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An Empirical Examination of A Four-Factor Theory of Leadership Using Smallest Space Analysis[1]

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The recent integrative four-factor theory of leadership proposed by Bowers and Seashore (1966) is studied with regard to the empirical clustering of variables typically used to measure the factors. Thirteen Supervisory Leadership questionnaire variables and eleven Work Group Leadership variables are examined for geometric proximity or clustering using Smallest Space Analysis. Data obtained from three different industrial organizations, a petroleum refinery, an insurance company, and a plastics producer are examined separately, with the refinery data reviewed in considerable detail. The results suggest that the four factors originally postulated exist as separately measurable entities with slight exceptions. Some modifications of the original factors seem necessary based on consistent differences across the three sites examined. Several differences among the three sites are also noted.

Over a period of many years much research and theoretical speculation has accrued in the area of organizational leadership. It is unfortunate, however, that attempts at integration among the goals of the various investigators have not kept pace.

Among the lately emerging efforts in this integrative direction is a four-factor theory presented by Bowers and Seashore (1966). This effort was an attempt to bring together much of the work done at the University of Michigan and at Ohio State University. The single description of this theory appears in the reference cited above, and was cast in the mode of a theoretical integrative model of leadership tested as a predictor of organization's effectiveness. These results were tested via a similar study using similar model and approach (Butterfield, 1969). In both cases, a model of leadership effectiveness was used a priori in a study of leadership effectiveness in organizations.

[1] The data for this study were collected in studies undertaken by the Center for Research on the Utilization of Scientific Knowledge, in the Institute for Social Research of the University of Michigan. Data analyses and preparation of this manuscript were supported in part by The Office of Naval Research Grant N000 14-67-A-0181 for research on organizational behavior. The author gratefully acknowledges the help and suggestions provided by Frank M. Andrews throughout the course of this activity.

As noted by Butterfield (1969, p. 20), Bowers and Seashore present data regarding the interrelationships among the four leadership variables. While nowhere in their paper do they argue that the four factors are independent of one another, or in some sense empirically clustered, the implication is strong that there is some degree of separateness among the factors. Their use of the term "factors" is further suggestive of a certain degree of uniqueness for each dimension. Although this uniqueness seems reasonable, personal communication with Bowers revealed that the clustering of individual items believed to measure each of the four factors has not been systematically investigated.

This report describes the first such investigative attempt. The method used in the present instance is the Guttman–Lingoes Smallest Space Analysis (SSA) (Guttman, 1968; Lingoes, 1965, 1966; Lingoes, Roskam, & Guttman, 1969). This technique can be considered as analogous to obtaining oblique factors from a nonmetric factor analysis. The resulting clusters may be found to be somewhat interrelated, but considering the actual nature of the data in the present study, these clusters will probably more closely mirror the data than would the factors derived from the more familiar factor analytic technique with its more stringent metric assumptions.

Briefly, Bowers and Seashore postulate a four-factor theory of leadership applicable to the activities of group members, as well as to the activities of a formal, designated leader. They therefore delineate two parallel structures of leadership: *Supervisory Leadership* in the four dimensions of Support, Goal Emphasis, Work Facilitation, and Interaction Facilitation, and *Peer Leadership* in the same four dimensions. It is for this reason that the present analysis was undertaken separately for supervisory and peer leadership items.

RESEARCH METHOD

The Samples Used

The analysis was carried out using data obtained from a survey of organizational behavior in a large oil refinery. These data included the responses of all employees, managerial and nonmanagerial, combined by work group (defined as all the persons who report to the same supervisor; N of work groups = 325, Median n within work groups = 5.9). Also included are data obtained from all employees in two regions of a casualty insurance company (N of work groups = 99, Median n within groups = 7.5), and from the employees of a plastics producer (N of work groups = 54, Median n within groups = 6.2).

Tables of Pearson product–moment correlations for each of the two

basic subsets (supervisory leadership, and work group or peer leadership) for each of the three samples act as the basic data matrices which will be analyzed below by SSA. The scores of all n people in a work group were averaged into a $\bar{X}_n$ value, and the correlations were then based upon N such $\bar{X}_n$ values (where $N = 325$, 99, and 54).

The Measurement Instrument

The questionnaire variables used in the present study consisted of 24 questions written to measure separately the four supervisory leadership dimensions and the four work group leadership dimensions. These 24 items are listed in Table 1 under the leadership dimensions they were developed to measure.

The survey instrument used in the three samples in this study is a questionnaire for use with industrial organizations recently developed from similar questionnaires used by investigators at the University of Michigan's Institute for Social Research over a period of many years. This standard questionnaire was developed in an effort to include in one instrument all of the variables found to be reasonably good estimators of organizational behavior, and which have manifested association with organizational effectiveness. The present instrument includes over 100 separate items measuring respondent perceptions of overall organizational characteristics, work group characteristics, individual satisfactions, and supervisory and peer group leadership (these last two being the focus of the present study). The majority of the questionnaire items, including nearly all of the measures used in the present study, use a standard five-response alternative set, which is a modification of the Likert scale typical of those used in many organizational survey studies. That alternative set is as follows:

1. To a very little extent.
2. To a little extent.
3. To some extent.
4. To a great extent.
5. To a very great extent.

Item 13 in Table 1 does not use the standard response scale above, but a modification of it which refers to frequency rather than extent.

Several years experience with the present instrument (using it essentially unchanged in form and content as a longitudinal measure in some ten different companies) reveals that the measures used manifest reasonably unimodal and symmetric distributions. Although reliability data is limited, what has been obtained is encouraging. Reliabilities for the leadership variables used here are fairly good. Over a 6-week period, with

TABLE 1
QUESTIONNAIRE VARIABLES USED TO MEASURE SUPERVISORY AND PEER LEADERSHIP

I Supervisory leadership
"To what extent is (does) your supervisor. . . ."
A Support
1 . . .friendly and easy to approach?"
2 . . .attentive to what you say?"
3 . . .willing to listen to your problems?"
B Goal emphasis
4 . . .encourage people to give their best effort?"
5 . . .maintain high standard of performance?"
6 . . .set an example by working hard himself?"
C Work facilitation
7 . . .encourage subordinates to take action without waiting for detailed review and approval from him?"
8 . . .show you how to improve your performance?"
9 . . .provide the help you need so that you can schedule work ahead of time?"
10 . . .offer new ideas for solving job-related problems?"
D Interaction facilitation
11 . . .encourage the persons who work for him to work as a team?"
12 . . .encourage people who work for him to exchange opinions and ideas?"
13 "How often does your supervisor hold group meetings where he and the people who work for him can really discuss things together?"

II Peer leadership
"To what extent are (do) people in your work group. . . ."
A Support
14 . . .friendly and easy to approach?"
15 . . .pay attention to what you're saying?"
16 . . .willing to listen to your problems?"
B Goal emphasis
17 . . .encourage people to give their best effort?"
18 . . .maintain high standards of performance?"
C Work facilitation
19 . . .help you find ways to do a better job?"
20 . . .provide the help you need so that you can plan, organize and schedule work ahead of time?"
21 . . .offer new ideas for solving job-related problems?"
D Interaction facilitation
22 . . .encourage its people to work as a team?"
23 . . .emphasize a *team* goal?"
24 . . .exchange opinions and ideas?"

a sample of respondents not used in the present study, coefficients of test–retest reliability averaged about .78, while over 13 months, with a different respondent sample, coefficients averaged about .43. It is reasonable to assume that similar characteristics exist for the three respondent samples used in the present study.

In all cases the data were collected on company premises by representatives of the University of Michigan. Respondents were asked to attend a session where they completed the questionnaire on company time. They were advised that their responses would remain anonymous, and were asked to identify their immediate supervisor, but not themselves. Response rates vary for the individual companies, but ranged between 85 and 95%.

Method of Analysis: The Technique of SSA

Guttman and Lingoes have developed a nonmetric technique that enables one to define a Euclidean space in which one may determine the proximities or distances among a set of points as a function of the interrelationships among those points, and to graphically portray these distances.

SSA provides a graphic portrayal of the data matrix which will be simple yet faithful in the sense of monotonicity. Interest in the original data matrix is focused, for present purposes, on estimating the clustering of individual questionnaire items in creating indices of those items which will provide more reliable measures of supervisory and work group member leadership behavior. Increased reliability in this case is a function of combining similar, yet nonduplicating items.

The notion of distance used in SSA is as follows: Given that an item A has a higher correlation with a second item B than it has with a third C, then item A will be considered closer to item B than to item C.

$$\text{Distance } (A, B) \leq \text{Distance } (A, C) \text{ whenever } rAB \leq rAC. \qquad (1)$$

The task of the numerical calculations by the computer is to express the distance between questionnaire items in an actual Euclidean space. In fitting an N-dimensional Euclidean space (E^n) to condition (1) above, N numerical coordinates are calculated for each item. Let XA_i be the i-th coordinate for item A. Then the Euclidean distance (in N space) between any two questionnaire items A and B, included in the original matrix, is given by the formula

$$\text{Euclidean distance between } A\ (X_1, X_2, \ldots, X_n), \text{ an element in } E^n, \text{ and } B\ (X_1, X_2, \ldots, X_n), \text{ an element in } E^n, \text{ is } p\ (A, B) = \sqrt{\sum_{i=1}^{n} (XA_i - XB_i)^2}$$

From any given set of XA_i, distances can be calculated by this formula and then examined to see how well they satisfy the crucial monotonicity

TABLE 2

INTERCORRELATIONS AMONG THE 13 SUPERVISORY LEADERSHIP VARIABLES, PEARSON PRODUCT-MOMENT, REFINERY DATA, $N = 325$ GROUPS

(FOR VARIABLE LABELS, SEE TABLE 1)

	Variables												
Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.0												
2	0.78	1.0											
3	0.80	0.87	1.0										
4	0.49	0.54	0.56	1.0									
5	0.70	0.69	0.73	0.75	1.0								
6	0.65	0.67	0.70	0.49	0.68	1.0							
7	0.52	0.51	0.59	0.39	0.47	0.47	1.0						
8	0.50	0.58	0.59	0.61	0.63	0.61	0.40	1.0					
9	0.60	0.65	0.68	0.54	0.67	0.63	0.43	0.71	1.0				
10	0.57	0.57	0.62	0.58	0.69	0.65	0.39	0.70	0.75	1.0			
11	0.62	0.72	0.73	0.64	0.71	0.65	0.52	0.69	0.75	0.73	1.0		
12	0.65	0.66	0.69	0.61	0.68	0.63	0.54	0.67	0.68	0.72	0.79	1.0	
13	0.39	0.42	0.44	0.34	0.42	0.40	0.35	0.32	0.40	0.37	0.48	0.51	1.0

condition (1). For given N the Guttman–Lingoes computer routine expresses goodness of fit between XA_i and the plotted distances in E^n (N space) by a coefficient of alienation ($\sqrt{1 - r^2}$), where r is the correlation between the actual distances $p(A, B)$ and the plotted distance in E^n for

TABLE 3

INTERCORRELATIONS AMONG THE 13 SUPERVISORY LEADERSHIP VARIABLES, PEARSON PRODUCT-MOMENT, INSURANCE OFFICES DATA, $N = 99$ GROUPS

(FOR VARIABLE LABELS, SEE TABLE 1)

	Variables												
Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.0												
2	0.76	1.0											
3	0.85	0.88	1.0										
4	0.65	0.74	0.75	1.0									
5	0.61	0.72	0.73	0.86	1.0								
6	0.57	0.68	0.66	0.73	0.82	1.0							
7	0.64	0.48	0.51	0.47	0.40	0.36	1.0						
8	0.55	0.59	0.63	0.70	0.71	0.61	0.35	1.0					
9	0.62	0.63	0.66	0.71	0.74	0.60	0.49	0.73	1.0				
10	0.49	0.47	0.53	0.58	0.61	0.55	0.34	0.73	0.59	1.0			
11	0.62	0.62	0.65	0.81	0.74	0.61	0.42	0.62	0.71	0.60	1.0		
12	0.66	0.66	0.66	0.79	0.72	0.61	0.46	0.61	0.68	0.56	0.82	1.0	
13	0.26	0.21	0.30	0.37	0.28	0.23	0.09	0.17	0.29	0.24	0.44	0.56	1.0

TABLE 4

INTERCORRELATIONS AMONG THE 13 SUPERVISORY LEADERSHIP VARIABLES, PEARSON PRODUCT–MOMENT, PLASTICS FACTORY DATA, $N = 54$ GROUPS (FOR VARIABLE LABELS, SEE TABLE 1)

Variables	Variables												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.0												
2	0.60	1.0											
3	0.82	0.72	1.0										
4	0.40	0.28	0.35	1.0									
5	0.47	0.49	0.55	0.63	1.0								
6	0.50	0.42	0.45	0.18	0.35	1.0							
7	0.52	0.53	0.58	0.02	0.17	0.35	1.0						
8	0.52	0.46	0.52	0.55	0.74	0.18	0.21	1.0					
9	0.41	0.42	0.46	0.46	0.60	0.31	0.25	0.72	1.0				
10	0.56	0.58	0.60	0.49	0.58	0.49	0.14	0.64	0.53	1.0			
11	0.59	0.49	0.52	0.38	0.59	0.52	0.35	0.44	0.46	0.59	1.0		
12	0.69	0.43	0.58	0.38	0.49	0.32	0.21	0.39	0.35	0.42	0.61	1.0	
13	0.08	0.33	0.16	0.06	−0.01	0.24	0.09	−0.26	−0.04	−0.01	0.13	0.15	1.0

all pairs of points. The smaller the coefficient of alienation, the better the fit.

The monotonicity condition (1) mentioned above is symmetric, distance (A, B) = distance (B, A). The intercorrelation coefficients are also symmetric, $r_{AB} = r_{BA}$. Therefore, the symmetric computer program was used here, viz., SSA-1 (Lingoes, 1965).

RESULTS

Supervisory Leadership: The data include 13 questionnaire items

Table 2 presents the intercorrelations among the supervisory leadership variables obtained in the oil refinery. Tables 3 and 4 present those intercorrelations for the insurance company and plastics plant, respectively.

The coefficients of alienation for the best 1 space, 2 space, 3 space, 4 space, 5 space, 6 space, and 7 space for the refinery data are plotted in Fig. 1. Those coefficients below .15 represent rather good fits of the plotted distances to actual distances (Guttman, 1968). Since the clustering pattern of variables does not substantially change when one looks at the 4, 5, 6, 7 spaces from what it was in the 3 space, we shall discuss the results in terms of the 3-space solution because of the greater ease of visualizing the space. To facilitate locating the variable points in the space, Table 5 presents the coordinates for the 3-space solution for the refinery data. Figure 2 shows a cross section of this 3 space in terms of the first and second axes with the coordinates of the third axis in paren-

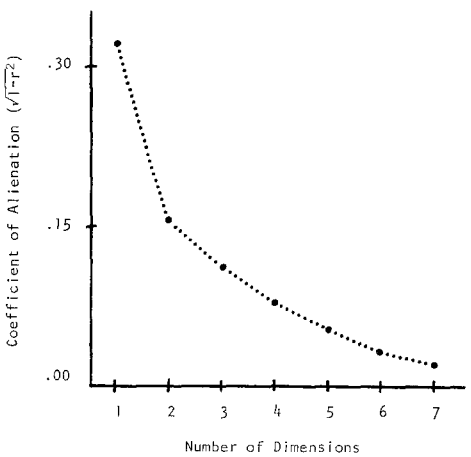

FIG. 1. Coefficients of alienation for 1, 2, 3, 4, 5, 6, 7 space solutions of 13 supervisory leadership variables, refinery data.

TABLE 5

COORDINATES FOR THE 13 SUPERVISORY LEADERSHIP VARIABLES IN THE 3-SPACE SOLUTION, REFINERY DATA (FOR VARIABLE LABELS, SEE TABLE 1)

Variable	Dimension		
	1	2	3
1	0.9	6.8	−8.5
2	1.4	4.5	−9.2
3	1.4	4.5	−7.1
4	6.3	−0.7	3.0
5	5.0	3.2	−3.0
6	6.4	5.3	−10.0
7	−8.0	9.7	−2.4
8	10.0	−1.3	−4.6
9	7.1	−1.1	−9.4
10	8.8	−1.8	−7.8
11	3.5	−0.7	−5.9
12	1.2	−1.5	−5.5
13	−10.0	−10.0	−7.6

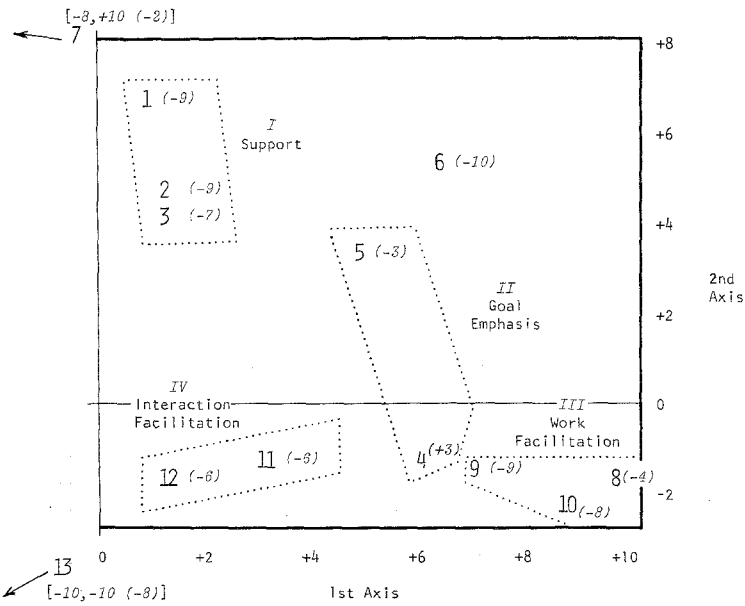

FIG. 2. Cross section of 3-space solution for 13 supervisory leadership variables, refinery data (variable coordinates on the 3rd axis are in parentheses). For variable labels, see Table 1.

TABLE 6

COORDINATES FOR THE 13 SUPERVISORY LEADERSHIP VARIABLES IN THE 3-SPACE SOLUTION,[a] INSURANCE OFFICES DATA, $\sqrt{1 - r^2} = .05$ (FOR VARIABLE LABELS, SEE TABLE 1)

	Dimension		
Variable	1	2	3
1	−3.8	6.7	−5.2
2	−0.7	6.3	−8.3
3	−0.8	6.4	−6.7
4	0.6	2.5	−6.1
5	2.5	3.1	−5.9
6	3.6	3.4	−10.0
7	−9.1	9.1	−0.4
8	4.9	2.9	−2.3
9	0.9	4.4	−1.5
10	4.7	−0.9	−1.8
11	−1.2	−0.9	−3.6
12	−2.8	−0.8	−5.7
13	−10.0	−10.0	−5.2

[a] Although the axes of the Euclidean space have been changed to allow more ready comparison to the refinery data, the configuration of points in the space and the distances among them remain the same.

TABLE 7

COORDINATES FOR THE 13 SUPERVISORY LEADERSHIP VARIABLES IN 3-SPACE SOLUTION,[a] PLASTICS FACTORY DATA, $\sqrt{1 - r^2} = .08$ (FOR VARIABLE LABELS, SEE TABLE 1)

	Dimension		
Variable	1	2	3
1	−1.0	3.5	−7.5
2	−2.7	5.7	−4.5
3	−2.1	5.2	−6.2
4	9.5	3.5	−6.6
5	6.2	6.1	−6.7
6	−2.3	1.3	1.2
7	−7.8	6.4	−7.4
8	6.3	8.1	−6.2
9	5.1	10.0	−5.1
10	3.3	5.6	−2.2
11	1.6	1.2	−4.2
12	0.8	0.3	−10.0
13	−10.0	−5.1	−6.3

[a] Although the axes of the Euclidean Space have been changed to allow more ready comparison to the refinery data, the configuration of points in the space and the distances among them remain the same.

theses beside the variables in the 2 space displayed. Tables 6 and 7 present the coordinates of 3 space solutions for the insurance offices and plastics plant data, respectively.

Arranging the items in this Euclidean space clearly segregates three clusters of items and possibly a fourth (see Table 3 and Fig. 2). With certain exceptions, the clusters of items match the combinations previously postulated by Bowers and Seashore (1966). The first cluster (Cluster I), Supervisory Support, shows a close proximity of the three items typically used to measure this concept: "Friendly and easy to approach" (V.1); "Pays attention to what you're saying" (V.2); "Willing to listen" (V.3). This pattern holds as well for the insurance offices and plastics plant data (Tables 6 and 7).

The second cluster, Goal Emphasis, although not as clearly spaced, possibly contains two of the items typically used in it: "Encouraging people to do their best" (V.4), and "Maintaining high standards of performance" (V.5). This cluster (II) is not clearly defined since the distance between V.5 and V.4 is as great as the distance between V.5 and V.11 in Cluster IV. The third item, "Sets example by working hard himself" (V.6) seems even less in close proximity to the other two. Since data on the same supervisory leadership items were available for two other companies, the insurance company and plastics producer, the 3-space coordinates used in the present analysis were compared with those in these latter sites (Tables 6 and 7). This comparison suggests that the refinery technology in this present study does not affect smallest space configuration of this particular item, (V.6) "Sets example by working hard." In the table of coordinates for the present analysis (Table 3) it can be seen that the "sets example" item (V.6) is less related to its mates in the goal emphasis cluster than to items in the other clusters. In the other two coordinate sets, it is found that the "sets example" item is also less related to its goal emphasis mates than to items in other indices. This suggests that the inclusion of variable 6 in the goal emphasis index is not empirically warranted.

The third and fourth clusters in Fig. 2 are quite clearcut. Cluster III, Supervisory Work Facilitation, is clearly a combination of three items: "Shows you how to improve performance" (V.8); "Provides help in scheduling work" (V.9); and "Offers new ideas" (V.10). Variable 7, "Encouraging subordinates to act without close review" does not cluster with the other three in any sense. Patterns of interrelationships with this fourth item, variable 7, in the other two companies (insurance and plastics) are close replicates of the pattern in this refinery (cf. Tables 6 and 7), although the insurance company data reveal a somewhat less proximate cluster. In all cases, it seems clear that variable 7 should not be included with the others in the Work Facilitation index.

TABLE 8
INTERCORRELATIONS AMONG THE 11 PEER LEADERSHIP VARIABLES, PEARSON PRODUCT-MOMENT CORRELATIONS, REFINERY DATA, N = 325 GROUPS (FOR VARIABLE LABELS, SEE TABLE 1)

	Variables										
Variables	14	15	16	17	18	19	20	21	22	23	24
14	1.0										
15	0.65	1.0									
16	0.62	0.77	1.0								
17	0.31	0.45	0.49	1.0							
18	0.40	0.57	0.53	0.55	1.0						
19	0.30	0.48	0.53	0.57	0.48	1.0					
20	0.32	0.46	0.53	0.62	0.47	0.66	1.0				
21	0.38	0.52	0.58	0.59	0.53	0.77	0.78	1.0			
22	0.40	0.53	0.51	0.62	0.50	0.61	0.62	0.66	1.0		
23	0.35	0.49	0.46	0.59	0.46	0.57	0.59	0.62	0.85	1.0	
24	0.42	0.50	0.49	0.42	0.41	0.45	0.51	0.61	0.69	0.65	1.0

Cluster IV in Fig. 2, Supervisory Interaction Facilitation, clearly includes two items: "Encourages people to work as a team" (V.11), and "Encourages his people to exchange ideas" (V.12). Cluster IV clearly does not include the item measuring the frequency of group meetings, (V.13). Once again, the coordinates derived from data from two other companies confirm the pattern of relationships between Variable 13, the

TABLE 9
INTERCORRELATIONS AMONG THE 11 PEER LEADERSHIP VARIABLES, PEARSON PRODUCT-MOMENT CORRELATIONS, INSURANCE OFFICES DATA, N = 99 GROUPS (FOR VARIABLE LABELS, SEE TABLE 1)

	Variables										
Variables	14	15	16	17	18	19	20	21	22	23	24
14	1.0										
15	0.81	1.0									
16	0.79	0.87	1.0								
17	0.66	0.66	0.64	1.0							
18	0.66	0.59	0.64	0.70	1.0						
19	0.52	0.51	0.63	0.68	0.58	1.0					
20	0.50	0.47	0.59	0.62	0.61	0.57	1.0				
21	0.61	0.62	0.70	0.69	0.62	0.63	0.61	1.0			
22	0.54	0.50	0.56	0.81	0.73	0.59	0.73	0.68	1.0		
23	0.46	0.44	0.49	0.70	0.63	0.45	0.65	0.60	0.89	1.0	
24	0.63	0.68	0.74	0.70	0.62	0.71	0.55	0.72	0.71	0.60	1.0

TABLE 10
INTERCORRELATIONS AMONG THE 11 PEER LEADERSHIP VARIABLES, PEARSON PRODUCT–MOMENT CORRELATIONS, PLASTICS FACTORY DATA, N = 54 GROUPS (FOR VARIABLE LABELS, SEE TABLE 1)

	Variables										
Variables	14	15	16	17	18	19	20	21	22	23	24
14	1.0										
15	0.53	1.0									
16	0.54	0.60	1.0								
17	0.38	0.54	0.56	1.0							
18	0.44	0.46	0.42	0.70	1.0						
19	0.38	0.27	0.34	0.47	0.37	1.0					
20	0.33	0.42	0.33	0.49	0.39	0.72	1.0				
21	0.40	0.35	0.46	0.42	0.30	0.79	0.76	1.0			
22	0.45	0.44	0.42	0.56	0.58	0.54	0.43	0.52	1.0		
23	0.32	0.31	0.27	0.57	0.51	0.36	0.44	0.40	0.66	1.0	
24	0.41	0.38	0.41	0.37	0.24	0.55	0.55	0.66	0.55	0.37	1.0

"frequency of meetings" item, and the other items found in the input matrix of the present analysis (cf. Tables 6 and 7). The exclusion of Variable 13 from the Interaction Facilitation index is clearly warranted.

Peer Leadership: 11 questionnaire items

Table 8 presents the intercorrelations among the 11 peer leadership variables used in the oil refinery analysis. Tables 9 and 10 present these intercorrelations for the insurance company and plastics plant, respectively.

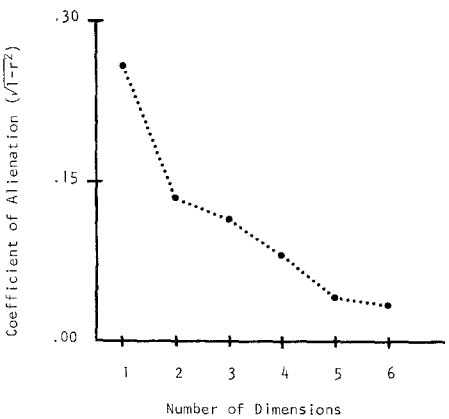

FIG. 3. Coefficients of alienation for 1, 2, 3, 4, 5, 6 space solutions of 11 peer leadership variables, refinery data.

TABLE 11

COORDINATES FOR THE 11 PEER LEADERSHIP VARIABLES IN THE 3-SPACE SOLUTION,[a] REFINERY DATA (FOR VARIABLE LABELS, SEE TABLE 1)

	Dimension		
Variable	1	2	3
14	5.9	4.2	−2.2
15	1.9	2.9	1.5
16	3.9	3.0	3.8
17	−4.9	−2.1	8.7
18	−4.6	2.9	3.1
19	1.1	−2.9	10.0
20	−1.5	−5.6	8.9
21	0.6	−4.0	7.2
22	−2.0	−5.6	3.3
23	−3.1	−6.9	4.1
24	0.8	−8.5	2.1

[a] Although the axes of the Euclidean Space have been changed to allow more ready comparison to the Supervisory Leadership data, the configuration of points in the space and the distances among them remain the same.

TABLE 12

COORDINATES FOR THE 11 PEER LEADERSHIP VARIABLES IN 3-SPACE SOLUTION,[a] INSURANCE OFFICES DATA, $\sqrt{1 - r^2} = .09$ (FOR VARIABLE LABELS, SEE TABLE 1)

	Dimension		
Variable	1	2	3
14	−9.4	7.6	2.1
15	−6.0	10.0	4.1
16	−3.5	7.3	4.7
17	−3.6	−1.7	0.8
18	−10.0	−2.0	1.2
19	6.8	1.5	1.9
20	−5.1	−7.4	10.0
21	−0.1	0.9	7.2
22	−4.0	−6.6	2.5
23	−4.6	−10.0	0.0
24	0.4	2.8	0.4

[a] Although the axes of the Euclidean Space have been changed to allow more ready comparison to the Supervisory Leadership data, the configuration of points in the space and the distances among them remain the same.

TABLE 13
COORDINATES FOR THE 11 PEER LEADERSHIP VARIABLES IN 3-SPACE SOLUTION,[a] PLASTICS PLANT DATA, $\sqrt{1 - r^2} = .09$ (FOR VARIABLE LABELS, SEE TABLE 1)

Variable	Dimension		
	1	2	3
14	10.0	−2.2	−7.1
15	3.0	9.0	−9.7
16	6.3	8.1	−7.6
17	−6.1	0.8	−5.2
18	−5.8	−2.3	−10.0
19	−0.6	2.4	9.0
20	−2.2	5.2	7.2
21	2.6	4.1	7.6
22	−2.1	−6.4	−1.9
23	−8.1	−10.0	−1.3
24	6.9	−0.9	6.7

[a] Although the axes of the Euclidean Space have been changed to allow more ready comparison to the Supervisory Leadership data, the configuration of points in the space and the distances among them remain the same.

The coefficients of alienation for the best 1 space, 2 space, 3 space, 4 space, 5 space, and 6 space for the refinery data are plotted in Fig. 3. As above, coefficients below .15 are understood to represent good fit between actual and plotted distances. Once again, compared with the 3-space solution, the clustering of variables does not substantially change in 4, 5, and 6 spaces. In order to provide comparison with the graphic display for the supervisory leadership clusters, the results will again be discussed in terms of the 3-space solution. Tables 11, 12, and 13 present the coordinates for the 3-space solution for the refinery, insurance company, and plastics plant, respectively.

Figure 4 shows a cross section of the 3-space solution for the refinery in terms of the first and second axes, with the coordinates of the third axis in parentheses beside the variable locations in the 2 space displayed.

Arranging the items in this Euclidean space clearly segregates three clusters, and possibly a fourth. Once again, these clusters of items match the combinations previously postulated by Bowers and Seashore. As replications of the refinery data, however, the two other companies do not match the peer leadership data as precisely as did the supervisory leadership data.

Cluster I in Fig. 4, Peer Support, includes the three items presumed to

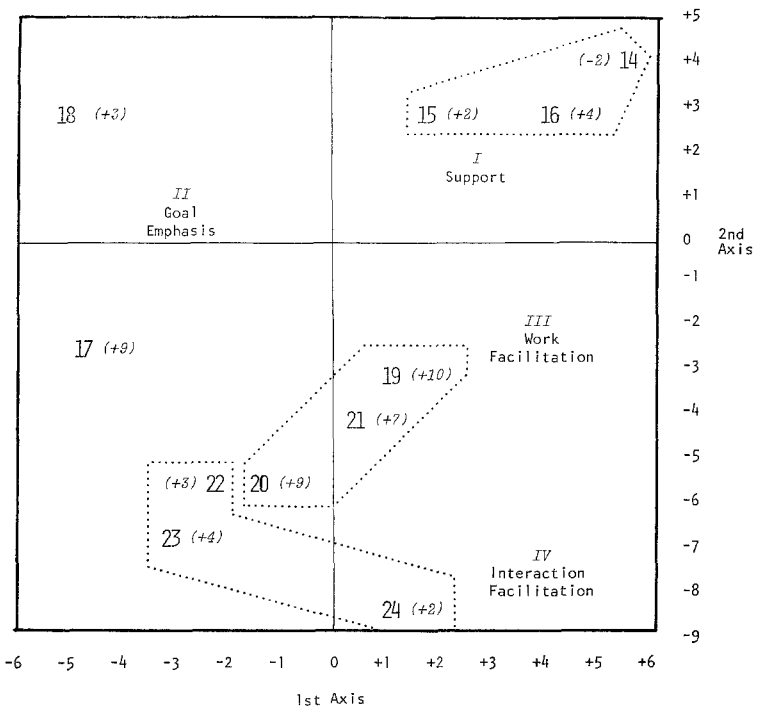

FIG. 4. Cross section of 3-space solution for 11 peer leadership variables, refinery data (variable coordinates on the 3rd axis are in parentheses). For variable labels, see Table 1. For purposes of display, axis labels have been changed to match those in the supervisory leadership 3-space array.

measure that concept: "Easily approached" (V.14); "Pays attention to what you're saying" (V.15); and "Willing to listen" (V.16). These three items also cluster well in the insurance data (cf. Table 12), although only two of them cluster well for the plastics plant (cf. Table 13).

Clusters III and IV in Fig. 4, Peer Work Facilitation and Interaction Facilitation, clearly include the items postulated to measure those concepts. There are no items which are disparate from either cluster for the refinery data. There is no clear work facilitation cluster for the insurance company (Table 12), with none of the three items (19, 20, and 21) clustering with anything else. Two of the three peer interaction facilitation items cluster together for the insurance data (variables 22 and 23), with variable 24 standing alone. Variables 22 and 23 in the interaction facilitation group also cluster well for the plastics producer (Table 13), with variable 24 standing alone. The work facilitation cluster obtained for the plastics plant, however, was as proximate as that obtained with the

refinery data. Thus, the peer work facilitation index seems to contain the postulated items, while the interaction facilitation index should probably include only two of the three proposed (V.22,23).

For the refinery data (Fig. 4, Table 11) the two-goal emphasis items form the weakest cluster (II) of the four obtained. Variable 17, for example, ("Encourage one another to give their best effort") is actually more distant from the other presumed goal emphasis item, Variable 18 ("Maintain high performance standards"), than it is from the work facilitation cluster (III), and is equidistant from either variable 22 in the interaction facilitation cluster (IV) or variable 18, its presumed mate. For the insurance company and plastics plant, on the other hand, these two variables in the goal emphasis index cluster rather well (cf. Tables 12 and 13). This suggests that the refinery data may have provided data biased in some way for estimating this goal emphasis factor. The goal emphasis index, therefore, probably should include both items.

It would appear that there is suitable evidence for concluding that all of the peer leadership factors are reasonably well measured by the variables included here, with the possible exception of variable 24, "Work group exchanges opinions and ideas" in the interaction facilitation index. In all other cases, at least two of the three companies provided data for which the predicted clusters obtained.

In conclusion, smallest space analysis of data relevant to the "Four-Factor Theory of Leadership" reveals reasonable isomorphism between what has been used as an operational definition of the four dimensions and what is empirically derived. Specifically, both supervisory and peer support indices stand as previously measured; that is, the items previously used in the support indices do, in fact, cluster together. Supervisory goal emphasis stands with the removal of one item. Peer goal emphasis probably stands as is. Supervisory work facilitation index remains with the removal of one component item, and peer work facilitation index stands as is. Peer interaction facilitation stands with the removal of one item, as does supervisory interaction facilitation.

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