

A powerful technique for combining complex path models with latent variables

Llopis-Albert, Carlos^a; Palacios-Marques, Daniel^b

^a Departamento de Ingeniería Mecánica y de Materiales, Universitat Politècnica de València, Camí de Vera s/n, Spain, 46022, email: cllopisa@upvnet.upv.es

^b Departamento de Organización de Empresas, Universitat Politècnica de València, Camí de Vera s/n, Spain, 46022, email: dapamar@doe.upv.es

Received: 2016-05-09; Accepted: 2016-10-23

Abstract

This article presents the use of Structural Equation Modeling (SEM) as a powerful technique for combining complex path models with latent variables. A case study is introduced together the estimation technique, the measurement scales, the hypothesis needed to relate the variables and the problems concerning the assessment and improvement of the model fit. The theoretical framework allows analyzing the relationships among the variables, which provides effective strategies in the decision-making process and problem solving.

Keywords: Structural Equation Models, Decision-Making Process, Model fit, latent variables

1. Introduction

There is an increasing use of Information and Communication Technologies (ICTs) in personal, business and education activities (e.g., King and Khauli, 2016; de Juan-Jordán et al., 2016; Eom, 2015; Uzun, 2015; El Ouiridi, 2015). Social Media Technologies (SMTs) have popularized the appearance of collaborations, knowledge sharing, creativity and innovation in organizations (Soto-Acosta et al. 2015; Palacios-Marqués et al. 2015; Soto-



Acosta et al. 2014). SMTs also generates economic and social value (Martínez-Simarro et al., 2015; Meyskens, 2010; Sigala and Chalkiti, 2014; Palacios-Marqués, et al., 2016).

This article applies SME to analyze relationships between social entrepreneurship, market orientation (MO) and crowdsourcing (CW) to improve their organizational performance (OP). SME covers mathematical models and statistical methods to fit networks of constructs to data (e.g., Xu et al., 2014). Similar approaches are found in other research fields (e.g., Llopis-Albert et al., 2010; 2014; 2016). Furthermore, other approaches can be used to determine the relationship of the variables at hand such as Fuzzy set Qualitative Comparative Analysis (Berbegal-Mirabent and Llopis-Albert, 2016; Llopis-Albert and Palacios-Marques, 2016) or Bayesian Networks (e.g., Molina et al., 2012).

We apply SMEs to 223 companies in the biotechnology and telecommunications sectors using a variety of measurement scales and hypothesis to relate the variables.

2. Material and methods

This section presents the concepts of market orientation and its relationship with crowdsourcing and entrepreneurship. This allows establishing the measurement scales, the hypotheses and theoretical models relating those variables and their validation. Marketing orientation is a part of a business that identifies and provides products or services for satisfying customers' needs and requirements (Hult et al., 2005; Fang et al., 2014) The final goal is to improve the productivity, profitability and organizational performance (Chad, 2014; Wirtz et al., 2014; Pinho et al., 2014; Llopis-Albert et al., 2015; 2015a). There are models in the literature that have analyzed the relationship about these issues (Narver and Slater, 1990; Slater and Narver, 1994; Kohli and Jaworski, 1990; Jaworski and Kohli, 1994; Matsuno et al., 2002; Kirca et al., 2005; Morgan et al., 2009; Kleemann et al., 2008; Magnusson et al., 2003; Wang 2014; Han et al., 1998; Hult et al., 2004; Rhee et al., 2010). As a result, we have formulated the subsequent hypothesis relating the studied variables. Hypothesis (H1) establishes a positive relationship between MO and the degree of implementation of CW tools. Hypothesis (H2) entails a positive relationship between the implementation of CW tools and OP. Eventually, hypothesis (H3) suggests a positive



relationship between MO, while OP is explained through the measurement of the degree of implementation of CR tools.

The properties of the measurement scales and indicators used in the empirical study to evaluate the goodness-of-fit of the model encompasses dimensionality, reliability and validity, which comprises discriminant, convergent and content validity. Several authors provide an explanation of those concepts (Hair et al., 2010; Anderson and Gerbing, 1982; Ullman, 2006; Hayes, 1998; Bollen, 1989; Mueller, 1996; Fornel and Larcker, 1981; Churchill, 1979; Lawshe, 1975; Bentler and Bonett, 1980; Anderson and Gerbing, 1982).

3. Case study

The case study is carried out using 223 Small and Medium-sized Enterprises (SMEs) in the telecommunications and biotechnology sectors. A survey with a set of questions were ranked with a scale ranging from 1 to 7. A 7 refers to an extensive use of crowdsourcing tools by the company, 4 for an occasional use of crowdsourcing tools and 1 if the company never uses crowdsourcing tools.

The statistical parameters of the survey results (mean and standard deviation), factorial loads and measurement errors for all measurement scales were obtained.

They were found to be suitable according to the literature. In addition to the adjustment indices of the measurement models, the reliability and validity were also analyzed. All the estimated parameters were statistically significant at 95% ($t > 1.96$). The values of the standardized factorial loads were high, i.e., above 0.4 (Hair et al., 2010).

Hence, the scales fulfills all the properties required by sociometric measurement scales in social sciences. The hypothesis were also tested using SEMs by means of the adjustment of the global model, the measurement model and the structural model. As shown in Table 1 we conclude that the models show a suitable relationship among the analyzed latent variables and a suitable fit of the structural model for all hypothesis.

A summary of the results for the validation of all hypothesis is shown in Table 2.



Table 1. Estimated parameters of the SEM for all hypothesis. (MO: Market Orientation; CW: Crowdsourcing; OP: Organizational Performance)

Model	Coefficients γ , β and α in the structural equations	Reliability	Coefficient t Is $t \geq 1.96$?
Hypothesis H1			
MO \longrightarrow CW	$\gamma = 0.721$	0.436	7.362
Hypothesis H2			
MO \longrightarrow CW	$\gamma = 0.824$	0.375	13.013
Hypothesis H3			
MO \longrightarrow CW \longrightarrow OP	$OP = \gamma CW + \beta MO + D$ $\gamma = 0.758$ (t=8.363) $\beta = 0.087$ (t=0.839)	0.504	γ (t=8.363) β (t=0.839)
MO \longrightarrow CW	$CW = \alpha MO + D$ $\alpha = 0.801$ (t=15.051)	0.344	-

Table 2. Summary of the results.

Hypothesis	Adjustment indices		Results
	Index	Value	
H1	Dof	32	The estimated parameter is statistically significant at 95%. A proper fit of the structural model is achieved. H1 is successfully proved.
	p	0.726	
	Chi ²	26.830	
	RMSR	0.016	
	BB NNFI	0.997	
	IFI	0.941	
	NC	0.840	
H2	Dof	41	The estimated parameter is statistically significant at 95%. A proper fit of the structural model is achieved. H1 is successfully proved.
	p	0.387	
	Chi ² Santorra-Bentler	42.950	
	RMSR	0.039	
	BB NNFI	0.983	
	IFI	0.958	
	NC	1.050	

H3	Dof	41	The indirect effect is much greater than the direct one. The direct effect is not statistically significant while the indirect is.
	p	0.681	
	Chi ² Santorra-Bentler	36.261	
	RMSR	0.020	
	BB NNFI	0.966	
	IFI	0.965	
	NC	0.890	

4. Conclusions

This paper shows the relationships among social entrepreneurship, market orientation, crowdsourcing with regard to the organizational performance companies. A theoretical framework based on structural equation modelling is presented. We determine the relationships among the latent variables and pose hypothesis with the aim to improve the organizational performance of companies. Theoretical framework and the hypothesis were empirically verified applying the SEM to 223 firms in the biotechnology and telecommunications sectors.

References

- Anderson, J.C., Gerbing, D.W. (1982). Some methods for respecifying measurement models to obtain unidimensional construct measurement. *Journal of Marketing Research*, 19, 453–460.
- Bentler, P.M., Bonett, D.G. (1980). Significance tests and goodness of fit in the analysis of covariance structures. *Psychological Bulletin* 88(3), 588-606.



- Beregal-Mirabent, J., Llopis-Albert, C. (2016). Applications of fuzzy logic for determining the driving forces in collaborative research contracts. *Journal of Business Research*, 69(4),1446–1451. DOI: 10.1016/j.jbusres.2015.10.123.
- Bollen, K.A. (1989). *Structural equations with latent variables*. John Wiley & Sons. ISBN: 978-0-471-01171-2.
- Chad, P., 2014. Organizational change within charities: Improved performance via introduction of market orientation and other strategic orientations. *International Review on Public and Nonprofit Marketing*, 11(1), 89–113. doi:10.1007/s12208-014-0113-4.
- Churchill, G.A. (1979.) A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research*, 16, 64–73.
- de Juan-Jordán, H.; Guijarro-García, M., Guardiola-Contreras, J. (2016). Corporate social networks applied in the classroom. *Multidisciplinary Journal for Education, Social and Technological Sciences*, 3(2). DOI: /10.4995/muse.2016.XXX.
- El Ouiridi, A., El Ouiridi, M., Segers; J., Henderickx, E. (2015). Employees' use of social media technologies: a methodological and thematic review. *Information Systems Management*, 34(5). DOI: 10.1080/0144929X.2015.1004647.
- Eom, M.T. (2015). How Can Organization Retain IT Personnel? Impact of IT Manager's Leadership on IT Personnel's Intention to Stay. *Information Systems Management*, 32(4). DOI: 10.1080/10580530.2015.1080001.
- Fang, S.-R., Chang, E., Ou, C.-C., Chou, C.-H. (2014). Internal market orientation, market capabilities and learning orientation. *European Journal of Marketing*, 48, 170–192. doi:10.1108/EJM-06-2010-0353.



- Fornel, C., Larcker, D.F. (1981). Evaluating structural equations models with unobserved variables and measurement error. *Journal of Marketing Research* 18(1), 39–50.
- Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. (2010). *Multivariate data analysis*. Prentice Hall, Upper Saddle River, NJ 07458.
- Han, J.K., Kim, N., Srivastava, R.K. (1998). Market orientation and organizational performance: is innovation a missing link? *Journal of Marketing* 62(4), 30-45.
- Hayes, B.E. (1998). *Measuring customer satisfaction: Survey design, use, and statistical analysis methods*. ASQ Quality Press.
- Hult, G.T.M., Ketchen, D.J., Slater, S.F. (2005). Market Orientation and Performance: An Integration of Disparate Approaches. *Strategic Management Journal*, 26, 1173–1181. DOI: 10.1002/smj.494.
- Hult, G.T.M., Hurley, R.F., Knight, G.A. (2004). Innovativeness: Its antecedents and impact on business performance. *Industrial Marketing Management* 33(5), 429–438. doi:10.1016/j.indmarman.2003.08.015.
- INE, 2016. Instituto Nacional de Estadística (Spanish Statistical Office). <http://www.ine.es/en>.
- Jaworski, B.J., Kohli, A.K. (1993). Market orientation: antecedents and consequences. *Journal of marketing*, 53–70.
- King, N, Khauli, L. (2016). Social Media Technology. *Information Systems Management*, DOI: 10.1080/10580530.2016.1220217.
- Kirca, A.H., Jayachandran, S., Bearden, W.O. (2005). Market orientation: A meta-analytic review and assessment of its antecedents and impact on performance. *Journal of marketing* 69, 24–41.



- Kleemann, F., Voß, G., Rieder, K. (2008). Un(der)paid Innovators: The Commercial Utilization of Consumer Work through Crowdsourcing. *Science, Technology & Innovation Studies* 4(1), 5–26.
- Kohli, A.K., Jaworski, B.J. (1990). Market orientation: the construct, research propositions, and managerial implications. *Journal of marketing*, 1–18.
- Lawshe, C.H. (1975). A quantitative approach to content validity. *Personnel psychology*, 28, 563–575. doi:10.1111/j.1744-6570.1975.tb01393.x.
- Llopis-Albert, C., Palacios-Marques, D. (2016). Applied Mathematical Problems in Engineering. *Multidisciplinary Journal for Education, Social and Technological Sciences*, 3(2). DOI: /10.4995/muse.2016.XXX.
- Llopis-Albert, C., Merigó, J.M., Xu, Y., 2016. A coupled stochastic inverse/sharp interface seawater intrusion approach for coastal aquifers under groundwater parameter uncertainty. *Journal of Hydrology*, 540, 774–783. DOI: 10.1016/j.jhydrol.2016.06.065.
- Llopis-Albert, C., Palacios-Marqués, D., Merigó, J.M. (2014). A coupled stochastic inverse-management framework for dealing with nonpoint agriculture pollution under groundwater parameter uncertainty. *Journal of Hydrology* 511, 10–16.
- Llopis-Albert, C., Palacios-Marqués, D., Soto-Acosta, P. (2015). Decision-making and stakeholders' constructive participation in environmental projects. *Journal of Business Research* 68(7), 1641–1644. DOI: 10.1016/j.jbusres.2015.02.010.
- Llopis-Albert, C., Rubio, F., Valero, F. (2015a). Improving productivity using a multi-objective optimization of robotic trajectory planning. *Journal of Business Research*, 68(7), 1429–1431. DOI: 10.1016/j.jbusres.2015.01.027.



- Llopis-Albert, C. and Capilla, J.E. (2010). Stochastic simulation of non-Gaussian 3D conductivity fields in a fractured medium with multiple statistical populations: a case study. *Journal of Hydrologic Engineering*, 15(7), 554-566.
- Magnusson, P.R., Matthing, J., Kristensson, P. (2003). Managing user involvement in service innovation experiments with innovating end users. *Journal of Service Research* 6 (2), 111–124.
- Martínez-Simarro, D., Devece, C., Llopis-Albert, C. (2015). The moderating effect of information system strategy on the relationship between business strategy and performance. *Journal of Business Research*, 68(7), 1592–1594. DOI: 10.1016/j.jbusres.2015.01.057.
- Matsuno, K., Mentzer, J.T., Özsoy, A. (2002). The effects of entrepreneurial proclivity and market orientation on business performance. *Journal of Marketing*, 66, 18–32.
- Meyskens, M., Carsrud, A.L., Cardozo, R.N. (2010). The Symbiosis of entities in the social engagement network: The role of social ventures, 22(5), 425,455.
- Molina, J.L., Pulido-Velázquez, M., Llopis-Albert, C., Peña-Haro, S., 2012. Stochastic hydro-economic model for groundwater quality management using Bayesian networks. *Water Science & Technology*, 67(3), 579-586. DOI: 10.2166/wst.2012.598.
- Morgan, N.A., Vorhies, D.W., Mason, C.H., 2009. Market orientation, marketing capabilities, and firm performance. *Strategic Management Journal* 30(8), 909–920.
- Mueller, R.O. (1996). *Basic principles of structural equation modeling: An introduction to LISREL and EQS*. Springer Science & Business Media.
- Narver J.L., Slater, S. (1990). The effect of a market orientation on business profitability. *Journal of Marketing*, 54, 20-35.



- Palacios-Marqués, D., Devece, C.A., Llopis-Albert, C. (2016). Examining the effects of online social networks, entrepreneurial orientation and innovation performance in the hotel industry. *Psychology & Marketing Journal*, XXX.
- Palacios-Marqués, D.; Merigo, J.M. & Soto-Acosta, P. (2015). Online social networks as an enabler of innovation in organizations, *Management Decision*, 53(9), 1906–1920.
- Pinho, J.C., Rodrigues, A.P., Dibb, S., 2014. The role of corporate culture, market orientation and organisational commitment in organisational performance: The case of non-profit organisations. *Journal of Management Development*, 33(4), 374–398. doi:10.1108/JMD-03-2013-0036.
- Rhee, J., Park, T., Lee, D.H. (2010). Drivers of innovativeness and performance for innovative SMEs in South Korea: Mediation of learning orientation. *Technovation* 30, 65–75.
- Sigala M., & Chalkiti K. (2014). Investigating the exploitation of web 2.0 for knowledge management in the Greek tourism industry: An utilisation–importance analysis. *Computers in Human Behavior*, 30(1), 800–812.
- Slater, S.F., Narver, J.C. (1994). Market orientation, customer value, and superior performance. *Business Horizons*, 37(2), 22–28.
- Soto-Acosta, P., Popa, S., Palacios-Marqués, D. (2015). E-business, organizational innovation and firm performance in manufacturing SMEs: an empirical study in Spain, *Technological and Economic Development of Economy*. doi: 10.3846/20294913.2015.1074126.
- Soto-Acosta, P. Perez-Gonzalez, D., & Popa, S. (2014). Determinants of Web 2.0 technologies for knowledge sharing in SMEs. *Service Business*, 8(3), 425–438.



- Statista, 2016. The portal for statistics. <http://www.statista.com>.
- Ullman, J.B. (2006). Structural equation modeling: reviewing the basics and moving forward. *Journal of personality assessment*, 87(1), 35–50.
- Uzun, L., Golz, R. (2015). The educational and technical courses in the ELT program in Turkey: Do they contribute to ICT skills? *Information Systems Management*, 3(1). DOI: 10.1080/2331186X.2016.1141454.
- Wang, C.-H. (2014). Does service innovation matter in high-tech industry? *Journal of Technology Management & Innovation* 9(2), 42–55.
- Wirtz, J., Tuzovic, S., Kuppelwieser, V.G., 2014. The role of marketing in today's enterprises. *Journal of Service Management*, 25(2), 171–194. DOI:10.1108/JOSM-01-2014-0037.
- Xu, Y., Llopis-Albert, C., González, J. (2014). An application of Structural Equation Modeling for Continuous Improvement. *ComSIS Consourtium*, 11(2), 797–808. DOI: 10.2298/CSIS130113043X.

