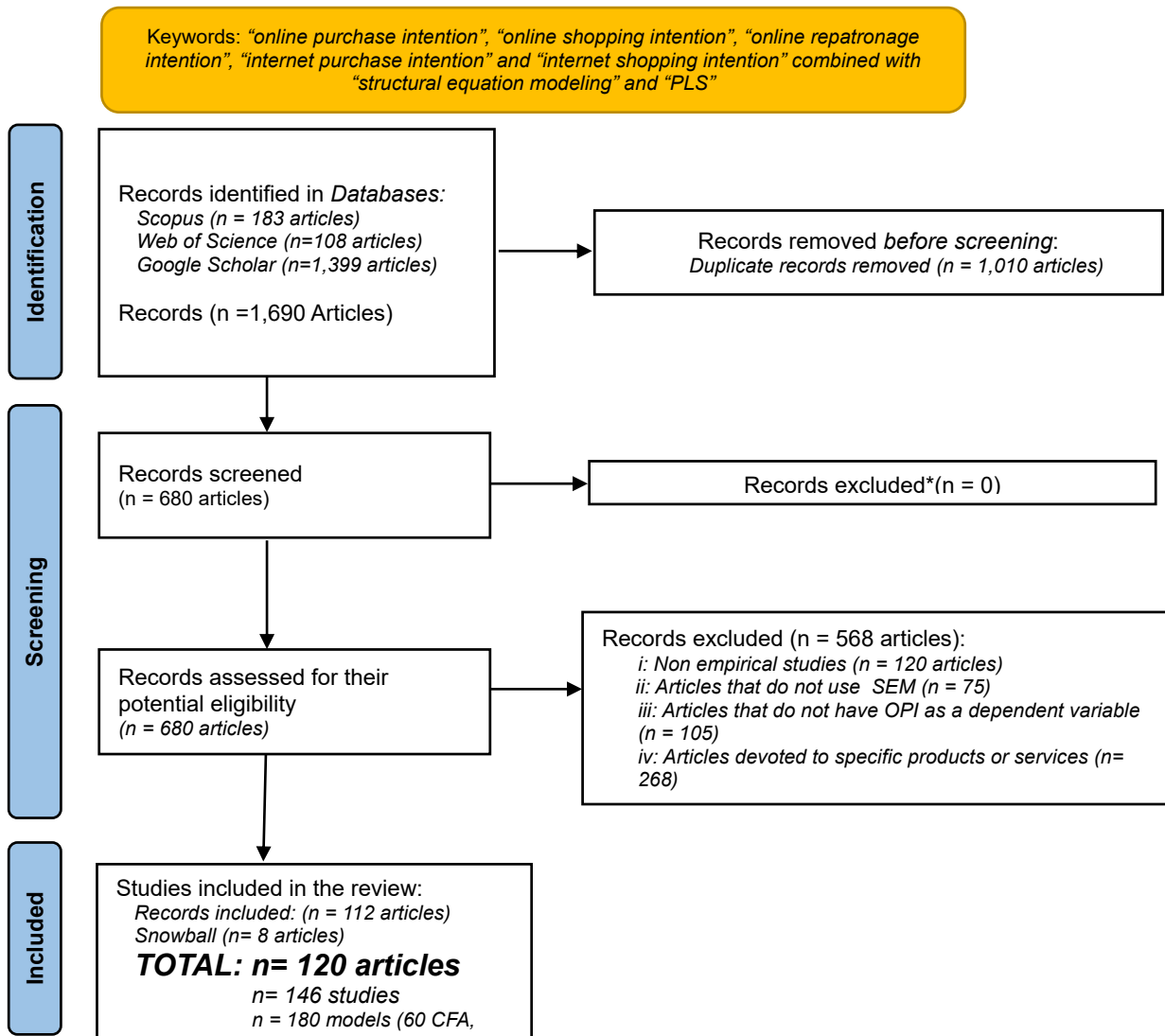


**SUPPLEMENTARY MATERIAL:**  
**An assessment of the use of *Structural Equation Modeling (CB-SEM and PLS-SEM)***  
**in the study of Online Purchase Intention**

- Article title: “An Assessment of the Use of Structural Equation Modeling (CB-SEM and PLS-SEM) in the Study of Online Purchase Intention”.
- Journal title: Technological Forecasting & Social Change
- doi: 10.17632/c3cty7cwy9.1.

**FIGURES**

Figure SF1. PRISMA flow diagram (based on Page *et al.*, 2021)



## TABLES

Table ST1. Databases, keywords and search strategy.

Database	Keywords and Search Strategy
Google scholar	"online purchase intention"; " <i>online shopping intention</i> "; " <i>online repatronage intention</i> "; " <i>internet purchase intention</i> "; " <i>internet shopping intention</i> " (In the title of the article)
Scopus	(TITLE-ABS-KEY ( "online purchase intention" ) OR TITLE-ABS-KEY ( "online shopping intention" ) OR TITLE-ABS-KEY ( "online repatronage intention" ) OR TITLE-ABS-KEY-AUTH ( "internet purchase intention" ) OR TITLE-ABS-KEY ( "internet shopping intention" ) ) AND ( TITLE-ABS-KEY ( "structural equation modeling" ) OR TITLE-ABS-KEY ( "SEM" ) OR TITLE-ABS-KEY ( "PLS" ) )
Web of Science	(TS=("online purchase intention") OR TS=("online shopping intention") OR TS=("online repatronage intention") OR TS=("internet purchase intention") OR TS=("internet shopping intention")) AND (TS=("structural equation modeling") OR TS=("SEM") OR TS=("PLS"))

Table TS2. Summary of studies included in the review.

Studies – in alphabetic order	Country or region	Solution approach	Software	Sample size	Number of free parameters	Quantity of latent variables	Quantity of observables variables
Abbasi (2021)	Malaysia	PLS-SEM	SmartPLS	246		4	15
Akram <i>et al.</i> (2021)	China	CB-SEM	AMOS	585	114	14	55
Alam <i>et al.</i> (2022)	India	PLS-SEM	SmartPLS	379		8	20
Alfina <i>et al.</i> (2014)	Indonesia	PLS-SEM	SmartPLS	114		9	27
Alharthey (2020)	Saudi Arabia	PLS-SEM	SmartPLS	452		8	30
Aloqool and Alsmairat (2022)	Jordan	PLS-SEM	SmartPLS	467		6	21
Amjad-ur-Rehman <i>et al.</i> (2019)	Pakistan	CB-SEM	AMOS	167	115	6	35
Aref and Okasha (2019)	Egypt	CB-SEM	AMOS	224	63	8	26
Aref (2022)	Egypt	CB-SEM	AMOS	479	62	8	30
Arora and Aggarwal (2018)	India	CB-SEM	AMOS	508	46	6	20
Awal <i>et al.</i> (2023)	Bangladesh	PLS-SEM	SmartPLS	259		5	23
Baqai <i>et al.</i> (2021)	Pakistan	PLS-SEM	SmartPLS	325		7	22
Bashir <i>et al.</i> (2018)	Malaysia	CB-SEM	N/A	400	38	3	18
Bazi <i>et al.</i> (2022)	UK	PLS-SEM	SmartPLS	349		7	20
Bazi <i>et al.</i> (2022) 2	UK	PLS-SEM	SmartPLS	68		7	20
Bazi <i>et al.</i> (2022) 3	UK	PLS-SEM	SmartPLS	71		7	20
Bazi <i>et al.</i> (2022) 4	UK	PLS-SEM	SmartPLS	70		7	20
Bazi <i>et al.</i> (2022) 5	UK	PLS-SEM	SmartPLS	68		7	20
Bazi <i>et al.</i> (2022) 6	UK	PLS-SEM	SmartPLS	72		7	20
Bazi <i>et al.</i> (2022) 7	UK	PLS-SEM	SmartPLS	218		7	20
Bazi <i>et al.</i> (2022) 8	UK	PLS-SEM	SmartPLS	129		7	20
Bedi <i>et al.</i> (2017)	India	CB-SEM	AMOS	300	66	8	31
Bhati <i>et al.</i> (2022)	India	CB-SEM	AMOS	449	94	11	34
Bhatti <i>et al.</i> (2022)	Pakistan	CB-SEM	N/A	410	48	5	19
Bhatti <i>et al.</i> (2022) 2	Pakistan	CB-SEM	N/A	410	37	4	16
Bhatti <i>et al.</i> (2022) 3	Pakistan	CB-SEM	N/A	410	31	4	13
Bianchi and Andrews (2012)	Chile	CB-SEM	AMOS	176	42	7	24
Bigne-Alcañiz <i>et al.</i> (2008)	Spain	CB-SEM	N/A	465	47	7	18
Blas <i>et al.</i> (2008)	Spain	PLS-SEM	SmartPLS and EQS	465		5	20
Çelik 2011	Türkiye	CB-SEM	AMOS	278	44	6	18
Chakraborty (2019)	India	CB-SEM	N/A	1038	51	7	21
Chaparro-Pinzón (2023)	Colombia	PLS-SEM	SmartPLS	171		8	27

Studies – in alphabetic order	Country or region	Solution approach	Software	Sample size	Number of free parameters	Quantity of latent variables	Quantity of observables variables
Chen and Cheng (2009)	N/A	CB-SEM	N/A	331	61	7	27
Chen and He (2003)	N/A	CB-SEM	LISREL	426	41	4	19
Chen and Yang (2021)	China	CB-SEM	AMOS	321	50	6	21
Cheong <i>et al.</i> (2020)	Malaysia	PLS-SEM	SmartPLS	215		4	15
Chiu <i>et al.</i> (2009a)	Taiwan	CB-SEM	LISREL	311	71	8	32
Chiu <i>et al.</i> (2009b)	Taiwan	PLS-SEM	PLS Graph	360		10	38
Chiu <i>et al.</i> (2014)	Taiwan	PLS-SEM	SmartPLS	782		14	43
Crespo <i>et al.</i> (2009)	Spain	CB-SEM	EQS	675	68	11	33
Crespo <i>et al.</i> (2009) 2	Spain	CB-SEM	EQS	323	68	11	33
Dang and Pham (2018)	Vietnam	CB-SEM	AMOS	221	45	5	19
Dang <i>et al.</i> (2020)	China	CB-SEM	N/A	407	66	8	32
Denaputri and Usman (2020)	Indonesia	CB-SEM	AMOS	237	23	4	9
Deng <i>et al.</i> (2021)	China	CB-SEM	AMOS	561	47	5	22
Dewi <i>et al.</i> (2020)	Indonesia	PLS-SEM	SmartPLS	252		6	24
Dewi <i>et al.</i> (2020) 2	Indonesia	PLS-SEM	SmartPLS	157		6	24
Dharmesti <i>et al.</i> (2021)	Australia	CB-SEM	AMOS	309	41	7	24
Dharmesti <i>et al.</i> (2021) 2	USA	CB-SEM	AMOS	306	41	7	24
e Silva <i>et al.</i> (2020)	Portugal	CB-SEM	AMOS	150	63	5	28
e Silva <i>et al.</i> (2020) 2	Portugal	CB-SEM	AMOS	75	63	5	28
e Silva <i>et al.</i> (2020) 3	Portugal	CB-SEM	AMOS	75	63	5	28
Eshaghi <i>et al.</i> (2016)	Iran and Malaysia	CB-SEM	AMOS	591	N/A	4	0
Eshaghi <i>et al.</i> (2016) 2	Iran and Malaysia	CB-SEM	AMOS	315	N/A	4	0
Eshaghi <i>et al.</i> (2016) 3	Iran and Malaysia	CB-SEM	AMOS	276	N/A	4	0
Fortes and Rita (2016)	Portugal	CB-SEM	LISREL	900	78	8	33
Ganguly, <i>et al.</i> (2009)	India	CB-SEM	AMOS	290	73	10	37
Giraldo Acosta <i>et al.</i> (2022)	Colombia	PLS-SEM	SmartPLS	501		19	61
Gong <i>et al.</i> (2023)	China	PLS-SEM	SmartPLS	535		6	21
Ha <i>et al.</i> (2010)	Korea	CB-SEM	AMOS	284	45	5	16
Ha <i>et al.</i> (2010) 2	UK	CB-SEM	AMOS	164	45	5	16
Hajiha <i>et al.</i> (2010)	Iran	CB-SEM	N/A	174	43	5	20
Hebbar <i>et al.</i> (2020)	India	PLS-SEM	SmartPLS	247		7	55
Heidari <i>et al.</i> (2023)	Iran	PLS-SEM	SmartPLS	363		12	28
Hsu <i>et al.</i> (2014)	Asia	PLS-SEM	N/A	242	98	15	47

Studies – in alphabetic order	Country or region	Solution approach	Software	Sample size	Number of free parameters	Quantity of latent variables	Quantity of observables variables
Indrawati <i>et al.</i> (2022)	Indonesia	PLS-SEM	SmartPLS	450		6	35
Iqbal <i>et al.</i> (2021)	Pakistan	PLS-SEM	SmartPLS	278	75	7	35
Isa <i>et al.</i> (2020)	Malaysia	PLS-SEM	SmartPLS	584		6	30
Jadil <i>et al.</i> (2022)	Morocco	PLS-SEM	SmartPLS	414		6	15
Jibril <i>et al.</i> (2020)	Ghana	PLS-SEM	SmartPLS	189		4	17
John (2012)	Asia	CB-SEM	AMOS	300	74	9	32
Jordan <i>et al.</i> (2018)	Slovenia	CB-SEM	LISREL	190	47	4	23
Kaur and Quareshi (2015)	India	CB-SEM	AMOS	216	63	7	30
Kaur and Thakur (2021)	India	CB-SEM	AMOS	600	79	7	39
Kaur and Thakur (2021) 2	India	CB-SEM	AMOS	600	79	7	39
Kaur and Thakur (2021) 3	India	CB-SEM	AMOS	600	79	7	39
Kaur and Thakur (2021) 4	India	CB-SEM	AMOS	600	79	7	39
Khan <i>et al.</i> (2023)	India	PLS-SEM	SmartPLS	262		9	33
Khwaja <i>et al.</i> (2019)	Pakistan	CB-SEM	AMOS	327	44	5	20
Kim <i>et al.</i> (2012)	Korea	CB-SEM	AMOS	293	101	10	45
Koo <i>et al.</i> (2008)	Korea	CB-SEM	LISREL	279	93	10	38
Korzaan (2003)	USA	CB-SEM	AMOS	342	27	4	13
Kouser <i>et al.</i> (2018)	Pakistan	CB-SEM	AMOS	502	90	10	42
Kuhlmeier and Knight (2005)	France	CB-SEM	LISREL	193	25	4	11
Kuhlmeier and Knight (2005) 2	Macao	CB-SEM	LISREL	148	25	4	11
Kuhlmeier and Knight (2005) 3	USA	CB-SEM	LISREL	151	25	4	11
Law and Ng (2016)	Hong Kong	PLS-SEM	SmartPLS	447		6	24
Law and Ng (2016) 2	Hong Kong	PLS-SEM	SmartPLS	338		6	24
Law and Ng (2016) 3	Hong Kong	PLS-SEM	SmartPLS	109		6	24
Law and Ng (2016) 4	Hong Kong	PLS-SEM	SmartPLS	264		6	24
Law and Ng (2016) 5	Hong Kong	PLS-SEM	SmartPLS	183		6	24
Law <i>et al.</i> (2016)	Honk Kong	PLS-SEM	SmartPLS	329		7	27
Li <i>et al.</i> (2022)	Honk Kong	CB-SEM	AMOS	374	50	6	22
Lim <i>et al.</i> (2016)	Malaysia	CB-SEM	AMOS	662	50	4	23
Liu and Luo (2019)	China	CB-SEM	AMOS	395	52	10	22
Mariano <i>et al.</i> (2016)	Brazil	PLS-SEM	SmartPLS	234		4	11

Studies – in alphabetic order	Country or region	Solution approach	Software	Sample size	Number of free parameters	Quantity of latent variables	Quantity of observables variables
Mathur <i>et al.</i> (2021)	India	CB-SEM	AMOS	260	53	6	22
Mensah <i>et al.</i> (2020)	China	PLS-SEM	SmartPLS	258		4	12
Mosunmola <i>et al.</i> (2018)	Nigeria	CB-SEM	AMOS	558	52	6	22
Nguyen <i>et al.</i> (2022)	Vietnam	CB-SEM	N/A	477	74	9	33
Odoom (2022)	Africa	CB-SEM	AMOS	607	56	5	25
Odoom (2022) 2	Africa	CB-SEM	AMOS	373	56	5	25
Odoom (2022) 3	Africa	CB-SEM	AMOS	234	56	5	25
Ofori and Appiah-Nimo (2019)	Ghana	PLS-SEM	SmartPLS	473		6	30
Oghazi <i>et al.</i> (2018)	Sweden	CB-SEM	LISREL	730	24	3	11
Oliveira <i>et al.</i> (2017)	Portugal	PLS-SEM	SmartPLS	365		16	52
Ozkara <i>et al.</i> (2017)	Türkiye	CB-SEM	AMOS	490	92	11	38
Peña García (2014)	Colombia	CB-SEM	EQS	101	38	3	18
Permata <i>et al.</i> (2022)	Indonesia	PLS-SEM	SmartPLS	125		4	16
Phan and Nguyen-Viet (2022)	Vietnam	CB-SEM	N/A	566	45	5	18
Polas <i>et al.</i> (2022)	Bangladesh	PLS-SEM	SmartPLS	356		6	25
Qalati <i>et al.</i> (2021)	N/A	PLS-SEM	SmartPLS	356		12	45
Rahaman <i>et al.</i> (2022)	Bangladesh	PLS-SEM	SmartPLS	432		6	20
Rahman <i>et al.</i> (2020)	Asia	PLS-SEM	SmartPLS	350		4	17
Ramayah <i>et al.</i> (2018)	Malaysia	PLS-SEM	SmartPLS	127		6	24
Ranganathan and Jha (2007)	USA	CB-SEM	AMOS	214	82	12	31
Rehman et a. (2019)	Pakistan	PLS-SEM	SmartPLS	384		16	35
Rezaei <i>et al.</i> (2014)	Malaysia	CB-SEM	AMOS	219	60	9	30
Román <i>et al.</i> (2014)	Spain	CB-SEM	N/A	578	124	17	57
Rose <i>et al.</i> (2012)	USA and Europe	PLS-SEM	PLS Graph	220		15	62
Saha <i>et al.</i> (2021)	China	PLS-SEM	SmartPLS	226		12	53
Sahi <i>et al.</i> (2016)	India	CB-SEM	AMOS	216	102	8	49
Saleem <i>et al.</i> (2022)	China	CB-SEM	AMOS	789	98	9	46
San Martín and Prodanova (2014)	Spain	CB-SEM	LISREL	447	42	5	18
Sethuraman and Thanigan (2019)	India	CB-SEM	AMOS	211	36	8	27
Shaouf <i>et al.</i> (2016)	UK	CB-SEM	AMOS	316	33	4	14
Shaouf <i>et al.</i> (2016) 2	UK	CB-SEM	AMOS	176	33	4	14
Shaouf <i>et al.</i> (2016) 3	UK	CB-SEM	AMOS	140	33	4	14

Studies – in alphabetic order	Country or region	Solution approach	Software	Sample size	Number of free parameters	Quantity of latent variables	Quantity of observables variables
Sharifi Fard <i>et al.</i> (2019)	Malaysia	CB-SEM	AMOS	370	56	5	25
Siddiqui <i>et al.</i> (2021)	India	CB-SEM	AMOS	256	48	7	18
Sivathanu <i>et al.</i> (2023)	India	PLS-SEM	SmartPLS	1180		7	29
Suprpto <i>et al.</i> (2022)	Indonesia	PLS-SEM	SmartPLS	260		7	25
Sütütemiz and Saygili (2020)	Türkiye	CB-SEM	AMOS	460	60	9	30
Tandon and Kiran (2018)	India	CB-SEM	AMOS	500	57	11	23
To <i>et al.</i> (2007)	Taiwan	CB-SEM	LISREL	206	108	15	52
Toska <i>et al.</i> (2023)	Kosovo	PLS-SEM	SmartPLS	262		6	39
Tran and Nguyen (2022)	Vietnam	CB-SEM	AMOS	358	76	7	33
ur Rahman <i>et al.</i> (2018)	Pakistan	PLS-SEM	SmartPLS	859		6	19
Vallejo <i>et al.</i> (2015)	Spain	PLS-SEM	SmartPLS	252		14	37
Varma <i>et al.</i> (2020)	India	CB-SEM	N/A	287	46	5	20
Ventre and Kolbe (2020)	Mexico	PLS-SEM	SmartPLS	380		4	12
VO <i>et al.</i> (2022)	Vietnam	PLS-SEM	SmartPLS	450		5	27
Wagner Mainardes <i>et al.</i> (2019)	Brazil	PLS-SEM	N/A	345		7	25
Wardhani (2020)	Indonesia	PLS-SEM	SmartPLS	N/A		4	20
Wu and Santana (2022)	Indonesia	PLS-SEM	SmartPLS	302		8	N/A
Ying <i>et al.</i> (2021)	China	CB-SEM	AMOS	513	139	12	64
Zamzuri <i>et al.</i> (2018)	N/A	CB-SEM	AMOS	217	50	5	23
Zeba and Ganguli (2016)	India	CB-SEM	AMOS	493	59	7	27
Zhu and Benyoucef. (2019)	China	CB-SEM	LISREL	473	63	9	28
Zhu <i>et al.</i> (2020)	Thailand	CB-SEM	AMOS	401	44	5	20

Table ST3. Minimum path coefficient frequency distribution and minimum sample size recommended in the study sample with PLS-SEM

Minimum path coefficient	<i>n</i>	<i>n<sub>1</sub></i>	Minimum sample size <sup>1</sup>
< 0.05	16	0	2473
0.05 – 0.1	15	4	619
0.11 – 0.2	24	48	155
0.21 – 0.3	2	10	69
0.31 – 0.4	1	0	39

*n*: number of studies with minimum path coefficient values in the interval; *n<sub>1</sub>*: number of studies with sample sizes that guarantee that path coefficients will be detected as significant in the interval (at 5% significance and 80% power); <sup>1</sup>: Minimum sample sizes proposed by Hair et al. (2020) (inverse square root method at 5% significance and 80% power)

Table ST4. Estimation methods and software used in the article sample.

CB-SEM			PLS-SEM		
	<i>n</i>	%		<i>n</i>	%
<i>Estimation method</i>			<i>Estimation method</i>		
MLE	65	92.86	Partial Least Squares	50	100
Robust MLE	4	5.71			
Unweighted Least Squares	1	1.43			
<i>Software</i>			<i>Software</i>		
LISREL	10	14.29	SMART-PLS	46	92.00
AMOS	47	67.14	PLS-GRAPH	2	4.00
EQS	3	4.29	Not specified	2	4.00
Not specified	10	14.29			

*MLE*: Maximum Likelihood Estimation

Table ST5. Methods applied for mediation (or indirect effects) analysis in the sample article.

	<i>CB-SEM</i>		<i>PLS-SEM</i>		<i>Total</i>	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
<i>Bootstrapping</i>	9	24.32	18	72.00	27	43.55
<i>Causal steps</i> (Baron and Kenny, 1986)	11	29.73	2	8.00	13	20.97
Sobel test	2	5.41	2	8.00	4	6.45
<i>Joint significance</i>	0	0.00	1	4.00	1	1.61
Not specified	15	40.54	2	8.00	17	27.42

## ***Annex SA1: On the importance and relevance of predictive analysis in PLS models applied to the social sciences. A summary***

In CB-SEM models, the primary objective is *explanation*, the model fit being the method to assess the structural model. The fact that CB-SEM was the first structural equation modeling method and has been the most widely used has led to explanatory models dominating social science research in general, and OPI research in particular.

However, this approach does not capture the *predictive power* of the models, which is their ability to generate accurate temporal and cross-sectional predictions of new interpretable observations (Shmueli & Koppius, 2011). The predictive power/capacity of a model is of utmost importance in practice since it is a key indicator of its suitability for generating more generalizable and valuable management recommendations that can improve decision-making (Shmueli *et al.*, 2016, Chin *et al.*, 2020). This is made possible when the measure of the in-sample and out-of-sample predictive capacity of the model show positive results, which indicates the generation of sufficiently accurate predictions of new temporal and cross-sectional observations (Shmueli *et al.*, 2019; Marin-Garcia *et al.*, 2023).

The predictive power enhances the retrospective character of explanatory models that dominate the field with prediction and helps build theories for explanation and prediction (Liengaard *et al.* 2021). Moreover, it allows us to know if the research model can offer transferable findings to other data sets and comparable situations. This is extremely important for improving decision making as stated above (see also Cheah *et al.* (2023).

At this point, regarding the predictive character of a research model, it is necessary to stress that this purpose can only be done with PLS-SEM or another composite-based SEM method (see Rigdon, 2012; Rigdon, 2016; Rigdon *et al.*, 2019a, 2019b). It should be also stressed that, as recently stated by Sabol *et al.* (2023), PLS-SEM is clearly the preferred SEM method when one important research objective is prediction.

Shmueli *et al.* (2016) proposed assessing the model's predictive power through its estimation in an analytical sample and assessing its predictive performance using another data sample known as the holdout sample (Hair *et al.*, 2019). In this method, known as PLS predict, the parameters estimated in the training sample are used to predict the values of the endogenous variables in the holdout samples. The predictions are then compared to reference values (simple means or results from a simple linear regression model) using metrics such as MAE (Mean Absolute Error) or RMSE (Root Mean Square Error).

Although prediction and explanation are disparate objectives, they can be combined in a study (Henseler, 2018, Dolce *et al.*, 2017, Shmueli, 2010), and using PLS predict involves a compromise between prediction and explanation to avoid overfit (Chin *et al.*, 2020).

The results of PLS predict can be confirmed by a further analysis of the out-of-sample predictive capacity with Cross-Validated Predictive Ability Test (CVPAT), proposed by Liengaard *et al.* (2021). This test compares whether the average loss of the PLS-SEM model is significantly lower than the average loss value of a prediction using indicator averages and the average loss value for a linear model (LM). CVPAT also provides a statistical test to compare the average loss against reference values (predictor average or linear model).

The above demonstrates the enormous importance of predictive assessment and of including PLS predict in the evaluation of PLS model results (Hair *et al.*, 2019, 2022), as well as of reinforcing it by using CVPAT. This is especially relevant in the dynamic context of online

shopping, where decisions must increasingly be data-driven. In this context, incorporating tools such as PLS predict and CVPAT into SEM applications improves not only the model's explanatory power but also its ability to predict future consumer behavior, thus increasing its theoretical robustness and practical relevance for marketing decision-making.

Despite this, the analysis of our sample shows that none of these methods were used in the analyzed papers that use PLS. This shortcoming is particularly significant considering that prediction is the primary objective of this methodological approach compared to CB SEM, and that predicting online purchase intention represents a critical factor for strategic business decision-making. Moreover, it is noteworthy that only 30% of OPI studies employing the PLS-SEM approach assess the model's predictive capability and rely exclusively on predictive relevance ( $Q^2$ ) as the evaluation indicator.

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