

Full Length Research Paper

Confirmatory factor analysis (CFA) of first order factor measurement model-ICT empowerment in Nigeria

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The purpose of confirmatory factor analysis (CFA) of first order factor measurement model is a way of testing how well measured variables represent in a small construct. Prior to this analysis, Cronbach Alpha, exploratory factor analysis (EFA) and uni-dimensional (CFA) were performed. After the Cronbach-Alpha of the first order model, the six variables or factors were further analyzed at the second order level. The second order analysis was carried out to achieve a valid model fit for the data obtained as well as theoretical supports behind the developed model.

Key words: Measurement model, constructs, reliability and validity.

INTRODUCTION

Confirmatory factor analysis (CFA) is a confirmatory technique and is theory-driven. Therefore, the planning of the analysis is driven by the theoretical relationships among the observed and unobserved variables. When a CFA is dis-conducted, the researcher uses a hypothesized model to estimate a population covariance matrix that is compared with the observed covariance matrix. Technically, the researcher wants to minimize the difference between the estimate and observed matrices (Long, 1983; Hu and Bentler, 1995; Baron and Kendy, 1986; Byrne, 1989, 2010; Hair et al., 2010).

In this study, confirmatory factor analysis (CFA) measurement model of ICT empowerment first order after exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) uni-dimensional test, was run using Analysis of Moment Structure (AMOS) 16 version to test the measurement models (James, 2005) on variables of ICT empowerment. However, confirmatory factor analysis approach to access uni-dimensionality was adopted because of the existence of single construct underlying a set of measures and as a set of items forming an instrument that in all measure one thing in common. The first fit measure in this thesis is the Chi-Square statistic. Bentler and Hu (1999) view that the Chi-Square statistic is the traditional measure for evaluating the overall model fit in covariance structure models and it access the magnitude of discrepancy between the sample and fitted covariance.

Barret (2007) view that a good model fit would provide an insignificant result of $p > 0.05$ threshold. Thus, the Chi-square statistics are often referred to as goodness or badness-of-fit whereby large χ^2 values correspond to bad fit and small χ^2 - values to good fit. The degree of freedom serve as a standard by which to judge χ^2 is small or large (Fitzgerald et al., 1997). Thus, Byrne (2001, 2010) view that other model fit such as GFI, AGFI, NNFI and IFI are applied to access the goodness of fit of the measurement model.

Reliability

In assessing the degree of measurement error present in any measure, the research must address two important characteristics of a measure: validity and reliability according to Hair et al. (2010) and Byrne (1989, 2010). The researchers' goal in this study is to reduce measurement error.

Validity is the degree to which instrument measures accurately represent what is supposed to measure, and the degree to which the "thing" that the instrument measures has meaning. Ensuring validity starts with a thorough understanding of what is to be measured and

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then making the measurement as correct and accurate as possible. However, accuracy does not ensure validity. If validity is assured still, consideration of reliability of the measurement is a must (Hair et al., 2010; Pallant, 2010; Andy, 2009).

Reliability can be assessed through internal consistency of the instrument (Zikmund, 2003; Andy, 2009), which is the most appropriate used in this study. The second dimension of reliability is used to assess the reliability of summated scale where several items are summed to form the total scores (Malhotra, 1996). If they are reliable, the items will show consistency in their indication of concept being measured. To avoid this problem, Cronbach's (1951) coefficient alpha which is one of the most common methods in gauging reliability (Nunnally, 1978; Peter, 1979; Sekaran, 2000), is considered appropriate. This technique estimates the degree to which the items in the scale are representative of the domain of the construct being measured. It is a measure of the internal consistency of a set of items, and is considered 'absolutely the first measure' one should use to assess the reliability of a measurement scale (Nunnally, 1978; Churchill, 1979). In addition to this, Cronbach's coefficient is important in measuring multi-point scale items (that is, 5-point Likert scale used in this study) (Sekaran, 2000). Accordingly, this method of internal consistency has been adopted to assess the reliability of the measures in this study.

Multi-items scales were employed in this study; Cronbach alpha estimate was used as a verification of the reliability of the composite items comprising each scale construct. Thus, the constructs of MTC, CGC, PPC, RLC, STC and TCC were subjected to such assessment. In assessing reliability through Cronbach's Alpha, some authors suggest different levels of acceptance. Nunnally (1967) recommended that an acceptable alpha is between 0.50 and 0.60 and in his other book titled "Psychometric Theory", Nunnally (1978) increased the level of acceptance and considered that alpha should exceed the minimum of 0.70 for internal consistency. However, Nunnally and Bernstein (1994) suggest a rule of thumb level of higher than 0.70, with a level as low as 0.60 being accepted for new scale. Other authors such as Carmines and Zeller (1979) indicate that at least 0.80 is required to establish internal consistency. While different view have been recommended about levels of acceptance, it is generally agreed that an alpha of 0.70 and above is acceptable. Therefore, this cut-off point (0.70) was used as the minimum for determining internal consistency of scale for this study.

This study adopted the procedure recommended by Churchill (1979) and Peter (1979) to develop the scales. The issues of this procedure concerning the item were determined using Cronbach's coefficient alpha and exploratory factor analysis. Similarly, Anderson and Gerbing (1988) expanded the scale to development procedure by including confirmatory factor analysis

(CFA). This was done as coefficient alpha is not a sufficient condition to assess uni-dimensionality. For this reason, other authors such as Steenkamp and Van Trijp (1991) and Byrne (2001; 2010) maintain that CFA provides a better estimate of reliability than coefficient alpha. Hinkin (1995) suggests that CFA approach is able to examine the stability of the factor structure in scale construction. Furthermore, assessing reliability by using CFA is also necessary to ensure that all measures used in this thesis are reliable, thus providing the researcher with greater confidence that individual items are consistent in their measurements (Hair et al., 1995, 2010).

Validity

Validity is the degree to which an instrument measures what it intends to measure, and the degree to which the "thing" that the instrument measures has meaning. Validity is viewed by Hair et al. (2010) as the extent to which a measure or set of measures correctly represents the concept of the study, and the degree to which it is free from any systematic or nonrandom error. Validity is concerned with how the concept is defined by the measures, whereas reliability relates to the consistency of the measures.

Reliability alone is not sufficient to consider that an instrument is adequate (Churchill, 1979; Anderson and Gerbing, 1988; Dunn et al., 1994; Hair et al., 1995, 2010). Therefore, validity is required to validate the constructs of this thesis. According to Zikmund (2003), validity means "the ability of a scale to measure what intended to be measured". Neuman (2003) points out that the better the fit between the conceptual and operational definitions, the greater the measurement validity. In addition to this, validity represents the relationship between the construct and its indicators (Punch, 1998).

Nunnally and Bernstein (1994) suggest that there are three important aspects of a valid construct. Firstly, the construct should be seen to be a good representation of the observable domain related to the construct. Secondly, the construct should well represent the alternative measures. Finally, the construct should be well related to other constructs of interest. Taking into account these considerations, three types of validity, including, content, construct (convergent and discriminant validity) and criterion were examined in this thesis. These are related to the internal validity of the scales and their respective items. As for the purpose of the generalizability of the research findings, external validity was also investigated.

Construct validity

Construct validity was therefore examined in this study by analyzing both convergent and discriminant validity. Convergent validity examines whether or not the measures of the same construct are correlated highly,

and discriminant validity determines if the measures of a construct have not correlated too highly with other constructs (Sekaran, 2000).

A number of methods were suggested for assessing convergent and discriminant validity: factor analysis, correlation, and even more advanced procedures including CFA existing in SEM. For the purpose of this study, convergent and discriminant validity were assessed by performing CFA. To demonstrate convergent validity, magnitude of the direct structural relationship between the item and latent construct (or factor) should be statistically different from zero (Holmes-Smith et al., 2006). In other words, the final items (not including deleted items) should be loaded highly on one factor (Anderson and Gerbing, 1988), with a factor loading of 0.50 or greater (Hair et al., 1995). Furthermore, average variance extracted (AVE) was used as an indicator for supporting convergent validity (Fornell and Larcker, 1981). As for discriminant validity, two methods have been employed in this study. The first method checks the estimated correlations between the factors (Kline, 2005).

This is consistent with the above discriminant validity definition of Sekaran (2000). That is, if the two factors are highly correlated, redundant items that show a lack of discriminant validity are deleted (Kline, 2005). The second method of assessing discriminant validity examines pattern structure coefficient to determine whether factors in measurement models are empirically distinguishable (Thompson, 1997). Pattern coefficient is the standardized factor loading derived from AMOS analysis. In addition to these restrictive assessments of convergent and discriminant validity, construct validity in this thesis was enhanced by assuring that the model (through goodness-of-fit results obtained from CFA) fits to the data adequately (Hsieh and Hsiang, 2004).

Criterion validity

Criterion validity is the third measure of validity demonstrated within this study. It refers to the ability of measures to correlate with other standard measures of the same construct (Zikmund, 2003). It can be classified as concurrent validity or predictive validity (Sekaran, 2000), depending on the time sequence in which the new measurement scale and the criterion measure are correlated (Zikmund, 2003). The former, for example, is established when a new measure is taken at the same time as criterion and is shown to be valid, while the latter is established when a new measure predicts a future event. According to Peter (1981), criterion validity was commonly used in earlier research. However, its popularity has vanished with the increased use of construct validity. This is because criterion validity is synonymous with convergent validity, and thus assessment of the latter would mean that the former was satisfied (Zikmund, 1994). Since convergent validity has

been used as a measure within this thesis, it is therefore assumed that criterion validity is also accounted for.

External validity

The final measure used to validate the measures of this study is external validity. While the above discussed validity relates to the internal validity of the scales and their respective items, external validity is concerned with establishing the extent to which the study findings can be generalized to other subjects or groups (that is, other youths in Nigeria) (Zikmund, 2003). In more specific terms, external validity is related to the generalizability of the cause-effect relationships of the research findings (Yin, 1994). Hence, evidence on external validity for this thesis has been obtained by employing a representative sample (that is, 389 youths within the ages of 18-35 years from the three locations in the area of study) (Leedy and Ormrod, 2001; Zikmund, 2003).

For the purpose of this study, four types of validity, including content, construct, criterion and external, were adopted.

METHODOLOGY

The research was conducted among 386 employed and unemployed youths between 18-35 years old in Bauchi State, Nigeria from the three geo-political zones present in the location of the study areas of the state (South - Bauchi with a population estimated as 493,810 and total land mass of 3,687 km²; North - Katagum whose population's estimate was 375,970 and total landmass of 4,625 km²; and Central - Ningi population was estimated at 295,970 with a total landmass of 1,436 local government (Figure 1) (NPC, 2006; FOS, 1987).

The questionnaire items have 65 indicators/constructs with the exception of demographic questions reflecting the relevant variables adapted from previous studies. The variables are divided into 6 broad categories related to, material cognitive, perceptual, relational, and technological and status changes. The questionnaire was developed using 5-point Likert Scale, ranging from (1=strongly disagree) to (5=strongly agree).

After data had been collected from the respondents, editing of the data was undertaken in order to ensure the omission, completeness and consistency of the data (Zikmund, 2003; Sekaran, 2000). Out of 500 questionnaires distributed during the survey, 420 were returned, which shows 84% of response rate. 389 respondents were identified and selected as representative sample size after series of screening.

Assessment of goodness of fit

The confirmatory factor analysis approach to assessing measurement model of ICT empowerment is adopted because of the existence of single constructor trait



Figure 1. Bauchi State map indicating the three zones of the study areas, that is, North (Katagum), Central (Ningi) and South (Bauchi). Source: http://www.speakersoffice.gov.ng/constituencies_bauchi.htm (2013).

underlying a set of measures and a set of items forming an instrument that all measure one thing in common. The first fit measure to be reported in this study is the Chi-

square statistic. Hair et al. (2010), Byrne (2010), Pallant (2010) and Barret (2007) stated that the Chi-square statistic is the traditional measure for evaluating overall

Table 1. Assessment of goodness of fit.

Types of constructs	Cut-off
Chi-square (χ^2)	Smaller to 0
Degree of freedom (df)	
Probability (P)	≥ 0.05
CMIN/df	$\leq 2-5$
Goodness of fit index (GFI)	≥ 0.90
Adjusted goodness of fit index (AGFI)	≥ 0.90
Comparative fit index (CFI)	≥ 0.95
Root mean squared error of approximation (RMSEA)	≤ 0.08

Source: Hair et al. (1998, 2010), Byrne (2001, 2010), and Ernest et al. (2008).

Table 2. Summary of goodness of fit for ICT empowerment (CFA of first order).

Test	Marker	Chi-sq	df	P	CMIN/df	GFI	AGFI	CFI	NFI	RMSEA
MM	-	573.979	309	0.000	1.858	0.904	0.883	0.956	0.911	0.047
MM1	PPC2	541.860	284	0.000	1.908	0.905	0.882	0.951	0.903	0.048
MM2	TCC5	462.502	260	0.000	1.779	0.916	0.895	0.958	0.910	0.045
MM3	PPC6	388.115	237	0.000	1.638	0.924	0.904	0.967	0.920	0.041
MM4	MTC7	335.134	215	0.000	1.559	0.930	0.910	0.971	0.924	0.038
MM5	RLC5	286.144	194	0.000	1.475	0.937	0.918	0.976	0.931	0.035
MM6	STC3	234.300	174	0.002	1.347	0.946	0.929	0.984	0.940	0.030
MM7	STC1	195.641	155	0.015	1.262	0.952	0.935	0.989	0.947	0.026
MM8	CGC3	160.931	137	0.079	1.175	0.958	0.942	0.993	0.954	0.021

Source: Developed from Quantitative Field Report (2013).

model fit in covariance structure models and it assess the magnitude of discrepancy between the sample and fitted covariance. However, they stated further that a good model fit would show a significant result of $p > 0.05$. The Chi-square statistics are often referred to as either a goodness or badness-of-fit measure, whereby large χ^2 values correspond to bad fit and small χ^2 values correspond to good fit. The degree of freedom serves as a standard by which to access χ^2 is small or large. Thus, as stated by Byrne (2001, 2009), Hair et al. (1998, 2010) and Ernest et al. (2008), other model fits such as GFI, AGFI, CMIN/df, P, CFI and RMSEA are employed to access the goodness of fit of the measurement model.

To evaluate the result of goodness of fit, in this thesis, the rule of thumb of cutoff point was adopted as related to the model only. Evaluating the goodness of fit using cutoff point (Byrne, 2001, 2010; Ernest et al., 2008; Hair et al., 1998, 2010), Table 1 presents assessment of goodness of fit.

ANALYSIS AND DISCUSSION

The model was subjected to first order confirmatory factor analysis using AMOS 16.0. The 27 items of empowerment were examined using confirmatory factor analysis (CFA) on the basis of EFA results (Gerbing and

Hamilton, 1996). This approach was applied to examine the dimensionality of each variable or factor and also to test the model fit of the six dimensions or factor of empowerment step by step (Table 2). Figures 2 and 3 present the results of the measurement model fit of the six dimensions or factor of empowerment.

The list of items removed or deleted from the model through the iteration process is shown in Table 3. The iteration process changed the number of factors under post-EFA construct of empowerment. Two factors, ICTTR7 and GSK3, were removed from the analysis. Thus, eight factors were resulted from CFA of first order factor model for empowerment. Table 3 presents summary of items removed or deleted from the analysis.

Cronbach Alpha scores for the six factors from CFA of first order factor model (the iterated model) were measured, and the dimensions show acceptable reliabilities as suggested by Nunnally (1978) with scores that exceed the required ≥ 0.70 . Table 4 shows summaries of the results for each Cronbach-Alpha of the dimensions level of empowerment CFA of first order model iterated.

Conclusion

After the Cronbach-Alpha of the first order model, the six

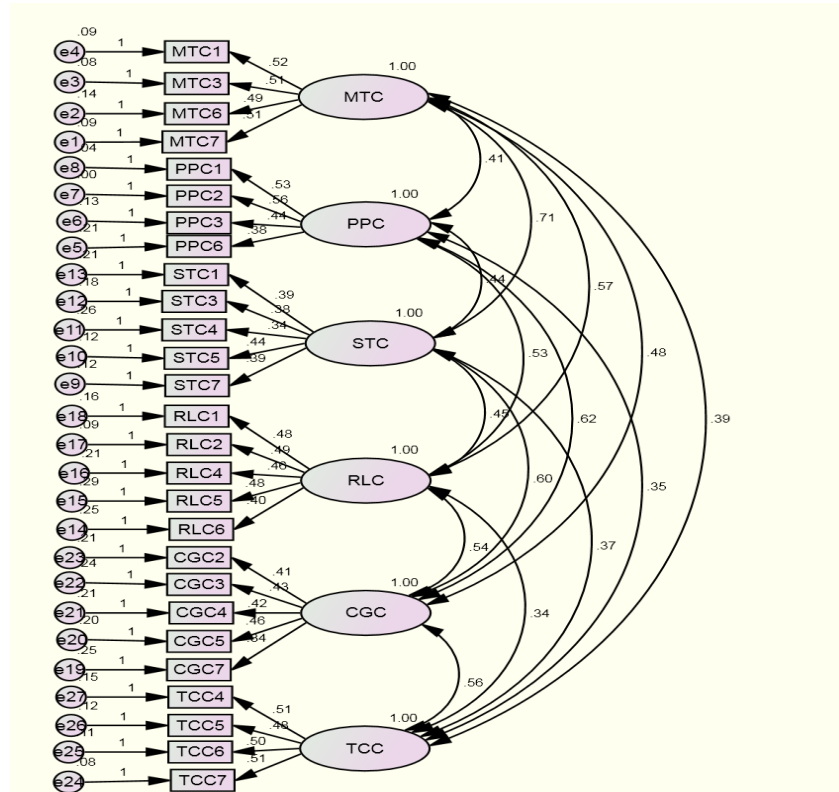


Figure 2. First order CFA model for empowerment - Measurement model.

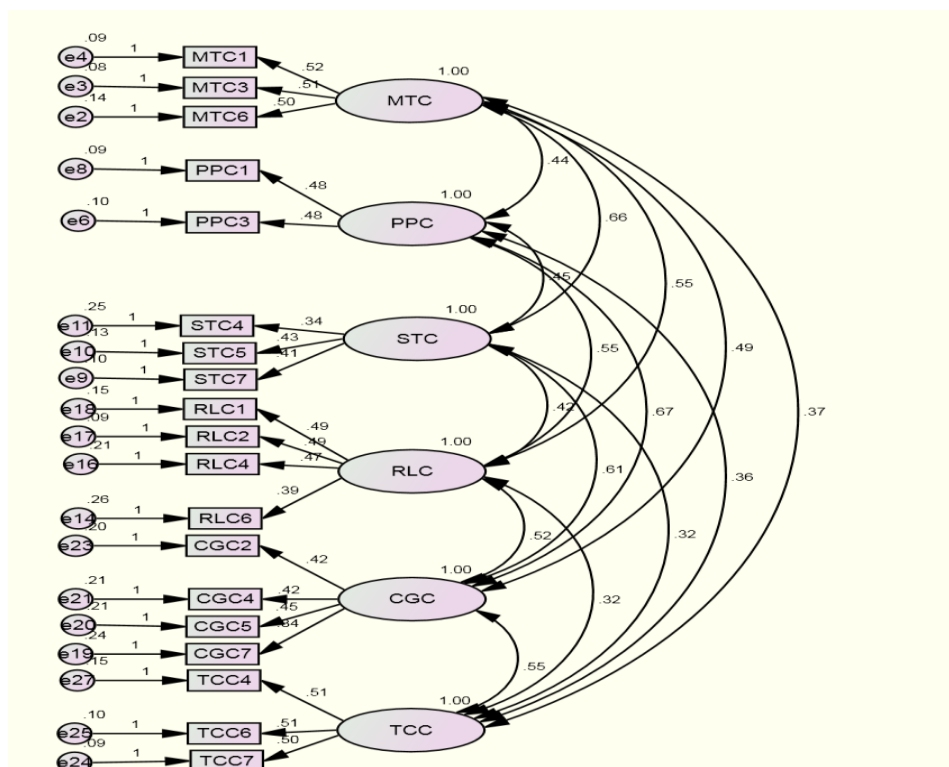


Figure 3. CFA model ICT empowerment - Final measuring model 8.

Table 3. Summary of items removed or deleted from the analysis.

Code	Construct	Item(s) statements	Removed at
e7	PPC2	Gaining ICT skills and knowledge enhances self esteem	Iteration 1 (e7)
e26	TCC5	ICT skills and knowledge contributes to research and development	Iteration 2 (e26)
e5	PPC6	Beneficial of ICT skill and knowledge can benefits their immediate communities	Iteration 3 (e5)
e1	MTC7	ICT skills and knowledge change one's life	Iteration 4 (e1)
e15	RLC5	ICT skills and knowledge enhance one's belief	Iteration 5 (e15)
e12	STC3	ICT skills and knowledge change one's social status	Iteration 6 (e12)
e13	STC1	ICT skills and knowledge increase the status from unemployed to employed	Iteration 7 (e13)
e22	CGC3	ICT skills and knowledge promote one's mental process	Iteration 8 (e22)

Source: Developed from Quantitative Field Report (2013).

Table 4. Cronbach-Alpha of the dimension level of empowerment-CFA of first order factor model (Iterated).

Factor	Description	Number of items (after iteration)	Cronbach-Alpha
1.	Material change (MTC)	3	0.882
2.	Perceptual change (PPC)	2	0.826
3.	Status change (STC)	3	0.741
4.	Relational change (RLC)	4	0.800
5.	Cognitive change (CGC)	4	0.752
6.	Technological change (TCC)	3	0.870

Source: Developed from Quantitative Field Report (2013).

variables or factors were further analyzed at the second order level. The analysis was carried out to achieve a valid model fit for the data obtained as well as theoretical supports behind the developed model. The test of the first order implies that six factors/variables were fit and represented in small construct. These factors are: material change, perceptual change, status change, relational change, cognitive change and technological change.

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