Examining Data Quality in Communication Model:
A Partial Least Squares (PLS) Approach to Estimating the Reliability and Validity of the Constructs in the Relationship between Media Literacy Competencies and Use of New Media for Civic Engagement

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Abstract
This study applied the Partial Least Squares PLS to test reliability of the instrument used for data collections and to establish the convergent validity and discriminant validity of the constructs specified for study. The aim is to ascertain the performance of PLS in measuring latent constructs (unobserved) and the manifest (observed) indicators in communication and media studies. Communication studies like other fields often involve the modeling of constructs relationships which requires higher level of analysis. The purpose of this study is to demonstrate the potentials of Partial Least Squares PLS approach to estimating the reliability and validity of measurements items and their latent constructs in a communication model. The motivation for the study was the observation that there is inconsistent application of PLS SEM in communication studies leading to low appreciation of its potentials in the field of communication and behavioral areas. PLS offers simple but robust options. In applying PLS SEM, the results enable the researcher to show that the specified model relationship contains measurement items that have strong relationship with their corresponding latent constructs. They also indicate convergent and discriminant validity of the constructs. The implication of the result is that PLS will assist communication and media studies that are designed as exploratory theoretical model that will lead to theory building
Keywords: partial least squares, media literacy, civic engagement, new media

1.0 Introduction
Communication studies like other fields often involve the modeling of constructs relationships which requires higher level of analysis. This realization led to the emergence and development of structural equation modeling SEM which is also referred to as second generation techniques. The family of SEM is also divided into two types: the Covariance Based (CB-SEM) and the Variance Based (PLS-SEM). Both techniques, according to Lowry and Gaskin (2014); provide extensive, scalable and flexible causal-modeling capabilities. While admitting and promoting the application of SEM in communication studies Lowry and Gaskin (2014) however, pointed out that their superior capabilities does not invalidate the need for first generation techniques. SEM demonstrates its strength in communication studies with complex chains of constructs. These constructs (endogenous, exogenous, moderating or mediating) may be reflective or formative.   Unlike the first generation techniques, SEM simultaneously measures network of effects between the variables. However, the covariance based and the variance based SEM approaches to statistical analysis do not work on the same assumptions. The covariance based SEM requires distributional assumptions and other stringent conditions while PLS works whether these assumptions are met or not. This notwithstanding, still the data collected for studies involving complex modeling must be subjected to quality test including ensuring that the data is free of outliers and is able to stand the process of reliability and validity test.

This study applied the Partial Least Squares PLS to test reliability of the instrument used for data collections and to establish the convergent validity and discriminant validity of the constructs specified for study. The aim is to ascertain the performance of PLS in measuring latent constructs (unobserved) and the manifest (observed) indicators in communication and media studies.

2.0 Statement of Problem
Partial Least Squares PLS is a relatively new statistical tool that belongs to the structural equation modeling approach for estimating relationship among constructs (Hair,2014). Application of PLS in scholarly work is popular in the marketing, business administration and finance but hardly applied in the field of communication research. This situation tends to create impression about the relevance of PLS to communication research. This perhaps informed Lowry and Gaskin (2014) to observe that there is little evidence that PLS is being used to its full potentials in the broad fields of communication and information research. They therefore lament that the scarce adoption of PLS in communication fields holds back communication research from more complete

understanding and testing of whole theoretical models that drive communication research phenomenon. PLS like its covariance based SEM, is potentially suitable for carrying out research albeit with its own area of appropriate application. This paper is an attempt to contribute to the understanding of the potentials of PLS as a tool of statistical analysis and its ability to contribute to theory building in the area of communication and media studies. In any research involving the analysis of constructs and their relationships, especially latent variables and their indicators measurement, there are certain process and requirement that must be followed. Prior to the test of the hypothesized relationship, the instrument being used must be validated and its reliability established. Secondly, communication researchers are interested in how their data fit into the hypothesized relationship in the actual situation of the research context (Hair et al, 2012, 2014). This present study is developing an instrument by adapting from Celot and Tonero 2009), the measurement of media literacy competencies and use of new media for civic engagement. Therefore,it presents opportunities to confirm the reliability and validity of the constructs through the PLS approach. In PLS-SEM, these fundamental requirements are met through the process referred to as measurement model assessment.

3.0 Research Questions
How well do the measurement items used in this study perform when subjected to reliability and validity test in the context of Partial Least Squares PLS?

4.0 Measures
4.0.1 **Access and usage skill** is the first dimensions of media literacy measures adapted from a scale of media literacy developed by Celot and Tonnero (2009). The concept measures ability to access in terms of ownership or having access to the facilities elsewhere like home, school or cybercafe. Usage skills refer to ability to use and the frequency of usage of the new media. Respondent were asked to indicate their response through a 5-point Likert Scale (1=Never to 5=Always).

4.0.2 **Critical Understanding** refers to the critical practices of the respondents in terms of attitude to information on the internet, skills to protect themselves and their gadget from various risks and evaluation skills of the information they are exposed to on the internet. These set of skills were tested by asking respondents to indicate their level of skills using a 5-points Likert scale. For Attitude to information, the scale contains (1=never to 5 always); and differently worded options for protection skills and evaluation skills(1=very low to 5=very much high).

4.0.3 **Communication ability** is the third dimensions of media literacy. The measure includes participation in public, self created content and social relations through the new media. Respondents were asked to indicate their frequency of using the new media for communication purpose using the Likert Scale (1=never to 5=Always).The instrument by Celot and Tonnero (2009) being adapted for this study had been tested in a study by Shapiro and Tonnero, (2011) and found to be reliable and valid.

4.0.4 **Use of new media for civic engagement**. The measurement indicators were developed from literature (Kahne,Lee,& Feezell, 2011); Gil de Zuniga & Valenzuela, 2010, Celot&Tonnero, 2009). It consists of 20 items designed to measure four aspects of civic engagement in the online context. The responses are in Likert scale having 5-point of (1=never to 5=always). This scale allows the researcher to adequately measure online civic engagement as an entity unlike the previous approach of subsuming it as parts of communication measurement in media literacy (Celot&Tonnero, 2009) or more extensive than the previous instrument (Lierat 2014).

4.0.5 **Media education** was used as moderator variable in this study between media literacy competence and Use of new media for civic engagement. The measures were adapted from literature. (UNESCO, 1982, 1999). it has 8 items measuring respondent exposure to formal and informal education meant to teach them about media and their characteristics. A 4-point Likert scale asking respondent to indicate their responses based on (1=strongly disagree to 4=strongly agree). The emerging instruments from these measures were subjected to quality test through expert validation and reliability and validity test in PLS as outlined by Hair et al, (2014).

4.1. Methods
4.1.1 Missing Data
The data were checked for missing data in line with Hair et al (2014) recommendation the data meant for PLS should be examined to ensure that they are free of missing data. Though PLS is a non parametric statistical method, still the data needs to be free from missing data because missing data can cause to inflate error in the estimation of the indicator relationship with their latent construct and also underestimate path coefficient. PLS as a second generation statistical methods aims to identify the error in its procedure. Therefore, when the data was examined it was ensured that the data contained no missing data serious enough to affect the analysis. Missing data becomes problem when any of this condition is present. First, the number of missing values in a single questionnaire should not exceed 15% of the data set in the questionnaire. Second, the proportion of the missing data in respect of a constructs should not exceeds 15% of the total for that constructs. If there is missing

data, PLS deals with this situation in two ways –the mean of the valid values replacement and the case wise deletion approaches. None of these was adopted because there were few cases of missing data and were not up to the 15% level.

4.1.2 Suspicious Response Data

Another source of problem in data collection is the situation where respondents adopt a straight lining attitude to answer the questions. In this case, the respondents just give the same score or mark for all or almost the responses or answer. The data for this study, when examined; are free of straight lining or inconsistency in answering the questionnaire. These two patterns of responses were avoided by the way the multi items questions were measured which ensured equidistant ordinal optional responses and careful worded instruction that precedes each sections of the instrument.

4.1.2 Outliers

In examining the data for possible extreme responses (outliers) to the questions, the data was run on IBM SPPS statistical packages. Few outliers were discovered. They were promptly removed in line with Hair et al (2014) recommendation for data with few identified outliers. This is possible if the sample size is large enough to accommodate the few deletions. This study works with a sample size of 506.

4.1.3 Data Distribution

As a non-parametric statistical method, PLS-SEM places less emphasis on normally distributed data. Equally, PLS is wary of extreme non- normal data which may prove problematic due to possibility of inflating the standard errors obtained from the bootstrapping procedures. In dealing with the data distribution, PLS- SEM also adopts the popular statistical methods of the Kolmogrov-Sminov test and the Shapiro-Wiliks. The result showed both significant non significant for some of the constructs indicating that some of the construct may have violated the assumptions of normality. As indicated by the Pallant (2011) such result is not uncommon in multivariate study with large sample. With PLS the result posses no problem since it handles non normal data distribution fairly well. Moreso, that the value of the Kurtosis and Skewness are not more than (1) which is an indicative of highly non.normal data (Hair et al 2014).

The next step in data quality examination is the reliability and validity of the constructs with their measurement indicators. The process involves internal consistency reliability; convergent reliability and discriminant validity. The process of carrying out this is referred to as measurement model assessment.

4.2 Measurement model

The measurement model shows the representation of the relationship pattern existing between the manifest (observable) indicators and their corresponding latent variables. Construct modeling in PLS is either specified as reflective or formative model. The essential difference between reflective and formative is that the indicators in the reflective model respond to changes in the latent variable which usually precedes variations in the indicators. Reflective measurement indicators are interchangeable due to the fact that they share common variance The interchangeability of the measurement indicators allow the researcher to focus on the underlying indicators of interest while measuring the measuring the constructs (Hair et al 2014, Hair et al, 2012, Henseler, Ringle, Sinkovics, 2009, Colman, 2008). This mean in effect that excluding or including indicators, in a reflectively specify model; would not necessarily lead to non reliability or impair the validity of the construct being measured. In this regards, Hair et al (2014) point out that in reflective models causality is assumed to flow from the construct to the indicators. A full model measurement has two aspects: the measurement (outer) model and the structural (inner) model (Henseler, Ringle, Sinkovics,2009. Data quality assessment which is what this study is all about relate to the measurement model assessment of the reliability and validity of the reflective constructs.

The individual reliability test was determined by examining the outer loading of the each of the constructs. The rule of thumb (Hair, et al, 2014, Hair et al 2012, Vinzi et al 2010) is to look for items in the outer loading that are between .40 and .70. In line with this guide, through a check of the path diagram in figure,1 it is discovered that out of a total of 72 indicators submitted for algorithm 30 items/indicators met the criterion. The breakdown is as follows. Three constructs used to measure media literacy competence, the access and usage skills have 25 items, only six of them were retained. Critical understanding has 18 items, 10 of them were retained just as 8 of the 12 items submitted for communication abilities, 12 items. For the civic engagement measurement, 20 items were submitted for assessment and measuring use of new media for civic engagement, 12 of them met the criteria; hence were retained. The last construct is the media education which has 8 items. Five (5) of them met the criteria and were retained. All the items that were retained have loadings between 771 and 861 far above the recommended 0.70 minimum for exploratory study. (Hair, 2012) Table 1 displays the items, the individual loadings, the average variance extracted, the composite reliability and the Cronbach's alpha of each constructs.

4.2.1 Internal Consistency Reliability

Cronbach alpha has been the traditional assessment procedure for internal consistency. But due to observations of Chin, (1998) that Cronbach alpha, in the context of PLS, tends to underestimate internal consistency reliability of latent variable (LV) researchers have shifted emphasis from Cronbach alpha to composite reliability coefficient. The Cronbach alpha works on the assumptions that all items with one construct depict the same range and meaning or that they contribute equally. This tends to obscure individual strength and weakness of the items and thereby either underestimate or overestimate the scale reliability. Following this observation, researchers, particularly those using the PLS approach; have been reporting the composite reliability. This composite reliability recognizes the individual loadings thereby highlighting the contribution of each item. However, both the Cronbach alpha and composite reliability use the threshold of .70 for exploratory research making the composite reliability coefficient to be interpreted the same way as the Cronbach alpha. For the purpose of reinforcing one and another both the Cronbach alpha and composite reliability were reported. Table 1 indicates the result of the internal consistency reliability for the main constructs of the models. The composite reliability results exceeded the threshold of 0.70 for the constructs in this study. The breakdown is as follows. Access and usage skills has 0.85; critical understanding 0.86; communication abilities has 0.83; Use of new media for civic engagement is 0.94; media education, 0.86. All of them exceeded the recommended 0.70 threshold for exploratory study using the PLS approach (Hair, et al, 2014; 2011; Pallant, 2011)

Table 1 Items loadings, average variance extracted, composite reliability and Cronbach alpha

Constructs	Items	Loadings	AVE	Composite Reliability	Cronbach Alpha
Access and Usage skills	AU1.5	.776	**.646**	**.845**	**.725**
	AU1.5	.776			
	AU3.5	.861			
	AU3.5	.861			
	AU3.6	.771			
	AU3.6	.771			
Communication Abilities	CA10	.788	**.557**	**.834**	**.734**
	CA10	.788			
	CA11	.746			
	CA11	.746			
	CA12	.734			
	CA12	.734			
	CA9	.715			
	CA9	.715			
Civic Engagement in New Media	CE10	.730	**.569**	**.941**	**.931**
	CE12	.745			
	CE13	.734			
	CE14	.777			
	CE15	.760			
	CE17	.778			
	CE18	.755			
	CE19	.809			
	CE20	.754			
	CE7	.731			
	CE8	.735			
	CE9	.741			
Critical Understanding	CU3.2	.705	**.556**	**.862**	**.800**
	CU3.2	.705			
	CU3.4	.727			
	CU3.4	.727			
	CU3.5	.720			
	CU3.5	.720			
	CU3.6	.787			
	CU3.6	.787			
	CU3.7	.785			
	CU3.7	.785			
media Education	ME3	.707	**.548**	**.858**	**.799**
	ME5	.735			
	ME6	.765			
	ME7	.753			
	ME8	.741			

Note**: AUS= Access &Usage, CA=Communication Abilities; CU=Critical understanding; CE= Use of new media for civic engagement; ME= Media education**

4.3 Validity Test
Validity measurement of the model is aimed at decreasing errors that are attributable to measurement items.

Instrument designed for a study is expected to measure what it is designed to measure. To evaluate this criterion, the instrument is subjected to convergent and discriminant validity measurements through the assessment of t-values, composite reliabilities and average variance extracted.

4.3.1 Convergent Validity

Convergent validity measures the extent to which the hypothesized items to a latent construct truly reflected the conceptualized model. Convergent validity confirms that a latent variable is able to explain more than half of the variance of its indicators on the average (Hair et al 2010). To examine the convergent validity, there is need to look at the factor loading of the measurement model that is above 0.50 which is an indication that the latent construct correlate with the items used to measure it (Fornell & Lacker, 1981, Chin, 1988). Table 2 indicates that the Average Variance Extracted for respective constructs are above 0.50 threshold thus confirming that the items have strong relationship with the construct they are measuring. Table 3 also shows that average variance extracted range between 0.55 and 0.66 which exceed the stipulated minimum of 0.5 (Fornell&Lacker 1981) which indicates that there is convergent validity between the latent constructs and their indicators in this study.

Table 2 Latent Variable Correlations and Square Roots of Average Variance Extracted AVE)

Constructs	1	2	3	4	5
1) Access& Usage skills	**.719**				
2) Civic engagement	.344	**.712**			
3) Critical understanding	.331	.441	**.723**		
4) Media Education	.092	.322	.177	**.714**	
5)Communication Abilities	.351	.663	.342	.275	**.707**

Note: (1) The values in bold represent the square root of AVE across the diagonal
(2) AUS=Access &Usage Skills; CENG=Civic Engagement; COMAB=Communication Abilities;
CRUND=Critical Understanding

Table, 3 Items, standard loadings, average variance extracted, composite reliability and cronbach alpha

Construct	Items	Standardized Loadings	AVE	Composite Reliability	Cronbachs Alpha
Access and Usage Skills	AU1.4	.664	.516	.841	.764
	AU1.5	.725			
	AU3.3	.623			
	AU3.5	.807			
	AU3.6	.759			
Communication Ability	CA10	.762	.500	.833	.749
	CA11	.730			
	CA12	.717			
	CA7	.607			
	CA9	.712			
Civic Engagement	CE10	.697	.507	.949	.942
	CE11	.703			
	CE12	.748			
	CE13	.722			
	CE14	.747			
	CE15	.736			
	CE16	.691			
	CE17	.795			
	CE18	.742			
	CE19	.789			
	CE2	.622			
	CE20	.728			
	CE3	.626			
	CE4	.568			
	CE6	.681			
	CE7	.757			
	CE8	.735			
	CE9	.694			
Critical Understanding	CU1.3	.636	.522	.765	.550
	CU1.5	.766			
	CU1.6	.759			
Media Education	ME2	.607	.509	.861	.813
	ME3	.710			
	ME5	.737			
	ME6	.755			
	ME7	.742			
	ME8	.721			

4.3.2 Discriminant Validity

Discriminant validity is to determine that each of the latent construct measurement indicators actually represents one latent construct and do not cross load with other latent construct. To test the discriminant validity, Fornell and Lacker (1981) recommend the use of average variance extracted where the square root average variance extracted of any construct being measured has to be greater than the latent variable correlations of all other constructs. Table 4 shows that the square root of Average Variance Extracted for each of the construct is higher when compared to the latent variable correlations of all other constructs. Discriminant validity for the measurement indicators can be confirmed by examining the cross loading of the indicators. As shown in table 3, indicator loading, when compared with other reflective indicators loading, is greater than the corresponding cross loading of other indicators. This implies that there is Discriminant validity among the constructs as well as the measurement indicators.

Table 4 Latent Variable Correlations and Square roots of Average Variance Extracted (AVE)

Constructs	AUS	CENG	COMAB	CRUND	MEDU
AUS	**0.804**				
CENG	0.311	**0.754**			
COMAB	0.297	0.607	**0.746**		
CRUND	0.171	0.162	0.180	**0.746**	
MEDU	0.077	0.313	0.247	0.125	**0.740**

Note: Square roots of AVE are the values in bold

4.3.3 Factor loading

Factor loading in PLS involves exploratory factor analysis. It is based on relevant criterion for measuring uni – dimensionality of model that has been specified in a reflective measurement. It is also a type of reliability assessment of measurement. The requirement is that measurement items should converge in the corresponding factors so that each items loads with a high coefficient on only one factor. An item loading is considered high if the loading coefficient is at least above 0.7 and considered low if the loading coefficient is below 0.4. The results of the factor analysis for this study as displayed in table 5 show the items that met these criteria and were retained for subsequent test.

5.0 Discussion

The results of this study showed that the measurement items have factorial validity with their latent constructs. This is demonstrated in the results of the measurements model involving internal consistent reliability, composite reliability and average variance explained by the measurement items in relation to their latent constructs. Each of the dimensions have loading above 0.70 recommended levels. Specifically, 25 items submitted for access and usage skills , six of them survived having loading above 0.70. Similarly, critical understanding originally has eighteen (18) items but only ten of them with loadings above 0.70 were retained. Among the Twelve (12) measurement items submitted for the communication abilities, 8 of them met the threshold level and thus were retained. For the construct measuring the use of new media for civic engagement, 20 items were submitted for analysis, 12 of them loads above the 0.70 threshold. In the same way, the moderating variable of media education was assessed with 8 measurement items of which 5 items load above 0.70 required levels. Furthermore, the results of the constructs of the model as multivariate measurement, have both convergent and discriminant validity. Therefore, the model gives assurance that it is suitable for measuring relationship between media literacy and use of new media for civic engagement. In other words, the model can be used in the next level of model assessment in the context of PLS through the process of structural measurement. This will demonstrate the predictive validity of the model as well as the ability of the independent variable (i.e media literacy competencies) to explain average variance of the dependent variable.--the use of new media for civic engagement.

Table 5 Factor Loading

Items	AUS	COMA	CENG	CRUND	MEDU
AU1.5	**.776**	.218	.246	.139	.049
AU1.5	**.776**	.218	.246	.139	.049
AU3.5	**.861**	.287	.284	.126	.066
AU3.5	**.861**	.287	.284	.126	.066
AU3.6	**.771**	.207	.218	.149	.069
AU3.6	**.771**	.207	.218	.149	.069
CA10	.188	**.788**	.459	.195	.190
CA10	.188	**.788**	.459	.195	.190
CA11	.221	**.746**	.441	.055	.234
CA11	.221	**.746**	.441	.055	.234
CA12	.258	**.734**	.461	.134	.122
CA12	.258	**.734**	.461	.134	.122
CA9	.223	**.715**	.452	.145	.196
CA9	.223	**.715**	.452	.145	.196
CE10	**.249**	**.396**	**.730**	**.169**	**.202**
CE12	.236	.493	**.745**	.051	.213
CE13	.202	.465	**.734**	.043	.254
CE14	.244	.417	**.777**	.173	.260
CE15	.231	.439	**.760**	.137	.206
CE17	.256	.476	**.778**	.107	.232
CE18	.211	.412	**.755**	.140	.214
CE19	.232	.490	**.809**	.148	.289
CE20	.230	.476	**.754**	.187	.265
CE7	.281	.512	**.731**	.109	.194
CE8	.205	.483	**.735**	.074	.237
CE9	.240	.437	**.741**	.113	.261
CU3.2	.148	.205	.174	**.705**	**.117**
CU3.2	.148	.205	.174	**.705**	.117
CU3.4	.155	.125	.124	**.727**	.125
CU3.4	.155	.125	.124	**.727**	.125
CU3.5	.105	.086	.038	**.720**	.070
CU3.5	.105	.086	.038	**.720**	.070
CU3.6	.118	.133	.114	**.787**	.054
CU3.6	.118	.133	.114	**.787**	.054
CU3.7	.107	.112	.145	**.785**	.099
CU3.7	.107	.112	.145	**.785**	.099
ME3	.039	.196	.204	.155	.707
ME5	.092	.186	.215	.124	**.735**
ME6	-.004	.131	.170	.144	**.765**
ME7	-.016	.158	.201	.143	**.753**
ME8	.123	.216	.314	-.029	**.741**

6.0 Conclusion

The purpose of this study is to demonstrate the potentials of Partial Least Squares PLS approach to estimating the reliability and validity of measurements items and their latent constructs in a communication model. The motivation for the study was the observation by Gaskin and Lowry (2014) that there is inconsistent application of PLS SEM in communication studies leading to low appreciation of its potentials in the field of communication and behavioural areas. In addition to performing similar function with regression analysis and its covariance-based structural equation modeling; PLS performs well in multivariate model without the strict distributional requirement that is mandatory in both regression analysis and covariance-based SEM. In exploratory theoretical model like the one in this study, PLS offers simple but robust options. In applying PLS SEM, the results enable the researcher to show that the specified model relationship contains measurement items that have strong relationship with their corresponding latent constructs. They also indicate convergent and discriminant validity of the constructs. The implication of the result is that PLS will assist communication and media studies that are

designed as exploratory theoretical model that will lead to theory building.

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