A STUDY TOWARDS THE VERIFICATION OF FACTOR ANALYSIS WITH MULTIDIMENSIONAL SCALING: MEYER AND ALLEN'S ORGANIZATIONAL COMMITMENT SCALE

Aslı Beyhan Acar[219]
Nil Selenay Erden[220]

DOI: https://doi.org/10.31410/eraz.2018.438

Abstract: *Aim of this paper is to compare the results of factor analysis conducted on Allen and Meyer's organizational commitment scale with the results of multidimensional scaling analysis conducted with the same scale. Results reveal that both analyses lead to similar outcomes. Therefore, it is highlighted that multidimensional scaling could be used as an alternative method for factor analysis, as also it gives the chance to see the scale items on a two-dimensional space. Recommendations for future research in line with study findings are discussed.*

Key words: *Factor analysis, multidimensional scaling, organizational commitment*

1. THEORETICAL BACKGROUND

First of all, paper gives general information about multidimensional scaling analysis in comparison to factor analysis. Second Allen and Meyer's organizational commitment scale is explained. Third, importance of the study is explained. Data collection method and analyses' results are presented so as to compare the results of factor analysis with MDS. Finally, the similarities among analyses' results and why researchers should consider using MDS as an alternative to factor analysis is discussed.

Multidimensional scaling (MDS) is an exploratory data analysis technique that can model nonlinear relationships among variables, can handle nominal or ordinal data, and does not require multivariate normality. As such, MDS provides an alternative to methods such as factor analysis and smallest space analysis [1].

"The goal of an MDS analysis is to find a spatial configuration of objects when all that is known is some measure of their general (dis)similarity. The spatial configuration should provide some insight into how the subject(s) evaluate the stimuli in terms of a (small) number of potentially unknown dimensions" [2].

MDS reveals the psychological dimensions hidden in the data that can meaningfully describe the data. The multidimensional representations resulting from MDS are also often useful as the representational basis for various mathematical models of categorization, identification, and/or recognition memory [3].

Factor analysis is likely the most frequently employed method for examining the structure of cognitive ability interrelations. However, MDS methods can provide alternative representations

[219] Istanbul University, School of Business, Avcilar Campus, Istanbul, Turkey
[220] Istanbul University, School of Business, Avcilar Campus, Istanbul, Turkey

of ability interrelations that are visual in nature and intuitively appealing [4]. MDS, descriptive in nature, albeit can present similarities between objects on a two-dimensional basis; whereas factor analysis, correlation matrices are used to define the dimensions of a construct.

MDS has been an important tool in psychology, mathematical anthropology, and social network analysis for understanding the structure of choices, cognitions, and social proximity. Cognitive psychology has used multidimensional scaling (and related procedures) in a wide variety of ways. In contrast, in political science (and more mainstream sociology) MDS has been very little used, while for decades factor analysis has been the standard analytic tool for modeling the dimensional structure of political or social attitudes [5].

To sum up, MDS is not used very often due to its descriptive nature. However, no normality is required in MDS. It gives distance models of which are intuitively appealing that can work with all data types. Factor analysis, on the other hand, has been the standard analytic tool for decades. It requires normality and works with at least interval scale types. No distance model can be drawn in factor analysis, only rotation matrices can be interpreted to find the underlying dimensions in the data set. Aim of this study is to compare factor analysis with mds analysis by using organizational commitment scale, to show that mds can also be used in organizational behavior, human resources management and related fields.

The organizational commitment is a positive attitude towards the organizations employees work in. According to Allen & Meyer's studies on the construct, organizational commitment has three components namely as affective commitment, continuance commitment and normative commitment. Affective commitment refers to an emotional attachment or identification with the organization. Continuance commitment refers to a kind of negative commitment; in which employees would possess due to not having another work place alternative, basically it is a realization of the costs associated with leaving the organization. Finally, normative commitment refers to a feeling of obligation to continue employment [6].

The next section summarizes the importance of the study and data collection method.

2. METHOD

The objective of the study is to compare factor analysis with MDS analysis by using organizational commitment scale of Meyer and Allen. The main aim of this study to show that MDS can be used instead of factor analysis in organizational behavior, human resources management and related fields as it's used in psychology and give more comprehensive results. However, we do not aim to assess the scale of Meyer and Allen. The scale is used as an example in order to prove MDS analysis should be used in researches in organizational behavior more than current.

In the scale of Meyer and Allen (1990) [7] 24 items are used. In this study we used original scale except from 4 items The items are coded such as OC1, OC2…OC20. Depending on the original scale, the number of items which belonged to each dimension are indicated in below:

- Affective commitment scale items: First 6 items belong to this dimension.
- Continuance commitment scale items: Items between 7-16 belong to this dimension.
- Normative commitment scale items: Items between 17-20 belong to this dimension.

160 supervisors of a training academy center of a telecommunication company have participated in the study. 5-point Likert scale is used in Organizational Commitment Questionnaire ranging from 1: absolutely disagree to 5: absolutely agree.

3. RESULTS

The original form of organizational commitment scale has three components as mentioned previously, however the data in this study presents five components. In this study it's mainly aimed to indicate that MDS and factor analysis give us parallel results while we can reach a wider conclusion by using MDS analysis. As such, the essential point is how similar results MDS and factor analysis can provide rather than reaching similar results with the original scale dimensions. In this respect, first, factor analysis results are summarized, second MDS findings are summarized.

Depending on Table 1, the data are suitable for factor analysis due to KMO value; 0,671> 0,50. The items that are used in the scale and their factor loadings can be seen in Table 2. Depending on factor analysis we found five components while there are three components in the original scale. Five factor loads explain 68,3% of variance as cumulative.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	,671
Sig.	,000

Table 1: KMO and Bartlett's Test

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6,068	30,340	30,340	6,068	30,340	30,340	3,594	17,970	17,970
2	2,626	13,129	43,470	2,626	13,129	43,470	3,002	15,008	32,978
3	1,812	9,061	52,531	1,812	9,061	52,531	2,686	13,430	46,407
4	1,620	8,098	60,629	1,620	8,098	60,629	2,352	11,762	58,169
5	1,540	7,700	68,329	1,540	7,700	68,329	2,032	10,159	68,329
6	,941	4,705	73,034						
7	,920	4,601	77,635						
8	,766	3,828	81,462						
9	,625	3,125	84,587						
10	,554	2,772	87,359						
11	,514	2,569	89,928						
12	,425	2,123	92,051						
13	,410	2,048	94,099						
14	,304	1,519	95,619						
15	,247	1,234	96,853						
16	,176	,882	97,735						
17	,156	,780	98,516						
18	,133	,666	99,182						
19	,093	,467	99,649						
20	,070	,351	100,000						

Table 2: Total Variance Explained

	Component				
	1	2	3	4	5
OC3	,770	,430	,001	-,150	-,160
OC2	,766	,341	,173	-,132	-,076
OC1	,703	,365	,229	-,142	-,170
OC6	,641	,405	,174	-,053	-,113
OC11	,544	,146	-,026	,293	,105
OC14	,515	-,239	,506	,073	,018
OC17	,251	,794	,176	,063	-,062
OC18	,250	,789	,211	,099	-,056
OC19	,101	,773	,110	,250	-,023
OC13	,314	,387	,583	,099	-,003
OC15	,020	,373	,556	-,125	-,200
OC16	,103	,120	,820	-,002	-,121
OC20	,035	,133	,864	-,067	-,066
OC7	-,511	,212	-,169	,419	,404
OC8	,182	-,008	,229	,651	,486
OC9	-,195	,136	-,015	,833	-,079
OC10	,092	,139	-,141	,801	-,136
OC4	-,128	,005	-,096	-,142	,874
OC5	-,163	-,228	-,226	,008	,819
OC12	-,563	,134	-,036	-,371	,152

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 14 iterations.

Table 3: Rotated Component Matrix[a]

In Table 3, each component found as a result of factor analysis are indicated. According to the factor analysis, the item coded OC12 has 0,152 (<0,30) factor load. It's appropriate to remove the items which have factor loadings less than 0,30. Due to this, OC12 should be removed from the scale.

Young's S-stress formula 1 is used.

Iteration	S-stress	Improvement
1	,22706	
2	,18836	,03870
3	,18542	,00294
4	,18502	,00040

Iterations stopped because
S-stress improvement is less than ,001000

For matrix
Stress = ,17774 RSQ = ,89079

Table 4: Evaluation of the Data with MDS Analysis

A small stress value indicates a good fitting solution, whereas a high value indicates a bad fit. Kruskal provided some guidelines for the interpretation of the stress value with respect to the goodness of fit of the solution [2].

Stress Goodness of fit
>0,20 poor

0,10 < 0,20 fair
0,05 < 0,10 good
0,025 < 0,05 excellent
0,00 < 0,025 perfect

In this study, the stress value is nearly 0,18 and indicates fair level fit. Stress value is computed as 0,89079. It means that stress value for k=2 dimension explains the data as the proportion of 0,89079.

Stimulus Number	Stimulus Name	1	2
1	OB1	1,5687	-,1460
2	OB2	1,7879	-,1863
3	OB3	1,6936	-,1578
4	OB4	-1,3287	-1,4674
5	OB5	-1,2680	-1,3322
6	OB6	1,5699	-,3933
7	OB7	-2,0354	-,0908
8	OB8	-1,5078	,1082
9	OB9	-1,4118	,6491
10	OB10	-1,6379	,7740
11	OB11	,6781	-,5708
12	OB12	-,2709	-1,6188
13	OB13	,0502	4739
14	OB14	,9459	-,3022
15	OB15	-,1030	,8038
16	OB16	-,5941	,8276
17	OB17	,6786	,2393
18	OB18	,5084	,6236
19	OB19	,3384	,8983
20	OB20	,3379	,8678

Optimally scaled data (disparities) for subject 1

	1	2	3	4	5	6	7	8	9	10	
1	,000										
2	,466	,000									
3	,333	,000	,000								
4	3,061	3,298	3,191	,000							
5	3,030	3,022	3,079	,773	,000						
6	,522	,453	,207	3,105	2,917	,000					
7	3,441	3,769	3,707	1,671	1,503	3,593	,000				
8	2,964	3,124	3,102	1,937	1,615	2,999	1,355	,000			
9	2,990	3,162	3,018	2,425	2,123	2,922	1,268	1,110	,000		
10	3,133	3,419	3,254	2,355	2,132	3,291	,981	1,215	,554	,000	
11	1,227	1,298	1,273	2,456	2,203	1,127	2,717	1,996	2,238	2,390	
12	2,526	2,756	2,517	1,919	2,109	2,226	2,252	2,530	2,353	2,861	
13	1,722	1,883	1,824	2,214	2,324	1,822	2,130	1,743	1,742	1,981	
14	1,209	1,140	1,097	2,609	2,421	,849	3,030	2,180	2,479	2,774	
15	1,870	2,152	2,125	2,289	2,427	2,322	2,165	2,102	2,013	2,074	
16	2,259	2,559	2,506	2,353	2,322	2,387	1,777	1,582	1,661	1,554	
17	1,366	1,551	1,303	2,599	2,523	1,127	2,501	2,337	2,157	2,254	
18	1,718	1,625	1,492	2,682	2,584	1,601	2,449	2,185	2,055	2,132	
19	1,925	2,008	1,690	2,767	2,526	1,786	2,478	2,112	1,958	2,083	
20	1,771	1,898	1,953	2,639	2,601	1,777	2,611	2,040	2,002	2,387	

	11	12	13	14	15	16	17	18	19	20
11	,000									
12	2,029	,000								
13	1,395	2,125	,000							
14	,933	2,093	1,343	,000						
15	1,744	2,017	1,130	1,585	,000					
16	2,113	2,146	1,079	1,631	1,396	,000				
17	1,182	2,072	1,229	1,312	1,583	1,750	,000			
18	1,300	2,247	1,188	1,471	1,651	1,647	,280	,000		
19	1,646	2,352	1,336	1,664	1,852	1,721	,759	,526	,000	
20	1,861	2,211	1,078	1,290	1,297	,832	1,472	1,480	1,810	,000

Table 5: Stimulus Coordinates Dimension

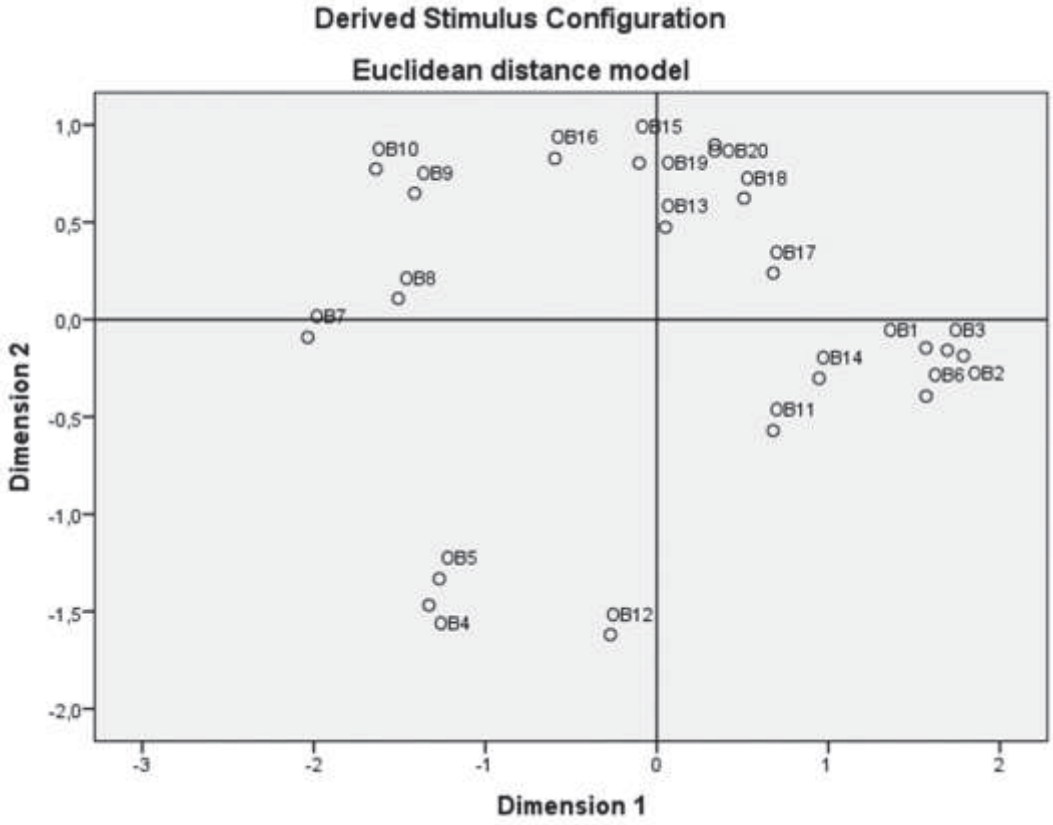

Figure 1: Euclidean Distance Model

The primary outcome of an MDS analysis is a spatial configuration, in which the objects (items) are represented as points. The points in this spatial representation are arranged in such a way, that their distances correspond to the similarities of the objects: similar object are represented by points that are close to each other, dissimilar objects by points that are far apart.

As seen in Stimulates Coordinates table, the items that are coded as OB1, OB2, OB3, OB6 have positive and over 1 degree. Due to this, these are the strongest dissociatives in the first dimension. In Figure 1, those items are very close one another in the area of (+ x, - y). According to the factor analysis these four items have relatively high factor loads as between 641-770. Additionally the items OB11 and OB14 are close points with the four items in Figure 1. According to the factor analysis those six items are in the same component as it's seen in Table3.

Depending on the Stimulates Coordinates table, OB4 and OB5 have negative and under 1 degree in both two dimensions. This shows that they are dissimilar items from the rest of the items in each dimensions. In Figure 1, it can be seen that OB4 and OB5 are very close one another while they are very far from other items. Depending on the findings in Table 3, these two items have more than 800 factor loads and form a component.

4. DISCUSSION

As can be seen from the results, MDS and factor analyses lead to similar outcomes. Besides, MDS has less number of assumptions compared to factor analysis and it is capable of creating figures on a two dimensional basis, and/or on a three dimensional basis. MDS is descriptive whereas factor analysis computes factor weights and is more inferential. As such, one can say that this is the main reason factor analysis is used more often. However, MDS can also be preferred if it serves for research aims; especially when distance models need to be drawn. This study recommends that MDS can be considered as an alternative method in behavioral researches.

***Aslı BEYHAN ACAR**, Associate Prof., in School of Business at Istanbul University. She is also responsible for the short-middle term education-training programs for business life in the Institute. She completed her bachelor's degree in the Faculty of Political Science at Istanbul University. After her graduation, she attended Faculty of Education at Kocaeli University for a while. She received her postgraduate (2006) and Ph.D. (2011) at the Department of Human Resources Management in the Faculty of Business Administration at Istanbul University. Her main research interests include training-development function of HRM, international industrial relations, labour economy, EU social policies, microfinance and employment in developing countries. She has been the director of Career Development Center since 2017. She lectures in human resources management and organizational behaviour fields.*

In addition to similarity of results, one can consider that it is essential to discuss the factor structure of Allen and Meyer's organizational commitment scale, revealed both with factor and MDS analyses. In this respect, we explain why the scale yielded to a more different structure rather than its original forms with evidence from the literature.

Scales developed on US samples containing multiple dimensions with positively or negatively worded items lead to consistent factor structures. However, when the same scale is translated into another language and tested on different ethnic groups, the original factor structure might not come up. Instead, it is observed that negatively worded items form artificial factors and item confounding happen among dimensions [8]- [9].

The mentioned phenomenon is observed on Turkish samples, as well. For example organizational commitment scale of Allen and Meyer does not always have three components as expected [10]. Especially reverse items form artificial factors, and items of affective and normative commitment do not appear in different dimensions. Instead, it is seen that they overlap with each other under multiple dimensions.

The reason behind the artificial factors formed by negatively worded or reverse items could be explained as such; negative items create cognitive dissonance in the mind of participants and lead to a kind of difficulty in interpretation of sentences [8]. On the other hand, positively

worded sentences are easier to understand and answer [11]. As such, even though positively and negatively worded sentences are formed in order to represent the same dimension, as their cognitive processing in the mind of participants differ, answers might vary among those items.

Confounding items from affective and normative commitment dimensions could be explained as such that individuals might perceive being emotionally attached to their workplace and sense of obligation in the same context instead of separating them. Besides, organizational commitment is viewed as a two component variable in exchange and psychological approaches. Exchange approach investigates commitment based on an exchange between the individual and the organization, while psychological approach investigates commitment based on an identification between the individual and organization [12]. Normative commitment might be developing in the context of this identification. Briefly, it would not be expected for an individual to have high levels of normative commitment if (s)he is not emotionally attached to his organization. Thus, it seems as if, in Turkish culture affective and normative commitment might be overlapping instead of appearing as different forms of commitment.

Nil Selenay ERDEN, *Ph.D., is an assistant professor of Organizational Behavior at Istanbul University, School of Business, at the department of Organizational Behavior since 2017. She served as a teaching and research assitant between 2010 and 2017, received her Ph.D. in 2015, currently lectures in Statistics, Research Methods, Social Responsibility and Behavioral Sciences. She specializes in research design and dark side of positive behavioral concepts. Her dissertation was "Extra-ordinary Role Behaviors and Job Creep: Relationships among Affect, Withdrawal Intention and Organizational Identification".*

Limitations of this study could be addressed as the usage of convenient sampling method which is highly judgmental and small sample size (160 participants). However, the aim of this study was to show that, MDS, a descriptive tool, is capable of providing the similar results with the popular factor analysis and could be used more often in social studies.

REFERENCES

[1] Jaworska, N. & Chupetlovska-Anastasova, A. (2009). A review of multidimensional scaling (MDS) and its utility in various psychological domains. Tutorials in Quantitative Methods for Psychology, 5 (1), 1-10.

[2] Wickelmaier, F. (2003). An introduction to MDS. *Sound Quality Research Unit, Aalborg University, Denmark*, *46*(5), 1-26.

[3] Steyvers, M. (2002). Multidimensional scaling. *Encyclopedia of cognitive science*, 1-7.

[4] Tucker-Drob, E. M., & Salthouse, T. A. (2009). Methods and measures: Confirmatory factor analysis and multidimensional scaling for construct validation of cognitive abilities. *International Journal of Behavioral Development*, *33*(3), 277-285.

[5] Brazill, T. J., & Grofman, B. (2002). Factor analysis versus multi-dimensional scaling: binary choice roll-call voting and the US Supreme Court. *Social Networks*, *24*(3), 201-229.

[6] Meyer, J. P., & Allen, N. J. (1991). A three-component conceptualization of organizational commitment. *Human Resource Management Review*, *1*(1), 61-89.

[7] Allen, N. J., & Meyer, J. P. (1990). The measurement and antecedents of affective, continuance and normative commitment to the organization. *Journal of Occupational Psychology*, *63*(1), 1-18.
[8] Wong, N., Rindfleisch, A. and Burroughs, J. (2003). Do reverse-worded items confound measures in cross-cultural consumer research? The case of the material values scale, *Journal of Consumer Research, 30,* 72-91.
[9] Schmitz, M. F. and Baer, J. C. (2001). The vicissitudes of measurement: A confirmatory factor analysis of the Emotional Autonomy Scale*, Child Development, 72*, 207-219.
[10] Uzun Ö. & Yiğit, E. (2011). Örgütsel stres ve örgütsel bağlılık ilişkisi üzerine orta kademe otel yöneticileri üzerinde yapılan bir araştırma. *Eskişehir Osmangazi Üniversitesi İİBF Dergisi, 6*, 181-213.
[11] Weems, G.H, Onwuegbuzie, A.J. & Collins, K.M. (2006). The role of reading comprehension in responses to positively and negatively worded items on rating scales. *Evaluation and Research in Education, 19*, 3-20.
[12] Mayer, Roger C. And Schoorman, David F. (1992). Predicting participation and production outcomes through a two dimensional model of organizational commitment. *Academy of Management Journal, 35*(3), 671-684.