership science as an independent field of study. Uncovering poor qualities in analytical applications may lead to serious suspicions about the leadership theories.

The next section of Table 2 gives a picture of the distribution of the sample sizes across the articles. Almost one-third of the total 46 analyses (32.61%) are based on data collected from samples that are modest to small (200 and less). Large example sizes (more than 200) are used for two-third of the analysis. The finding is encouraging as a significant number of EPA is based on sample sizes that are expectable for quality analysis. However, a reasonable number of EFA is done with data collected from samples too small to be considered as true representative of the population.

The section of Table 2 reflecting the distribution of p:f ratio reveals that in almost half (48.83%) of the analysis adequate variable to factor ratio (4:1 to 6:1) is used. This result is positive compared to the findings of Fabrigar et al. (1999) and Conway & Huffcutt (2003). The present review found that only 4.35% of the analysis have used inadequate p:f ratio (3:1) and in none of the analysis below 3:1 p:f ratio is used.

The fourth section of the table shows that a sizable number of analysis has relied on a poor n:p ratio of 9:1 and less (30.43%). Another discouraging aspect of the result is that, like p:f ratio, almost 24% of EFAs in these articles didn't give the required information for determining p:f ratio. So, less than 50% of EFAs conducted in this sample of leadership studies appropriately based on this important decision criterion.

The next section of Table 2 explains one of the principle decision criteria for quality EFA, viz. the purpose of conducting EFA. Represent study found that the leadership scholars used EFA equally for both the latent construct exploration (new measure development) and data reduction (evaluation of an existing measure). In frequency use it is 50.00% and 48.83%, respectively. Furthermore, in 28.26% of the analysis, along with developing a new measure or evaluating an existing measure, EFA is applied for hypothesis-testing.

The sixth section of Table 2 elucidates another basic decision criterion, viz. factor extraction model used. Interestingly, and contrary to the results of some other EFA reviews in organizational research and psychology (Conway & Huffcutt 2003, Russell 2002, Fabrigar et al. 1999), the current study found that the predominant majority of leadership studies (73.91%) have preferred to use PCA, which is available as a default setting in the statistical software packages like SPSS. Amongst the analysts only 10.87% were found had used maximum likelihood criterion, and the use of common FA and principal axis factoring is seen to be very uncommon (only 2.17% each).

The subsequent section of Table 2 shows the distribution of decision criteria for factor retention. This procedure is considered yet another principle decision criterion in quality use of EFA (Conway &Huffcutt, 2003). The result show that Kaiser criterion (eigenvalue ≥ 1.0) persists to be popular in leadership research as found in other areas (for example, Conway & Huffcutt, 2003). Even worst, the preference in leadership studies for this criterion is significantly high (62.22%) compared to 17.8% found in organizational research by Conway & Huffcutt (2003). The other two most preferred criteria in leadership research are factorloading criterion of > 0.4 (30.43%) and scree plot test (19.57%). However, in 41.30% of the analysis multiple criteria are found to be used compared to 43.48% of analysis based on the use of single criterion.

The next section of Table 2 indicates the distribution of factor rotation methods used in EFA of leadership constructs. The results are discouraging as almost three-fourth of the analysts has used VARIMAX, a method not considered as a better option for factor rotation **(Russell, 2002)**. The present study found that in only one out of 46 analyses an oblique rotation method is used (2.17%).

The last session of Table 2 demonstrates some additional indicators of quality EFA used in the sample of analyses reviewed by the current author. It is encouraging to note that a good majority of authors have provided the factorloading matrix (89.13%), however, providing correlation matrix is found to be infrequent (13.04%). Furthermore, predominate majority of factor analyses didn't estimate reliability coefficient and only 19.57% of the analyses contained this information. Regarding submitting the percentage variance accounted for; the results of current study are encouraging. About 74% of the analysts have shown this indicator in their results.

Generally, the above findings portray a gloomy picture of the use of EFA in leadership research. More specifically, the researchers were found widely using default setting of the available statistical software (e.g eigenvalue ≥ 1.0 criterion, VARIMAX factor rotation methods, and PCA has factor rotation model). Unfortunately, these default setting options are found to be not ideal options in factor analysis **(Conway & Huffcutt, 2003)**. Nonetheless, the leadership scholars were found to be practicing some good traditions in their EFA. For example, compared to the reviews of Conway & Huffcutt (2003) and Fabrigar et al. (1999) in organizational research and psychology, the leadership researchers submit sufficient information, are comparatively clearer on selecting EFA while having the research purpose in mind, etc.

Guidelines for future research and conclusions

The results of this review are consistent with the general belief that EFA is used with negligence and its quality gets poorer when used supplementary for preparation and refinement of data for further statistical analyses. It is found that the choices of the decision alternatives are not optimal and are guided by convenience and tradition, rather than reason and justification. Fabrigar et al. (1999) have identified three causes for poor use of EFA by researchers: (i) lack of required knowledge and training, (ii) compulsion to follow traditions and practices of past works a reasonable number of which is unsound, and (iii) convenience provided by the statistical softwares having inappropriate EFA procedural options has default settings. Same reasons can be found for poor use of procedures in the analyses reviewed under the current study.

Based on the above it is suggested that the causes of poor EFA be removed or at least minimized, by inclusion of EFA with breadth and depth in the research methodology courses. Additionally, more attention by reviewers of journal articles are needed on the issues discussed in the present paper and their encouragement is required in innovative ways and patterns for different combinations of EFA procedures. Furthermore, further review is needed covering a larger sample of studied to seek out the weaker aspects of EFA in leadership literature. The statistical software producing companies should seek advices from the academia with latest knowledge on EFA so that the new version of their products does not carry inappropriate default options.

The major leadership constructs developed and espoused can only be legitimized and relied upon when are statistically processed and refined through quality analytical tools and procedures.**(Annexture A)**

Annexure A

Construct used	Author(s)	Sample size	Purpose of conducting EFA	Factor Extraction model Used	Decision Criteria for number of factors Retained	Rotation Method	Reporting information	P:f ratio	n:p Ratio
Vision	Sosik & Dinger (2007) *LQ*	183	New measure development	PCA	Eigenvalue≥1.0 (2-factor solution)	VARIMAX	correlation matrix descriptive statistics % of Variance	12:2 (6:1)	183:12 (15:1)
i) Transformational leadership (TL)	Nemanich & Keller (2007) *LQ*	447	Evaluation of an existing Measure		Maximum percentage of Variance accounted for (55%) (1-factor solution)		correlation Matrix % of Variance Cornbach's Alpha	20:1 (20:1)	447:20 (22:1)
ii) Support creative Thinking		447	New measure development	PCA			item loadings Cornbach's Alpha	4:1 (4:1)	447:4 (112:1)
iii) Acquisition Acceptance		447	mix of new & existing measure development	PCA			item loadings Cornbach's Alpha	4:1 (4:1)	447:4 (112:1)
i) Behavioral	Carmeli &	116	Evaluation	PCA	Eigenvalue≥1.0	VARIMAX	item loadings	9:1	13:1

Integration	Schaubroeck (2006) *LQ*		of an existing Measure		(1-factor solution)		% of Variance		
ii) Decision quality		116	New measure development	PCA	Eigenvalue≥1.0 (1-factor solution)	VARIMAX	item loadings % of Variance	7:1	17:1
iii) Organizational Decline		116	New measure development	PCA	Eigenvalue≥1.0 (1-factor solution)	VARIMAX	item loadings % of Variance	5:1	23:1
iv) Industry Conditions		116	New measure development	PCA	Eigenvalue≥1.0 (1-factor solution)	VARIMAX	item loadings % of Variance	3:1	39:1
v) Organizational characteristics		116	New measure development	PCA	Eigenvalue≥1.0 (1-factor solution)	VARIMAX	item loadings % of Variance	2:1	58:1
i) CEO leadership Behaviour	Tsui et al. (2006) *LQ*	542	Evaluation of an existing Measure	PCA	Eigenvalue≥1.0 (5-factor solution)	VARIMAX	item loadings % of Variance	21:5 (4:1)	542:21 (26:1)
ii) Organizational Culture		542	Evaluation of an existing Measure	PCA	Eigenvalue≥1.0 (5-factor solution)	VARIMAX	item loadings % of Variance	24:5 (5:1)	542:24 (23:1)
i) Reactions to Change	Tyler & Cremer (2005)*LQ*	540	New measure development	Maximum Likelihood	(2-factor solution)	VARIMAX	item loadings correlation Matrix Descriptive		

							statistics Variance		
ii) Merger implementation		540	New measure development	Maximum Likelihood	(2-factor solution)	VARIMAX	item loadings correlation Matrix Descriptive statistics Variance		
i) Charismatic Leadership	Sosik (2005) *LQ*	218	Evaluation of an existing Measure	PCA	Eigenvalue≥1.0 (1-factor solution)	VARIMAX		12:1	218:12 (18:1)
ii) Charismatic Leadership Outcomes		218	Evaluation of an existing Measure	PCA	Eigenvalue≥1.0 (1-factor solution)	VARIMAX		9:1	218:9 (24:1)
iii) Social Desirability		218	Evaluation of an existing Measure	PCA	Eigenvalue≥1.0 (3-factor solution)	VARIMAX		13:3 (4:1)	218:13 (17:1)
Leader's political Skills	Douglas & Ameter (2004) *LQ*	141	Evaluation of an existing measure with modification Hypothesis testing Item reduction	PCA	Eigenvalue≥1.0 (2-factor solution)	VARIMAX	item loadings % of Variance Coefficient Alpha reliability	18:2 (9:1)	141:18 (8:1)
i) Influence-	Krause	399	New	PCA	Eigenvalue≥1.0	VARIMAX	item loadings	18:5	399:18

based Leadership	(2004) *LQ*		measure development		Scree plot (5-factor solution)		% of Variance Coefficient Alpha reliability	(4:1)	(22:1)
ii) Innovative Behaviour		399	New measure development	PCA	Eigenvalue≥1.0 Scree plot (5-factor solution)	VARIMAX	item loadings % of Variance Coefficient Alpha reliability	22:5 (4:1)	399:22 (18:1)
i) Transformational Leadership behavior	Xen & Pelled (2003) *LQ*	72	Evaluation of an existing measure Hypothesis testing	PCA	Eigenvalue≥1.0 (2-factor solution)	VARIMAX	item loadings % of Variance Coefficient Alpha reliability	7:2 (4:1)	72:7 (10:1)
ii) Vertical conflict		72	Evaluation of an existing measure Hypothesis testing	PCA	Eigenvalue≥1.0 (2-factor solution)	VARIMAX	item loadings % of Variance Coefficient Alpha reliability	8:2 (4:1)	72:8 (9:1)

Transformational leadership	Shahin & Wright (2004) *LODJ*	243	Evaluation of an existing measure New measure development	PCA	ITTC for variable reduction (r>0.4) Eigenvalue≥1.0 (7-factor solution)		item loadings % of Variance Labeling	44:10 (4:1)	243:44 (6:1)
i) Transformational leadership	Block (2003) *LODJ*	782	Evaluation of an existing measure New measure development	PCA	Eigenvalue≥1.0 Discontinuity test (3-factor solution)	VARIMAX	item loadings % of variance correlation matrix Labeling		
ii) Organizational Culture		782	Evaluation of an existing measure New measure development	PCA	Eigenvalue≥1.0 Discontinuity test (3-factor solution)	VARIMAX	item loadings % of variance correlation matrix Labeling		
Leadership Development	Tirmizi (2002) *LODJ*	113	Preliminary evaluation of a new measure		Factor loading > 0.4 (1-factor solution)		item loadings % of Variance Labeling	22:5 (4:1)	113:22 (5:1)
Transformational leadership	Lim (1997) *LODJ*	85	Evaluation of an existing measure	CFA	Eigenvalue≥1.0 (6-factor solution)		item loadings % of variance correlation matrix Labeling	28:7 (4:1)	85:28 (3:1)

i) Charisma & Vision	Khatri, Ng & Lee (2001) *APJM*	455	Hypothesis testing	PCA	Dropping factors with 1 or 2 items (4-factor solution)	VARIMAX	Factor Loadings		
ii) Leadership Outcomes		455	Hypothesis testing	PCA	(4-factor solution)	VARIMAX	Factor Loadings		
i) Leadership in Australia	Trenor-Roberts, Ashkansay & Kennedy (2203) *APJM*	344	New measure development Hypothesis testing	Maximum Likelihood	Factor loading > 0.4 for variables Scree plot for factor extraction (4-factor solution)	VARIMAX	Factor Loadings % of Variance Labeling	21:4 (5:1)	344:21 (16:1)
ii) Leadership in New Zealand		184	New measure development Hypothesis testing	Maximum Likelihood	Factor loading > 0.4 for variables Scree plot for factor extraction (4-factor solution)	VARIMAX	Factor Loadings % of Variance Labeling	21:4 (5:1)	184:21 (9:1)
Leadership	Dastmal-Chian, Javaidan & Alam (2001) *AP*	300	New measure development Hypothesis testing		Eigenvalue≥1.0 (7-factor solution)	VARIMAX	Factor Loadings % of Variance Labeling	135:7 (19:1)	300:135 (2:1)
Leadership	Paşa, Kabasakal &	92	New measure development		Factor loading > 0.5 (4-factor solution)	VARIMAX	Factor Loadings % of	23:4 (6:1)	92:23 (4:1)

	Bodur (2001) *AP*		Hypothesis testing				Variance Labeling Cornbach's alpha factor mean		
Transformational leadership	Lievens, Van Geit & Coetsier (1997) *EJWOP*	189	New measure development Hypothesis testing	Principal Axis Factoring (5-factor solution)	Factor loading > 0.3 for variables Eigenvalue≥1.0	VARIMAX Labeling	Factor Loadings % of variance	40:7 (6:1)	189:40 (5:1)
Transformational leadership	Hetland, Sandal (2003) *ELWOP*	177	New measure development	PCA	Eigenvalue≥1.0 Scree plot (3-factor solution)	VARIMAX	Factor Loadings % of variance		
Leadership	Ogbonna & Haris (2000) *IJHRM*	342	Evaluation of an existing measure New measure development	PCA	Concept Interpretability & Clarity Eigenvalue≥1.0 (3-factor solution) Loading>0.3 for Item selection	VARIMAX	Factor Loadings % of variance Labeling		
Transformational leadership	Carless, Wearing & Mann (2000)	1,432	New measure development	PCA Maximum Likelihood	Eigenvalue≥ 1.0 Scree plot (1-factor solution)		Factor Loadings % of variance		

	JBP								
Transformational leadership	Alimo-Metcalfe & Alban-Metcalfe (2001) *JOOP*	811	New measure development	PCA 1st order 2nd order	Scree plot (9-factor solution) Eigenvalue≥1.0 (2-factor solution)	OBLIMIN OBLIMIN	Factor Loadings % of variance Labeling	76:11 (7:1) 9:2 (5:1)	811:76 (11:1) 811:9 (90:1)
Transformational leadership by Organizational level	Godwin & Neck (1998) *IJOTB*	477	Hypothesis testing	PCA	(4-factor solution)	VARIMAX	Factor Loadings % of variance Cornbach's Alpha	12:4 (3:1)	477:12 (40:1)
i) Perceived Charismatic leadership profile	Javidan & Waldman (2003) *PAR*	204	Data reduction Hypothesis testing	PCA	Eigenvalue≥1.0 (3-factor solution) Loading>0.45 for Item retention	VARIMAX	Item Loadings % of variance Cornbach's Alpha Labeling	37:6 (6:1)	204:37 (6:1)
ii) Motivational effects of Charismatic Leadership		204	New measure development	PCA	Eigenvalue≥1.0 (3-factor solution) Loading>0.45 for Item retention	VARIMAX	Item Loadings % of variance Cornbach's alpha Labeling		

Transformational leadership	Singh & Krishnan (2007) *IJCCM*	379	New measure development	EFA (in fact PCA)	Eigenvalue≥1.0 scree plot Number of item per factor≥2 (6-factor solution) Loading>0.3 for Item retention	VARIMAX	Item Loadings % of variance Cornbach's alpha Labeling	51:9 (6:1)	379:51 (7:1)
Charismatic leadership profile	Javidan & Carl (2005) *MIR*	554	Evaluation of a new measure Hypothesis testing	EFA	Eigenvalue≥1.0 Multiple factor loading>0.4 for (8-factor solution) Loading>0.45 for Item retention	OBLIMIN	Factor Loadings % of variance	123.8 (15:1)	554:123 (5:1)
Charismatic leadership profile	Javidan & Carl (2004) *JMS*	178	Evaluation of a new measure	EFA	Eigenvalue≥1.0 Multiple factor loading>0.4 for (8-factor solution) Loading>0.45 for Item retention	VARIMAX	Item Loadings % of variance Cornbach's alpha	37:7 (5:1)	178:37 (5:1)
Transformational leadership	Krishnan & Srinivas (1998) *AAM proceedings*	337	Evaluation of an existing measure	Common FA	Eigenvalue≥1.0 scree plot (6-factor solution) Loading>0.3 for	Oblique	Factor Loadings Labeling	41:7 (6:1)	337:41 (8:1)

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					Item retention				
i) CEO charisma	Agle & Sonnenfeld (1994) *AMBP*	250	Evaluation of an existing measure	PCA	(5-factor solution)		Factor Loadings Labeling	48:5 (10:1)	250:48 (5:1)
ii) CEO performance	*Proceedings*	123	Evaluation of a new measure	PCA	(2-factor solution)		Factor Loadings Labeling		
i) Transformational Leadership	Waldman, Siegel & Javaidan (2004) *RWPE*	234	Evaluation of an existing measure	PCA	Eigenvalue≥1.0 (2-factor solution)	VARIMAX	Factor Loadings % of variance Cornbach's alpha	13:2 (7:1)	234:13 (11:1)
ii) Corporate social Responsibility		537	New measure development	PCA	Eigenvalue≥1.0 (2-factor solution)	VARIMAX	Factor Loadings % of variance Cornbach's alpha	8:3 (3:1)	537:8 (67:1)

REFERENCES

References with an asterisk indicates data of studies included in this paper

*Agle, B. R., & Sonnenfeld, J. A. (1994). Charismatic chief executive officer: Are they more effective?

An empirical test of charismatic leadership theory. *Academy of management best paper proceedings*, 2-6.

*Alimo-Metcalfe, B., & Alban-Metcalfe, R. J. (2001). The development of a new transformational leadership questionnaire. *Journal of Occupational and Organizational Psychology*, 74, 1-27.

Berger, P. L (1967). *The Sacred Canopy: Elements of a Sociological Theory of Religion*. NY: Anchor Books.

*Block, L. (2003). The leadership-culture connection: An exploratory investigation. *The Leadership & Organiztional Development Journal*, 24(6), 318-334.

*Carless, S. A., Wearing, A. J., & Mann, L. (2000). A short measures of transformational leadership. *Journal of Business and Psychology*, 14(3), 389-405.

*Carmeli A. & Schaubroeck, J. (2006). Top management team behavioral integration, decision quality, and organizational decline. *The Leadership Quarterly*, 17, 441-453.

Conway, J. M., & Huffcutt, A. I. (2003). A review and evaluation of exploratory factor analysis practices in organizational research. *Organizational Research Methods*, 6(2), 147-168.

*Dastmalchian, A., Javaidan, M., & Kamran, A. (2001). Effective leadership and culture in Iran: An empirical study. *Applied Psychology: An International Review*, 50(4), 532-558.

*Dougles, C., & Ammeter, A. P. (2004). An examination of leader political skill and its effect on ratings of leader effectiveness. *The Leadership Quarterly*, 15, 537-550.

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1990). Evaluating the use of exploratory factor analysis in psychology research. *Psychological Methods*, 4(3), 272-299.

*Godwin, J. L., & Neck, C. P. (1998). Desired transformational behaviors in religious organization: Analysis by hierarchical organizational level *International Journal of Organization Theory & Behavior*, 1(2), 163-179.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W.C. (2006). *Multivariate Data Analysis (Sixth Edition)*. NJ: Prentice Hall.

*Hetland, H., & Sandal, G. M. (2003). Transformational leadership in Norway: outcomes and personality correlates. *European Journal of Work and Organizational Psychology*, 12(2), 147-170.

Hogarty, K.Y., Hines, C. V., Kromrey, J. D., Ferron, J. M., & Mumford, K. R. (2005). The quality of factor solutions in exploratory factor analysis: The influence of sample size, communality, and overdetermination. *Educational and Psychological Measurement*, 65(2), 202-226.

*Javidan, M., & Waldman, D. A. (2003). Exploring charismatic leadership in the public sector: Measurement and consequences. *Public Administration Review*, 63(2), 229-242.

*Javidan, M., & Carl, D. E. (2004). East meets West: A cross-cultural comparison of charismatic leadership among Canadian and Iranian executives. *Journal of Management studies,* 41(4), 665-691.

*Javidan, M., & Carl, D. E. (2005). A leadership across culture: A study of Canadian and Taiwanese executives. *Management International Review,* 45(1), 23-44.

*Khatri, N., Ng, H. A., & Lee, T. H. (2001). The distinction between charisma and vision: An empirical study. *Asia Pacific Journal of Management,* 18, 373-393.

*Krause, D. E. (2004). Influenced-based leadership as a determinant of the inclination to innovate and innovation-related behaviors. An empirical investigation. *The Leadership Quarterly,* 15, 79-102.

*Krishnan, V. R., & Srinivas, E. S. (1998). *Transactional and Transformational Leadership: An Examination of Bass's (1985) conceptualization in the Indian Context.* Paper presented at the Asia Academy of Management Meeting, Hong Kong.

*Lievens, F., Geit, P. V., & Coetsier, P. (1997). Identification of transformational leadership qualities: An examination of potential biases. *European Journal of Work and Organizational Psychology,* 6(4), 415-430.

*Lim, B. (1997). Transformational leadership in the UK management culture. *The Leadership & Organizational Development Journal,* 18(6), 283-289.

Lowe, K. B., & Gardner, W. L. (2000). Ten Years of The Leadership Quarterly: Contributions and challenges for the future. *The Leadership Quarterly,* 11(4), 459-514.

Nunnally, J. C. (1978). *Psychometric Theory (Second Edition).* NY: McGraw-Hill.

Merenda, P. F. (1997). Methods, plainly speaking. A guide to the proper use of factor analysis in the conduct and reporting of research: Pitfalls to avoid. *Measurement and Evaluation in Counseling and Development,* 30, 156-164.

*Nemanich, L. A., & Keller, R. T. (2007). Transformational leadership in an acquisition: a field study of employees. *The Leadership Quarterly,* 18, 49-68.

*Ogbonna, E., & Harris, L. C. (2000). Leadership style, organizational culture and performance: Empirical evidence from UK companies. *International journal of Human Resource Management,* 11(4), 766-788.

*Pasa, S. F., Kabasakal, H., & Bodur, M. (2001). Society, organizations and leadership in Turkey. *Applied Psychology: An International Review,* 50(40), 559-589.

Podsakoff, P. M., Mac Kenzie, S. B, Podsakoff, N. P.,& Lee, J. Y. (2003). The mismeasure of management and its implications for leadership research. *The Leadership Quarterly,* 14, 615-656.

Proverbs. (2007). King Games Bible. Retrieved 28-09-2007, from http://bible.cc/proverbs/25-2.htm

Russell, D. W. (2002). In search of underlying dimensions: The use (and abuse) of factor analysis in personality and Social Psychology Bulletin *Personality and Social Psychology Bulletin* 28(12), 1629-1646.

*Shahin, A. I., & Wright, P. L. (2004). Leadership in the context of culture: An Egyptian perspective. *The Leadership and Organizational Development Journal,* 25(6), 499-511.

*Singh, N., & Krishnan, V. R. (2007). Transformational leadership in India: Developing and validating a new scale using grounded theory approach. *International Journal of Cross-cultural Management,* 7(2), 219-236.

*Sosik, J. J. (2005). The role of personal values in the charismatic leadership of corporate managers: A model of preliminary field study. *The Leadership Quarterly,* 16, 221-244.

*Sosik, J. J. & Dinger, S. L. (2007). Relationship between leadership style and vision content: The moderating role of need for social approval, self-monitoring, and need for social power. *The Leadership Quarterly,* 18, 134-153.

Stewart, D. W. (1981). The application and misapplication of factor analysis in marketing research. *Journal of Marketing Research,* 18(1), 51-62.

*Tirmizi, S. A. (2002). The 6-L framework: A model for leadership research and development. *The Leadership and Organizational Development Journal,* 23(5), 269-279.

*Trevor-Roberts, E., Ashkanasy, N. M., & Kennedy, J. C. (2003). The Egalitarian leader. A comparison of leadership in Australia and New Zealand. *Asia Pacific Journal of Management,* 20,517-540.

*Tsui, A. S., Zhang, Z., Wang, H., Xin, K. R., & Wu, J.B. (2006). Unpacking the relationship between CEP leadership behavior and organizational culture. *The Leadership Quarterly*, 17, 113-137.

*Tyler, T. R., & De Cremer, D. (2005). Process-based leadership: fair procedures and reactions to organizational change. *The Leadership Quarterly*, 16, 529-545.

*Waldman, D. A., Siegal, D. S., & Javidan, M. (2004). *CEO transformational leadership, and corporate social responsibility* (working paper No. 0415). NY: Rensselaer Polytechnic Institute.

*Xin, K. R., & Pelled, L. H. (2003). Supervision-subordinate conflict and perceptions of leadership behavior: a field study. *The Leadership Quarterly*, 14,25-40.