UNDERSTANDING SERVICE QUALITY: A MULTIDIMENSIONAL SCALING APPROACH

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Abstract

This paper purports to uncover the underlying attributes used by customers to gauge service quality. Data was collected by administering questionnaires to 50 respondents and then analyzed by using Multidimensional Scaling methodology. The findings indicate that there are two primary dimensions to service quality. This analysis helped determine us two alternatives to naming the dimensions: Experience properties of service and Price value of the service, or Responsiveness of service provider employees and Reliability of service providers.

I . Introduction

This paper purports to uncover the "hidden structure" underlying a service quality evaluation database using a set of mathematical technique called multidimensional scaling (MDS). Using data collected from 31 respondents who evaluated 12 restaurants on the basis of perceived service quality. They were asked to compare pairs of restaurants in terms of how dissimilar they perceived the service quality between the pair.

The endeavor was to understand what features can be derived from the service quality comparison database which would help service management researchers to better understand what led customers to make service quality judgments? MDS helps to address this issue by locating the restaurants in a spatial configuration or "map." Having located the restaurants in a multidimensional space, we can seek to analyze what differentiates these restaurants in spatial terms.

MDS enables us to reduce the data about 12 restaurants to two dimensions which represent the hidden structure of data (Experience properties of service and Price value of the service, or

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Responsiveness of service provider employees and Reliability of service providers). Thus we have determined what in essence differentiates the restaurants at opposite ends of the dimensions. This can provide us a valuable clue as to how to develop indicators to measure service quality in future research endeavors.

II. Service quality research: a literature review

It is imperative to understand that service quality is a very subjective concept, understanding the mind of the customer in regards to service quality perception is essential to better manage the service delivery. Research has focused on the paradigm of "expectancy disconfirmation" to measure service quality. Service quality research is predominantly based on meeting or exceeding expectations (Erevelles & Leavitt, 1992; Oliver, 1977, 1980, 1981; Oliver and DeSarbo 1988; Tse, Nicosia & Wilton, 1990; Yi, 1990).

Service quality is operationally measured as expectancy disconfirmation in the mind of the customer which comprises of two processes. The first step involves formulation of expectations based on certain external and internal cues (Oliver and Winer, 1987). The second step involves a "disconfirmation" judgment by the customer or a comparison between the formed expectations and perception of the outcome (Oliver, 1980; Oliver & DeSarbo, 1988).

Although much has been said and written about manufactured goods quality, service quality is different due to the two main characteristics of services. Service outcome is comprised of several intangibles and production of service outcome requires the involvement of the customer. In light of this fact, Parasuraman, Zeithaml, and Berry have defined the formulation of a service quality construct and measured service quality in various industries (Parasuraman, Zeithaml, & Berry , 1985, 1988, 1990). According to them service quality can be measured in terms of subjective disconfirmation between expectations about a service and perceived outcome from the service. They proposed that customers formulate certain expectations about a service through internal and external cues, then they observe and experience the actual service, and finally based on disconfirmation they form perceptions about the service. Their model simply stated is:

$$Perceived Service Quality = Perception - Expectation$$

Using the technique called factor analysis they suggested 10 dimensions of service quality. Upon further empirical

investigation they reduced 10 dimensions to 5 (tangibles,reliability, responsiveness, assurance and empathy). They also formulated an instrument called SERVQUAL to measure the service quality based on the five determined dimensions. The 22-item instrument for measurement of perceived service quality although widely accepted in the business world has come under a lot of criticism by researchers.

The first attack on the SERVQUAL was based on the evidence that it was not replicable (Carman,1990). Carman in an attempt to replicate the SERVQUAL research found that there was a need to add and expand certain dimensions that were differentially important across different type of services. Another research (Babakus & Boeller, 1992) found that exploratory factor analyses yielding a five-dimensional solution produced low discriminant and convergent validity. The interpretation of dimensions also turned out to be very different than those suggested by Parasuraman et al.

Another major criticism (Cronin & Taylor, 1992) questioned the conceptual basis of SERVQUAL, claiming that it confounded service satisfaction (Oliver, 1980; Churchill & Surprenant, 1982) with service quality. It was suggested that service quality should be measured as an attitude, i.e., merely measured as the service performance. Another statistical issue governing this controversy was the fact that there was a strong autocorrelation between perceptions and expectations measure.

We contend that several of the criticism leveled against the old paradigm of perceived. quality measurement are due to the nature of the methodology used (factor analysis). In light of this,a new way to measure service quality is proposed based on multidimensional scaling (MDS) methodology.

Ⅲ. Advantages of MDS over Factor Analysis

The MDS model is based on distances between points,whereas Factor Analysis model is based on angles between vectors. Although both models generally use Euclidean space, MDS has an advantage in terms of the fact that it is easier to interpret distances between points than angles between vectors.

Factor Analysis often results in relatively large number of dimensions mainly because most procedures are based on the linear associations between the variables. When dealing with perceptual data, this is a rather severe assumption. And more often than not it does not hold good.

MDS, on the other hand,does not rely on this assumption and as a result it normally provides more readily interpretable solutions which have lower

dimensionality. Researchers have to bear in mind that although a higher-dimensional solution generally gives a better fit to the data, this does not mean that the high-dimensional solution is necessarily correct. Data will always contain noise.

An empirical advantage of MDS over Factor Analysis is in the type of data collected. Data collected for MDS is direct judgment of dissimilarities. Thus it is less susceptible to experimenter contamination and more likely to contain a suitable and relevant structure. In Factor Analysis,one obtains scores for several stimulus forced onto respondents by researchers. It comprises of a long list of attributes (called "shopping list of attributes" by researchers as opposed to multidimensional scaling) which may or may not be relevant.

It has been empirically and geometrically proved that MDS is better than Factor Analysis (Schiffman, Reynolds, and Young, 1981). Thus we use the Multidimensional Scaling approach to uncover a better and lower dimensional structure in regards to perceived service quality.

Ⅳ. Data Collection

50 respondents (of which only 31 were usable) were administered a questionnaire, the first part of which required them to compare the service quality provided by a pair restaurants. There were 12 restaurants and 66 pairs of restaurants to be compared. The respondents evaluated the comparative service quality on a dissimilarity scale ranging from 1 for "very similar" to 5 for "very dissimilar". In order to keep the responses pure, the respondents were given no instructions regarding what to characteristics to use when making comparisons. This enabled the use of the power of multidimensional scaling where the purpose is to discover than to impose (Kruskal & Wish, 1978).

In the second part of the questionnaire the respondents rated the stimuli used in parities combinations (i.e. restaurants) on 6 bipolar scales. The bipolar scales measured attributes of services: price value of the service, appeal of the atmosphere at the service site, reliability of service received, responsiveness of the service employees, courteousness of service employees, and the nature of personal attention received during the service process. The rating scales ranged from 1 to 7. For example, when measuring reliability of service, 1 meant extremely unreliable service and 7 meant extremely reliable service. The ratings on these bipolar scales were intended to guide the interpretation of dimensions following the example of Kruskal and Wish (1978).

A point of note is that in order to control for the length of the

Figure 1. Matrix of mean dissimilarity ratings for twelve restaurants

MD	-											
DE	3.48	-										
CO	3.39	2.11	-									
SU	2.36	3.12	3.44	-								
OG	4.33	3.1	2.5	3.85	-							
KF	1.64	3.08	3.38	1.87	3.9	-						
MC	4.11	2.94	2.46	3.58	2	4.23	-					
TB	1.41	3.45	3.16	2.04	4.2	1.62	4.06	-				
RL	4.52	3.09	2.62	4.23	1.88	4.04	2.07	4.52	-			
NU	3.22	2.82	2.88	2.55	3.37	3.11	2.86	3.11	3.6	-		
SZ	3.45	2.37	2.55	3.52	2.47	3.5	2.58	3.65	2.52	2.5	-	
YO	2.27	3.38	3.46	2.88	3.86	2.33	3.92	2.29	3.86	3.33	3.38	-

questionnaire, the respondents only had to rate 3 out 12 restaurants on the bipolar scales (second part of the questionnaire). The three restaurants to be evaluated were chosen at random. This was done as it was felt that fatigue might systematically bias the responses.

V. Analysis

The first phase of the analysis was to compute the mean dissimilarity rating for each of the 66 pairs (total combinations of 12 restaurants). The mean ratings were arranged into a matrix form (Figure 1) to be used as an input to an MDS software routine.

The matrix is quite easy to interpret. For instance, the restaurants, designated as RL and TB were perceived to be the most dissimilar (mean = 4.52) in terms of service quality than any other pair. On the other hand, the restaurants designated as MD and TB were perceived to be most similar (mean rating = 1.41) in terms of service quality as compared to any other pair.

1. Determining dimensionally

Figure 2 shows the how the stress values change with higher dimensionality. The stressvalues shown are calculated using Kruskal's stress formula. It can be interpreted as the measure that demonstrates how far the data depart from the model.

Figure 2. Changes in stress with dimensionality

Dimensions		
2	3	4
0.08153	0.06598	0.02091

Figure 3 shows how the squared correlations change with higher level of

dimensionality. The squared correlations show the proportion of variance of the disparities accounted for by the MDS model. Since squared correlation has a simple interpretation, it can be used as a good indicator to show how well the model fitsthe data. It is contended that squared correlation is a better indicator of appropriate dimensionality than stress (Schiffman, Reynolds & Young, 1981).

Figure 3. Changes in squared correlations with dimensionality

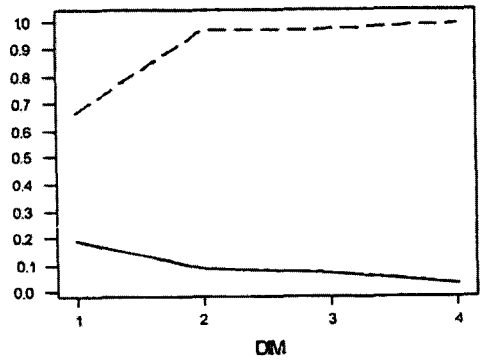
Dimensions		
2	3	4
0.96866	0.97488	0.99395

The figures above (Figure 2 and Figure 3) show that there are no large reductions in stress and no large increases in squared correlations as we increases the number of dimensions from 2 to 3 or 4.

Figure 4 also shows the change in stress and squared correlation with the increase in number of dimensions. We can see that the stress does not decrease significantly beyond two dimensions. In the same manner squared correlation does not substantially increase beyond two dimensions. So in conclusion it seems that a two dimensional analysis will be appropriate for service quality attributes.

It seems that a two dimensional solution would be adequate for analysis. Further Kruskal and Wish (1978) have pointed out that as a rule of thumb I>4R, where I is number of objects and R is the number of dimensions. In case of this research,we have 12 objects. Therefore, two dimensions will be appropriate, whereas 3 dimensions will violate the rule of thumb provided by Kruskal and Wish.

Figure 4: Stress/RSQ versus dimensions



2. Two dimensional analysis

Figure 5 shows the list of dimensional coordinates for the twelve restaurants and plot of the coordinates is shown in Figure 6. Interpretation of the dimensions will be done later in this section. Looking at the coordinate graph (Figure 6), we could see that the 12 restaurants can be clustered into three distinct categories: fast food restaurants, moderately expensive restaurants with decent menu size, and the upscale restaurants.

Figure 5. Stimulus Coordinates

Stimulus number	Stimulus name	Dimension 1	2
1	MD	1.5500	0.4595
2	DE	-0.3567	0.6262
3	CO	-0.7542	-0.2359
4	SU	1.2119	0.5822
5	OG	-1.7484	-0.2804
6	KF	1.4521	-0.2039
7	MC	-1.5548	0.6456
8	TB	1.5848	-0.2351
9	RL	-1.8699	-0.4777
10	NU	0.0871	0.9941
11	SZ	-0.8048	0.0102
12	YO	1.2029	-0.9657

Figure 7 shows the scatter diagram of distances versus disparities. The values of fitted distances are called disparities. The monotonicity assumption requires the plot have a characteristic jagged appearance. The diagram in Figure 7 shows that points of the configuration are strongly clumped. This could be the case because the objects have natural clustering, as described earlier the 12 restaurants can be loosely clumped into three groups. Thus the dissimilarities between objects in different clusters are larger than the dissimilarities within each cluster.

Figure 7. The scatter diagram of distances versus disparities.

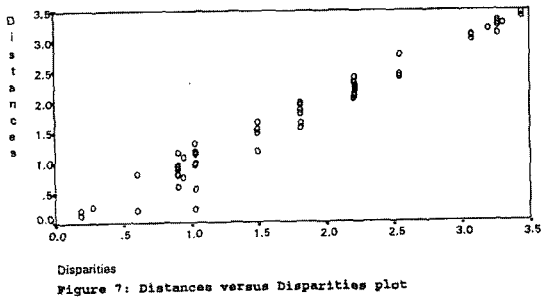


Figure 6: Stimulus Coordinates

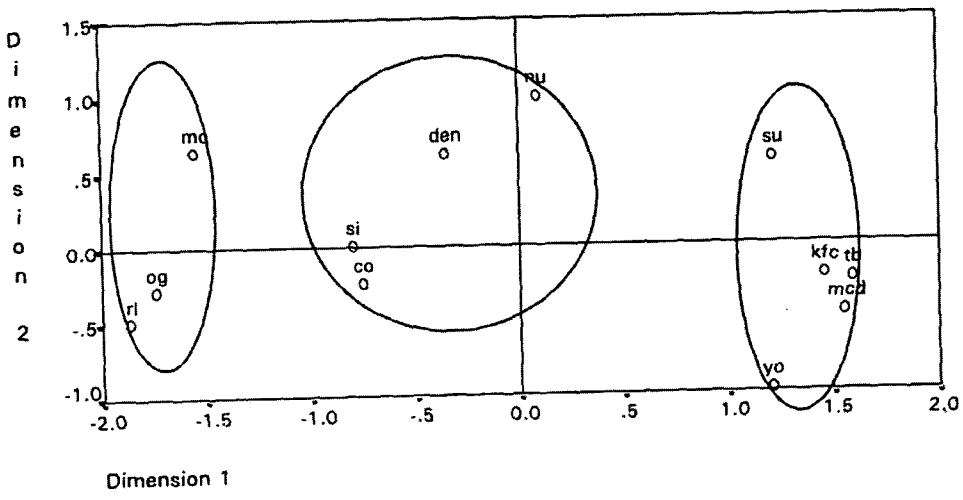


Figure 8. Dimension coordinates and Mean ratings of the restaurants on the six bipolar scales

	Price	Appeal	Reliable	Response	Courteous	Personal	Dim1	Dim2
MD	6.3	4.1	6.1	4.3	4.9	3.9	1.55	0.4595
DE	6.1	4.4	4.9	4.6	4.6	4	-0.3567	0.6262
CO	4.63	4.75	5.25	5	5.25	4.88	-0.7542	-0.2359
SU	5	3.86	4.71	4.14	4.29	3.86	1.2119	0.5822
OG	4.57	5.43	5	5.14	5	5.57	-1.7484	-0.2804
KF	4.71	3	3.86	3	3.14	2.29	1.4521	-0.2039
MC	4	4.67	4	4.33	4.33	4	-1.5548	0.6456
TB	5.6	2.4	4.4	4	3.8	3.2	1.5848	-0.2351
RL	3.75	4.75	4.5	5.25	5.25	4.75	-1.8699	-0.4777
NU	4.29	3.86	4.43	4.43	4.71	4.43	0.0871	0.9941
SZ	4.56	4.56	5.11	4.67	4.67	4.56	-0.8048	0.0102
YO	4.13	3.13	3.88	3.75	3.38	3	1.2029	-0.9657

3. Interpreting the dimensions

The first step to take towards interpretation of the dimensions is to calculate the average respondent ratings of each restaurant on the six bipolar scales. Figure 8 shows the average of ratings on the bipolar scales and the coordinates of the two dimensions.

The easiest way to determine the name of the dimensions would be to correlate the dimensional coordinates with means of each of the bipolar scales. The name of the highest correlated scale with the dimension will guide the naming of the dimensions. Figure 9 shows the correlations between the bipolar scales and the dimensions.

The ratings on the Appeal of restaurants atmosphere has a strong negative correlation with the dimension I (correlation=-0.854). This can also be seen from the scatter plot shown in Figure 10. It would be easy to name the Dimension 1 as Appeal of service facilities using the correlation method. But unfortunately Dimension 2 does not exhibit a strong correlation with any item on the bipolar scales thus this method is not useful in naming both the dimensions together.

Another approach to determine the interpretation of the dimensions is to regress the dimension co-ordinates on the mean ratings of the bipolar scale. The bipolar scale with the highest beta coefficient will be the name of the corresponding dimension. Figure 11 shows the beta coefficients for the two regressions.

We can see that Responsiveness has the highest beta coefficient for the regression on Dimension 1. Thus we can name Dimension 1 as responsiveness.

Figure 9. Correlation between bipolar scale means and dimensions

	Dim1	Dim2	Price	Appeal	Reliable	Response	Courteous
Dim2	-0.071						
Price	0.48	0.058					
Appeal	-0.854	0.162	-0.233				
Reliable	-0.061	-0.075	0.587	0.443			
Response	-0.773	0.064	-0.158	0.822	0.502		
Courteous	-0.628	0.159	-0.006	0.815	0.686	0.931	
Personal	-0.746	0.155	-0.206	0.876	0.512	0.949	0.91

Interestingly Responsiveness also has the highest coefficient for regression on Dimension 2. But since we already named the Dimension 1 as the Responsiveness dimension, we look at the bipolar scale that has the next highest beta coefficient. We can observe that Reliability has the next highest coefficient. So we can name Dimension 2 as Reliability. Figure 12 shows the coordinate map subsequent to naming of dimensions.

VI. Findings and conclusions

Since both bipolar scales had negative coefficients on regression with their respective dimensional coordinates, the higher values for either dimension represents lower attribute presence. In other words, the positive extreme of Dimension 1 represents extremely unresponsive services and vice versa. Same is the case with Dimension 2.

Looking at the coordinates of the restaurants designated OG and RL have highly responsive services, whereas the fast food restaurants (designated as KF, MD, and TB) have low responsive services. This confirms with intuitive sense, fast food restaurants are run as mass production units, whereas the upscale restaurants are analogous to customized production (or services in this case).

Figure 10. Correlation between Appeal and Dimension 1

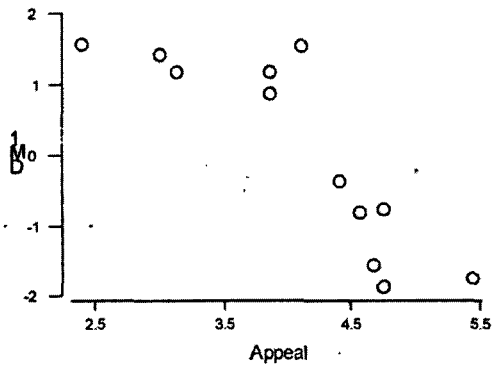


Figure 11. Regression coefficient of bipolar scales

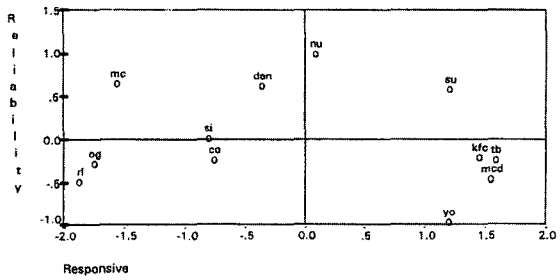
The regression equation is
DIM1 = 0.067 Pr - 1.27 Ap + 0.397 Rel - 1.48 Res + 0.553 Cort + 0.789 Per

Predictor	Coef	Stdev	t-ratio	p
Pr	0.0665	0.2708	0.25	0.814
Ap	-1.2682	0.3031	-4.18	0.006
Rel	0.3975	0.3737	1.06	0.328
Res	-1.4785	0.5986	-2.47	0.048
Cort	0.5532	0.5816	0.95	0.378
Per	0.7892	0.5679	1.39	0.214

The regression equation is
DIM2 = 0.673 Pr + 0.022 Ap - 1.14 Rel - 1.50 Res + 1.40 Cort + 0.949 Per

Predictor	Coef	Stdev	t-ratio	p
Pr	0.6729	0.2539	2.65	0.038
Ap	0.0219	0.2841	0.08	0.941
Rel	-1.1377	0.3503	-3.25	0.018
Res	-1.5045	0.5611	-2.68	0.036
Cort	1.3970	0.5452	2.56	0.043
Per	0.9487	0.5323	1.78	0.125

Figure 12. Named Dimensions



In terms of Dimension 2 (reliability), a restaurant designated as YO surprisingly fares the highest on reliability and one designated as NU lowest. The group of fast restaurants and upscale restaurant are identified with moderate reliability.

The research presented in this studyfound Reliability and Responsiveness as the two underlying attributes customers use to formulate service quality perceptions. This is an interesting fact, since Parasuraman et al. found these two dimensions to be the strongest among all the five dimensions they specified in their SERVQUAL instrument. Thus as pointed out earlier the other three dimensions might be redundant, resulted from overfitting the data by Factor Analysis.

It will be interesting to replicate this study for other services in order to determine whether the same two dimensions are the underlying attributes. This would indicate that service quality measurements are driven by two stable dimensions: Responsiveness and Reliability.

Ⅶ. Further research issues

We in an endeavor to name the dimensions proposed looking at the factor analysis approach to group the bipolar scale attributes and use the factors obtained to name the stable dimensions obtained through multidimensional scaling. This section reports the results of the endeavor.

The mean ratings for the six bipolar scales shown in Figure 8 were used to conduct the exploratory factor analysis. Figure 13 presents the results from the analysis.

Figure 13. Factor Analysis of bipolar scale ratings

Figure 13a. Initial Factor Matrix

	Factor 1	Factor 2
PERSONAL	.98066	-.06332

COURTEOUS	.97391	-.00319
RESPONSE	.96794	-.01905
APPEAL	.90009	-.19308
RELIABLE	.80685	.51303
PRICE	-.16155	.96884

Figure 13b. Rotated Factor Matrix (Orthogonal Rotation) Factor 1Factor 2

PERSONAL	.97748	-.10111
COURTEOUS	.97306	-.04076
RESPONSE	.96648	-.05638
APPEAL	.89197	-.22766
RELIABLE	.82604	.48152
PRICE	-.12405	.97436

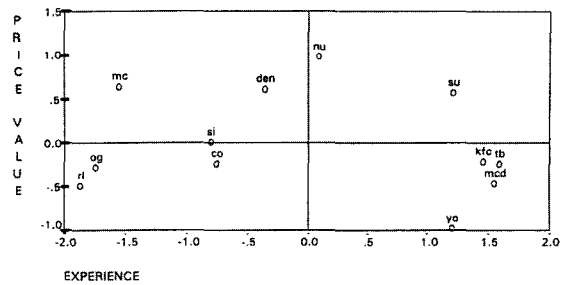
Figure 13c. Rotated Pattern Matrix (Oblique Rotation) Factor 1Factor 2

PERSONAL	.97735	-.08052
COURTEOUS	.97319	-.02025
RESPONSE	.96654	-.03601
APPEAL	.89126	-.20888
RELIABLE	.82838	.49899
PRICE	-.11988	.97184

Figure 13 shows that the same factors were obtained irrespective of which factor rotation method was used (same factors from Orthogonal and Oblique rotation). The first factor seems to be a combination of appeal of the atmosphere at service facility, reliability of the service, responsiveness of the service employees, courteousness of the service employees, and the personal attention received by the customer during the service .process. These together seem to be the *experience properties of a service*, thus we can name the first factor as the experience properties of service. The second factor is solely attributable to *price value of the service* and we can name the-second factor accordingly.

These derived factors can now be used to name the dimensions obtained through MDS analysis of service quality attributes. Thus Dimension 1 on the coordinate map in MDS analysiscan be named as experience properties of service and the Dimension 2 as the price value of the service. The coordinate map after naming the dimensions in this manner is shown in Figure 14.

Figure 14. Named Dimensions (EFA)



The upscale restaurants (those designated as RL and OG) have a good experience properties associated with them by the customers. On the other hand fast food restaurants (those designated as MD, KF, and TB) have low experience properties associated with them. This is in line with what would be expected intuitively.

Similarly, a restaurant designated as YOis considered to have a high value for price

charged for the service whereas one designated as NU has a low value for price charged. The reason for this could that although YO charges the same price for meals as the fast food restaurant but the customers perceive the quality of food to be better and healthier. NU which is a pizza restaurant charges high prices for its pizzas as compared to other pizza restaurants but does not offer anything differentiating in the way of service.Also the quality of the products is not significantly different for them to justify high prices. Thus the customers perceive NU as a restaurant which has a low price value.

The interpretation of the MDS dimensions using the exploratory factor analysis seems to be very easy and intuitive. This might be a better way to interpret MDS dimensions but further research is needed in this direction to validate our proposed methodology.

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