



**សាកលវិទ្យាល័យ ភូមិន្ទភ្នំពេញ**  
**ROYAL UNIVERSITY OF PHNOM PENH**

**DEPARTMENT OF INTERNATIONAL BUSINESS MANAGEMENT—IBM**

**APPLIED RESEARCH METHODOLOGY**

**BACHELOR PROGRAM**

**4<sup>TH</sup> YEAR, SEMESTER 1**

**MATERIAL INFO**

**Authors:** Veasna SOU., Sambath PHOU., & Phichhang OU

**Published online** at [www.spss.site](http://www.spss.site): 11-Sept 2024

© 2024 Published by Research Office, (RUPP)

All rights reserved.

---

**TUTORING SERIES-05: Factor Analysis and Reliability Test**

---



## FACTOR ANALYSIS AND RELIABILITY TEST

### **PURPOSES:**

Maximum likelihood factor analysis is a statistical method used to estimate factor matrices and test the accuracy of a factor analysis model in representing attributes in a population (Tucker & Lewis, 1973). Factor reliability tests are crucial tools in research for assessing the quality and structure of measurement instruments. Together, factor analysis and reliability tests help researchers ensure that their instruments are both valid and reliable, supporting the integrity and validity of empirical conclusions. Factor analysis serves two primary functions in data analysis: identifying underlying constructs in data and reducing the number of variables to a more manageable set. Researchers use factor analysis to retain as much information as possible while making the remaining variables meaningful and easy to work with, ensuring a more accurate and meaningful analysis (Aaker et al., 2019).

### **FACTOR ANALYSIS:**

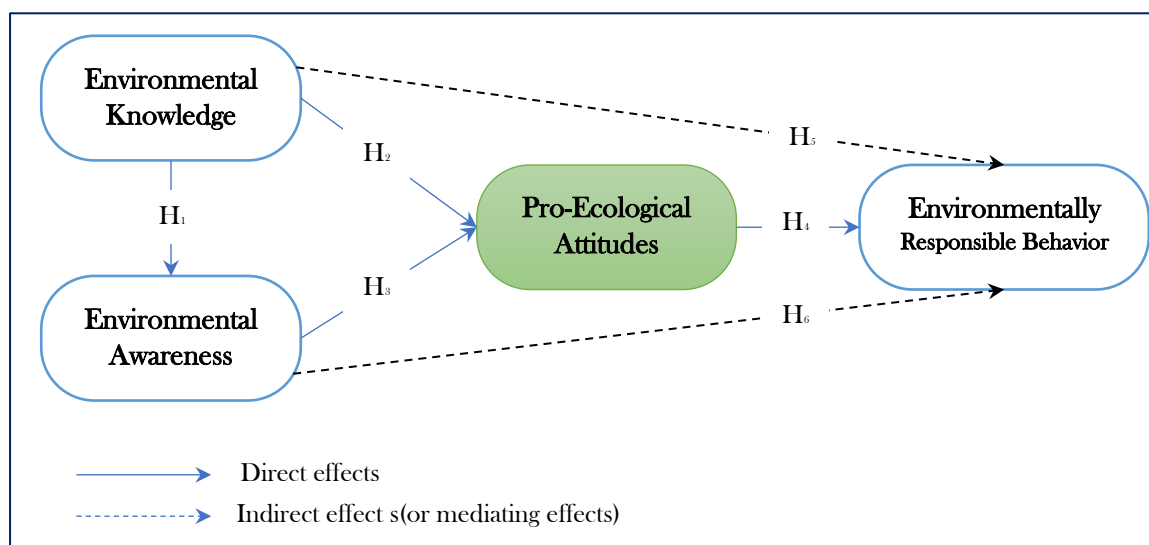
Factor analysis is a prototypical multivariate, interdependence technique (Zikmund et al., 2013). Factor analysis is a statistical method used to determine the tendency of multiple-indicator measures to form distinct clusters, known as factors. It aims to reduce the number of variables researchers need to deal with and assess the inherent structure of the large number of items in measures like Likert scales (Bryman, 2016). Similarly, factor analysis is a technique capable of statistically identifying a reduced number of factors from a larger number of measured variables (Babin et al., 2020). Factor analysis is a method used to identify relationships between measured variables, simplify data, and validate survey instruments by determining if items group together as expected, thus aiding in understanding complex concepts and developing theoretical frameworks.

### **RELIABILITY TEST:**

Reliability is an indicator of a measure's internal consistency, while it represents a measure's homogeneity or the extent to which each indicator of a construct converges on some common meaning (Zikmund et al., 2013). Reliability is the degree to which a measure of a concept is stable (Bryman, 2016). Reliability tests, primarily Cronbach's alpha, assess the internal consistency of a scale or test by measuring the closeness of a set of items to the same construct (Babin et al., 2020). High reliability ensures stable results over repeated applications, enhancing research credibility and accuracy. Reliability analysis helps refine and improve measurement tools.



## CONCEPTUAL FRAMEWORK AND HYPOTHESES DEVELOPMENT:



### 1. RULE OF THUMBS: FACTOR ANALYSIS AND RELIABILITY TEST

**Table 1.** The Rule of Thumbs: Factor Analysis and Reliability Test

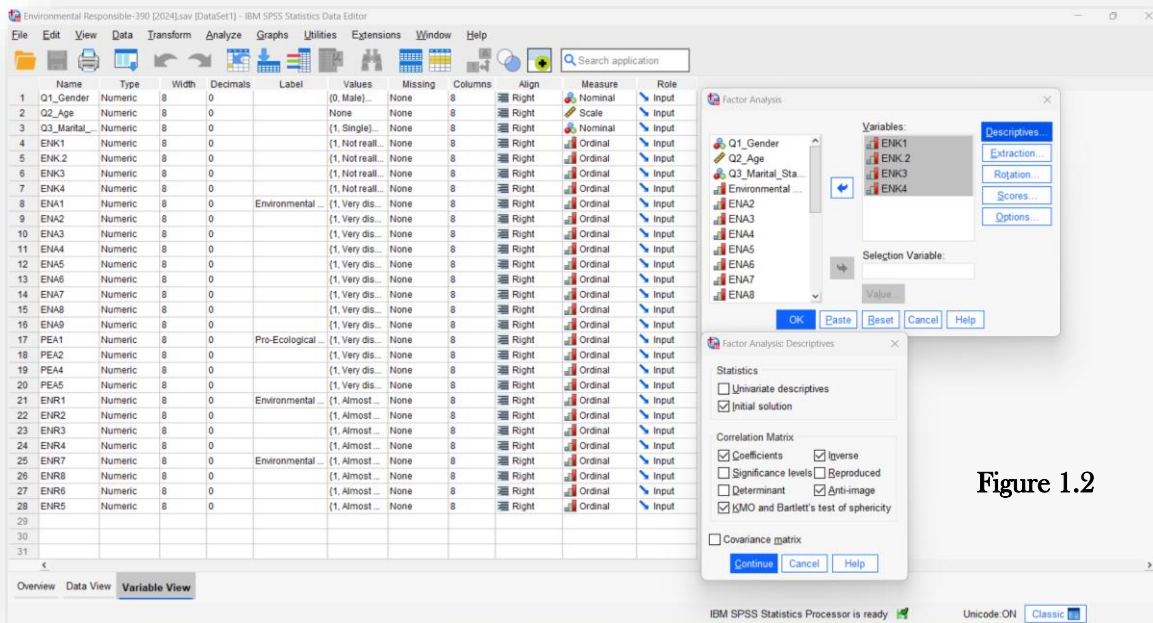
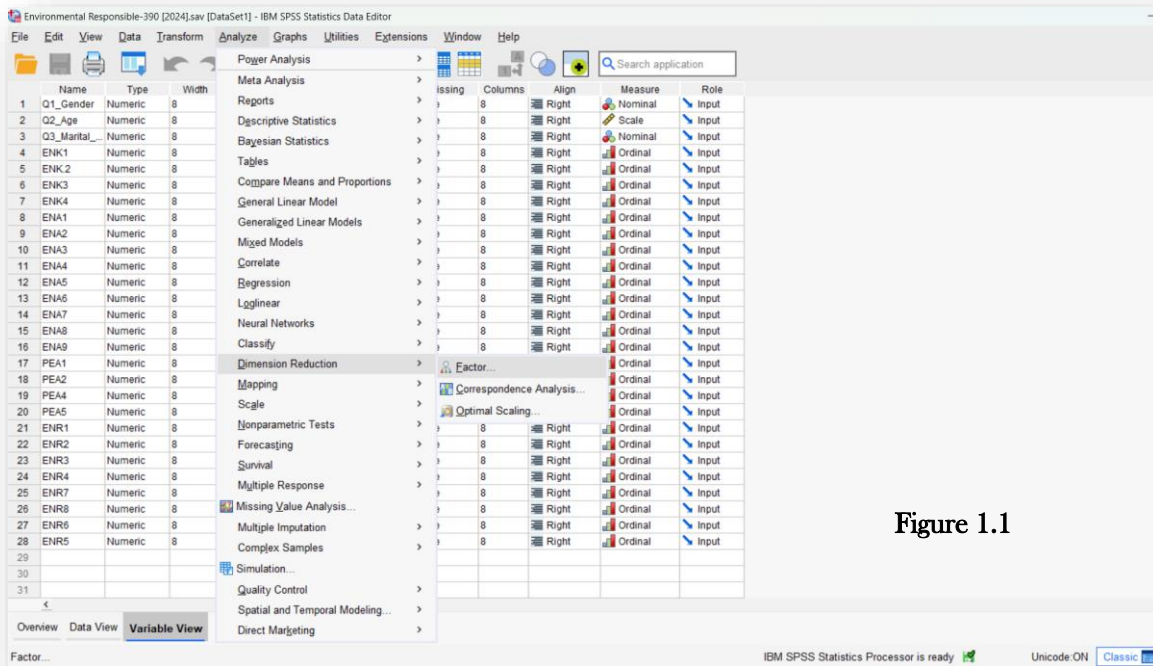
Descriptions	Threshold Values	
	Factor Analysis	Reliability Test
1. Factor Loading (FL)	> 0.60 or 0.70	
2. KMO	≥ 0.50	
3. Eigenvalue	> 1	
4. Cumulative %	> 60%	
5. Item-total-Correlation		≥ 0.50
6. Cronbach's Alpha ( $\alpha$ )		> 0.60 or > 0.70

Sources: (Hair Jr et al., 2019; Hair Jr et al., 2021)

### 2. STEP BY STEP...

#### 2.1. FACTOR ANALYSIS AND RELIABILITY TEST

Go to **Analyze >> Dimension Reduction** (Figure 1.1) >> **Factor** (move items for individual construct to "Variable box" (Figure 1.2) >> **Descriptives** (check: Coefficient, Inverse, Anti-image, and KMO) and then click **Continue** (Figure 1.2) >> **Extraction** (type number 1 into Fixed number of factors) and click **Continue** (Figure 1.3) >> **Rotation** >> Select **Varimax** and click **Continue** (Figure 1.4) >> **Options** click "Shorted by size" >> click **Continue** >> **OK**. Then, you will see the following outputs of research variable—"Environmental Knowledge"



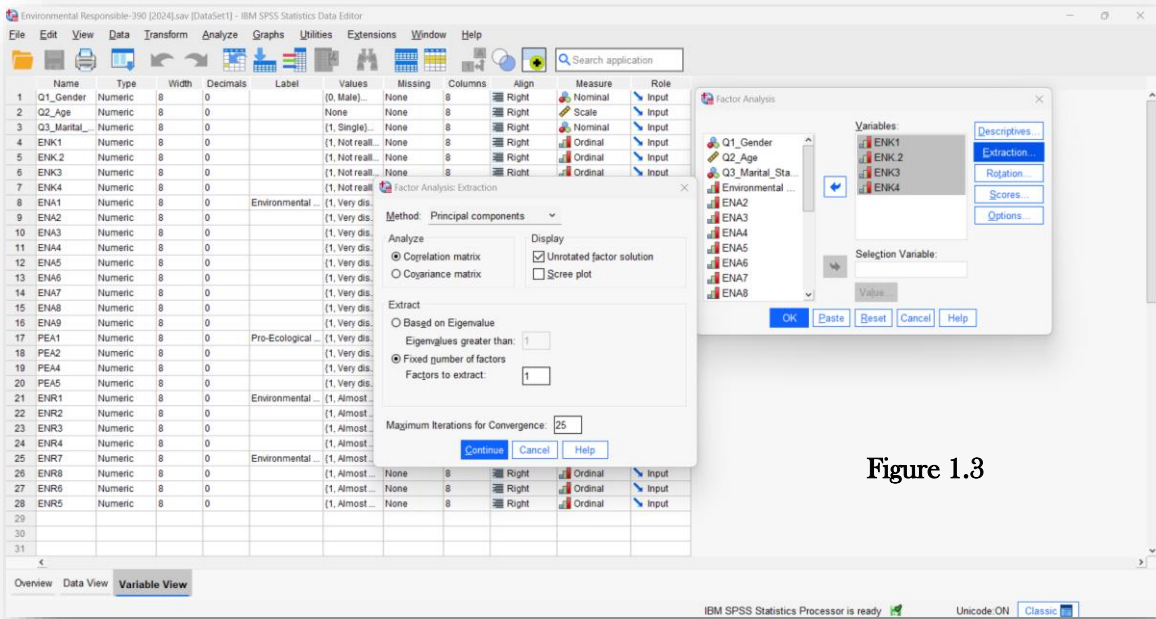


Figure 1.3

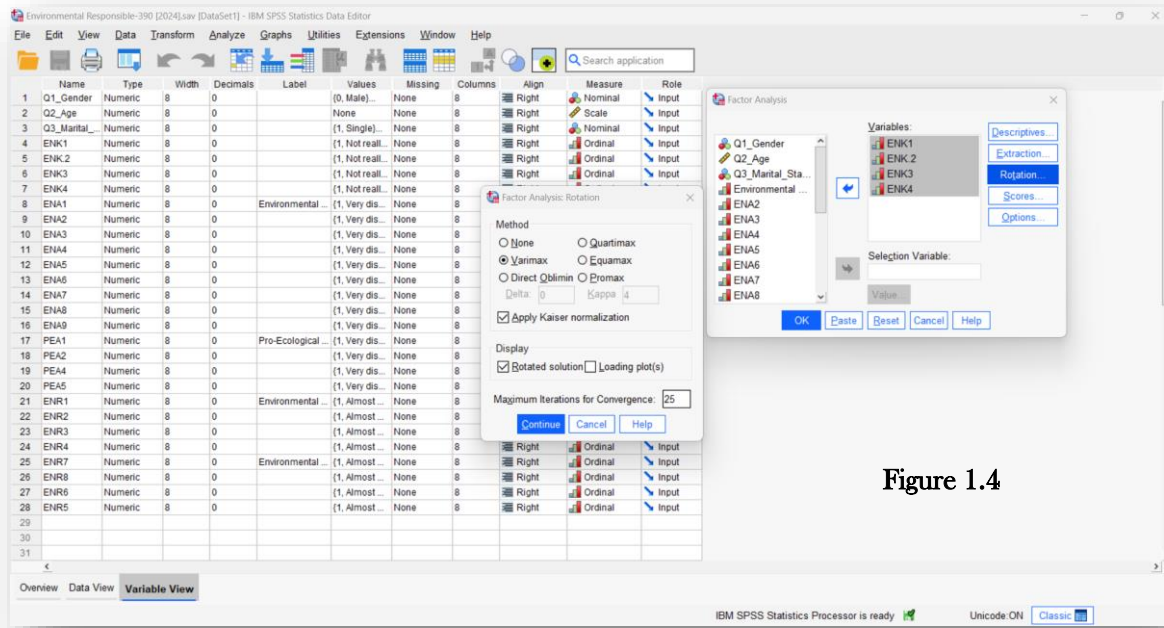


Figure 1.4



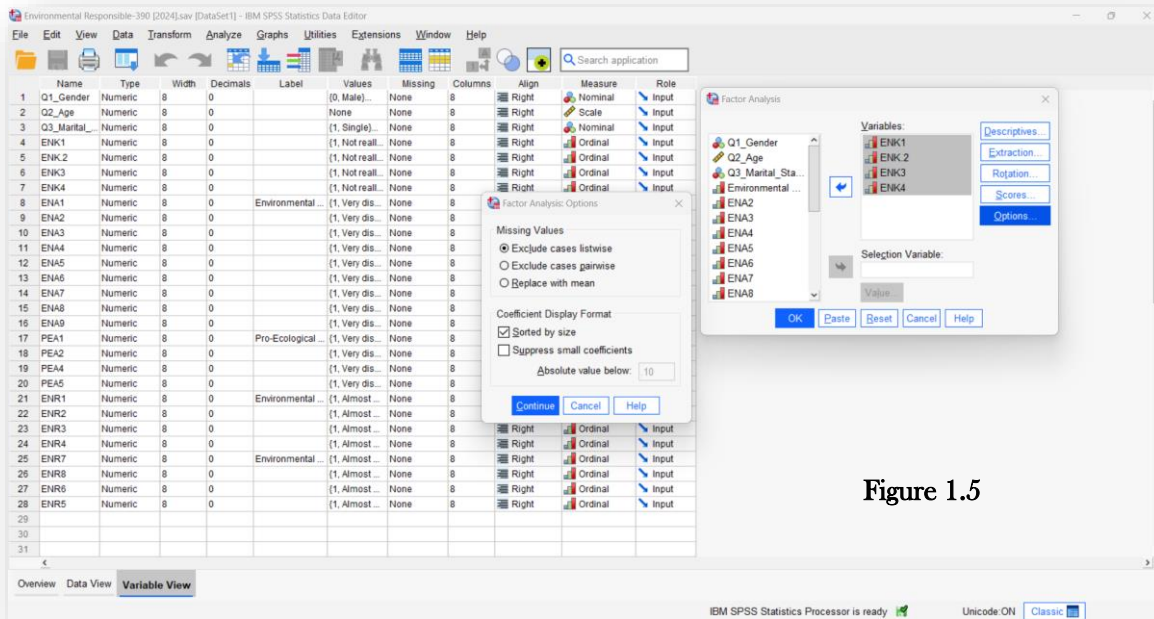


Figure 1.5

## 2.2. FACTOR ANALYSIS AND RELIABILITY TEST: OUTPUTS

In outputs section, you can report the most common practices following tables. After you completed the factor analysis step and make sure that all questionnaire items from this stage must meet the rule of thumbs, as listed in **Table 1**. The formal format for this result is reported in **Table 2**.

<b>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</b>		.799
<b>Bartlett's Test of Sphericity</b>	<b>Approx. Chi-Square</b>	616.203
	<b>df</b>	6
	<b>Sig.</b>	<.001

Component	Total	Initial Eigenvalues		Extraction Sums of Squared Loadings		
		% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.715	67.878	67.878	2.715	67.878	67.878
2	.513	12.813	80.692			
3	.441	11.027	91.719			
4	.331	8.281	100.000			

Extraction Method: Principal Component Analysis.

	Component 1
ENK1	.843
ENK3	.836
ENK.2	.823
ENK4	.793

Extraction Method:  
Principal Component Analysis.  
a. 1 components extracted.

## 2.3. RELIABILITY TEST

Go to **Analyze >> Scale >> Reliability Analysis** (Figure 2.1) >> move 4 items of “Environmental Knowledge” by ordered (Figure 2.2) to **Items** box >> **Statistics** (select: Item, Scale if item deleted, Correlation, and Covariance) >> **Continue** >> **OK** (Figure 2.3). Then, you will see the following outputs of reliability test (see section 2.4).

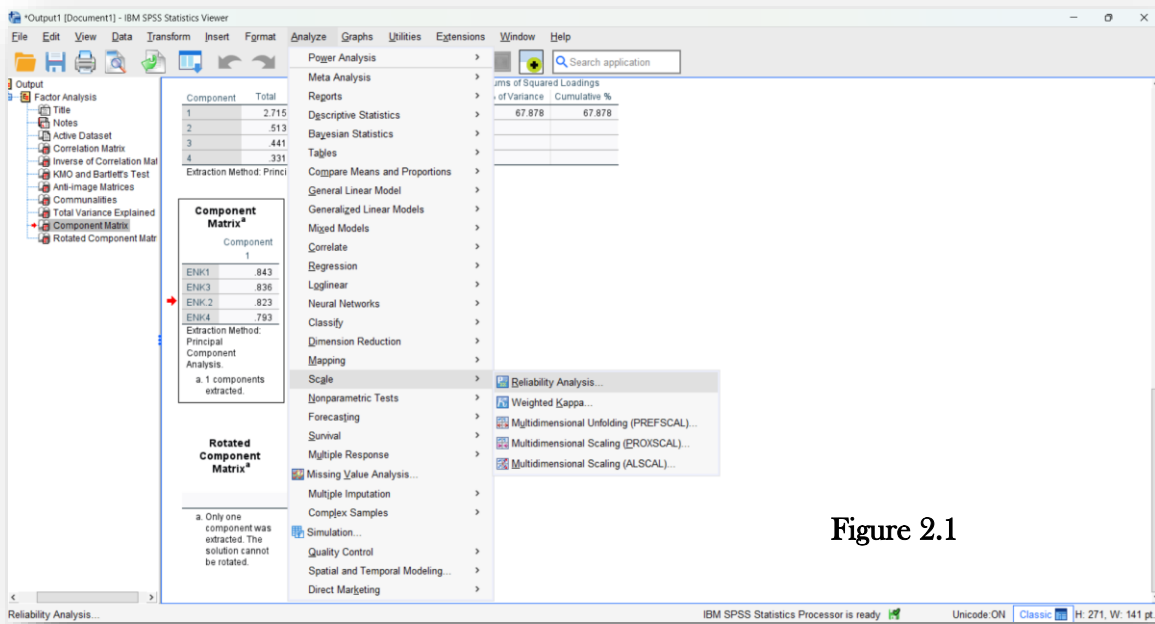


Figure 2.1

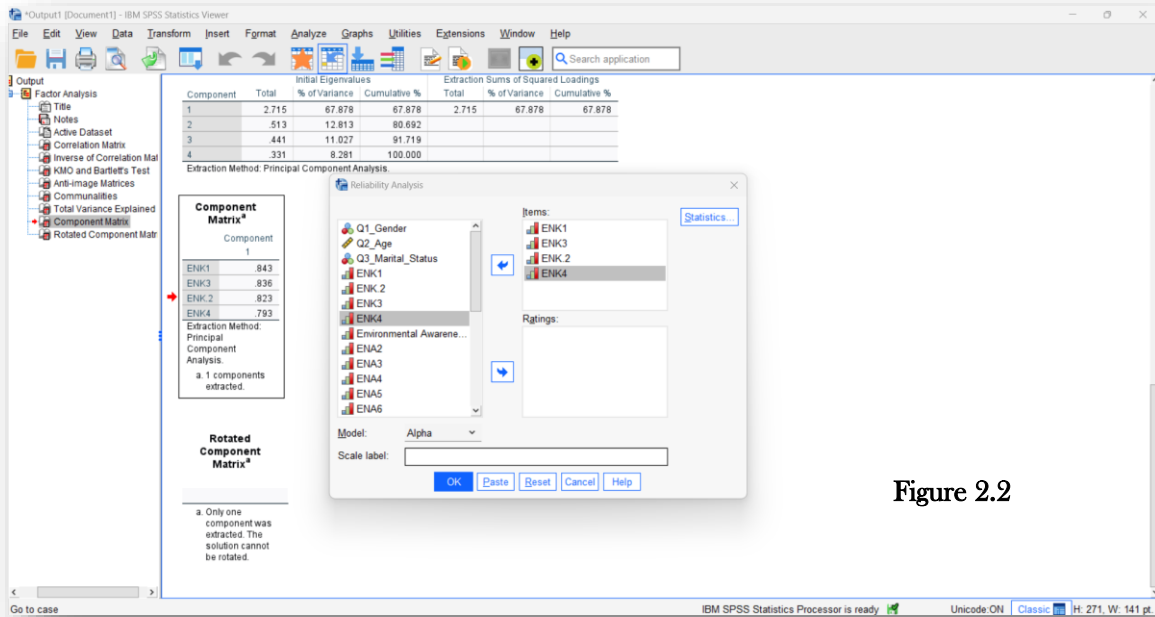


Figure 2.2

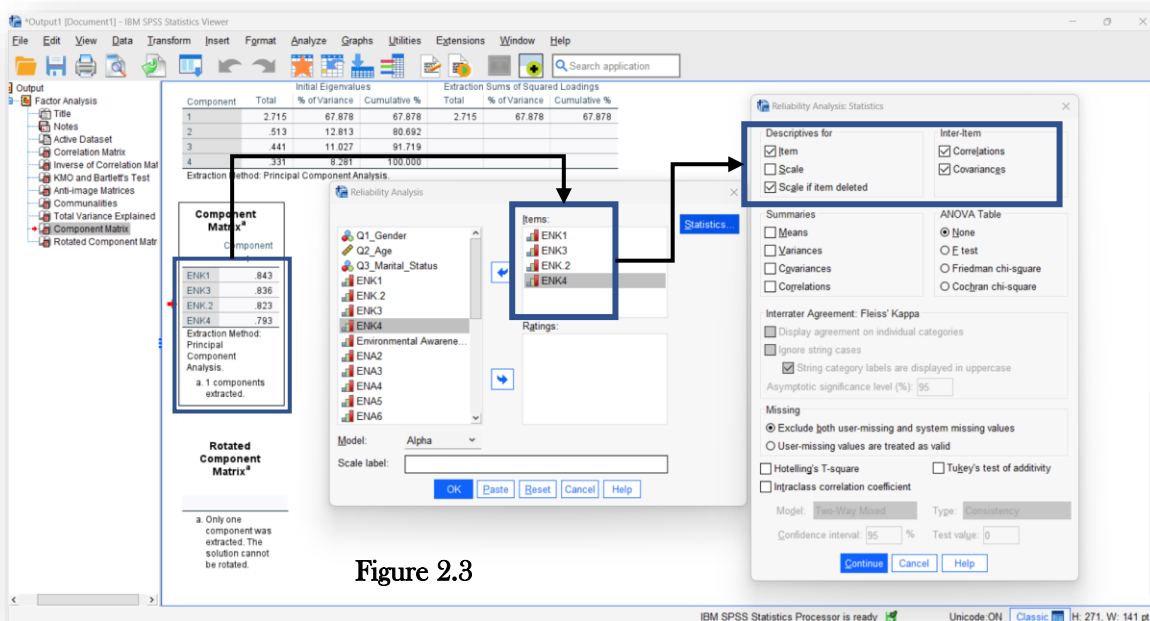


Figure 2.3

## 2.4. RELIABILITY TEST: OUTPUTS

In outputs section, you can report the most common practices following tables. After you completed this step and make sure that all questionnaire items from this stage must meet the rule of thumbs, as listed in **Table 1**. The formal format for this result is reported in **Table 2**.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.842	.842	4

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
ENK1	9.65	4.311	.702	.513	.789
ENK3	9.58	4.316	.694	.492	.792
ENK.2	9.65	4.408	.675	.469	.801
ENK4	9.62	4.585	.635	.413	.818





2.5. TABLE FORMAT

Table 2. The Results of Factor Analysis and Reliability Test

Code	Item Descriptions	Factor Analysis				Reliability Test	
		FL	KMO	Eig.	Com.%	ITC	Alpha (α)
<b>Environmental Knowledge—[ENK]-ចំណេះដឹងខាងបរិស្ថាន</b>							
ENK2	I know when I buy products and packages that are environmentally safe.	0.898	<b>0.852</b>	<b>3.173</b>	<b>79.335</b>	0.814	<b>0.913</b>
ENK4	I know more about recycling than average person.	0.891				0.802	
ENK3	I understand the environmental phrases and symbols on product package.	0.888				0.797	
ENK1	I am very knowledgeable about environmental issues.	0.886				0.794	
<b>Environmental Awareness—[ENA]-ការយល់ដឹងខាងបរិស្ថាន</b>							
ENA2	I deliver information on the environment to my family members	0.874	<b>0.925</b>	<b>5.908</b>	<b>65.639</b>	0.819	<b>0.934</b>
ENA9	I am aware of my responsibility towards the environment.	0.852				0.800	
ENA6	I conserve the use of water supply.	0.845				0.788	
ENA4	I do not use plastic bags to wrap things	0.802				0.731	
ENA5	I conserve the use of electric energy at home	0.800				0.733	
ENA8	I am involved in environmental awareness activities in my social life	0.790				0.714	
<b>ENA7</b>	I am concerned about environmental problems at my place.	0.785				0.742	
ENA3	I always discuss environmental problems with my friends.	0.784				0.741	
ENA1	I read about environmental issues in the mass media (i.e., TV, social media)	0.753				0.706	
<b>Pro-Ecological Attitudes—[PEA]-ឥរិយាបថគាំទ្រជល់អេកូឡូហ្សឺ</b>							
PEA2	This eco-tourism community employs local residents.	0.880	<b>0.848</b>	<b>3.547</b>	<b>70.936</b>	0.802	<b>0.897</b>
PEA3	This eco-tourism community well-manages trash (i.e., recycles waste and paper).	0.862				0.773	
PEA4	This eco-tourism community provides information about the quality of the local environment.	0.849				0.754	
PEA5	This eco-tourism community supplies health food in the restaurants.	0.827				0.723	
PEA1	This eco-tourism community strictly adheres to	0.790				0.678	



	environmental rules and regulations.						
<b>Environmental Responsible Behavior—[ERB]-ទំនួលខុសត្រូវលើបរិស្ថាន</b>							
<b>General Protection Behavior-ឥរិយាបថទូទៅលើការការពារជល់បរិស្ថាន</b>							
ENR1	I try to learn how to solve environmental problems in our eco-tourism community.	0.837	0.815	2.672	66.800	0.691	0.834
ENR4	I try to convince partners to protect the natural environment in our eco-tourism community.	0.825				0.674	
ENR3	I discuss with people the issues of environmental protection in our eco-tourism community.	0.818				0.664	
ENR2	I read the reports or books about the environment of our eco-tourism community.	0.789				0.626	
<b>Particular Regulation Behavior-ឥរិយាបថខាងច្បាប់ប្រកាសរបស់បរិស្ថាន</b>							
PRB1	According to the law, I will deter any behavior damaging the environment in our eco-tourism community.	0.857	0.786	2.722	68.043	0.720	0.843
PRB4	When I see others' inadequate environmental behavior in our eco-tourism community, I will report it to the authorities.	0.834				0.696	
PRB3	I participate in cleanup activities for our eco-tourism community.	0.804				0.650	
PRB2	I pick up trash and branches when I see them in our eco-tourism community.	0.803				0.644	
<b>Commitment Behavior-ឥរិយាបថនៃការចូលរួម ឬបង្កើន</b>							
COM3	I believe that the well-being of the natural environment can affect my own well-being.	0.898	0.821	3.037	75.918	0.806	0.894
COM4	I feel committed to keeping the best interests of the environment in mind.	0.883				0.782	
COM2	Feeling a connection with the environment is important to me.	0.854				0.741	
COM1	I am interested in strengthening my connection to the environment in the future.	0.850				0.734	

**Note:**

- FL: Factor Loading score
- KMO: Kaiser-Meyer-Olkin (Bartlett's Test)
- Eig.: Eigenvalue
- Com.: Cumulative %
- ITC: Item-total-Correlation
- Alpha: Cronbach's Alpha ( $\alpha$ )



## 2.6. RESULTS AND INTERPRETATION

Table 2 indicates that “Environmental Knowledge” has 4 items, whose FL ranged from 0.886 to 0.898, exceeding the threshold value by more than 0.70. KMO is 0.852 higher than 0.50, eigenvalue is 3.173 higher than 1, and cumulative % is 79.335 %, exceeding 60%. This finding concludes that these 4 items are satisfied with a 5-point Likert scale. Indeed, item-total correlation for all items is higher than 0.50, and Cronbach’s Alpha ( $\alpha$ ) is 0.913 (91.3%), which is higher 0.70 (70%). Thus, we can conclude that the research construct of “environmental knowledge” has strong validation and high reliability. Then, these four research items can be used for further analyses, such as correlation matrix, regression analysis, and so on.

Table 2 indicates that “Environmental Awareness” has 9 items, whose FL ranged from 0.753 to 0.874, exceeding the threshold value by more than 0.70. KMO is 0.925 higher than 0.50, eigenvalue is 5.908 higher than 1, and cumulative % is 65.639 %, exceeding 60%. This finding concludes that these 9 items are satisfied with a 5-point Likert scale. Indeed, item-total correlation for all items is higher than 0.50, and Cronbach’s Alpha ( $\alpha$ ) is 0.934 (93.4%), which is higher 0.70 (70%). Thus, we can conclude that the research construct of “environmental awareness” has strong validation and high reliability. Then, these four research items can be used for further analyses, such as correlation matrix, regression analysis, and so on.

Table 2 indicates that “Pro-Ecological Attitudes” has 9 items, whose FL ranged from 0.790 to 0.880, exceeding the threshold value by more than 0.70. KMO is 0.848 higher than 0.50, eigenvalue is 3.547 higher than 1, and cumulative % is 70.936 %, exceeding 60%. This finding concludes that these 4 items are satisfied with a 5-point Likert scale. Indeed, item-total correlation for all items is higher than 0.50, and Cronbach’s Alpha ( $\alpha$ ) is 0.897 (89.7%), which is higher 0.70 (70%). Thus, we can conclude that the research construct of “pro-ecological attitudes” has strong validation and high reliability. Then, these four research items can be used for further analyses, such as correlation matrix, regression analysis, and so on.

Table 2 indicates that “environmentally responsible behavior” consists of two sub-dimensions: 1) general protection behavior has 4 items (i.e., FL ranged from 0.789 to 0.837; KMO=0.815; eigenvalue=2.672; cumulative % = 66.800%; item-total-correlation ranged from 0.626-0.691; and Alpha = 0.834), 2) particular regulation behavior has 4 items (i.e., FL ranged from 0.803 to 0.857; KMO=0.786; eigenvalue=2.722; cumulative % = 68.043%; item-total-correlation ranged from 0.644-0.720; and Alpha = 0.843), and 3)-commitment behavior has 4 item (i.e., FL ranged from 0.850 to 0.898; KMO=0.821; eigenvalue=3.037; cumulative % = 75.918%; item-total-correlation ranged from 0.734-0.806; and Alpha = 0.894), exceeding the threshold value by more than 0.70. Both sub-dimensions have a KMO exceeding 0.50, an eigenvalue exceeding 1, and a cumulative percentage exceeding 60%. This finding concludes that these two sub-dimensions and 12 items are satisfied with a 5-point Likert scale. Indeed, item-total correlation for all items is higher than 0.50, and Cronbach’s Alpha ( $\alpha$ ) is ranged 0.834 (83.4%) and 0.894 (89.4%), which are higher than 0.70 (70%). Thus, we can conclude that the research construct of “environmentally responsible behavior” has strong validation and high reliability. We can then use these four research items for further analyses, including correlation matrix and regression analysis, among others. Overall, these four research variables are satisfied, validated, and reliable. This means that the questionnaire items in this study are approaching closer to reality among 390 respondents.

## REFERENCES

- Aaker, D. A., Kumar, V. L., Robert P., & Day, G. S. (2019). *Marketing research*. Wiley.
- Babin, B. J., d'Alessandro, S., Winzar, H., Lowe, B., & Zikmund, W. G. (2020). *Marketing research*. Cengage Learning.
- Bryman, A. (2016). *Social research methods*. Oxford university press.
- Hair Jr, J., Black, W., Babin, B., & Anderson, R. (2019). *Multivariate data analysis: A global perspective*. Prentice Hall and Pearson.



- Hair Jr, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2021). *A primer on partial least squares structural equation modeling (PLS-SEM)*. Sage publications.
- Tucker, L. R., & Lewis, C. (1973). A reliability coefficient for maximum likelihood factor analysis. *psychometrika*, 38(1), 1-10. <https://doi.org/10.1007/BF02291170>
- Zikmund, W. G., Babin, B. J., Carr, J. C., & Griffin, M. (2013). *Business research methods*. Cengage learning.

## GLOSSARY

- **Factor Loading:** Indicates how strongly a measured variable is correlated with any factor.
- **Coefficient Alpha ( $\alpha$ ):** The most commonly applied estimate of a multiple-item scale's reliability. It represents the average of all possible split-half reliabilities for a construct.
- **Validity:** The accuracy of a measure or the extent to which a score truthfully represents a concept.