

Structural Equation Modelling Report

This report contains the results of tests of a measurement model and a structural model to explain the Use of Social Commerce

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Methodology

The main objective of testing a measurement model is to test construct validity. Construct Validity is defined as “the extent to which a set of measured variables actually represent the theoretical latent construct they are designed to measure” (Hair et al., 2014, p. 543). Confirmatory Factor Analysis (CFA) was used in the analysis, as it is an adequate method to be used as evidence of construct validity of theory-based instruments (Li, 2016). This type of analysis is used when a researcher wishes to confirm a specific pattern of variables that are predicted based on theory or previous analytical studies (DeVellis, 2012). That is, based on knowledge of the theory, he or she assumes the a priori factorial structure and then tests this hypothetical arrangement statistically (Byrne, 2016).

CFA was conducted using SPSS AMOS software, which uses Maximum Likelihood (ML) algorithm to estimate the results. ML is the most common method used to estimate parameters in CFA, because of its attractive statistical properties (i.e., asymptotic unbiasedness, normality, consistency, and maximal efficiency) (Li, 2016). After defining the model in the software and executing the analysis, four main phases were conducted to examine construct validity (1) assessment of model fit; (2) assessment of convergent validity; (3) assessment of discriminant validity and (4) respecification of the model (if necessary).

The statistics that were used to assess model fit and their rules of thumb are presented in the table below.

Fit index	Rules of thumb
Normed chi-square (χ^2/df)	The division between the chi-square value and the model's degrees of freedom should be less than 4.
Root mean square error of approximation (RMSEA)	RMSEA < 0.08
Comparative fit index (CFI)	CFI > 0.90
Normed fit index (NFI)	NFI > 0.90

After the assessment of model fit, convergent and discriminant validity were examined. Convergent validity refers to the “extent to which indicators of a specific construct converge or share a high proportion of variance in common” (Hair et al. 2014, p. 601), while discriminant validity is defined as the “extent to which a construct is truly distinct from other constructs both in terms of how much it correlates with other constructs and how distinctly measured variables represent only this single construct (Hair et al. 2014, p. 601).

A second important concept to test is construct's reliability. This was done using the Composite Reliability index (which is based on factor loadings) and Cronbach's Alpha (which is based on correlations).

A summary of the indicators used to measure constructs' validity and reliability are detailed below (table below).

Indicator of convergent validity	Definition	Rules of thumb
Factor loadings (λ)	Correlation between the original variables and the factors, and the key to understanding the nature of a particular factor. Squared factor loadings indicate what percentage of the variance in an original variable is explained by a factor.	In the case of high convergent validity, high one-factor loadings would indicate that they converge on a common point, the latent construct. At a minimum, all factor loadings must be statistically significant. Because a significant load can still have quite weak strength, a good rule of thumb is that standardized loading estimates should be 0.5 or higher and ideally 0.7 or higher.
AVE	A summary measure of convergence among a set of items representing a latent construct. It is the average percentage of variation explained (variance extracted) among the items of a construct.	An AVE of 0.5 or higher is a good rule of thumb suggesting adequate convergence (Fornell and Larcker, 1981). An AVE of less than 0.5 indicates that, on average, more error remains in the items than variance explained by the latent factor structure imposed on the measure.
Indicator of discriminant validity	Definition	Rules of thumb
AVE and correlations (p)	The square root of the variance extracted estimates for a construct should be greater than the correlation estimates between this and other constructs.	$\sqrt{AVE} > p$ (Fornell and Larcker, 1981).
Indicator of reliability	Definition	Rules of thumb
Composite Reliability	Measure of reliability and internal consistency of the measured variables representing a latent construct. Must be established before construct validity can be assessed. It is computed from the squared sum of factor loadings for each construct and the sum of the error variance terms for a construct.	0.7 or higher suggests good reliability. Reliability between 0.6 and 0.7 may be acceptable, provided that other indicators of a model's construct validity are good.
Cronbach's Alpha	This statistic provides an indication of the average correlation among all of the items that make up the scale. Values range from 0 to 1, with higher values indicating greater reliability (Pallant, 2010)	0.7 is the minimum acceptable level (Pallant, 2010).

Data preparation

Before inputting the dataset in AMOS, an inspection of the distribution of the data and patterns of missing values was conducted. 8 participants had missing values on the 'Accept_2' and the 'Accept_1' variables, 7 cases had blank values on the 'Accept_3' variable. Since this represents only 2.1% of all 380 participants, they can be considered negligible. The mean score of each respective

variable was imputed on the missing cases since Structural Equation Modelling requires a full dataset. All other variables showed no missing values whatsoever. Normal distribution of the variables is not expected due to the data being extracted from 5-point ordinal scales.

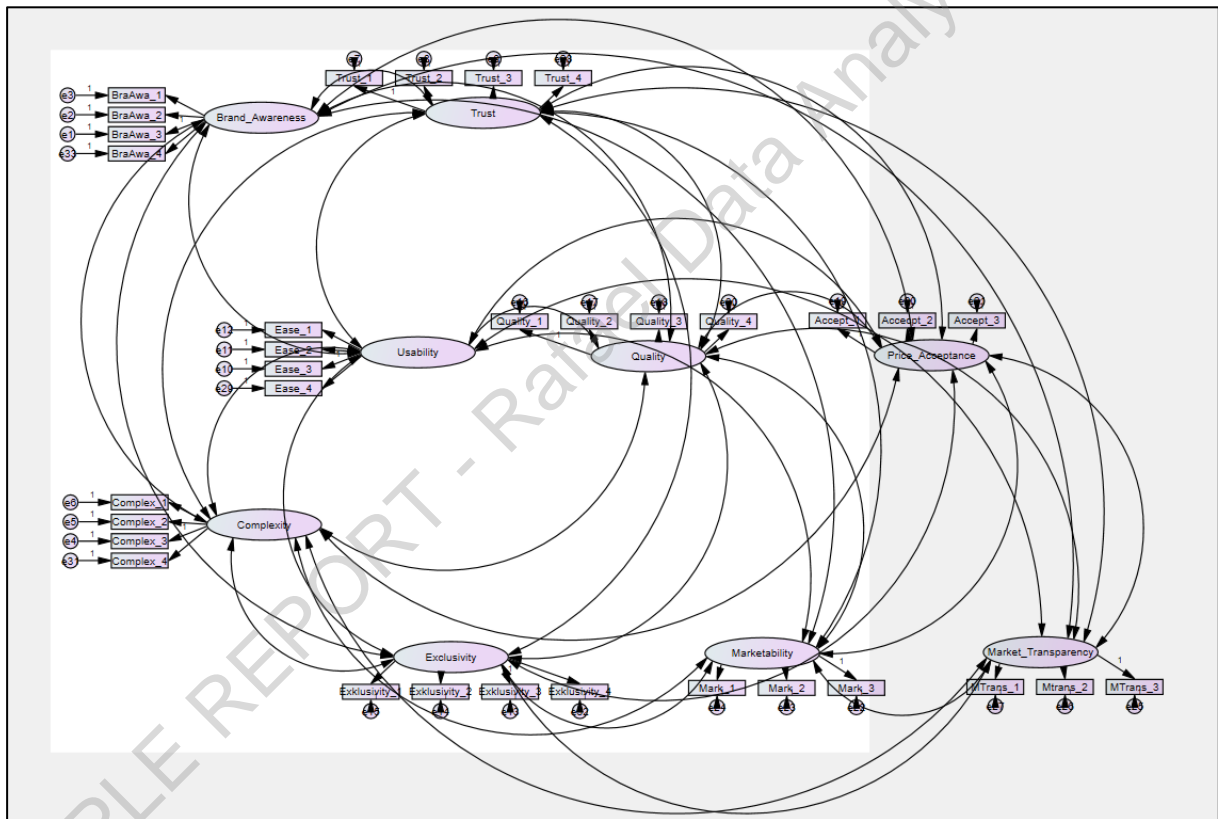
The table below shows the results of skewness and kurtosis, along with mean and standard deviations for all variables. Skewness and Kurtosis should remain between -2 and +2 to indicate no severe departs from the normal distribution. Nevertheless, non-normality in the data is also not problematic as Maximum Likelihood estimation was found to be robust to this condition (Benson and Fleishman, 1994).

Descriptive Statistics	Mean	Std. Deviation	Skewness	Kurtosis
BraAwa_1	4.837	1.549	-0.821	0.313
BraAwa_2	4.808	1.559	-0.820	0.309
BraAwa_3	5.011	1.611	-0.683	-0.147
BraAwa_4	5.095	1.626	-0.905	0.280
Complex_1	5.363	1.339	-0.818	0.766
Complex_2	4.839	1.358	-0.392	0.040
Complex_3	5.045	1.403	-0.581	0.075
Complex_4	5.521	1.276	-0.871	0.685
Trust_1	5.374	1.432	-1.002	0.883
Trust_2	5.426	1.340	-1.011	1.063
Trust_3	5.311	1.370	-0.790	0.556
Trust_4	5.389	1.451	-1.002	0.688
Ease_1	5.955	1.269	-1.489	2.401
Ease_2	5.742	1.261	-1.012	0.695
Ease_3	4.695	1.572	-0.478	-0.317
Ease_4	5.111	1.366	-0.706	0.402
Exklusivity_1	4.842	1.562	-0.672	-0.086
Exklusivity_2	5.384	1.451	-0.951	0.647
Exklusivity_3	4.763	1.491	-0.635	0.110
Exklusivity_4	4.776	1.529	-0.585	0.081
Quality_1	5.939	1.254	-1.436	1.914
Quality_2	5.653	1.394	-1.202	1.335
Quality_3	6.153	1.150	-1.830	4.225
Quality_4	5.745	1.320	-1.217	1.647
Mark_1	5.200	1.383	-0.742	0.472
Mark_2	4.989	1.312	-0.700	0.783
Mark_3	5.821	1.226	-1.165	1.302
MTrans_1	5.153	1.387	-0.657	0.249
Mtrans_2	4.963	1.647	-0.526	-0.511

MTrans_3	4.813	1.596	-0.556	-0.158
Accept_1	5.852	1.265	-1.038	0.634
Accept_2	5.573	1.221	-0.900	1.088
Accept_3	4.836	1.398	-0.561	0.259

Confirmatory Factor Analysis

The model included all latent variables to be tested in the structural model, with all their respective items. The representation of the initial model is shown in the figure below.



The model showed unacceptable levels of fit (χ^2 (459, N = 380) = 993.987; $p < .001$; $\chi^2/df = 2.166$; RMSEA = 0.055; CFI = 0.854; NFI = 0.762, GFI = 0.861). An examination of factor loadings revealed several loadings lower than 0.500, including 'BraAwa_3', 'Complex_2' etc. The factor loadings and respective Average Variance Extracted are shown below.

Standardized Factor Loadings			λ	AVE
BraAwa_3	<---	Brand_Awareness	0.474	0.448
BraAwa_2	<---	Brand_Awareness	0.764	
BraAwa_1	<---	Brand_Awareness	0.825	
BraAwa_4	<---	Brand_Awareness	0.552	
Complex_3	<---	Complexity	0.564	0.300
Complex_2	<---	Complexity	0.431	
Complex_1	<---	Complexity	0.568	
Complex_4	<---	Complexity	0.610	
Trust_1	<---	Trust	0.625	0.428
Trust_2	<---	Trust	0.725	
Trust_3	<---	Trust	0.683	
Trust_4	<---	Trust	0.574	
Ease_3	<---	Usability	0.375	0.287
Ease_2	<---	Usability	0.635	
Ease_1	<---	Usability	0.634	
Ease_4	<---	Usability	0.449	
Exklusivity_3	<---	Exclusivity	0.568	0.341
Exklusivity_2	<---	Exclusivity	0.638	
Exklusivity_1	<---	Exclusivity	0.628	
Exklusivity_4	<---	Exclusivity	0.490	
Quality_1	<---	Quality	0.709	0.437
Quality_2	<---	Quality	0.610	
Quality_3	<---	Quality	0.803	
Quality_4	<---	Quality	0.478	
Accept_1	<---	Price_Acceptance	0.610	0.267
Accept_2	<---	Price_Acceptance	0.515	
Accept_3	<---	Price_Acceptance	0.403	
Mark_3	<---	Marketability	0.700	0.522
Mark_2	<---	Marketability	0.731	
Mark_1	<---	Marketability	0.735	
MTrans_3	<---	Market_Transparency	0.621	0.391
Mtrans_2	<---	Market_Transparency	0.696	
MTrans_1	<---	Market_Transparency	0.550	

Several of the AVE scores were below the acceptable level of 0.500. For these cases, and only when the number of items loading on the construct was three or more, the respective lowest factor loading was excluded from the model. The second measurement model included 25 items from the original 33. The respecified measurement model showed an acceptable fit (χ^2 (239, N = 380) = 406.776; $p < .001$; $\chi^2/df = 1.702$; RMSEA = 0.043; CFI = 0.939; NFI = 0.866, GFI = 0.923).

An examination of factor loadings however, still showed AVE scores of less than 0.500 and two factor loadings lower than 0.500 (table below).

Standardized Factor Loadings			λ	AVE
BraAwa_2	<---	Brand_Awareness	0.783	0.529
BraAwa_1	<---	Brand_Awareness	0.824	
BraAwa_4	<---	Brand_Awareness	0.544	
Complex_3	<---	Complexity	0.572	0.347
Complex_1	<---	Complexity	0.547	
Complex_4	<---	Complexity	0.645	
Trust_1	<---	Trust	0.620	0.468
Trust_2	<---	Trust	0.755	
Trust_3	<---	Trust	0.671	
Ease_2	<---	Usability	0.645	0.333
Ease_1	<---	Usability	0.654	
Ease_4	<---	Usability	0.393	
Exklusivity_3	<---	Exclusivity	0.528	0.366
Exklusivity_2	<---	Exclusivity	0.667	
Exklusivity_1	<---	Exclusivity	0.613	
Quality_1	<---	Quality	0.711	0.509
Quality_2	<---	Quality	0.614	
Quality_3	<---	Quality	0.803	
Accept_1	<---	Price_Acceptance	0.625	0.317
Accept_2	<---	Price_Acceptance	0.494	
Mark_3	<---	Marketability	0.714	0.520
Mark_2	<---	Marketability	0.717	
Mark_1	<---	Marketability	0.733	
MTrans_3	<---	Market_Transparency	0.680	0.500
Mtrans_2	<---	Market_Transparency	0.733	

'Ease_4' and 'Accept_2' had poor loadings. However, since the exclusion of 'Accept_2' would lead to a single-item construct, only 'Ease_4' was deleted and a third measurement model was tested.

The third model showed an even better fit (χ^2 (216, N = 380) = 364.276; $p < .001$; $\chi^2/df = 1.686$; RMSEA = 0.043; CFI = 0.944; NFI = 0.876; GFI = 0.928). There were still some AVE's lower than 0.500, which suggested lack of convergent validity. An inspection of factor loadings, however, did not show any particularly poor loading for any of the constructs, which indicates that additional exclusion of items would not improve validity substantially. This lack of convergent validity is likely related to issues in the data or scales and should be considered when examining the model results. The final set of factor loadings are shown below, along with final AVE's and indicators of constructs' reliability (composite reliability – CR and Cronbach's Alpha).

Indicators			λ	AVE	CR	Cronbach's Alpha
BraAwa_2	<---	Brand_Awareness	0.784	0.529	0.766	0.748
BraAwa_1	<---	Brand_Awareness	0.822			
BraAwa_4	<---	Brand_Awareness	0.545			
Complex_3	<---	Complexity	0.573	0.348	0.614	0.610
Complex_1	<---	Complexity	0.547			
Complex_4	<---	Complexity	0.645			
Trust_1	<---	Trust	0.620	0.468	0.724	0.722
Trust_2	<---	Trust	0.757			
Trust_3	<---	Trust	0.669			
Ease_2	<---	Usability	0.657	0.437	0.608	0.608
Ease_1	<---	Usability	0.665			
Exklusivity_3	<---	Exclusivity	0.530	0.367	0.633	0.637
Exklusivity_2	<---	Exclusivity	0.666			
Exklusivity_1	<---	Exclusivity	0.613			
Quality_1	<---	Quality	0.713	0.509	0.755	0.739
Quality_2	<---	Quality	0.613			
Quality_3	<---	Quality	0.802			
Accept_1	<---	Price_Acceptance	0.622	0.316	0.478	0.472
Accept_2	<---	Price_Acceptance	0.496			
Mark_3	<---	Marketability	0.717	0.520	0.765	0.764
Mark_2	<---	Marketability	0.715			
Mark_1	<---	Marketability	0.731			
MTrans_3	<---	Market_Transparency	0.679	0.500	0.666	0.665
Mtrans_2	<---	Market_Transparency	0.734			

The construct Price Acceptance has shown particularly poor reliability ($\alpha = 0.472$) and convergent validity

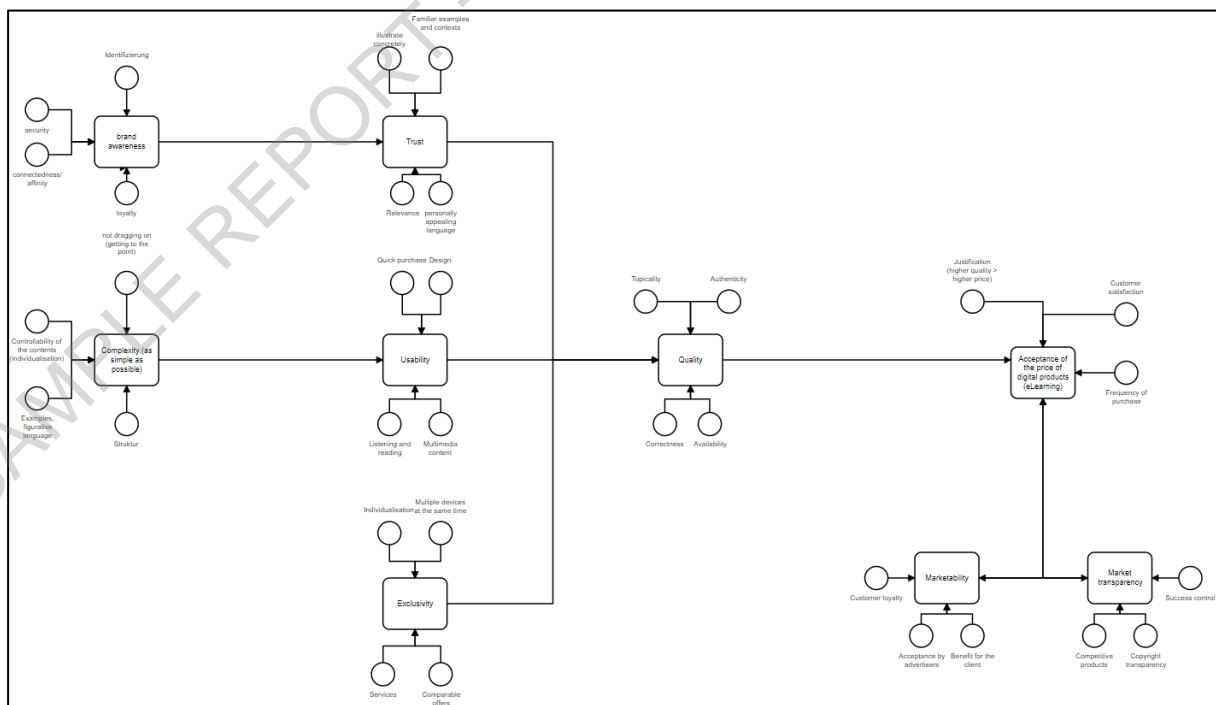
With regards to discriminant validity, the correlations among latent variables were compared to the square root of the AVE, as per the guidelines of Fornell and Lacker (1981). The table below shows a matrix with all pairwise correlation coefficients. The diagonal of the table shows the square root of AVE for each construct. If any coefficient for a single construct was larger than the square root of its AVE, this would mean that discriminant validity is not present.

Constructs	1	2	3	4	5	6	7	8
Brand_Awareness (1)	0.727							
Complexity (2)	0.331	0.590						
Trust (3)	0.466	0.769	0.684					
Usability (4)	0.477	0.659	0.699	0.661				
Exclusivity (5)	0.521	0.428	0.600	0.682	0.606			
Quality (6)	0.315	0.615	0.738	0.782	0.529	0.714		
Price_Acceptance (7)	0.446	0.527	0.695	0.805	0.652	0.715	0.563	
Marketability (8)	0.367	0.371	0.367	0.606	0.655	0.427	0.723	0.721

The table above shows that discriminant validity is not present in some pairs of constructs. For instance, Price Acceptance does not discriminate significantly from several other constructs, since the square root of its own AVE is lower than its correlations with all constructs except Brand Awareness. This lack of convergent and discriminant validity poses some limitations to the interpretation of the final model. Nevertheless, it does not make the results invalid. The report proceeds to the examination of the structural model.

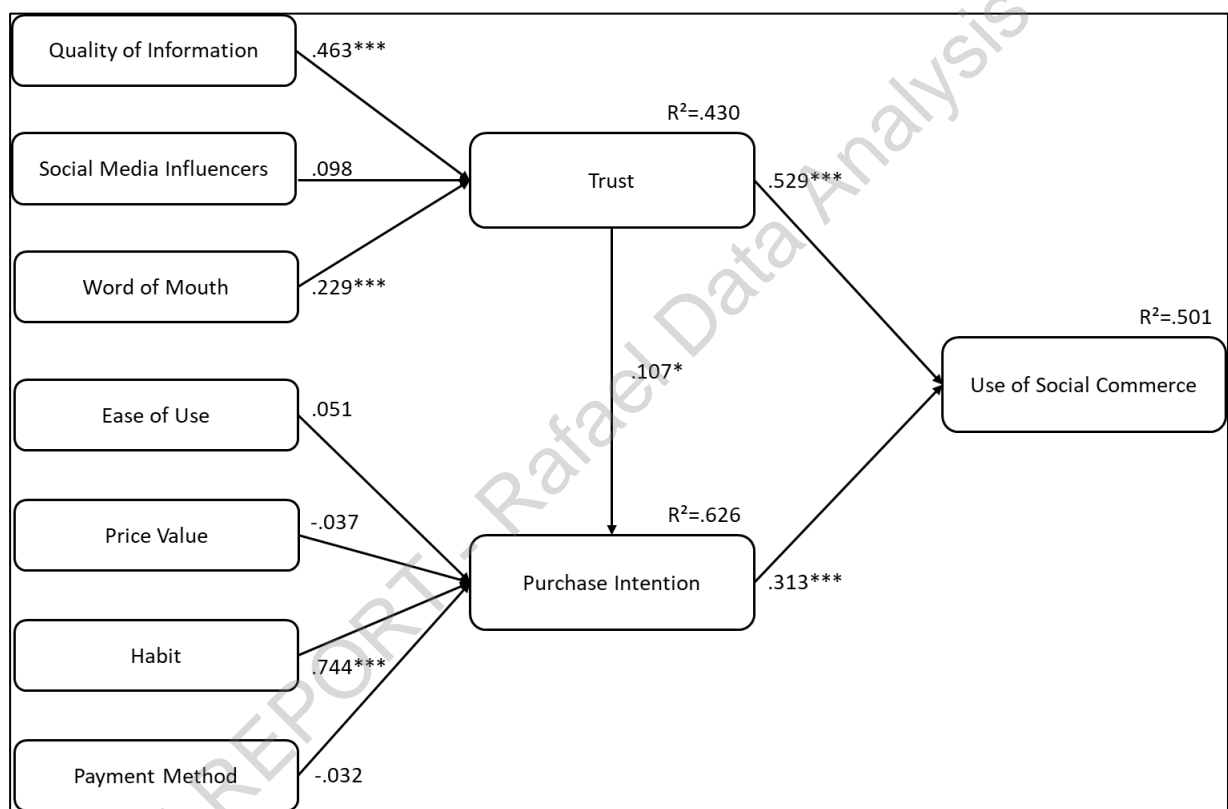
Structural Model

The next step was to build the structural model (path model), according to the conceptual model that was assumed (figure below).



The model showed unacceptable fit (χ^2 (234, N = 380) = 545.352; $p < .001$; $\chi^2/df = 2.331$; RMSEA = 0.059; CFI = 0.883; NFI = 0.815, GFI = 0.894; SRMR = 0.0817). An inspection of modification indices showed that the inclusion of a path from Complexity to Trust would substantially improve model fit (MI = 58.108). This path was added to the model and the final model showed good fit (χ^2 (233, N = 380) = 421.756; $p < .001$; $\chi^2/df = 1.81$; RMSEA = 0.046; CFI = 0.929; NFI = 0.857, GFI = 0.917; SRMR = 0.055).

Next figure shows a diagram with the resulting path coefficients (regression coefficients) and explained variance (R^2) of all endogenous constructs.



***: $p < 0.001$, *: $p < 0.05$. Note: coefficients without any superscript star were not significant at $p < 0.05$.

The squared multiple correlation (R^2) of Price Acceptance was 0.809, indicating that 80.9% of the variance of acceptance was explained by the model. Quality and Marketability showed a positive effect (influence) on Price Acceptance, with the effect of Marketability being relatively higher ($\beta = 0.607$, $p < 0.001$). Market Transparency showed a negative effect on Acceptance ($\beta = -0.232$, $p = 0.022$). The only non-significant effects were shown by Brand Awareness on Trust and Exclusivity on Quality, which demonstrates no significant relationship between these factors ($p > .05$). The effect of Complexity on Trust ($\beta = -0.816$, $p < .001$) and Usability ($\beta = 824$, $p < .001$) were particularly strong.

Tests of Hypotheses

The table below shows the summary of the hypotheses that were tested in this study.

Hypothesis	Conclusion
Quality has a significant positive effect on Price Acceptance.	Confirmed
Marketability has a significant positive effect on Price Acceptance.	Confirmed
Market Transparency has a significant negative effect on Price Acceptance.	Confirmed
Exclusivity has a significant positive effect on Quality.	Rejected
Trust has a significant positive effect on Quality.	Confirmed
Usability has a significant positive effect on Quality.	Confirmed
Complexity has a significant positive effect on Usability.	Confirmed
Complexity has a significant positive effect on Trust.	Confirmed
Brand Awareness has a significant positive effect on Trust.	Rejected

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