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FACTOR ANALYSIS FOR CONSTRUCT VALIDITY: AN APPLIED STUDY*

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Abstract

In this article, the 19-item information dimension of the scale, originally named "Sustainability Consciousness Questionnaire", was developed by Michalos, Creech, Swayze, Kahlke, Buckler & Rempel (2012) and updated by Gericke, Pauw, Berlung & Olsson (2018), whose factor structure was previously revealed. (latent variable) Construct validity was tested by applying it to a new data set of 307 people. IBM SPSS and AMOS statistical package programs were used in the analysis of the data. According to the results obtained in the study; It was found that the information dimension of the scale was gathered under three factors as in the original and it could explain 61.72% of the total variance. As a result of the reliability analysis, it was determined that the scale had a high level of reliability according to the Cronbach's-α coefficient (Cronbach's-α =0.923). In the confirmatory factor analysis, the improvement in the goodness of fit coefficients was examined by controlling the modification indices. In addition, the path coefficients of how much the 19 items belonging to the first level of the scale predict the latent variable are all significant. Among the items, it was found that the 13th and 14th items had the most effect (β1= 0.828, p<0.01).

Key words: Goodness of Fit Indices, Structural Equation Modeling, Factor Analysis.

YAPI GEÇERLİLİĞİ İÇİN FAKTÖR ANALİZİ: UYGULAMALI BİR ÇALIŞMA

Özet

Bu makalede daha önce faktör yapısı ortaya konmuş Michalos, Creech, Swayze, Kahlke, Buckler & Rempel (2012) tarafından geliştirilen, Gericke, Pauw, Berlung & Olsson (2018) tarafından güncellenen orijinal adı "Sustainability Consciousness Questionnaire"olan ölçeğin 19 maddelik bilgi boyutunun (gizil değişken) 307 kişilik yeni bir veri setine uygulanarak yapı geçerliliği test edilmiştir. Verilerin analizinde IBM SPSS ve AMOS istatistik paket programları kullanılmıştır. Çalışmada elde edilen sonuçlara göre; ölçeğin bilgi boyutu orijinalindeki gibi üç faktör altında toplandığı ve toplam varyansın %61,72'sini açıklayabildiği elde edilmiştir. Güvenilirlik analizi sonucunda Cronbach's-α katsayısına göre, ölçeğin yüksek bir güvenilirlik düzeyine sahip olduğu belirlenmiştir (Cronbach's-α =0.923). Doğrulayıcı faktör analizinde modifikasyon indislerinin kontrolü ile uyum iyiliği katsayılarındaki iyileşme incelenmiştir. Ayrıca ölçeğin

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birinci düzeyine ait 19 maddenin gizil değişkeni ne kadar yordadığına dair yol katsayılarının hepsi anlamlıdır. Maddeler arasından en fazla etkiye sahip olan maddenin 13. ve 14. Madde olduğunu bulunmuştur ($\beta 1 = 0,828$, $p<0,01$).

Anahtar kelimeler: Uyum İyiliği İndeksleri, Yapısal Eşitlik Modellemesi, Faktör Analizi.

INTRODUCTION

In the analyzes made in the fields of social sciences, educational sciences, psychology, biology and medicine, the relationship between measurable (observed) variables such as age, income, score, weight, pressure, etc., with non-directly measurable (latent) variables such as attitude, behavior, knowledge, anxiety, personality, intelligencei s frequently needed. It is also very important how confidently the items used in scale studies measure the variable to be measured. While looking at the relationship between several variables in classical methods, Structural equation modeling (SEM) detects the effects of latent and observed variables on each other simultaneously. Although it is a statistical method in which the results of factor analysis and regression analysis can be interpreted simultaneously, it is preferred by researchers even though it contains difficult techniques. Confirmatory factor analysis and exploratory factor analysis are a general and broad family of analyzes including multiple regression analysis and correlation analysis (Harrington, 2009).

Confirmatory Factor Analysis (CFA), which is the most widely used in the literature, is an extension of Explanatory Factor Analysis (EFA). It was first developed by Karl Jöreskog in 1967 in order to evaluate the construct validity of the data (Jöreskog, 1967). While EFA is trying to provide a determination function, to obtain information for forming hypotheses, CFA is used to test whether there is a sufficient level of relationship between these determined factors, which variables are related to which factors, whether the factors are independent from each other, and whether the factors are sufficient to explain the model (Özdamar, 2008). In summary, factor analysis as a whole (EFA or CFA) focuses on how and to what extent the observed variables are related to the underlying latent factors (Byrne, 2009).

The researcher may want to determine both the relationships between the items and the margins of error, the factor structure that will be formed with the help of these items, and the relationship between these factors, at the same time, with the survey study prepared in the Likert scale type. While DFA produces answers to all these questions, it also checks the prerequisites for these analyzes. Before starting CFA, it is necessary to analyze the normality of the data, outlier and outlier control, and missing data analysis. Whether the questions in the scale form a whole in a homogeneous structure is determined by the Cronbach Alpha Coefficient (Cronbach, 1951). If the questions in the form are reliable, this coefficient will be close to 1.

In this study, the validity of the Sustainability Knowledge dimension, which is one of the 3 different dimensions of the Sustainability Awareness Scale, was subjected to SEM processes with a new data set. Outlier analysis, item analysis, explanatory factor analysis, reliability analysis and confirmatory factor analysis, which should be used in the test of construct validity, were tried to be demonstrated in practice.

MATERIAL AND METHODS

Material

In this study, Sustainability Consciousness Questionnaire, originally called "Sustainability Consciousness Questionnaire", was developed by Michalos, Creech, Swayze, Kahlke, Buckler, and Rempel (2012) and updated by Gericke, Pauw, Berlung, and Olsson (2018), whose factor structure was revealed by using explanatory factor analysis. Consciousness Scale was used. The original scale consists of 50 items and 3 dimensions (Sustainability Knowledge, Sustainability Attitude and Sustainability Behavior) and is in the 5-point Likert type. The knowledge dimension includes 19 items, and the Attitude and Behavior dimensions include 14 and 17 items, respectively. Each dimension contains items belonging to environmental, social and economic components. The scale developed for primary and secondary school students was updated in the following years and applied to teachers as well. The descriptive mean of the scale's Sustainability Awareness dimension is M= 5.197 (SD= 1.112).

Methods

The data of this study were drawn randomly from a survey of 1943 people applied through google forms between 17.3.2021-1.6.2021. There is no missing value in the data. After the extreme value (outlier) analysis, the number of data decreased to 297. The universe of the study is 7.,8.,9.,10. class students. Since the findings obtained in the study were not tried to be generalized to any universe, the universe-sample relationship was not entered and was carried out in a theoretical framework. There are different software used in the literature to perform SEM analysis. In this study, AMOS Version 23, which is preferred by researchers, was used. The exploratory factor analysis and the control of the prerequisites for these analyzes were made in SPSS Version 26 software.

Statistical Analysis

In this study, exploratory factor analysis was performed with SPSS Version 26 and a new data set on the information dimension consisting of the first 19 items of the Sustainability Awareness Scale, and then Confirmatory Factor Analysis was performed with AMOS Version 23. There is no missing value in the data.

The normality of the data and the extreme values were checked. Normality assumption was checked with skewness and kurtosis values. In the exploratory factor analysis, 19 items belonging to the latent variable were grouped under 3 factors. The factorization structure is compatible with the original source. With item analysis in the Amos program, it is possible to determine the fit of the model as a whole with more than one model goodness coefficient. In addition, the path coefficients that give the latent variable explanation coefficient of each item can also be looked at. If acceptable coefficient ranges are not reached when the program is first run, evidence of mismatch is captured by modification indices (change indices), which can be conceptualized as a degree of freedom χ^2 statistic (Jöreskog & Sörbom, 1993).

Modification indices detect highly correlated error terms. By assigning covariance between these terms, it is tried to reach acceptable goodness of fit coefficients. In addition to the modification process, it is possible to remove items from the analysis for acceptable model fit. However, this move should not be made regardless of the significance of the path coefficients, the factor load of the items, and the item validity coefficients in the Item-Total statistics table. In Confirmatory Factor Analysis, the $\chi 2$ fit test, that is, the CMIN/DF value, is expected to be between 2 and 5 (Kelloway, 1998). Since the value of CMIN, i.e. $\chi 2$ (N-1) is equal to the value of (N-1)Fmin (N Sample volume F is the minimum fit function for any calculation methods used such as ML (Maximum Likelihood), GLS (Generalized Least Squares) or ULS (Unweighted Least Squares) (Erkorkmaz et al. ., 2012. Due to the estimated number of parameters and sample size used in its formula, it can take values up to very high levels (Kline, 2011).

Researchers have taken these limitations into account and suggested more practical and utilitarian fit indices (Gerbing & Anderson, 1993; Hu & Bentler, 1995; Marsh, Balla & McDonald, 1988; Tanaka, 1993; Bryne, 1993). Other than the χ^2 chi-square test (CMIN/DF), the ones that are frequently used in the literature are; Root Mean Square Error of Approximation (RMSEA); Comparative Fit Index (CFI, Comparative Fit Index); Goodness of Fit Index (GFI, Goodness of Fit Index); Root Mean Errors (SRMR); It can be listed as scaled fit index (NFI; Normed Fit Index). In this study, the theoretical formulas of these indexes are not mentioned. Threshold values of these indices in various sources are given in Table 1.

Table1. Threshold values of goodness of fit coefficient according to different sources

Reference Comment	Critical Value	Comment
Hooper, Coughlan and Müllen, 2008	GFI≥0.95	Perfect fit
Kline, 2011	0.95≥GFI≥90	Good fit
Anderson and Gerbing, 1984	0.85≥GFI≥0.90	Acceptable
Hu and Bentler, 1999	NFI≥0.95	Perfect fit
Kline, 2011	0.95≥NFI≥90	Good fit
Hooper, Coughlan and Müllen, 2008	0.80≥NFI≥0.90	Acceptable
Hooper, Coughlan and Müllen, 2008	0.03≥RMSEA	Perfect fit
Jöreskog and Sörborn, 1993	0.05≥RMSEA≥0.03	Good fit
Jöreskog and Sörborn, 1993	0.08≥RMSEA≥0.05	Acceptable
Tabachnick and Fidell, 2011	SMRM≈0	Perfect fit
Kline, 2011	0.05≥SMRM	Good fit
Anderson and Gerbing, 1984	0.08≥SMRM>0.05	Acceptable

RESULTS

Demographic information of the participants participating in the study is given in Table 2.

Table2. Demographic information

	Frequency	Percentage
Gender		
Girl	146	49.1
Male	151	50.8
Class		
7. Class	62	20.9
8. Class	79	26.6
9. Class	78	26.3
10. Class	78	26.3
Mother Education Status		
Illiterate	10	3.3
Primary school	107	36.0
Middle School	51	17.2
High school	90	30.3
University	39	13.1
Father Education Status		
Illiterate	7	2.0
Primary school	69	23.2
Middle School	45	15.1
High school	112	37.7
University	65	21.9
Do You Have Own Room		
Yes	230	77.4
No	67	22.5
Do you have a computer at home		
Yes	217	73.1

No	80	26.9

Since the likert scale of the expressions to be analyzed affects the normality test, the skewness and kurtosis coefficients, which are the indicators of the normal distribution of each expression, were examined. In practice, it is seen that various coefficients regarding skewness and kurtosis values are ±1.5 (Tabachnick & Fidell, 2001) according to some authors and ±2 (George & Mallery, 2010) according to some authors. ±1.5 coefficient, which is a close value, is taken as basis.

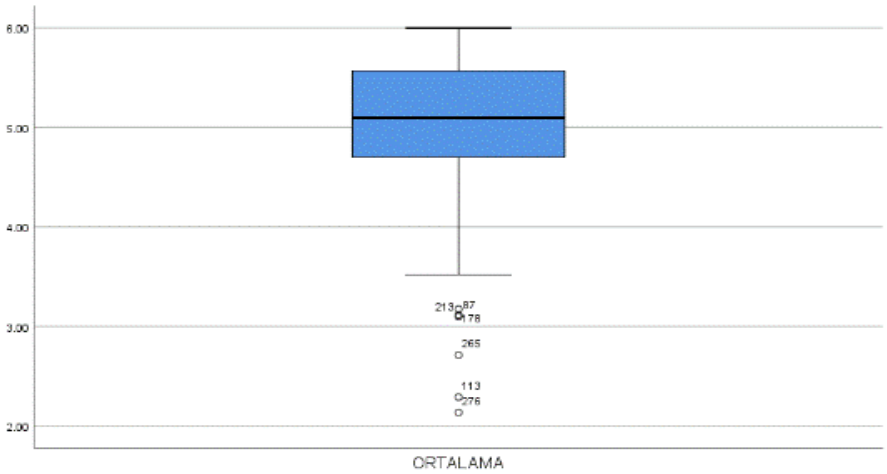

Figure 1. Boxplot for outlier (outlier) values check

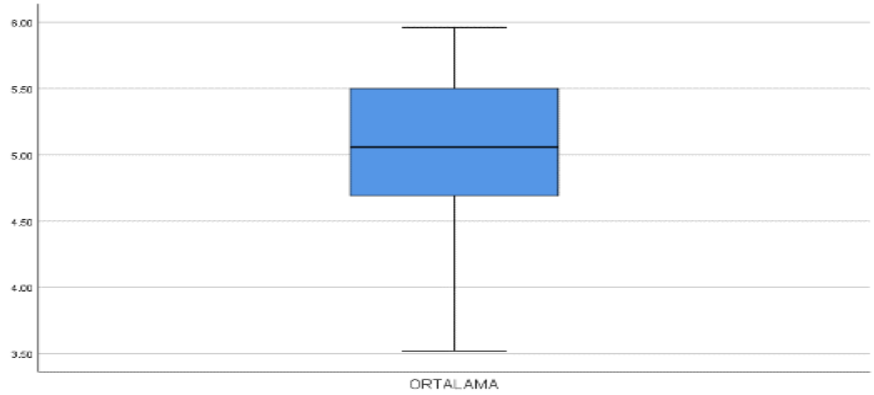

Figure 2. Boxplot when outliers are extracted

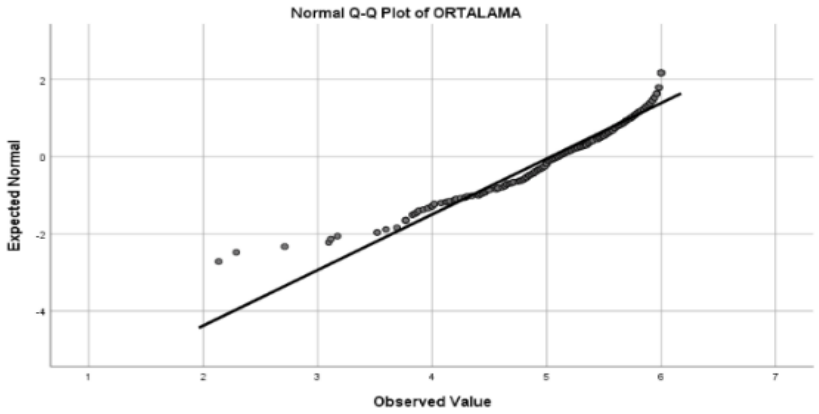

Figure 3. q-q plot for outlier (outlier) outliers are removed

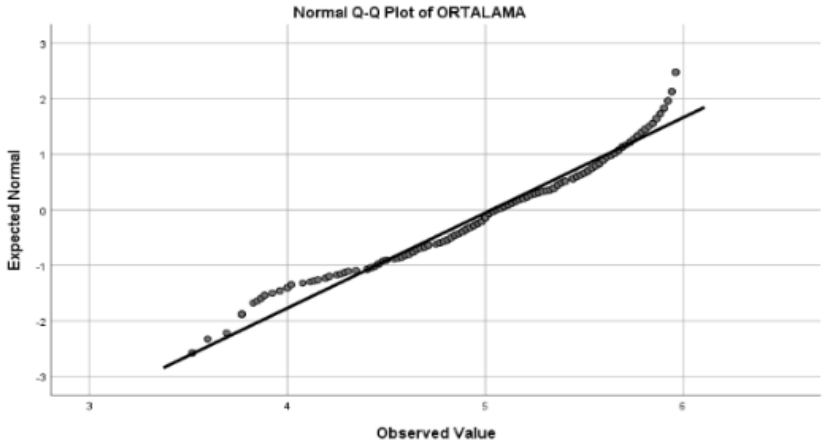

Figure 4. q-q plot when values control

The answers of some participants were outside the normal distribution values of ±1.5 at the confidence interval of 0.05. The data entry number of the participants who were not included in the distribution is shown in Figure 1. A total of 10 participants were excluded from the analysis by deleting them, as this would negatively affect the analyzes and factor dimensions to be made within the scope of factorization. After examining the contradictions between the answers, finding the values outside the answer range, and cleaning the data with extreme values, skewness=-0.559; std.err=0.141 and kurtosis=-0.313; It was found to be std.err=0.282. After clearing out the outliers, Boxplot and qq plot are given in Figure 2 and Figure 4, respectively.

Before the exploratory factor analysis, the reliability analysis of the item was also done. The Cronbach's Alpha Coefficient for the reliability analysis is 0.923. In addition, item-total (Item-Total) statistics were also examined. The results are presented in Table3. According to the Cronbach's Alpha if Item Deleted column, which shows the change in Cronbach's Alpha value in case of item

deletion, it is seen that the coefficient will decrease if any item is deleted. According to the analysis output, it can be read that the coefficient will be preserved if only the M3 and M6 items are deleted. Similarly, if item M5 is deleted, it seems that the Cronbach's Alpha value will decrease from 0.923 to 0.918. This situation provides guidance to the researcher regarding the decision of item deletion while checking the model goodness coefficients in the confirmatory factor analysis, which is the next step.

Table 3. Item-Total Statistics

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
M1	93.34	157.779	.443	.922
M2	93.37	157.057	.491	.921
M3	93.61	155.273	.437	.923
M4	93.28	155.649	.567	.920
M5	93.57	150.928	.639	.918
M6	93.72	154.378	.458	.923
M7	93.60	151.504	.635	.918
M8	93.37	153.742	.536	.921
M9	93.39	152.571	.650	.918
M10	93.49	152.582	.589	.919
M11	93.47	151.825	.648	.918
M13	93.51	149.035	.724	.916
M14	93.56	147.571	.725	.916
M16	93.74	147.867	.643	.918
M17	93.73	149.947	.625	.919
M18	93.70	149.725	.599	.919
M19	93.60	149.782	.585	.920

In order to continue the factor analysis, the data must come from a multiple normal distribution. In order to detect this, the Bartlett sphericity test is performed. KMO and Bartlett tests were performed to determine whether the data set was suitable for factorization. The analysis output giving the test statistics values is given in Table 4.

Table 4. KMO and Bartlett' s Tests

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.913
Bartlett's Test of Sphericity	Approx. Chi-Square	3115.301
	df	171
	Sig.	.000

The KMO value, which indicates the suitability of the data for factor analysis, is required to be greater than 0.7 (Bartlett, 1950). After determining the suitability of the data for factorization, exploratory factor analysis was performed. The output of common variance values is given in Table 5.

Table5. Communalities

Communalities		
	Initial	**Extraction**
M1	1.000	.626
M2	1.000	.643
M3	1.000	.546
M4	1.000	.637
M5	1.000	.570
M6	1.000	.428
M7	1.000	.520
M8	1.000	.755
M9	1.000	.701
M10	1.000	.533
M11	1.000	.513
M12	1.000	.625
M13	1.000	.705
M14	1.000	.713
M15	1.000	.633
M16	1.000	.724
M17	1.000	.619
M18	1.000	.558
M19	1.000	.554

When the Common variance (Communality) table of the Exploratory Factor Analysis is examined, there is no value with a common variance value below 0.30. In this case, it is another clue that item deletion should not be preferred for this data set.

In exploratory factor analysis, there are 3 components with eigenvalues greater than one. This means that the 19 items used in the scale will be grouped under 3 factors. In the original of the scale, the items in this dimension were distributed over 3 factors. The percentage of explanation of the total variance of these factors is 61,072%. The graph showing the total variance and factorization structure explained in the program output Table 6 is given in Table 7 and Figure 5, respectively.

Table6. Explained total variance table

Components	Eigenvalues			Total Variance Explained		
	Total	%of variance	Cumulative%	Total	%of variance	Cumulative%
1	8.124	42.759	42.759	5.276	27.768	27.768
2	2.374	12.496	55.256	3.827	20.144	47.912
3	1.105	5.816	61.072	2.500	13.159	61.072
4	.929	4.890	65.962			
5	.766	4.033	69.995			
6	.650	3.423	73.418			
7	.605	3.187	76.605			
8	.542	2.854	79.459			
9	.511	2.692	82.151			
10	.496	2.609	84.761			
11	.484	2.547	87.308			
12	.434	2.284	89.592			
13	.382	2.010	91.602			
14	.341	1.797	93.399			
15	.305	1.607	95.006			
16	.283	1.489	96.495			
17	.257	1.355	97.849			
18	.224	1.180	99.029			
19	.185	.971	100.000			

As seen in Figure 5, a sharp return is observed after the first third eigenvalue. This is a sign that the scale will be three-dimensional.

Table 7. Rotated factor matrix

	Components		
	1	2	3
M16	.830		
M13	.785		
M14	.777		
M17	.768		
M15	.736		
M18	.724		
M12	.665		.371
M19	.600		.441
M11	.555		.383
M1		.785	
M2		.775	
M4		.759	
M3		.729	
M6		.616	
M5		.614	.320

M7	.391	.555	
M8			.818
M9	.362		.722
M10	.351		.596

When Table 7 is examined, it is seen that some M5, M7, M9, M10, M11, M12, M19 items are included in two factors. Items that create loads in more than one factor are called overlapping items, and if the fraction between two loads is less than 0.1, it is recommended to exclude the item from the analysis (Pallant, 2002). Since the load difference between the overlapping items in the table was greater than 0.1, the next step was continued without deleting the item.

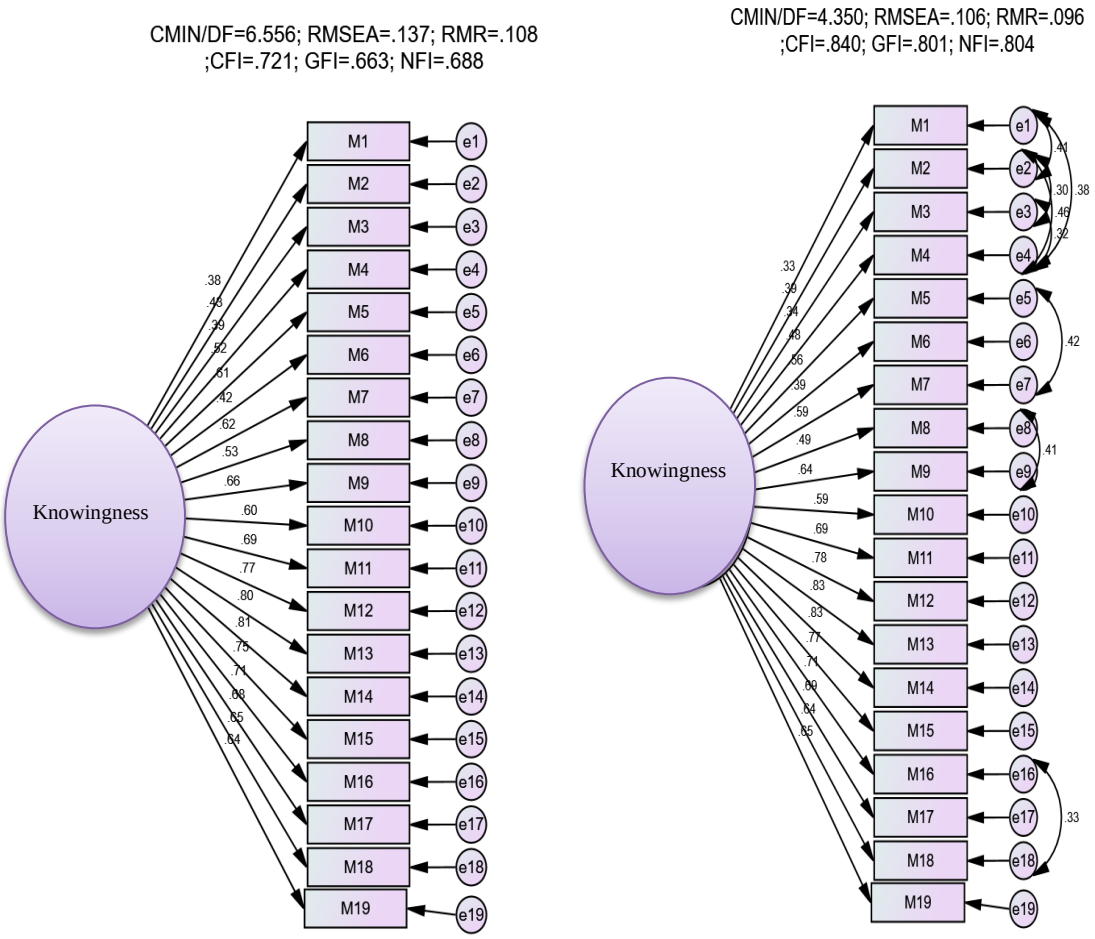

Figure 5. Path diagram before and after covariance assignments (Modification)

The path diagram of the items in each dimension created in Amos is given in figure 6. Since the coefficients of goodness of fit and path coefficients were not at the desired level when the model was first run, a modification was made between the error terms with a high correlation between them. The Amos program gives the correlations between each variable and the improvement

that will occur in the goodness of fit and path coefficients after the covariance assignment to be defined between them. The highly correlated error terms were determined from the "modification indices" tab in the output interface, and covariance assignment (modification) was made one by one, starting with the error terms with the highest correlation. The program algorithm rearranges the goodness-of-fit coefficients for each modification. For this reason, the modification process should be done one by one, starting with the error terms with the highest correlation, checking after each start-up. The improvement in the goodness-of-fit coefficients after the modification moves are given in Table 8.

Table 8. Improvement in covariance assignments and cohesiveness coefficients

	CMIN/DF	RMSEA	SRMR	CFI	GFI	NFI
Covariance Assignments						
When the model first runs	6.556	0.137	0.108	0.721	0.663	0.668
e1-e2 between	6.077	0.131	0.106	0.746	0.702	0.713
e2-e4 between	5.886	0.128	0.105	0.757	0.712	0.723
e1-e4 between	5.406	0.122	0.103	0.783	0.744	0.748
e3-e4 between	5.328	0.121	0.102	0.788	0.747	0.753
e2-e3 between	5.183	0.119	0.099	0.796	0.754	0.761
e5-e7 between	4.856	0.114	0.098	0.814	0.776	0.778
e8-e9 between	4.527	0.109	0.098	0.831	0.795	0.794
e16-e18 between	4.350	0.106	0.096	0.840	0.801	0.804

Before and after the modification assignments, the goodness-of-fit coefficients showed correct improvement to acceptable values. A total of 8 modifications were made. As long as this modification process is continued, the model fit coefficients will improve each time. Although the number of modifications is related to the number of items, there is no consensus on how many modifications should be made (Tuğrul and Çitil, 2020; Tuğrul and Çitil, 2021).

Table 9. Regression coefficients of the items

Structural paths		Regression coefficients	Std. Regression coefficients	Critical Ratio	P value	
M1	<---	Unobservable latent variable (information dimension)	1	0.326		
M2	<---		1.118	0.39	5.71	***
M3	<---		1.301	0.342	4.15	***
M4	<---		1.374	0.483	5.988	***
M5	<---		2.018	0.557	5.082	***
M6	<---		1.506	0.387	4.417	***
M7	<---		2.079	0.59	5.169	***
M8	<---		1.733	0.487	4.861	***
M9	<---		2.083	0.644	5.289	***

M10	<---		2.071	0.587	5.163	***
M11	<---		2.338	0.688	5.371	***
M12	<---		2.971	0.78	5.507	***
M13	<---		2.975	0.828	5.564	***
M14	<---		3.202	0.828	5.565	***
M15	<---		3.074	0.767	5.491	***
M16	<---		3.012	0.712	5.41	***
M17	<---		2.673	0.685	5.367	***
M18	<---		2.63	0.643	5.285	***
M19	<---		2.701	0.648	5.298	***

Table 9 shows the path coefficients (regression coefficients) showing the relationship between each item and the latent variable. After the modification processes, it was seen that all of the path coefficients of the items were significant. It can be said that the items with the highest effect among the items related to the latent variable are the 13th and 14th items. There is a positive linear relationship between these two items and the latent variable ($\beta 1= 0.828$, $p<0.01$).

DISCUSSION AND CONCLUSION

For construct validity in the study; outlier (outlier) values analysis, explanatory factor analysis and confirmatory factor analysis, item analysis were performed in order of priority.

Examining the contradictions between the answers, the values outside the answer range and the data with extreme values affect both the factorization structure and the distribution of the data. In order to clear these, outlier value analysis was performed, since in the answers of the participants numbered 288, 276, 265, 213, 178, 169, 145, 131, 113, all questions were marked the same option, leaving all the items blank or answering lightly, the analysis was done has been excluded. After this extraction, when the program was run again, the normality of the data was determined by the skewness and kutosis values (skewness=-0.559; std.err=0.141 and kurtosis=-0.313; std.err=0.282).

In order to reveal the construct validity, factor analysis was performed by adhering to the original structure of the scale. As a result of the exploratory factor analysis, 3 factors with eigenvalues greater than 1 and explaining 61.072% of the total variance in the Knowledge subscale were obtained. The factor loads of the items in the first factor ranged from 0.555 to 0.830, the items

in the second factor ranged from 0.555 to 0.785, and the items in the third factor ranged from 0.596 to 0.818.

Confirmatory factor analysis of the three-factor structure obtained as a result of EFA was used to control the fit indices. According to the results obtained, χ^2/df=4.330; RMSEA=0.106; SRMR=0.096; CFI=0.840; GFI=0.801; NFI = 0.804. The Turkish version of the Sustainable Consciousness Scale used in the study has been used in different studies before. In the study of Confirmatory Factor Analysis was used to reveal whether the scale was validated in the sample of Turkish students, and the goodness of fit coefficients of the knowledge dimension (χ^2/df=4.330; CFI = 0.924; IFI = 0.935; NFI = 0.936; RMSEA). = 0.064) were determined.

Finally, the path (regression coefficients) of each item is given in order to reveal the effect of the items on the knowledge dimension. It has been determined that the item with the highest effect among the items related to the latent variable is the 13th and 14th items ($\beta_{1=}$ 0,828, p<0,01).

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GENİŞLETİLMİŞ ÖZET

Giriş

Bu çalışmada daha önce açıklayıcı faktör analizi yapılarak faktör yapısı ortaya konmuş Michalos, Creech, Swayze, Kahlke, Buckler ve Rempel (2012) tarafından geliştirilen, Gericke, Pauw, Berlung ve Olsson (2018) tarafından güncellenen orjinal adı "Sustainability Consciousness Questionnaire" olan Sürdürülebilirlik Bilinci Ölçeği kullanılmıştır. Sürdürülebilirlik Bilinci Ölçeğinin 3 farklı boyutundan biri olan Sürdürülebilirlik Bilgisi boyutunun geçerliliği yeni bir veri seti ile YEM süreçlerine tabi tutulmuştur. Yapı geçerliliğinin testinde kullanılması gereken aykırı uç değerler analizi, madde analizi, açıklayıcı faktör analizi, güvenilirlik analizi ve doğrulayıcı faktör analizi uygulamalı olarak gösterilmeye çalışılmıştır. Orijinal ölçek 50 madde ve 3 boyuttan (Sürdürülebilirlik Bilgisi, Sürdürülebilirlik Tutumu ve Sürdürülebilirlik Davranışı) oluşmakta olup 5-li Derecelendirmedir (Likert) tipindedir. Bilgi boyutu 19, Tutum ve Davranış boyutları sırası ile 14 ve 17 madde içermektedir. Her boyutun çevresel sosyal ve ekonomik bileşenlere ait maddeler içermektedir. İlköğretim ve orta öğretim öğrencileri için geliştirilen ölçek ileriki yıllarda güncellenerek öğretmenlere de uygulanmıştır. Ölçeğin Sürdürülebilirlik Bilinci boyutuna ait ait betimsel ortalaması M= 5.197 (SD= 1.112) şeklindedir.

Materyal ve Method

Bu çalışmanın verileri 17.3.2021-1.6.2021 tarihleri arasında google formlar aracılığıyla uygulanan 1943 kişilik anketten 307 veri tesadüfi olarak çekilmiştir. Veride kayıp değer yoktur. Uç değer (aykırı değer) analizinin ardından veri sayısı 297'ye düşmüştür. Çalışmanın evrenini 7.,8.,9.,10. sınıf öğrencileri oluşturmaktadır. Çalışmada elde edilen bulgular herhangi bir evrene genellenmeye çalışılmadığından evren örneklem ilişkisine girilmemiş ve kuramsal çerçevede yürütülmüştür. YEM analizlerini gerçekleştirmek için alanyazında kullanılan farklı yazılımlar mevcuttur. Bu çalışmada araştırıcılar sık tercih edilen AMOS Versiyon 23 kullanılmıştır. Açımlayıcı faktör analizi ve bu analizlere dair önşartların kontrolü ise SPSS Versiyon 26 programında yapılmıştır.

Bulgular

Yapı geçerliliği için; öncelik sırasına göre aykırı (uç) değerler analizi, açıklayıcı faktör analizi ve doğrulayıcı faktör analizi, madde analizi yapılmıştır. Cevaplar arasındaki çelişkilerin incelenmesi, cevap aralığı dışında kalan değerler ve aşırı değere sahip veriler hem faktörleşme yapısını hemde verilerin dağılımını etkilemektedir. Bunların temizlenmesi amacıyla aykırı (uç) değer analizi

yapılmış veri setinden 288, 276, 265, 213, 178, 169, 145, 131, 113, numaralı katılımcıların cevaplarında tüm soruları aynı şıkkı işaretleme tüm maddeleri boş bırakma ya da ciddiyetsiz cevaplama durumları sözkonusu olduğundan analiz dışı bırakılmıştır. Bu ayıklamanın ardından program tekrar çalıştırıldığında verilerin normalliği skewness ve kutosisi değerleri ile tespit edilmiştir (skewness=-0.559; std.err=0.141 ve kurtosis=-0.313; std.err=0.282). Analize tabi tutulacak ifadelerin likert ölçekli olması normallik testini etkilediğinden dolayı her bir ifadeye ait normal dağılımın göstergesi olan çarpıklık (skewness) ve basıklık (kurtosis) katsayıları incelenmiştir. Uygulamada çarpıklık ve basıklık değerlerine ilişkin bazı yazarlara göre ±1,5 (Tabachnick ve Fidell, 2001) bazılarına göre ±2 (George ve Mallery, 2010) çeşitli katsayıların 0,05 güven aralığı düzeyinde normal kabul edildiği görülmekle birlikte bu çalışmada 1'e en yakın değer olan ±1,5 katsayısı esas alınmıştır.

Tartışma ve Sonuç

Yapı geçerliliğini ortaya koymak amacıyla ölçeğin orijinal yapısına bağlı kalarak faktör analizi yapılmıştır. Açımlayıcı faktör analizi sonucunda Bilgi alt ölçeğinde toplam varyansın %61.072'sini açıklayan ve özdeğeri 1'den büyük olan 3 faktör elde edilmiştir. Birinci faktörde yer alan maddelerin faktör yükleri 0.555-0.830 arasında, ikinci faktörde yer alan maddelerin 0.555-0.785 ve üçüncü faktörde yer alan maddeler 0.596-0.818 arasında değişmektedir.

Açıklayıcı faktör analizinden önce madderin güvenilirlik analizi de yapılmıştır. Güvenilirlik analizine dair Cronbach's Alfa Katsayısı 0.923'tür. Ayrıca madde-toplam (Item-Total) istatistiklerine de bakılmıştır. Madde silinmesi durumunda Cronbach's Alfa değerindeki değişimi gösteren Cronbach's Alpha if Item Deleted sutununa göre herhangi bir madde silinmesi durumunda katsayının düşeceği görülmektedir. Analiz çıktısına göre sadece M3 ve M6 maddelerinin silinmesi durumunda katsayının korunacağını okunabilmektedir. Benzer şekilde örneğin M5 maddesinin silinmesi durumunda Cronbach's Alpha değerinin 0.923'ten 0.918'e düşeceği gözükmektedir. Bu durum bir sonraki aşama olan doğrulayıcı faktör analizinde model iyiliği katsayıları kontrol edilirken araştırıcıya madde silme kararıyla ilgili yönlendirmeler sağlar.

AFA sonucu elde edilen üç faktörlü yapının doğrulayıcı faktör analizi ile uyum indekslerinin kontrolleri yapılmıştır. Elde edilen sonuçlara göre $\chi^2/df=4.330$; RMSEA=0.106; SRMR=0.096; CFI=0.840; GFI=0.801; NFI= 0.804 şeklindedir. Çalışmada kullanılan Sürdürülebilir Bilinç Ölçeği'nin türkçe uyarlaması daha önce farklı araştırmalarda kullanılmıştır. Yüksel ve yıldız (2019) çalışmasında ölçeğin Türk öğrencilerden oluşan örneklemde doğrulanıp doğrulanmadığını ortaya koymak üzere Doğrulayıcı Faktör Analizi (DFA) yapmış bilgi boyutuna

ait uyum iyiliği katsayılarını (χ^2/df = 4.92; CFI = 0.924; IFI = 0.935; NFI = 0.936; RMSEA = 0.064) olarak belirlemişlerdir.

Son olarak maddelerin bilgi boyutundaki etkisini ortaya koymak amacyla her maddenin yol (regresyon katsayıları) verilmiştir. Gizil değişkene bağlı maddeler arasından en fazla etkiye sahip olan maddenin 13. ve 14. Madde olduğunu tespit edilmiştir ($\beta_{1=}$ 0,828, p<0,01).