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DEPARTMENT OF INTERNATIONAL BUSINESS MANAGEMENT-IBM

APPLIED RESEARCH METHODOLOGY

BACHELOR PROGRAM

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Authors: Veasna SOU., Sambath PHOU., & Phichhang OU Published online at <u>www.spss.site</u>: 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 (α)		> 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"

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22	ENR2	Numeric	8 0			{1, Almost	None	8	Continue	Cancel	rieip	
23	ENR3	Numeric	8 0			{1, Almost	None	8	Right Right	Ordinal	> Input	
24	ENR4	Numeric	8 0			{1, Almost	None	8	Right	Ordinal	Y Input	
25	ENR7	Numeric	8 0	1	Environmental	{1, Almost	None	8	疆 Right	Ordinal	> Input	
26	ENR8	Numeric	8 0			(1, Almost	None	8	Right	Ordinal	> Input	
27	ENR6	Numeric	8 0			{1, Almost	None	8	Right	Ordinal	> Input	Figure 1.5
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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**.

kin Meası	ire of S	apapling Adag		Rive and Bartlett's Test										
	Caiser-Meyer-Olkin Measure of Sampling Adequacy799													
Bartlett's Test of Sphericity Approx. Chi-Square 616.203														
	df			6			1							
Sig. <.001														
						ENK3	.836							
	Total	Variance Exp	lained			ENK.2	.823							
Initial E	igenvalu	les	Extractior	n Sums of Squar	ed Loadings	ENK4	.793							
l %of∨	ariance	Cumulative %	Total	% of Variance	Cumulative %	Extraction M	lethod:							
715	67.878	67.878	2.715	67.878	67.878	Principal								
513	12.813	80.692				Componen	t							
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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**).



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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**.



Item-Total Statistics												
	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

Code	Item Descriptions	Factor A	Analysis			Reliabi	lity Test
		FL	KMO	Eig.	Com.%	ITC	Alpha (α)
Environn	nental Knowledge-[ENK]-	นื้ออาอ	ຍເໜື				
ENK2	I know when I buy products	0.898	0.852	3.173	79.335	0.814	0.913
	and packages that are						
	environmentally safe.						
ENK4	I know more about recycling	0.891				0.802	
ENK 9	than average person.	0 000				0 707	
LINKO	phrases and symbols on	0.000				0.797	
	product package.						
ENK1	I am very knowledgeable about	0.886				0.794	
	environmental issues.						
Environn	nental Awareness-[ENA]-miesa	ເຮືອອາຄ	೨೮೫ನ್ನುಲ				
ENA2	I deliver information on the	0.874	0.925	5.908	65.639	0.819	0.934
	environment to my family						
	members	0.050				0.000	
ENA9	I am aware of my responsibility	0.852				0.800	
ENA6	I conserve the use of water	0.845				0.788	
	supply.						
ENA4	I do not use plastic bags to	0.802				0.731	
	wrap things	0.000				0 = 00	
ENA5	I conserve the use of electric	0.800				0.733	
ENA8	L am involved in environmental	0.790				0.714	
	awareness activities in my social	0					
	life						
ENA7	I am concerned about	0.785				0.742	
	environmental problems at my						
ENA3	place. L always discuss environmental	0 784				0 741	
	problems with my friends.	0.701				0.7 11	
ENA1	I read about environmental	0.753				0.706	
	issues in the mass media (i.e.,						
	TV, social media)	0	· 6				
Pro-Ecole	ogical Attitudes-[PEA]-#56553	ສາເອຂາ	ດເສຟີສ ົ່າ ອນໃ	ł			
PEA2	This eco-tourism community	0.880	0.848	3.547	70.936	0.802	0.897
DFA9	This ago tourism community	0.869	_			0.779	-
ILAO	well-manages trash (i.e.,	0.002				0.770	
	recycles waste and paper).						
PEA4	This eco-tourism community	0.849	_			0.754	-
	provides information about the						
	quality of the local						
PFA5	This eco-tourism community	0.897	_			0.793	-
1 12135	supplies health food in the	0.027				0.720	
	restaurants.						
PEA1	This eco-tourism community	0.790	_			0.678	-
	strictly adheres to						

Table 2. The Results of Factor Analysis and Reliability Test



	environmental rules and						
	regulations.						
Environm	ental Responsiblele Behavior—[EF	B]- នំឆ្លូវ	៴១៷៲ឣូទ	លើមរិស្ថាន			
General P.	rotection Behavior-តំំយោមឧន្លូនៅខែ	ຜັສາເສາເ	ពោះឧល់មរិត	స్టుల			
ENR1	I try to learn how to solve	0.837	0.815	2.672	66.800	0.691	0.834
	environmental problems in our						
	eco-tourism community.						
ENR4	I try to convince partners to	0.825				0.674	
	protect the natural environment						
	in our eco-tourism community.						
ENR3	I discuss with people the issues	0.818				0.664	
	of environmental protection in						
	our eco-tourism community.						
ENR2	I read the reports or books	0.789				0.626	
	about the environment of our						
D 1	eco-tourism community.	- A . V		A			
Particulai	Regulation Behavior #1555827	95NU	ច្បា មមេសម	ស្ថោន			
PRB1	According to the law, I will	0.857	0.786	2.722	68.043	0.720	0.843
	deter any behavior damaging						
	the environment in our eco-						
	tourism community.	0.004				0.000	
PKB4	When I see others' inadequate	0.834				0.696	
	environmental behavior in our						
	eco-lourism community, I will						
DDD 9	I participate in cleanup	0.804				0.650	
L UD9	activities for our eco tourism	0.004				0.030	
	community						
PRB9	L pick up trash and branches	0.803				0 644	
T RD2	when I see them in our eco-	0.000				0.011	
	tourism community.						
Commitm	nent Behavior- ส์เียวยอเอกาเย ณ	15 555	2				
COM3	I believe that the well-being of the	0.898	0.821	3.037	75.918	0.806	0.894
	natural environment						
	can affect my own well-being.						
COM4	I feel committed to keeping the	0.883				0.782	
	best interests of the						
0010	environment in mind.	0.054				0 = 11	
COM2	Feeling a connection with the	0.854				0.741	
	environment is important to						
COM	me.	0.050				0.794	
COMI	n an interested in strengthening	0.000				0.734	
	environment in the future						

Note:

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



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 (α) 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 (α) 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 (α) 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 subdimensions 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 (α) 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.

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GLOSSARY

- Factor Loading: Indicates how strongly a measured variable is correlated with any factor.
- **Coefficient Alpha (α):** 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.