

Method Article**A Parametric Approach Using Z-Test for
Comparing 2 Means to Multi-Group Analysis
in Partial Least Square Structural Equation
Modeling (PLS-SEM)****ABSTRACT**

Aims: Multi-group analysis can be known as modeling the moderator variable since the strength of this method to moderates the influences of exogenous on endogenous variable. Basically, researchers interest to employ such method to extend their study to be more intense and practical.

Sampling: This paper work used stratified sampling which is one of the probability sampling. Thus, the parametric method can be applied as set of statistical assumption.

Methodology: Thus, multi-group analysis has become convenient to be practice in second generation modeling namely Structural Equation Modeling (SEM). Nevertheless, the limitation of Covariance Based Structural Equation Modeling (CB-SEM) causes the difficulties of researchers to further their studies. Hence, Partial Least Square Structural Equation Modeling (PLS-SEM) introduced to satisfy the necessity of researchers. Truthfully, multi-group analysis is not implement in most of PLS-SEM software.

Result: Therefore, this paper intend to demonstrate a parametric approach using z-test to attain the probability level with the help of SmartPLs 2.0. Generally, z-test comprised of two types of comparing for each groups namely means and population proportion. However, this paper work apply comparing of means to attain the value of z-scores. Consequently, the aimed of this paper work is success since the implementation of z-test approach to multi-group analysis.

Conclusion: In this case, categorical variable which is constituted for 2 groups namely gender group was the one to be moderator variable. The findings reveal that all the exogenous construct that link on endogenous construct fail to meet the required level of family wise error rate.

Keywords: Structural Equation Modeling (SEM), Covariance Based Structural Equation Modeling (CB-SEM), Partial Least Square Structural Equation Modeling (PLS-SEM), Multi-group analysis, z-test approach, categorical variable, family wise error rate.

401. INTRODUCTION

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42 Nowadays, Partial Least Square Structural Equation Modeling (PLS-SEM) often to be an
43 attractive method due to the capability and benefit of methodology established.
44 Previously, Covariance Based Structural Equation Modeling (CB-SEM) will be a main
45 preferences for some researchers to carry on their research more deeply and
46 comprehensive and of course to substitute the first generation of modeling. However, the
47 statistical assumption is required to satisfy first before subsequent the further analysis
48 (Afthanorhan, 2014). Thus, PLS-SEM is an alternative method for any researchers that
49 has faced difficulties to carry on their research. In particular, their ideology to justify
50 analogous concept is unlimited since they do not have to rely on statistical conditions.

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52 In seek of obsessing to create and proved their concept on the basis of PLS-SEM, they
53 start to undertake research in many issues related on their expertise. One of the
54 interested method is multi-group analysis. Indeed, some of the articles regarding on this
55 approach has become an intense topics to employ such as from Ringle et. al. (2005),
56 Henseler et. al (2011), Hair et. al (2012), Sarstedt (2009) and other prominent
57 academicians.

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59 Consequently, there are several approaches has been introduced to ascertain the
60 scholar make their decision based on the reports. Afthanorhan (2014) had stress on this
61 method using parametric and non-parametric test to demonstrate the readers of their
62 strength, limitation, technique, and efficiency. Thus, this paper work decide to reveal
63 other one approach of parametric test that involving on the large data which is z-test or
64 z-score approach.

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662. MULTI-GROUP ANALYSIS

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68 Multi-group analysis is usually to identify whether other factor can affect the influence of
69 causal effect between exogenous and endogenous construct (Afthanorhan, 2014).
70 Generally, the categorical variable such as gender, level education, status, citizenship,
71 or other factor will be preferred to let these factors plays their role as moderator variable.
72 In particular, moderator variable is certified to identify of whether the influence of
73 exogenous and dependent variable can be affected by other factor in certain
74 circumstances. However, the continuous variable also can be conducted if the
75 researchers has a good reason to support their substantive concept.

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77 In CB-SEM using Analysis Moment of Structural (AMOS) application, this particular
78 method can be tested with the difference of chi-square test by comparing of structural
79 model for two groups (example: Male versus Female). Chi-square test once consider as
80 non-parametric test if conducted for one group solely but if the process is involving for
81 more than one group, this approaches was automatically considered as parametric test.
82 This is because the distribution of chi-square different test is the same thing as z-test.
83 This approach has been justify by some of articles regarding on the chi-square
84 difference test by Zainudin (2010), Hair et. al (2010) and Afthanorhan (2014).

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86 Nevertheless, CB-SEM is quite cumbersome and complicated since this method relies
87 on statistical assumption. In other words, if the requirement of CB-SEM is failed, the
88 finding will be meaningless. In fact, CB-SEM have a lot of requirement that should be
89 satisfied by all users if they intend to carry on their studies. Thus, PLS-SEM was
90 established to solve the limitation of CB-SEM so as help the researchers to constantly
91 continuous on their work.

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In PLS-SEM, most of application currently are not employed of multi-group analysis unless SmartPls 3.0 (Ringle, 2014). However, this article is interested to implement of multi-group analysis using SmartPls 2.0 (Ringle, 2005) with the introduced of z-test to determine the probability level. Previously, the authors demonstrate the parametric test using equal and unequal variance of t-test but since the limitation of this approaches has been discovered, thus, z-test was conducted for this research work. Hence, this aimed of the research work is to provide a parametric approach using z-test to multi-group analysis so as to extend the capability of aforementioned method. In statistics discipline, z-test or z-score can be implement once the data attained is large sample size which is greater than 30.

Conversely, t-test can be implement if the data obtained was below than 30 (Ott, 1984; Afthanorhan, 2014). Indeed, most of the articles stand their point to use of equal and unequal t-test approach for their research but the finding can be argue. Thus, the execution of z-test is conducted to multi-group analysis.

1093. THEORETICAL FRAMEWORK

Theoretical framework is performed once the researchers identify which one of the factor that should be carry on for the multi-group analysis. Since the aimed of this research paper to guide the calculation of z-test approach, thus, the explanation regarding of each factors applied are neglected. In this case, the authors implement five constructs that has been approved to be a main problems. In particular, four out of five constructs will be an exogenous construct namely Benefit, Barrier, Challenge, and Motivation respectively.

The data were collected using stratified sampling technique because this method is more relevant and efficient rather than the simple random sampling (Zainudin, 2012). Then, the authors collected absolute 453 respondents using these technique. In this instances, the authors had addressed to use gender group to be implement in multi-group analysis, in particular, 159 and 193 respondents are represent for male and female group respectively. The framework of this particular analysis is presented as follows:

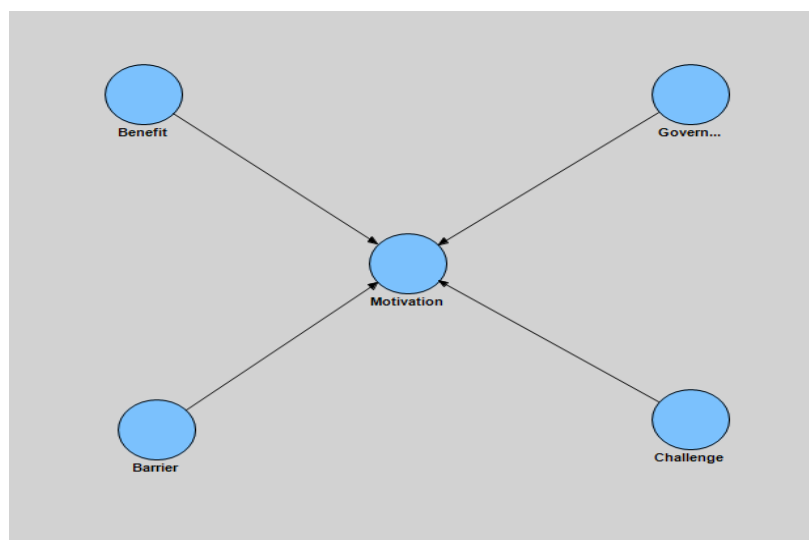


Figure 1

1284. Z-test For Comparing Means to Multi-Group Analysis in PLS-SEM

In statistics discipline, z-test have two types that can be explained for one group and two groups. In the basic of multi-group analysis, two groups and above are considered to carry on this particular method. In the accordance of Chin & Dibbern (2009), the usage of z-test is adequate to put into practice of multi-group analysis for large sample size. In other words, the t-test for large sample size is inadequate to be practice since the elementary of t-test is limited for small sample size. Z-test for two population proportion is used when the researchers want to know whether two populations or groups (example: male and female; urban and rural; single and married, indigenous and non-indigenous) are significant difference on some influences of exogenous towards endogenous constructs. Thus, there are two requirement that should be stressed such as:

1411. A random sample of each of the population groups to be compared

1422. The sample size should be greater than 30

1433. The data should be in categorical

1444. The equation of z-test is present as below:

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$$146 \quad Z\text{-test} = \frac{(p_1 - p_2) - 0}{\sqrt{p(1-p)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

147 Where:

148 a) P_1 : Population for Male

149 b) P_2 : Population for Female

150 c) p : Probability of gender group

151 d) n_1 : Total population for Male

152 e) n_2 : Total population for Female

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154 Formula for p as follows:

$$155 \quad p = \frac{x_1 + x_2}{n_1 + n_2}$$

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157 Where:

158 a) X_1 : The number of Male

159 b) X_2 : The number of Female

160 c) N_1 : Total population for Male

161 d) N_2 : Total population for Female

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163 However, this paper works is decide to use the methodology of comparing means including of two groups (Male. and Female). Basically, this approach illuminated once the studies had established the value of standard error or standard deviation. If the researchers fail to perform the standard error in their research, z-test to comparing between population proportions can be used as aforementioned above. Then, the formula of z-test of comparing means is presented as follows:

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$$170 \quad Z\text{-test} = \frac{(p_1 - p_2) - 0}{\sqrt{p(1-p)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

171 Where:

172 a) P_1 : Population for Male

173 b) P_2 : Population for Female

174 c) p : Probability of gender group

175 d) n_1 : Total population for Male

176 e) n_2 : Total population for Female

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178 Now, the authors will guide the readers on how to execute the multi-group analysis using SmartPLS 2.0 and the calculation to attain the probability level (family wise error rate) as follows:

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- 182• The first thing is the scholars should execute the full data by PLS algorithm and
- 183 Bootstrapping approach. PLS algorithm is aimed to provide the outer loading and outer
- 184 weight for researchers to identify the strength of each manifest variables (items).
- 185 Bootstrap technique is used to generate the standard error for each constructs, thus, t-
- 186 test will be performed.
- 187• Then, identify the moderator variable that will be implement. In this case, the authors use
- 188 gender (male and female) to be a moderator variable.
- 189• Then, split the data into two model that represent structural model for Group 1 (male)
- 190 and Group 2 (female)
- 191• Execute both structural model as the full model previously.
- 192• Copy the result of male and female respectively in other word document so that these
- 193 result will be extended to carry on the subsequent steps.
- 194• The calculation of z-test will be present at the subtopic of findings.

1965. FINDINGS

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198 As aforementioned, the authors promised to demonstrate the calculation of z-test
199 population proportion using gender group as categorical variable to be moderator factor.
200 Since the procedure of multi-group analysis is given, thus, the researchers should have
201 the same matter to attain the probability level. The result of Table 1 and Table 2 can be
202 obtained by SmartPLS 2.0 as presented below:

Male	Original Sample (O)	Sample Mean (M)	Standard Error (STERR)	T Statistics (O/STERR)
Barrier -> Motivation	0.078119	0.0813	0.052801	1.479489
Benefit -> Motivation	0.688298	0.6868	0.064688	10.640206***
Challenge -> Motivation	0.012209	0.0274	0.054873	0.222503
Government -> Motivation	0.124517	0.1250	0.061750	2.016464**

Table 1

*: p-value ≤ 0.01 ; **: p-value ≤ 0.05 ; ***: p-value ≤ 0.01

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207 Table 1 is the result of male that comprised of original sample, sample mean, standard
208 error and t-statistics. All of these result was appeared once the researchers execute the
209 bootstrap technique. Based on the T-statistics given, there are two exogenous construct
210 namely Benefit and Government have meet the required level of probability level which
211 is greater than 1.96 (p-value ≤ 0.05). Conversely of other factors since they failed to
212 meet the required level. By inspecting through for each column of original sample,
213 Benefit factor is the most importance factor to influence onMotivation factor. Thus, it can
214 be perceived that this group strongly agree that Benefit factor is the most significant that
215 should be addressed.

Female	Original Sample (O)	Sample Mean (M)	Standard Error (STERR)	T Statistics (O/STERR)
Barrier -> Motivation	0.0776	0.0785	0.0398	1.9520*
Benefit ->	0.6922	0.6890	0.0468	14.7998***

Motivation				
Challenge -> Motivation	0.0134	0.0214	0.0381	0.3518
Government -> Motivation	0.1197	0.1237	0.0447	2.6780***

Table 2

*: p-value ≤ 0.01; **: p-value ≤ 0.05; ***: p-value ≤ 0.01

Table 2 is a result for female group that comprised of original sample, sample mean standard error and t-statistics same as male group. Based on the t-statistics performed, there are one variable that present the different hypothesis which is Barrier factor. For male group, they disagree that Barrier factor is significant on Motivation factor differ for female group. This group seems belief this factor has a significant impact on Motivation. However, both group are agree to decide Benefit and Government factors are have significant impact on Motivation. Afterwards, both of these results will be computed in a new table as Table 3:

Z-Test Approach	MALE	FEMALE	Z-SCORE	P-Value
Barrier -> Motivation	0.0813	0.0785	0.1051	0.9124
Benefit -> Motivation	0.6868	0.6890	0.0088	0.99202
Challenge -> Motivation	0.0274	0.0214	0.402	0.68916
Government -> Motivation	0.1250	0.1237	0.04	0.9681

Table 3

Table 3 is a result of z-test approach that comprised of male, female, z-score and p-value for each construct provided. Based on the p-value result, all of these construct failed to meet the required level of 0.05. Thus, it can be indicates that male and female do not have a significant different between exogenous and endogenous construct. The calculation of z-test is performed as follows:

Hypothesis:

H₀: Male do not has a significant different with female between Barrier and Motivation

H₁: Male has a significant different with female between Barrier and Motivation

Test Hypothesis:

$$Z\text{-test} = \frac{(p_1 - p_2) - 0}{\sqrt{p(1-p)\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$Z\text{-test} = \frac{(0.0813 - 0.0785) - 0}{\sqrt{\left(\frac{0.0398}{159} + \frac{0.05281}{193}\right)}}$$

$$Z\text{-test} = 0.1051$$

Conclusion:

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- ➔ Z-test will be considered significant different once the absolute value of z-test is greater than 1.96 (p-value < 0.05). In this case, the findings shows that the absolute z-test is below than 1.96. Thus, one can be conclude that the male do not has a significant different with female between Barrier and Motivation.
 - ➔ However, some of the researchers fail to contribute the p-value to provide a better understanding for the readers. Thus, this paper works shows the step by step to attain p-value using the calculator as follows:
 - a) Press "Mode" two times
 - b) Press "1" which is represent for SD
 - c) Then, press "Shift" and "3" that will present [P (Q(R(→ t]
 - d) And last press "1". In this stage, the readers can include the value of z-test. In this case, the authors type 0.1051 as presented above in calculator.
 - ➔ This procedure is repeated for the subsequent path analysis.

2646. CONCLUSION

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266 In this study, the authors address z-test approach to carry on the multi-group analysis.
267 As aforementioned, z-test is appropriate to be conducted since the data used are large
268 sample size. Thus, the requirement of equal and unequal variance t-test that has been
269 proposed by Keil (2000) are limited. This is because the t-test is normally be practice for
270 small sample size, thereby, this method is inadequate for large sample size. Thus, this
271 paper work decide to demonstrate the application of z-test with the help of SmartPLs 2.0
272 software.

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274 By regarding on the findings, the z-test was success to be implemented for multi-group
275 analysis since this test are achieve the requirement needs for z-test population
276 proportion. Besides, the procedure to employ is also ease to be conducted along of the
277 p-value. On the use of z-test approach towards four exogenous constructs, all of these
278 variables failed to meet the requirement of family wise error rate (p-value ≤ 0.05). Hence,
279 one can be conclude that there are no significant different between male and female on
280 each of causal effect.

281 2827. RECOMMENDATION

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284 Once objective research are achieve, there might have suggestion or recommendation
285 to improve the strength of research. In this case, the authors had address the issues
286 regarding on the limitation of potential t-test approach to multi-group analysis. In fact, z-
287 test also had significant to be implemented. The first thing is the requirement that should
288 be achieve are the normality of data. In statistics discipline, z-test is considered as
289 parametric test since the distribution is bell-shaped curved. Thereby, the normality using
290 Shapiro-wilks, Kolmogorov-Smirnov, histogram and other related test should be
291 conducted first. In accordance of Razali & Afthanorhan (2014), Shapiro-wilks are
292 powerful once the data obtained are small sample size whereas Kolmogorov-Smirnov
293 test are useful for large sample size.

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295 The second things is z-test is appropriate for large sample which is greater than 30. If
296 the sample size less than 30, the result will be meaningless due to the deficiency of
297 small sample size. The last things is about the moderator effect (gender) applied is might
298 inefficient due to the failed of research hypothesis. Thus, the future research should be
299 highlight the other factor that has a potential to discriminant of each categorical variable.

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