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Literature Review Of Cronbachalphacoefficient (A) And Mcdonald's Omega Coefficient (Ω)

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ABSTRACT

Cronbach's Alpha coefficient (α) is commonly engaged to measure the reliability in social, behavioural and education sciences. It is found to be observed that every study call for measuring a construct through multiple items. The estimation methods of Cronbach's Alpha coefficient (α) and McDonald's Omega coefficient (ω) absolutely considers that data is complete and normally distributed. Cronbach's Alpha coefficient (α) relies on assumptions, whereas McDonald Omega coefficient (ω) is relying on fewer and better realistic assumption/s than the Cronbach's Alpha coefficient (α). The impact of item deletion has been not observed on population reliability if Cronbach's Alpha coefficient (α) item deleted, but in case of McDonald Omega coefficient (ω), it reflects true population estimates of reliability through the removal of certain scale of item.Cronbach's Alpha coefficient (α) shall be replaceable with McDonald's Omega coefficient (ω) and it is strongly recommended to use in place of McDonald's Omega coefficient (ω). Literature Review of Cronbach Alpha Coefficient (α) and McDonald's Omega Coefficient (ω) has been carried out by me to implement the McDonald's Omega Coefficient (ω) concept in the analysis of my research work data/responses.This concept is applicable, wherever the responses from a sample (i.e., out of universe) is required to be collected for analysis and to conclude (i.e., to arrive at decision) at a particular issue in under mentioned study area/s and they are business management (human resources, marketing etc.), medical (virus, diabatology, aids etc.,), arts, science, engineering (civil, mechanical etc.)

Key words: Cronbach's Alpha coefficient (α), McDonald Omega coefficient(ω), Reliability, Internal consistency, Tau-equivalence

1. INTRODUCTION:

To measure the human gig and conduct, psychometric scales shall be engaged and which is acceptable in the present practice, but the quality of test and responses always remains as not cross examined.A valid and reliable scale required to measure abstract characteristics. Hence, the scale shall be tested for its reliability through engaging a suitable statistical

method. Classical test theory (CTT) shall be regarded as true score theory and it is introduced based on the three concepts of a) errors in measurements, b)error as a random variable, c) correlation and how to index it. In CTT a portion of the variability in participants' responses is assumed to be due to a true underlying difference - the true score (T) - in the trait being measured (X). The rest of the portion of variability shall be composed of random measurement errors (E).Hence, X = T + E. Reliability is defined as the ratio of true score variance (i.e. $\sigma T2$) to the observed score variance, which in turn is the sum of true plus error variance(i.e.$\sigma X2$).

Reliability =[$(\sigma T2)/(\sigma X2)$] = [$(\sigma T2)/(\sigma T2 + \sigma E2)$]

The repercussion of sticking to CTT's reliability that anything that affect error will inevitably change the reliability. Hence, reliability is not a property of a test alone, but, it is property of scale extend in a mentioned situation to a particular population. (Miller, 1995; Thompson &Vacha-Haase, 2000). The degree of error of a scale estimated based on certain limitation and they are a) validity of exact value of a test's reliability in a specified situation is not known, b) sampling error of E and T is not knows due to sampling error, c)model under the C.T.T are "under identified" due to parameters are being greater in number than statistics and due to multifold degrees of freedom, reliability estimate can take any realizable value. Three different models has been forwarded and shall be engaged in reliability testing and they as follows a) tau equivalent, b) congeneric parallel, c) parallel and these models well connected by underlying properties of a)unidimensionality, b) sensitivity, c) same variance, d) error variance and properties summarized in Table 1.

Table 1:
Properties of different models

S.No.	Tau equivalent	Congeneric	Parallel
1	• Less restrictive, • Assumes constant variances for true scores, • Allows true score means and error variances of item to vary.	• Least restrictive, • Assumes constant variance of true scores and the error variances allowed to vary.	• Restrictive, • Constant item means, variance, error variances, • Hence, all items tap same personality trait on same scale with identical precision and error.

To ascertain the reliability of scale it is in practice to arrive either CronbachAlpha coefficient(α)or McDonald's Omega coefficient(ω)through a suitable statistical method. The reliability coefficient range between "0" and "1". The scale reliability shall be examined by repeated application of scale once, twice and or applying the equivalent scale once. The coefficient will pass an information/ property of a defined subject. The under mentioned sections shall be reliability estimates and they are a) Inter-rater reliability: It shall be of degree of concurrence between two or moreraters in their estimation, b) Test-retest reliability: It shall be the degree to which test scores are consistent from one survey administration to the next, by retaining same conditions of testing. It comprises intra-rater reliability, c) Inter-method reliability/Parallel form method: Whenever there is variation in the method/instrument engaged, this method examines to what extent the test scores consistent. Parallelforms reliability shall be considerable if forms are dealt,d) Internal consistency reliability: It examines the uniformity of results across items within a test.Internal consistency may be affected due to mistaken administration, poor recording, and time being changes in personal completion. The split half method manages to examine the data to a group of

individuals and examine by splitting in to half, then the results correlates the scores ofone-half group with other half group. This correlation shall be used in evaluating the reliability of the test. To maintain the similarity of two halves in terms of content and respondent's circumstance, it is required to be grouped in to odd and even factors as a part twodifferent group/sections. Encapsulating the information about the population parameter is known as point estimation (a 'statistic').

Cronbach Coefficient Alpha (α) = [k/(k-1)] * [1-(Σσi2/σx2)]

k is the number of items/factors
Σσi2is the sum of itemvariances
σx2is the total variance of the scale

McDonald Omega coefficient (ω) is computed as ratio of the variance due to the common attribute (i.e., factor) to the total variance. In this case the tau equivalent model or independent item residuals are ignored. Among few factors correlated errors are found and it is not with all factors. Hence, Gignac (2009) has proposed two versions of coefficient and they are a) McDonald Omega coefficient (ωA), in which error terms of items on a factor are not correlated and it is formulated (Hancock and Mueller 2001) as

$$\omega_{\mathrm{A}} = \frac{\left(\sum_{i=1}^{k} \lambda_i\right)^2}{\left(\sum_{i=1}^{k} \lambda_i\right)^2 + \sum_{i=1}^{k} \delta_{ii}}$$

where,

λi is standardized factor loading and
δii is standardized error variance (i.e., δii= 1-λi2).

b) McDonald Omega coefficient (ωB), where the error terms of the items on a factor are correlated (Raykov 2001) it is formulated as

$$\omega_{\mathrm{B}} = \frac{\left(\sum_{i=1}^{k} \lambda_i\right)^2}{\left(\sum_{i=1}^{k} \lambda_i\right)^2 + \sum_{i=1}^{k} \delta_{ii} + 2\sum_{1 \le i < j \le k} \delta_{ij}}$$

where,

λi is standardized factor loading and
δii is standardized error variance (i.e., δii = 1-λi2).
δijis the correlation between item error terms

It is being difficulty to estimate Cronbach Alpha coefficient (α) through meeting the assumptions, hence, it is appropriate to latent variable (McDonald Omega coefficient) approach to the estimation of internal consistency reliability.

2. OBJECTIVES OF THE STUDY

The objectives of this study are

a) To explore the Cronbach Alpha coefficient (α) and its limitation/s, and

b) To find difference/s among the Cronbach Alpha (α) and Mc Donald Omega

3. METHODOLOGY

The proposed study will be carried based on available secondary data (i.e. Research journals, thesis's, books etc.,) and the study is of descriptive in nature.

4. LITERATURE REVIEW:

To measure the human gig and conduct, psychometric scales shall be engaged and which is also acceptable in the present practice, but the quality of test and respondent's responses shall always remain as unquestioned in the survey.
Carmines, E. G., & Zeller, R. A. (1982) in their paper it is concluded that "there is a strong conclusive relationship between the total number of variables/items and reliability coefficient".

Raykov (1997, 2007) in his work it is found to be concluded that "the concept of item deletion may lead to over or under population estimation of Cronbach's Alpha coefficient(α) and also implied population inferences due to item deletion shall not be carried over to uses to alternative samples, hence it shall be summarized that the it is not a true or population reliability of a scale.

IlkerErcan et al., (2007) in their paper, it is found to be concluded that "Sample size will impact the fidelity of reliability coefficient especially with Cronbach's Alpha coefficient (α) based on principal component analysis, but based on factor analysis, Mc Donald Omega coefficient found to be varying with respect of sample size and also found that increase in factors/ variables/items will lead stabilized Mc Donald Omega coefficient even for all sample sizes".

Thompson (2002) in his paper it is observed to be concluded that " there is strong opinion of developing the compromised results by researchers due to poor measurement reliability".

Waller (2008) in his work it is found to be concluded that "in the majority of instances commingling (i.e. when scores are derived from multiple populations) inflatesCronbach's Alpha coefficient (α) (overestimation), in others it attenuates it (underestimation)".

Revelle and Zinbarg(2009) in their article it is found to be concluded that "portion of variance of total score that is attributable to the true score variancerepresented by reliability,but it is being not possible to calculate the true score variance andreliability itself, reliability is estimated in a mentioned quantifying situation. Cronbach's Alphacoefficient(α)is a multi-iteminstrument to estimate reliability".

Terry & Kelley (2012); Raykov (2002) in their work it is found to be concluded that"reliability measure Cronbach's Alpha coefficient (α) found to a flaw application because of point estimates".

Timothy Teo,Xitao Fan (2013) in their article it is found to be concluded that "even though Cronbach's Alpha coefficient (α) is commonly used as reliability estimate, Cronbach's Alpha coefficient's(α) use and interpretation decreases its validity and correctness, if tau-equivalency and independent of error assumptions are violated, in such cases coefficient

theeta(θ) and coefficient McDonald Omega(ω)shall become more viable and also these estimates (i.e. α,θ,ω) are of for composite score. The measurement error source is in question is internal consistency, to estimate source errorinter-rater reliability, test–retest reliability shall be engagedand are suitable for single source. There is chance of rater's rate to lead two measurement errors and they are a) internal consistency across multiple items and b) inter rater consistency across different rater. In the situation where mutilple measurement errors prevails, generalizability theory (G-theory) is recommended frame work to handle multiple error sources simultaneously, multiple errors from multiple error sources can be estimated simultaneously".

Thomas J. Dunn et.al., (2013) in their it is found to be concluded that " internal consistency reliability of a scale mayimpact, if assumptions are not met in the case Cronbach's Alpha coefficient (α) ".

Zhiyong Zhang and Ke-Hai Yuan (2016) in their article it is found to be concluded that "Data found to be complete and normally distributed in traditional estimation methods (i.e. Alpha(α) and McDonald Omega (ω)) and McDonald's Omega coefficient is recommended to use in place of Cronbach's Alpha coefficient (α), to deal with non-tau -equivalent items"

Anne M. Gadermann, Martin Guhn& Bruno D. Zumbo (2012) in their article it is found to be concluded that " Conventionally, reliability coefficients, such as Cronbach's alpha, is calculated using a Pearson correlation matrix. Ordinal reliability coefficients, such as ordinal (i.e., based on Likerts scale) alpha, use the polychoric correlation matrix (Zumbo, Gadermann, &Zeisser, 2007)".

JonasMoss (2020) in his article it is found to be concluded that "Standardized alpha, which is a cousin of coefficient alpha is calculated from correlation matrix instead of covariance matrix shall be avoided to interpret the datareliability. Ordinal alpha computed by engaging polychoric correlation matrix concept should also be avoided to interpret the data reliability. Hence, standardized alpha and ordinal alpha reliability coefficients should be avoided for data reliability conclusion".

5. FINDING/S

The under mentioned points have been foundduring exploration:

a) Cronbach's Alpha coefficient (α) relies assumptions and they are rarely met,

b) Violation of assumption lead Cronbach's Alpha coefficient (α) to blown up ordiminishes,

c) The impact of item deletion has been not observed on population reliability if Cronbach's Alpha coefficient (α) item deleted,

d) Cronbach's Alpha coefficient (α) is being point estimate it does not demonstrate variability during the estimation process, which may lead false confidence in the consistencyof theregulating of a scale.

Difference/s among the Cronbach Alpha (α) and Mc Donald Omega

a) Cronbach's Alpha coefficient (α) relies on assumptions, whereas McDonald Omega coefficient (ω) is relying on fewer and better realistic assumption than Cronbach's Alpha coefficient (α),

b) The impact of item deletion has been not observed on population reliability ifCronbach's Alpha coefficient (α) item deleted, but in case of McDonald Omega coefficient (ω), it reflects true population estimates of reliability through the removal of certain scale of item,

c) The computing of McDonald Omega coefficient (ω) parallel to a confidence interval contemplate much closer the variability in the estimation process, providing a more accurate degree of confidence in the consistency of the regulating of a scale.

6. CONCLUSION

From the literature review, it is to conclude that

a) McDonald Omega coefficient(ω) preferred over the Cronbach's Alpha coefficient(α).

b) The McDonald's Omega Coefficient (ω) concept will be engaged in the analysis of my research work data/responses.

7. RECOMMENDATION

This concept is applicable, wherever the responses from a sample (i.e., out of universe) isrequired to be collected for analysis and to conclude (i.e., to arrive at decision) on a particular issue in under mentioned study area/s and they are

a) Business management (Human Resources, Marketing etc.),
b) Medical (Virology, Diabatology, Aids etc.,)
c) Engineering and Technology (Civil, Mechanical, Manufacturing, Production etc.)
d) Arts and Science

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