University of Tehran Press

Iranian Journal of Management Studies (IJMS)
Home Page: https://ijms.ut.ac.ir

Online ISSN: 2345-3745

Reflective– formative Type II model of ecosystem – ecosystem: alignment with value creating ecology through PLS-SEM

Reza Saeidi

Department of Management, Faculty of Management and Economics, University of Shahid Bahonar Kerman, Kerman, Iran. Email: reza.saeidi@uk.ac.ir

ARTICLE INFO

Article type:
Research Article

Article History:
Received 01 May 2022
Revised 23 December 2022
Accepted 24 Janaury 2023
Published Online 09 September 2023

Keywords:
Digital Business Ecosystem (DBE), Mobile-Social Ecosystem (MSE), Analytical- Cloud Ecosystem (ACE), Value-Creating Ecology (VCE), Ecosystem – Ecosystem (ECO-ECO).

ABSTRACT

The purpose of this study is to investigate the creation of ecological values through the extraction of customer ideas from social networks through the interaction of the digital business ecosystem with the analytical-cloud and mobile-social ecosystems. The hierarchical PLS method, reflective–formative Type II, use for quantitative analysis with a two-step SEM approach. In the second-order analysis, the relationship between the variables and components of the clusters obtained from the review of the subject literature was measured quantitatively. Later in the first-order analysis, the interaction of ecosystems in creating ecological value is tested through research hypotheses. The reports provided for the analysis phase of the tests, while assessing the structural validity of the research model, include the testing of hypotheses at two levels. The results of quantitative tests based on experts' opinions state that the interaction of ecosystems provides ecological value.

Cite this article: Saeidi , R (2023). Reflective– formative Type II model of ecosystem – ecosystem: alignment with value creating ecology through PLS-SEM. *Iranian Journal of Management Studies* (*IJMS*), 16 (4), 873-887. DOI: http//doi.org/10.22059/ijms.2023.341996.675073

DOI: http//doi.org/10.22059/ijms.2023.341996.675073

1. Introduction

A two-stage structural analysis for creating ecological value is provided by linking the digital business ecosystem (DBE) to the social-mobile ecosystem (S-ME) and Analytical-cloud Ecosystem (A-CE).

There are three criticisms of the value chain that are of interest here. First, that the activities within the value chain are carried out sequentially, nearby Cardoso et al (2022) have recently argued the activity that occurs within the organization is revisited and interconnected, thereby creating more of a value network than a sequential chain. Second, it proposes that not all activities carry the same value, as example Klingenberg et al (2022) identify one of the more valuable activities as the recognition of customer’s requirements. Third, the value chain criticizes for over-simplifying what is going on in firms by, for example, bundling together activities that are inhomogeneous (Cook et al, 2021).

MacBryde et al (2013) stated that the greatest weakness of the supply chain is that it is linear and mainly affects manufacturing companies. Romero (2011) pointed to interactive networked organizations and virtual communities of customers, which have a high potential for co-creation of value. Facilitating the depth and networked essential interactions for real engagement of customers, social networking sites act as a means of enhancing customer relationships through the co-creation of value (Diffley et al 2015). The Supply/value chains are inefficient in today's networked world (Singhal et al 2012; Cambra-Fierro et al 2017).

The concept of ecology explains the relationships of complex business networks within or between industries (Perfetto et al 2018). The organizations, companies, individuals (employees and customers), industries and different stakeholders by participating with each other add value to the network (Tan et al. 2020). So, value comes from the interaction of one company that operates in heterogeneous industries. They have shifted their simple linear supply chain to a complex network value ecology (Aagaard et al. 2021).

Besides, while value considers ecology (Matthews et al 2017), co-creation is also evaluated as a strategy (Audretsch 2020). For companies that are members of the business ecosystem; Strategy proposed as ecology (Levien 2004), concluded that the concept used in this research is an ecology co-creation of value.

The process by which networked customers, experts, firms, designers, and industries; interrelationships established between them eventually create new values, called ecological co-creation of value. Value creation achieves through data/big-data collection, storage, processing & analysis, and sharing (Birkel et al 2021). The main question of research is whether the interaction between ecosystems provides ecological value.

The digital business ecosystem (DBE), as a first-order latent model variable, consists of higher-order eight main components. Cloud-analytic and mobile-social ecosystems are four separate ecosystems that together briefly form the S-M & A-C ecosystem. The main purpose of the proposed model is to show that the acquisition of data / big data from the business ecosystem level of the mobile-social ecosystem and their transfer to the cloud-analytical ecosystem for analysis, processing, and storage can lead to value ecology. Because ecosystems have a network of stakeholders/actors, and add value to the new end; Ecology takes precedence over the value chain because it emphasizes network value creation (Hearn et al., 2007, Radzevicius 2018).

Connecting the digital business ecosystem with the mobile-social ecosystem and the cloud-analytical ecosystem in a way that leads to ecological value creation is the main innovation of this article.

The problem of customer access and the ability to collect and distribute data through the mobile ecosystem solved (Sophus Lai et al 2020), the social ecosystem provides a common platform for user exchange (Bollinger et al. 2018). The cloud ecosystem provided a platform for analyzing data and storing comments, and customer data and analytical tools (Senturk et al. 2018). Evaluating these comments and data, classifying, and inferring from them performs by the analytical ecosystem in networked businesses (Lismont et al. 2017, Urbinati et al. 2019).

The structure of the article is as follows: Part I: The introduction and abstract of the article are given. The importance of the relationship between the main categories of the article is investigated in this section and presented the available evidence. Part II: The literature of the subject of the article is described. Based on the previous literature interpreted the relationship between the higher-order variables and the dependent variable (main categories). Part III: PLS-SEM explicated to the appraisal of a hierarchical, reflective–formative Type II Analysis of structural equation modeling with a two-stage approach and first & higher-order analysis as well as hypothesis testing. Part IV extends the conclusion and explanation of the research results.

2. Literature Review

DBE comprises two concepts: the digital ecosystem and business ecosystem. Digital ecosystem comprises software, hardware, networks, and Internet services that connect and interact between digital devices (Kerssens et al 2021). Business ecosystems are like a metaphor to describe the intertwining relationships of enterprises that may even be incompatible and are active in unlike industries (Weiss et al 2020). DBE is an interactive environment composed of entities that co-create value thanks to ICT (Senyo et al. 2019). The different components of the DBE interacted and, by converging across values that these components provide, ultimately provide value co-creation (Baggio 2020).

Economy, business, population, community, ecology, multi-agent systems, co-evolution, and topology are DBE components (Graça et al 2017). Business as a component of DBE focuses on the value-creating connecting a large specialized company (Keystone) with a group of SMEs (Tsatsou et al. 2010). DBE's diverse industries, customers, firms and stakeholders co-evolve (Tan et al. 2020). All ecosystem actors contribute to the co-creation of value afterward co-evolution establishes among members (Aarikka-Stenroos et al 2017). DBE members come together and build communities based on shared culture and interests. They distribute their views and opinions in communities. Comments that are acquired by the higher layer and become the basis of value-creation (Romanelli 2018). Ecology refers to the interconnectedness of the ecosystem actor's life. Industries, customers, skilled, and semi-skilled workers and firms have vital ecological relationships (Lin 2018). Multi-agent systems (MASs) are the essential elements for self-organization and self-optimization in value creation. Agents choose their partners intelligently to maintain profitable business relationships (Gupta et al. 2019). The economy supports the growth of all social and economic actors. Economic interactions based on the interests of the parties are important (Pütz et al. 2019). Organizations, SMEs, stakeholders, players, customers, and industries are the DBE population. An important factor in DBE is the diversity and flexibility of populations in interaction with other ecosystem components (Camarinha-Matos et al 2003). DBE is a network of networks. Configuration topology defines how networks interact, i.e., P2P (Brychan Celfyn 2019).

Value co-creation activities require the intense involvement of people interacting with each other, thus shaping the social ecosystem (Zhang et al. 2017). The mobile ecosystem has made a favorable platform for social ecosystem activity. Old online social networks (OSNs) today have become mobile social networks (MSN). Mobile-Social ecosystem (M-SE) shares and collect opinions and needs of customers and stakeholders (Thomas Keith 2019).

Concerning networked enterprises in the business ecosystem, the number of actors and the diversity of industries involved and interacting become more essential. Managing and examining this vast amount of data requires a range of experts and tools that provide the analytical ecosystem (Stephen et al., 2015). The analytics ecosystem extraction of information from big data is done to make value (Chae, 2019). A cloud ecosystem is a complex system of interdependent components that all work together to enable cloud services (Burford et al 2022). In general terms, a cloud ecosystem is composed of a network of suppliers and providers (zhang et al 2022).

VCE includes integrant of a shift from customer to value co-create, shift from competition or cooperation to competition and cooperation (Co-opetition), and shift from the product value to network value (Hearn et al. 2007). The combination of these elements creates value-creating ecology.

In value co-creation, the convergence of the cloud and analytical and social and mobile ecosystems, using formal and informal social networks, a social engagement platform (Shelton 2013) emerges through which collect customers' data and comments. These big data exploit by the analytical ecosystem, data mining, and exploration through a tool that places on the cloud ecosystem due to the limited volume and lower processing capacity of changeable devices. In this way, many clients, regardless of cultural, spatial, and geographic constraints, proposed their ideas to create value.

Network ecology is the study of complex ecological systems (e.g., meta-populations, communities, ecosystems) by modeling them as a network of actions and using network analytics (Borrett et al. 2013). Coopetition represented knowledge combination of intra and inter-organizations (Sindakis et al. 2017), combining information of populations and communities of industry, employees, customers, organizations, and firms (Wang 2021), generating ideas and expanding innovation (Li et al. 2021), synchronicity of competition and cooperation (Ritala et al 2014, Hani et al 2020). VCE is the shift from a traditional value/supply chain to ecological value. The table below made a comparison between them.

Table 1. comparing key elements of value creatin (Saeedi, 2022)

Elements	Supply Chain	Value Chain	Value-creating ecology (VCE)
Customers	Consumers	Consumers	Consumers, suppliers, competitors etc.
Environment	Static/Stable	Static/Stable	Chaotic/uncertain
focus	Supply side OR demand side, not both	Supply and demand sides	Supply and demand sides
Value creation	Limited emphasis on value creation	Emphasizes a value creation approach which adds value at every node	Emphasizes a holistic approach to value creation throughout the ecosystem
Relationship Type	Vertical integration	Timid teaming	Dynamic and evolving
Risk	Low	Medium	High
Profit focus	Increase own profits	Increase own profits	Increase ecosystem profits
Cost focus	Minimize own cost	Optimize own cost	Share costs
Knowledge leverage	Within the enterprise	Within the enterprise	Across the ecosystem
Knowledge approach	Storing	Hoarding	Sharing
Resource approach	Defending	Guarding	Sharing
Time orientation	Short term	Long term	Long term
Key driver	Cost	Revenue	Knowledge

3. Research hypotheses

In this part, explained the research hypotheses and their relationship with the conceptual model.

H1: The relationship between the digital business ecosystem (DBE) and the analytics-cloud ecosystem (ACE) is significant.

The relationship between DBE and ACE enables companies to expect consumption and market trends, improve performance, customize offerings, innovate their products and services, and provide fast feedback and transparency for companies (Vecchio et al. 2018). Connect the business ecosystem with the cloud ecosystem, as organizations are known for their role in producing and delivering services to their customers. The cloud ecosystem connects to the business ecosystem by integrating resources, providing services to its possible jointly by a network with a weak pair in interconnected networks. These are specifically granted by the multilayer architecture of cloud services (IaaS, PaaS, SaaS) (Floerecke et al. 2020).

H2: The relationship between the DBE and the mobile-social ecosystem (MSE) is significant.

The term mobile ecosystem refers to a complex network of manufacturing companies and service providers that together provide a wide range of products and services for movable devices and smartphones (Hyrynsalmi et al. 2014). It has characterized by a very spacious and complicated interaction between a network of companies. Thus, the mobile ecosystem converges with the digital enterprise ecosystem concept in terms of extensive interaction between different companies and even across industries (Basole 2009). Industry needs to gather customer feedback to turn these ideas into a final product and made them available to end consumers. The mobile ecosystem includes a variety of platforms and devices. Portable platforms compromise iOS, Android, and Microsoft Windows Phone.

H3: The relationship between the DBE and value creation ecology (VCE) is significant.

In the test of any structural equation model, there must be a relationship between the independent and dependent variables. The inclusion of mediating variables to the model should not impair this relationship. In the literature section, the relationship between digital business ecosystem and value creation ecology was explained. All components of the DBE play a role in value creation.

H4: The connection of the MSE with the ACE is significant.

To argue why in the research model, data extracted from the stakeholders of the digital business ecosystem flows from the mobile-social ecosystem to the analytical-cloud ecosystem; It reasoned that cloud computing is also available through mobile so that schemed the cloud-mobile ecosystem. With the expansion of portable device use and increasing the need for users to use different applications on changeable devices and the other hand, compact device limitations in terms of storage space and performing complex calculations, as well as the need for availability of these technologies everywhere, the utilizing cloud computing capabilities to overcome these constraints shapes the mobile cloud ecosystem (Bhattacharya et al 2017). The set up a system for collecting, storing, and preparing data and computing random hazards; exploit cloud-based analytical ecosystems (Karim et al. 2017).

H5: The relationship between the ACE and the VCE is significant.

With transferring almighty volumes of data related to customers, businesses, and small and medium enterprises to the cloud, evaluation of that enormous amount of diverse and sometimes heterogeneous data requires analytical tools and analysts to classify data and infer from them.

H6: The connection of MSE with VCE is significant.

Devices such as smartphones, tablets IOS and Android TVs, smartwatches, and other devices that are accessible to most corporate customers allow them to express their ideas, expectations, and comments for creating different products. So, customers can create value for the business ecosystem through the mobile ecosystem and add value to the network (Fernández-Rovira et al. 2021). The social ecosystem promotes collaboration with serious players in the business ecosystem to create value through digital technology (Romanelli 2018).

4. Methodology

Research applies as regards purpose and descriptive-survey and correlational concerning data collection. The data-collection tool in the current research is a closed questionnaire. Using the review of theoretical and research literature, designed a questionnaire consisting of 153 questions on the 5-option Likert scale (from very high to very low). This electronic questionnaire sends to IT specialists of knowledge-based companies that establish the statistical society of the research. Firms selected based on their relationship in the field of ecological value creation and the business ecosystem (Kim et al. 2010, Petrescu 2019).

For sampling, based on the official statistics of the Web site of the Iranian Vice Presidency for Science and Technology; 1400 companies are active in ICT and computer software in Iran. Since unknown the exact number of active researchers in knowledge-based companies is the size of the appropriate statistical sample calculated based on Cochran's sampling formula from the unknown population and at the confidence level of 95% with the agreement ratio of 50% and the sampling error of 5%, the number of 384 people. Due to the large size of the statistical population and the impossibility of compiling the framework of the statistical population used non-random sampling and accessible sampling in this research. The validity of the research questionnaire was investigated in two ways: face content validity and construct validity. To measure face validity the designed questionnaire was given to a number of professors and experts in the field of information technology management as well as a number of researchers from knowledge-based companies. The condition of completing the questionnaire by the respondents was their familiarity with the specialized field of research. After collecting the opinions of experts made changes to the questionnaire. After collecting the questionnaires, Cronbach's alpha calculates to adjust the validity of the questionnaire. Based on Cronbach's alpha calculations, a questionnaire of 0,902 gauges, shows the proper reliability (≥ 0.70) of the adjusted questionnaire. Then, the questionnaires distribute nationwide among the statistical population (Kautsarina et al. 2020, Lopez-Odar, et al. 2020). These companies ask to complete questionnaires for research project managers of the business ecosystem. Response time defines as four months. After this period, 173 valid questionnaires return and were selected to test the model and research hypotheses. On the limited number of experts who are proficient in the specialized field of the questionnaire, was conceivable the bounded return of the questionnaires. Figure 1 shows the research model.

The sample size is a determining factor for the accuracy of clustering elements of the factor analysis technique. The Kaiser-Mayer-Olkin (KMO) index should be above 0.7, although between 0.5 and 0.7 is also acceptable with caution (Garg et al., 2020). The results from the KMO test are equal to 0.824 (sig=0.00), which is a sign of the strong and appropriate adequacy of the sample size based on the statistical population of the research.

4.1 Analyzing

The research devoted PLS-SEM to the appraisal of a hierarchical, reflective–formative Type II to avoid the constraints of CBSEM as regards inopportune solutions or empirical under-recognition. The disassociate two-stage approach applied in Explanatory (Aggarwal et al 2021) and confirmatory research design. Due to the soft architectonics' hypotheses, the PLS-SEM algorithm supports in avoiding positively biased model fit indexes for our large-complex model. The PLS is as capable in the confirmatory as it is in the exploration field(Sarstedt et al. 2011, Akter et al. 2017). Study handling the approach of repeated indices in evaluating the hierarchical VCE model. It is also effective to manipulate the frequent approach to validate the SEM model supported by the concept model (Akter et al. 2011, Becker et al. 2012).

4.2 The measurement models

The key feature of Smart PLS based on the variance in data analysis with small sample size, analysis formative composites and satiety for normal distribution of variables (Henseler et al. 2016).

Precisely, the nonparametric bootstrapping exam(Chin 2010) were applied with 5000 frequencies to acquire the standard errors of the estimates (Streukens et al 2016) and a path weighting scheme for the inside assessment. Table 2 donates measurement features of the firs-order constructs in order to survey reliability, convergent validity and discriminant validity. The critical attributes, including loadings of manifest variables, Cronbach's alpha (Alpha), composite reliabilities (CRs) and average variance extracted (AVE) certified scale reliability (Hair et al. 2020) by strongly realizing in order taller or equal threshold of 0.7, 0.7, 0.7 and 0.5. The convergent validity ensures that the load factor observed variables in the construct thereof is higher than other structures. The study also calculated the square root of the AVE in Table 2 to confirm discriminant validity. The square root of the AVE should be higher than the correlation inter- group and thus have discriminant validity (Fornell et al 1981, Wu et al. 2018).

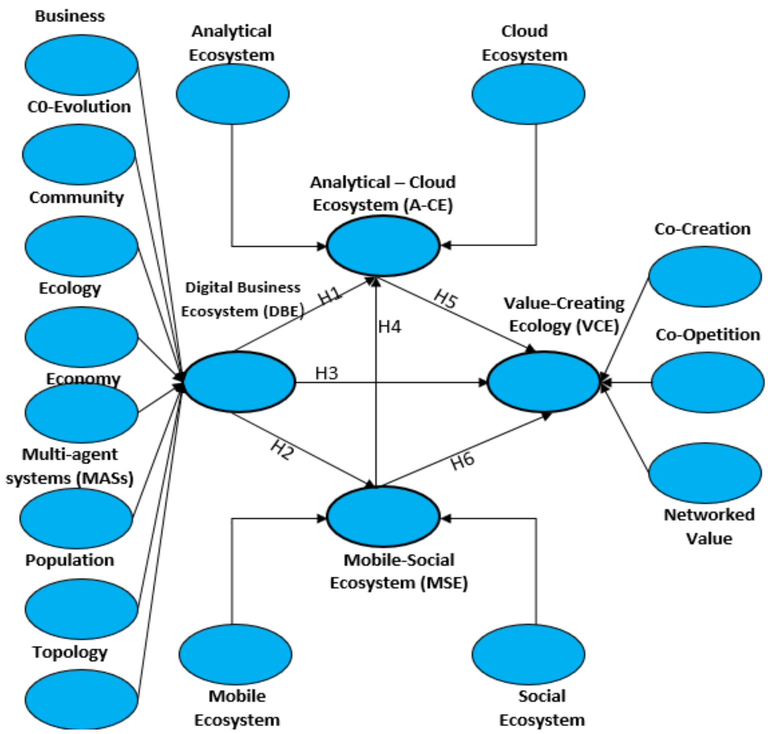

Figure 1. Conceptual model and research hypotheses

Table 2. DBE, MSE, ACE and VCE properties for first-order constructs

Dimension	subdimension	Cronbach's alpha (Alpha)	Composite Reliabilities (CRs)	Average Variance Extracted (AVE)
Digital Business Ecosystem (DBE)	Business (BUSI)	0.809	0.887	0.724
	Co-Evolution (COEV)	0.830	0.899	0.748
	Community (COMU)	0.842	0.905	0.760
	Ecology (ECOL)	0.837	0.901	0.753
	Economy (ECON)	0.762	0.864	0.681
	MASs	0.772	0.867	0.686
	Population (POPU)	0.834	0.898	0.747
	Topology (TOPO)	0.713	0.839	0.635
Mobile-Social Ecosystem (MSE)	Mobile Ecosystem (MBOE)	0.736	0.850	0.655
	Social Ecosystem (SOCE)	0.747	0.856	0.665
Analytical-Cloud Ecosystem (ACE)	Analytical Ecosystem (ANAE)	0.730	0.847	0.649
	Cloud Ecosystem (CLOE)	0.701	0.834	0.625
Value creation ecology (VCE)	Co-Creation (COCR)	0.830	0.898	0.746
	Coopetition (COOP)	0.894	0.927	0.760
	Networked Value (NETV)	0.838	0.903	0.756

the high coherence of the model constructs and increases the probability of confirming the hypotheses(Cheah et al. 2018).

To create convergent validity, factor loads less than 0.7 are removed from the model. The intelligent interaction variable of the MASs construct is excluded from the model.

4.3 Measurement model of Second-order formative construct

SMART-PLS, when second-order constructs have a reflective relationship to lower-order constructs, adds their scores to higher-order constructs. Mode B for the second-order constructs was employed to calculate the difference scores between the two levels(Aggarwal et al 2021). Table 3, shows the findings of the digital business ecosystem (DBE) as formative second-order constructs. The Variance Inflation Factors (VIF) of all the indicators of DBE, MSE, ACE & VCE (formative constructs) are calculated. The threshold VIF value is limited to 5. So, the model does not face the multicollinearity problem. The outer weights are the standardized resultant coefficients of multiple regressions, Which indicates the comparative importance of the corresponding index for the formative constructs; (outer weight p-value ≤ 0.05) (Hair Jr et al. 2013).

4.4 Structural complex model assessment

According to the figure1, the constitutional model is analyzed by the values of determination coefficient (R^2), effect size (f^2), predictive relevance (Q^2), SRMR magnitude, goodness-of-fit (GOF) and the gravity of structural relationships(Hair et al. 2019, Aggarwal et al 2021). The SRMR value, the ecological value creation models fit indices, is 0.064 (table 2), i.e., below the SRMR threshold of 0.08. GOF measurement for PLS-SEM is only essential and useful if the research has followed the CFA process. A value of 0.65 was calculated for GOF. The GOF is higher than 0.36 and indicates a good fit for the structural model. The GOF indices evaluate the distinction between the variance-covariance matrix applied in the empirical sample, and it based on the modeled constructs. The strength of this criterion indicates the predictability of the structural model (Wetzels et al. 2009, Hair et al. 2020).

Table 3. VIF values and significance of outer weight formative second-order constructs

Second-order constructs	VIF	Original Sample (O)	T Statistics (O/STDEV)	Outer weight/ P Values
DBE	1.959	0.283	2.067	0.000
MSE	2.131	0.411	4.293	0.000
ACE	2.400	0.393	4.244	0.000

The two R^2 amounts for two dependent variables, 0.580 for the analytical-cloud ecosystem, 0.379 for mobile-social ecosystem, and 0.716 for value-creating ecology, announce high predictive accuracy of the digital business ecosystem; For example, 58% variations in the ACE being explained by the DBE. Effect size (f^2) helps to evaluate the true influence of the independent variable on the dependent by calculating the change in the coefficients of determination.

The f^2 are determined assuming the exogenous variable is excluded from the model(Hair et al. 2013). Table 4 illustrates the f^2 values, which declare the digital business ecosystem (DBE) as a construct has a 0.218 effect size on higher-order construct Analytical-cloud ecosystem and large f^2 (0.611) on MSE and 0.565 effect size on VCE.

MSE effect on the ACE as third-order construct variables had about 0.325 of particular consequence. The quantity calculations for the effect size are 0.02, 0.15, and 0.35, which show the small, medium, and large impact sizes, respectively(Benitez et al. 2020).

Table 4. structural model evaluation

GOF		**0.65 ≥ 0.36**			
SRMR		**0.064 ≤ 0.08**		**f^2**	
	R^2	Q^2	ACE	MSE	VCE
ACE	0.580	0.608			0.217
MSE	0.579	0.545	0.325		0.205
VCE	0.617	0.629			
DBE			0.218	0.611	0.565

The Q^2 quantity finer than 0.25 and 0.5 express medium and large predictive relevance of the PLS-SEM model(Ali et al. 2018, Hair et al. 2020). Table 4 shows that the Q^2 values are 0.608 for the analytical-cloud ecosystem, 0.545 for the mobile-social ecosystem, and 0.629 for value-creating ecology, all three of endogenous variables are above sizeable prognostic relevance (Q^2>0.5) and mentioned high out-of-sample predictive relevance for the path model. After a survey of the values R^2, Q^2, f^2, GOF, and SRMR, the final step in evaluating the structural model is hypothesis testing.

4.5 Multiple mediation analysis

The figure 2, the ACE and MSE mediate in the parallel the relationship between constructs DBE and VCE in case of additional relationship from build DBE to VCE in the second-order make up model. This situation is described as serial multiple mediation (i.e., mediator MSE follows ACE). When we encounter multiple mediators, The model of all relevant mediators must be analyzed at the same time (Zhao et al. 2010).

There is a complementary partial mediation between independent and dependent variables and mediator variables. In a compatible partial mediation; Indirect effect beta multiplication the endogenous and exogenous variables attached to the mediator are in the same direction (positive or negative) as the direct effect beta (e.g., β1×β5 and β2 are positive). In evaluating the strength (portion) in the case of partial mediation, applied the criterion of the indirect to the total effect.

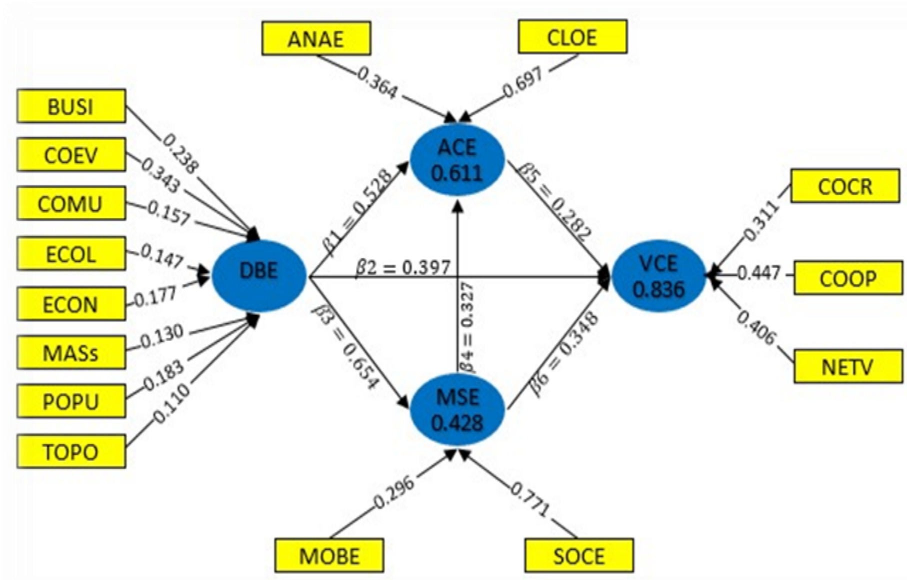

Figure 2. Step two of disjoint-two stage approach

The variance accounted for (VAF) value regulates the degree to which the mediation process describes the dependent variable's variance. The threshold 0.20≤VAF≤0.80 illustrates partial mediation. The table 5 shows the different VAF scenarios. However, for a more precise analysis of mediation, especially in more complex model structures (e.g., multiple mediators); determine the results Bootstrap is essential for indirect effects (Carrión et al. 2017).

Table 5. VAF calculation – strength of mediator

Mediator	computation	Results
ACE	$\frac{(\beta 1 \times \beta 5)}{(\beta 1 \times \beta 5) + \beta 2}$	0.273
	$\frac{(\beta 4 \times \beta 5)}{(\beta 4 \times \beta 5) + \beta 6}$	0.288
MSE	$\frac{(\beta 3 \times \beta 6)}{(\beta 3 \times \beta 6) + \beta 2}$	0.364
	$\frac{(\beta 3 \times \beta 4)}{(\beta 3 \times \beta 4) + \beta 1}$	0.209

Mediating variables should not undermine the relationship between the independent and dependent variables (i.e., β2). As shown in Table 5, the intensity of the indirect effect of mediator variables on the dependent is not sufficient to impair the independent direct effect on the dependent. Thus, mediator variables remain in the model. After confirming the indirect effect of mediating variables, describes the tests of the research hypotheses.

Table 6 demonstrates the digital business ecosystem, as a construct, with path coefficients of 0.528 and 0.654 values has a significant direct impact on the analytical-cloud system, and the mobile-social ecosystem (i.e., H1&H2 assumptions). The DBE (β=0.397), analytical-cloud ecosystem (β=0.282), and mobile-social ecosystem (β=0.348) have a meaningful direct impact on the dependent variable;

value-creating ecology (i.e., H3, H5&H6 hypotheses). The mobile-social ecosystem with a path coefficient of 0.327 (H4 assumption) has a significant direct effect on the analytical-cloud ecosystem. The straight effect of all these coefficients is positive, with t-statistics ≥ 1.96 & P-Values ≤ 0.05.

Table 6. Testing hypotheses

	Hypotheses	Paths	(O)	(STDEV)	T-statistics (O/STDEV)	P-Values
Direct effect	H1	DBE→ACE	0.528	0.090	5.847	0.000
	H2	DBE→MSE	0.654	0.054	12.157	0.000
	H3	DBE→VCE	0.397	0.072	5.511	0.000
	H4	MSE→ACE	0.327	0.082	3.987	0.000
	H5	ACE→VCE	0.282	0.062	4.507	0.000
	H6	MSE→VCE	0.348	0.074	4.702	0.000
Specific Indirect effect						
	H7	DBE→MSE→ACE→VCE	0.060	0.018	3.346	0.001

The casual model is designed to investigate the significance of a specific indirect path of extracting ideas from DBE and converting them into ecological value through the mediation of M-S and A-C ecosystems. The significance of an accidental path is measured by assumption H7.

H7: Extracting opinions from DBE by MSE and transferring them to ACE for analysis, classification, and storage turns them into an ecological value.

This route will be explained in more detail in the next section. As shown in Table 6, the significance of the indirect relationship between second-order constructs is confirmed (t-test=3.346≥1.96). In the H7 hypothesis, the oblique path coefficient is positive and the data transfer between the second-order structures of the model leads to value-creating ecology.

5. Discussion & Conclusion

Confirmatory factor analysis of first-order variables groups confirmed the accuracy of a systematic study in identifying the components of latent second-order variables. Business, Co-evolution, ecology, population, topology, community, MASs, and Economy are the elements of the construct of the independent variable of the digital business ecosystem, as well as the constituent components of the mediator of social, mobile, analytical, and cloud ecosystems are effective in benefiting from Co-creation, Coopetition, and Net-value as ecological values. In a second-order analysis according to the research methodology, Hypotheses H2, H4, and H5 in direct path analysis, as well as H7 hypothesis in an indirect analysis, confirm the model path. The heterogeneity of customers' tastes and desires has increased. Providing a platform for entering customers into the product design process is the core approach within the research framework. Companies acting in various industries and their stakeholders operate at the level of the DBE. Cloud is a model of computing where servers, networks, storage, development tools, and even applications (apps) that these facilities be available to DBE elements as well, enabled through the Internet (Li et al 2022). Therefore, DBE members enable directly interact with the cloud ecosystem. The storage space and applications attainable in a cloud ecosystem are not only available through the mobile platform but even accessed through other tools connected to the Internet, e.g., PC (H1). The mobile-social ecosystem collects data from the DBE level(H2). In a study, the necessary data to evaluate the student's learning level after the end of the course collect by the M-SE (Wang et al 2022). Customer data collected about the product, such as correction comments, and met/ unmet customer expectations. However, investigate customer engagement behaviors in social media. The results showed that this behavior was used for capturing innovation opportunities from customer’s ideas (Carlson et al 2018). The experts of the companies also provide their corrective and specialized opinions. Feedback is transmitted to the analytical-cloud ecosystem(H4). In a study conducted on the effectiveness of covid drugs, because patients are scattered all over the world, consumers around the world were asked about the effectiveness of drugs through the social network affiliated with WHO. These data were analyzed by transferring to the cloud-analytical secure technology, and the results were provided to the researchers (Mahesh et al 2022). The data is analyzed, and the information obtained can be the basis for ecological value creation(H5). In Mahesh et al 2022, the results obtained from the convergence of drugs applied to the development and production of more effective drugs. Loonam & O'Regan 2022 see the emergence of global value chains due to the growth and globalization of digital platforms. According to them, the emergence of digital platforms plays a key role in value co-creation. They also state that to maintain the position of the customer as the main axis of value creation, companies must move towards ecosystems. It focuses on the concept of ecosystems and value co-creation is based on customer expectations using digital platforms. Another study presented a framework for the cooperation of industrial firms in the development of special technology in the form of an ecosystem. These companies that created industrial ecosystems make great innovations that be destructive sometimes, and ecosystems cause a transformation in the cooperation of industries (Oghazi, P., et al. 2022). Comparing the results of previous research with the study conducted in this article obtained two results. a) alignment of the results studies with preceding, b) innovation of the conducted research. Research innovation is discussed from two dimensions. One, none of the results presented from past research on business ecosystems addressed the ecosystem-ecosystem and its outcomes, and the study has for the first time presented a model that, through the acquisition, storage, and analysis of customer opinions, values ecologic provide by taking advantage of ecosystem-ecosystem interaction. By enabling the enjoyment of ecological values companies try to consolidate their capabilities to offer modern products by turning competition into cooperation. The resulting value network can be an infinite resource for refining existing products and introducing new products to the market. In this way, reduced competition between firms, and they work together for survival and co-evolution. With the cooperation of the ecosystem (Eco-Eco) the individual value creation of firms transforms the value network.

References

Aagaard, A., et al. (2021). "Mapping the types of business experimentation in creating sustainable value: A case study of cleantech start-ups." Journal of Cleaner Production 279: 123182.

Aarikka-Stenroos, L. and P. Ritala (2017). "Network management in the era of ecosystems: Systematic review and management framework." Industrial Marketing Management 67: 23-36.

Aggarwal, V. S. and M. Kapoor (2021). "Multigroup analysis of higher-order model of knowledge variables in the context of global ventures through PLS-SEM." South Asian Journal of Business Studies 10(1): 128-146.

Akter, S., et al. (2011). "Trustworthiness in mHealth information services: An assessment of a hierarchical model with mediating and moderating effects using partial least squares (PLS)." Journal of the American Society for Information Science and Technology 62(1): 100-116.

Akter, S., et al. (2017). "Why PLS-SEM is suitable for complex modelling? An empirical illustration in big data analytics quality." Production Planning & Control 28(11-12): 1011-1021.

Ali, F., et al. (2018). "An assessment of the use of partial least squares structural equation modeling (PLS-SEM) in hospitality research." International Journal of Contemporary Hospitality Management 30(1): 514-538.

Audretsch, D. B. and M. Belitski (2020). "The role of R&D and knowledge spillovers in innovation and productivity." European Economic Review 123: 103391.

Baggio, R. (2020). Digital Ecosystems, Complexity, and Tourism Networks. Handbook of e-Tourism. Z. Xiang, M. Fuchs, U. Gretzel and W. Höpken. Cham, Springer International Publishing: 1-20.

Basole, R. C. (2009). "Visualization of interfirm relations in a converging mobile ecosystem." Journal of Information Technology 24(2): 144-159.

Becker, J.-M., et al. (2012). "Hierarchical Latent Variable Models in PLS-SEM: Guidelines for Using Reflective-Formative Type Models." Long Range Planning 45(5): 359-394.

Benitez, J., et al. (2020). "How to perform and report an impactful analysis using partial least squares: Guidelines for confirmatory and explanatory IS research." Information & Management 57(2): 103168.

Bhattacharya, A. and P. De (2017). "A survey of adaptation techniques in computation offloading." Journal of Network and Computer Applications 78: 97-115.

Birkel, H. and J. M. Müller (2021). "Potentials of industry 4.0 for supply chain management within the triple bottom line of sustainability – A systematic literature review." Journal of Cleaner Production 289: 125612.

Bollinger, L. A., et al. (2018). "Multi-model ecologies for shaping future energy systems: Design patterns and development paths." Renewable and Sustainable Energy Reviews 82: 3441-3451.

Borrett, S. R., et al. (2013). "Network ecology." Encyclopedia of environmetrics 4.

Brychan Celfyn, T. (2019). Organizational Ecosystems: Innovation and Social Capital Dimensions. Innovation and Social Capital in Organizational Ecosystems. T. Brychan Celfyn and M. Lyndon John. Hershey, PA, USA, IGI Global: 23-42.

Burford, N., Shipilov, A. V., & Furr, N. R. (2022). How ecosystem structure affects firm performance in response to a negative shock to interdependencies. Strategic Management Journal, 43(1), 30-57.

Camarinha-Matos, L. M. and H. Afsarmanesh (2003). "Elements of a base VE infrastructure." Computers in Industry 51(2): 139-163.

Cambra-Fierro, J., et al. (2017). "“Towards a co-creation framework in the retail banking services industry: Do demographics influence?”." Journal of Retailing and Consumer Services 34: 219-228.

Cardoso, A., Silva, T.F.B.d., Takagi, N., Silva, C. and Micelli, A. (2022), "A value chain development model for the public sector", Business Process Management Journal, Vol. 28 No. 5/6, pp. 1229-1250.

Carlson, J., Rahman, M., Voola, R. and De Vries, N. (2018), "Customer engagement behaviours in social media: capturing innovation opportunities", Journal of Services Marketing, Vol. 32 No. 1, pp. 83-94.

Carrión, G. C., et al. (2017). Mediation Analyses in Partial Least Squares Structural Equation Modeling: Guidelines and Empirical Examples. Partial Least Squares Path Modeling: Basic Concepts, Methodological Issues and Applications. H. Latan and R. Noonan. Cham, Springer International Publishing: 173-195.

Cheah, J.-H., et al. (2018). "Convergent validity assessment of formatively measured constructs in PLS-SEM." International Journal of Contemporary Hospitality Management 30(11): 3192-3210.

Chin, W. W. (2010). How to Write Up and Report PLS Analyses. Handbook of Partial Least Squares: Concepts, Methods and Applications. V. Esposito Vinzi, W. W. Chin, J. Henseler and H. Wang. Berlin, Heidelberg, Springer Berlin Heidelberg: 655-690.

Cook David, Rui Biscaia, Karolos Papadas, Lyndon Simkin & Libby Carter (2021) The creation of shared value in the major sport event ecosystem: understanding the role of sponsors and hosts, European Sport Management Quarterly,1-22.

Diffley Sarah & McCole Patrick. (2015). Extending customer relationship management into a social context, The Service Industries Journal, 35:11-12, 591-610,

Fernández-Rovira, C., et al. (2021). "The digital transformation of business. Towards the datafication of the relationship with customers." Technological Forecasting and Social Change 162: 120339.

Floerecke, S., et al. (2020). "Cloud computing ecosystem model: evaluation and role clusters." Electronic Markets: 1-21.
Fornell, C. and D. F. Larcker (1981). "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error." Journal of Marketing Research 18(1): 39-50.
Garg, A., Gupta, S., Mathew, M., & Singh, S. (2020). Prioritising the preference of factors affecting the mobile network selection: A combination of factor analysis and best worst method. Journal of Public Affairs, n/a(n/a), e2345.
Graça, P. and L. M. Camarinha-Matos (2017). "Performance indicators for collaborative business ecosystems — Literature review and trends." Technological Forecasting and Social Change 116: 237-255.
Gupta, R., et al. (2019). "Business, innovation and digital ecosystems landscape survey and knowledge cross sharing." Technological Forecasting and Social Change 147: 100-109.
Hair, J. F., et al. (2020). "Assessing measurement model quality in PLS-SEM using confirmatory composite analysis." Journal of Business Research 109: 101-110.
Hair Jr, J. F., et al. (2013). A primer on partial least squares structural equation modeling (PLS-SEM), Sage publications, Thousand Oaks, CA.
Hair, R., et al. (2019). " When to use and how to report the results of PLS-SEM." European Business Review.
Hani, M. and G.-B. Dagnino (2020). "Global network coopetition, firm innovation and value creation." Journal of Business & Industrial Marketing.
Hearn, G., et al. (2007). "FROM VALUE CHAIN TO VALUE CREATING ECOLOGY." International Journal of Cultural Policy 13(4): 419-436.
Helo, P., et al. (2021). "Cloud manufacturing ecosystem analysis and design." Robotics and Computer-Integrated Manufacturing 67: 102050.
Henseler, J., et al. (2016). "Using PLS path modeling in new technology research: updated guidelines." Industrial management & data systems 116(1): 2-20.
Hyrynsalmi, S., et al. (2014). "Sources of value in application ecosystems." Journal of Systems and Software 96: 61-72.
Karim, L., et al. (2017). "Deploying Real Time Big Data Analytics in Cloud Ecosystem for Hazmat Stochastic Risk Trajectories." Procedia Computer Science 109: 180-187.
Kautsarina, et al. (2020). "Data modeling positive security behavior implementation among smart device users in Indonesia: A partial least squares structural equation modeling approach (PLS-SEM)." Data in Brief 30: 105588.
Kerssens, N. and J. v. Dijck (2021). "The platformization of primary education in The Netherlands." Learning, Media and Technology: 1-14.
Kim, H., et al. (2010). "The role of IT in business ecosystems." Communications of the ACM 53(5): 151-156.
Klingenberg, C. O., Júnior, J. A. V. A., & Müller-Seitz, G. (2022). Impacts of digitalization on value creation and capture: Evidence from the agricultural value chain. Agricultural Systems, 201, 103468.
Levien, R. and M. Iansiti (2004). "Strategy as ecology." Harvard Business Review 82(3): 68-78.
Li, D., Deng, L., Cai, Z., & Souri, A. (2022). Blockchain as a service models in the Internet of Things management: Systematic review. Transactions on Emerging Telecommunications Technologies, 33(4), e4139.
Li, Z., et al. (2021). 5G+Ecosystem: Constructing the 5G Open Ecosystem. 5G+: How 5G Change the Society. Singapore, Springer Singapore: 95-105.
Lin, S. (2018). "The structural characteristics of innovation ecosystem: a fashion case." European Journal of Innovation Management 21(4): 620-635.
Lismont, J., et al. (2017). "Defining analytics maturity indicators: A survey approach." International Journal of Information Management 37(3): 114-124.
Loonam, J. and N. O'Regan (2022). "Global value chains and digital platforms: Implications for strategy." Strategic Change 31(1): 161-177.
Lopez-Odar, D., et al. (2020). "Validity and reliability of the questionnaire that evaluates factors associated with perceived environmental behavior and perceived ecological purchasing behavior in Peruvian consumers." Social Responsibility Journal 16(3): 403-417.
MacBryde, J., Paton, S. and Clegg, B. (2013), "Understanding high-value manufacturing in Scottish SMEs", International Journal of Operations & Production Management, Vol. 33 No. 11/12, pp. 1579-1598. https://doi.org/10.1108/IJOPM-07-2010-0205
Mahesh, T. R., Vivek, V., Saravanan, C., & Vinay Kumar, K. (2022). Data Analytics: The Challenges and the Latest Trends to Flourish in the Post-COVID-19. In Proceedings of the International Conference on Paradigms of Communication, Computing and Data Sciences (pp. 509-517). Springer, Singapore.
Matthews, D. and L. Rothenberg (2017). "An assessment of organic apparel, environmental beliefs and consumer preferences via fashion innovativeness." International Journal of Consumer Studies 41(5): 526-533.

Oghazi, P., Parida, V., Wincent, J., & Mostaghel, R. (2022). Ecosystems transformation through disruptive innovation: A definition, framework and outline for future research. Journal of Business Research, 147, 16-26.
Perfetto, M. C. and A. Vargas-Sánchez (2018). "Towards a Smart Tourism Business Ecosystem based on Industrial Heritage: research perspectives from the mining region of Rio Tinto, Spain." Journal of Heritage Tourism 13(6): 528-549.
Petrescu, M. (2019). "From marketing to public value: towards a theory of public service ecosystems." Public Management Review 21(11): 1733-1752.
Polites, G. L., et al. (2012). "Conceptualizing models using multidimensional constructs: a review and guidelines for their use." European Journal of Information Systems 21(1): 22-48.
Pütz, F., et al. (2019). "Connected automated vehicles and insurance: Analysing future market-structure from a business ecosystem perspective." Technology in Society 59: 101182.
Radzevicius, Martynas. (2018). International Journal on Global Business Management & Research; Chennai Vol. 7, Iss. 2, : 1-11.
Ritala, P. and A. Tidström (2014). "Untangling the value-creation and value-appropriation elements of coopetition strategy: A longitudinal analysis on the firm and relational levels." Scandinavian Journal of Management 30(4): 498-515.
Romanelli, M. (2018). "Towards Sustainable Ecosystems." Systems Research and Behavioral Science 35(4): 417-426.
Romero David & Arturo Molina (2011) Collaborative networked organizations and customer communities: value co-creation and co-innovation in the networking era, Production Planning & Control, 22:5-6, 447-472
Saeedi, Reza (2022) Ecological Value Creation: A Novel Economic Paradigm of Interactions in Business Ecosystems, World Futures, DOI: 10.1080/02604027.2022.2094196
Sarstedt, M., et al. (2011). Multigroup Analysis in Partial Least Squares (PLS) Path Modeling: Alternative Methods and Empirical Results. Measurement and Research Methods in International Marketing. M. Sarstedt, M. Schwaiger and C. R. Taylor, Emerald Group Publishing Limited. 22: 195-218.
Senturk, I. F., et al. (2018). "A resource provisioning framework for bioinformatics applications in multi-cloud environments." Future Generation Computer Systems 78: 379-391.
Senyo, P. K., et al. (2019). "Digital business ecosystem: Literature review and a framework for future research." International Journal of Information Management 47: 52-64.
Shelton, T. (2013). Business models for the social mobile cloud: Transform your business using social media, mobile internet, and cloud computing, Wiley Online Library.
Sindakis, S., et al. (2017). Coopetition and Knowledge Dynamics: Knowledge Creation and Management for Growth. Global Opportunities for Entrepreneurial Growth: Coopetition and Knowledge Dynamics within and across Firms. S. Stavros and T. Panagiotis, Emerald Publishing Limited: 165-185.
Singhal, K. and J. Singhal (2012). "Imperatives of the science of operations and supply-chain management." Journal of Operations Management 30(3): 237-244.
Sophus Lai, S. and S. Flensburg (2020). "A proxy for privacy uncovering the surveillance ecology of mobile apps." Big Data & Society 7(2): 2053951720942543.
Streukens, S. and S. Leroi-Werelds (2016). "Bootstrapping and PLS-SEM: A step-by-step guide to get more out of your bootstrap results." European Management Journal 34(6): 618-632.
Tan, F. T. C., et al. (2020). "Digital transformation of business ecosystems: Evidence from the Korean pop industry." Information Systems Journal 30(5): 866-898.
Thomas Keith, T. (2019). Bridging social boundaries and building social connectedness: Through youth development programs.
Tsatsou, P., et al. (2010). "Towards a Taxonomy for Regulatory Issues in a Digital Business Ecosystem in the EU." Journal of Information Technology 25(3): 288-307.
Urbinati, A., et al. (2019). "Creating and capturing value from Big Data: A multiple-case study analysis of provider companies." Technovation 84-85: 21-36.
Vecchio, P. D., et al. (2018). "Creating value from Social Big Data: Implications for Smart Tourism Destinations." Information Processing & Management 54(5): 847-860.
Wang, P. (2021). "Connecting the Parts with the Whole: Toward an Information Ecology Theory of Digital Innovation Ecosystems." MIS Quarterly 45(1): 397-422.
Wang, J., Zareapoor, M., Chen, Y. C., Shamsolmoali, P., & Xie, J. (2022). What influences news learning and sharing on mobile platforms? An analysis of multi-level informational factors. Library Hi Tech, (ahead-of-print).
Weiss, J. and A. Seric (2020). "Industrial policy: Clarifying options through taxonomy and decision trees." Development Policy Review.
Wetzels, M., et al. (2009). "Using PLS Path Modeling for Assessing Hierarchical Construct Models: Guidelines and Empirical Illustration." MIS Quarterly 33(1): 177-195.

Wu, P., et al. (2018). "Developing a conceptual framework to improve the implementation of 3D printing technology in the construction industry." Architectural Science Review 61(3): 133-142.

Zhang, T., et al. (2017). "Engaging Generation Y to Co-Create Through Mobile Technology." International Journal of Electronic Commerce 21(4): 489-516.

.Zhang, T., Lu, C., & Kizildag, M. (2017). Engaging Generation Y to Co-Create Through Mobile Technology. International Journal of Electronic Commerce, 21(4), 489-516. https://doi.org/10.1080/10864415.2016.1355639

Zhang, X., Ming, X., Bao, Y., & Liao, X. (2022). System construction for comprehensive industrial ecosystem oriented networked collaborative manufacturing platform (NCMP) based on three chains. Advanced Engineering Informatics, 52, 101538.

Zhao, X., Lynch, J. G., Jr., & Chen, Q. (2010). Reconsidering Baron and Kenny: Myths and Truths about Mediation Analysis. Journal of Consumer Research, 37(2), 197-206. https://doi.org/10.1086/651257