14th Annual International Conference on Industrial Engineering and Operations Management
Dubai, United Arab Emirates (UAE), February 12-14, 2024
Publisher: IEOM Society International, USA DOI: 10.46254/AN14.20240139
Published: February 12, 2024

Organizational Culture and Innovation in Aerospace Industry´S Smes in Mexico

Christian Muñoz-Sánchez, Dulce María Monroy-Becerril, Alonso Rojas Rodríguez, Jorge Alejandro Silva Rodríguez de San Miguel and Eugene Hakizimana
Escuela Superior de Comercio y Administración, Unidad Santo Tomás (ESCA-STO)
Instituto Politécnico Nacional (IPN)
Mexico City, Mexico
cmunozs@ipn.mx, dmonroyb@ipn.mx, arojasro@ipn.mx, jasilva@ipn.mx,
he57515@gmail.com

Abstract

This paper studies the relationship between organizational culture (OC) and innovation in small and medium-sized enterprises (SMEs) in the aerospace industry (AI) of the state of Querétaro, Mexico. For this purpose, the research strategy consisted in analyzing five case studies in SMEs of AI in Querétaro in 2023. The empirical analysis was carried out through a series of key factors of OC to demonstrate the development of an innovation culture. The study shows a positive relationship between OC and innovation activities in the evaluated SMEs.

Keywords
Organizational Culture, Innovation, Aerospace Industry, SMEs

1. Introduction

Innovation has increasingly become recognized as a key influence on business competitiveness, regions, cities and nations (Asheim et al., 2011). There is a growing interest in the analysis of OC as a main variable that influences innovation processes in small and medium-sized enterprises (SMEs) in medium-high technology sectors (Tang et al., 2020; Lijauco et al., 2020; Dabić et al., 2019; Sánchez-Báez et al., 2019). The dynamism of innovation in SMEs depends on the introduction and adoption of new technologies, new organizational forms and the implementation of OC that encourages innovation activities. SMEs face many barriers to innovate, including organizational factors, there is a great opportunity for SMEs to innovative by removing these barriers (Connolly et al., 2012).

The development of AI in Queretaro has been maintained for the last ten years and has been consolidating as the region of Mexico that records the highest growth in terms of economic indicators. Between 2010 and 2020 the foreign direct investment (FDI) accumulated in the aerospace sector of Queretaro amounted to 1,300 million usd , making it the region with the highest index of FDI in Mexico. Currently the state of Querétaro has some of the key company-players in the AI like: Bombardier, Airbus, GE, Safran, ITP and PCC Aerostructures, it also has the first and only university specialized in the AI in Mexico, (Universidad Aeronáutica de Querétaro), (FEMIA, 2022).

SMEs dedicated to AI in Mexico need a culture that develops and establishes values and attitudes prone to promote ideas and changes that lead to improvements the operation and efficiency of enterprises. The aim is to examine the influence of OC in fostering innovation in SMEs of medium-high technology in the s in the aerospace sector in Mexico. For this purpose, we focused on multiple exploratory case studies in five SMEs of AI located in the state of Queretaro, Mexico.

2. Literature Review

2.1 Organizational Culture

Despite abundant documentation on OC, there is no consensus on a definition. A first approach to the concept of OC is a metaphor that is adequate to provide an approximation to OC, is described by Ouchi (1982:130): "An organization is similar to ourselves. Just as we have beliefs, attitudes, goals and habits that make us unique, the organization develops over time a characteristic personality, which I have called the culture of its organization". There is a large number of concepts related to organizational culture. Table 1 summarizes some of these concepts provided over time. Since there is no agreement on a particular definition it is importrant to clarify for the purpose of this research our approach to Organizational Culture.

Table 1. OC Literature.

Author	Concept
(Ouchi, 1982)	The culture of the organization consists of a series of symbols, ceremonies and myths that communicate to the company personnel the values and beliefs that are most deeply rooted within the organization.
(García-Echevarría & Pümpin, 1988)	Under the concept of organizational culture, we understand the set of norms, values and ways of thinking that characterize the behavior of staff at all levels of the company.
(Miron, et al., 2004)	Set of beliefs and values shared by members of the same organization which influences their behavior.
(Lee, et al., 2016)	Organizational culture is made up of the symbols, language, ideology, beliefs, rituals, and myths of an organization. Culture encompasses all areas of organizational life; it is a core of values, assumptions, interpretations, and approaches that characterize an organization.
(Nazarian, et al., 2017)	Organizational culture is the main resource that organizations have to maintain their competitive advantage. It also represents a combination of characteristics such as teamwork, innovation, risk taking, market response and customer satisfaction.

For this study, OC is understood as the set of beliefs, symbols, ideology and values shared by members of the same organization. In the following section, the second relevant theoretical construct is presented.

2.2 Innovation

Innovation is explained as a key factor in economic and social development; knowledge conceived through collective learning is the most important resource to activate the innovation process (Lundvall, 2007; Nelson, 1993).

According to The Oslo manual (OECD) (2018:20) an innovation is defined: "an innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)". Innovation is a powerful factor that explains the differences in performance between companies, regions and countries; Firms that are successful in innovation thrive at the expense of their less capable competitors and have higher productivity and income than less innovative ones (Malerba, 2002). Thus, Innovation is an business activity, it is a mechanism that uses the company as a means to make its results felt in society. Another characteristic that should be pointed out is that innovation is a different way of doing things, the product of new combinations, which have a significant influence on the economy and which is generally linked to the field of production; However, innovating not only applies to the company, but also to society and culture .

3. Methods

For this article, the multiple exploratory case study is used as a research strategy. An isolated case is not susceptible of generalizations and is potentially open to various distortions in its interpretation (Ellet, 2007), the evidence of multiple cases is more reliable, and the investigation generally acquires a more solid character (Yin, 2018).
The companies considered for this study have the following characteristics:

- They are enterprises considered SMEs according to the classification of the Ministry of Economy (SE) in Mexico

- SMEs that offer products and services for AI
- SMEs located within the state of Querétaro, Mexico

4. Data Collection

The field work was established in two stages: the first, in February 2023, managers from selected SMEs were contacted to communicate the research and define the criteria to carry out an interview with managers and a survey of company workers. The second stage, in July 2023, where the interviews and the worker survey were applied. From these visits, the analysis of the data collection instrument is derived (Table 2).

Table 2. Profile of SMEs for the study

Enterprise	Main products and services	Main customers	Position of interviewed	Interview duration
GICS	Engineering and design tools	Bombardier Aernnova	Project Manager	1 hr 10 min
CRA	Aircraft interior design	Embraer Bell Helicopter	CEO	40 min
AEROM	Manufacture and repair of compressors	Sermati Safran	Administrative Manager	1 hr 5 min
TECHB	Material handling equipment	Airbus Daher	Project Manager	50 min
ITM	Thermal and surface treatments	Embraer Safran	Production Manager	45 min

To complement the analysis of OC and its relationship with innovation activities, indexes was developed to demonstrate this relationship.

To determine the indexes, the first step is to evaluate the variables of OC, through a questionnaire with dichotomous questions evaluating the influence of OC on innovative activities. Each positive statement, for each SME, adds +1; conversely, each negative statement does not add up. The positive responses of each statement are added, based on the sum, companies that promote an innovation culture are rated.

With information from the questionnaire (Appendix B), three indicators were formulated:

- Innovation cultural index (ici)
- Innovation activity index (iai)
- Organizational innovation index (oii)

For evaluating the indexes, we have the following matrix:

	E= 5	...	m
ic=1	Z_{icE}	..	Z_{1m}
n	Z_{n1}	..	Z_{mn}

Where, *ic* represents each manifestation of an innovation culture (from *ic* to *n*) established in the the questionnaire (Appendix B), likewise, *E* represents the number of case study SMEs, *m* and *n* represent that we work with non-square matrices; *Z* is the dichotomous data that is assigned to the previously established value true (+1) and false (not sum) with which each manifestation (*ic*) is related to each case study (*E*).
With the information from the matrix, a frequency indicator is generated towards manifestations of a culture of innovation. It is calculated by:

$$Fic = \sum_{E=1}^{n} Z_{icE}$$

The elaboration of the index implies that the SME with the highest F*ci* value equals 100 and is used as a basis to compare the others SMEs.

$Fic = (Fic / \Sigma ic)*100$

Through the indexes, SMEs can be directly compared to each other in terms of cultural manifestations oriented towards innovation.

5. Results and Discussion

The analysis strategy allows evaluating the interviews directed to the managers of the case studies, according to the research instrument. The results are presented in the proposed categories in Table 3.

Table 3. Results of the cultural manifestations.

Company	Values	Strategy Planning	Company´s Purpose	Role of employees	Rituals	Role of innovation
GICS	Integrity, perseverance, teamwork, trust, communication	"It is made in conjunction with all the departments of the enterprise"	"Generate a successful enterprise in the aerospace industry, seek the development of all the personnel that make up GICS"	"The company's most valuable asset"	"The anniversary of the company is celebrated, Christmas meeting and new year, where the organization is paid by the company"	"Innovation is the engine for development at GICS"
CRA	Transparency, competitiveness, respect, teamwork	"The strategies are carried out attending to the suggestions of the whole enterprise"	"Solve the needs of our clients with the highest quality and innovation"	"It is important to treat employees as collaborators"	"Engineers tend to have informal meetings at a restaurant near the company"	"We generate competitive advantages through innovation"
AEROM	Adaptability, competitiveness, honesty	"The strategies are implemented based on the objectives we want to achieve "	"Develop a leading Mexican enterprise in the aerospace industry"	"Workers are the key to the success for AEROM"	"The managers organize a meeting in December (posada) to celebrate the workers"	"Innovation enables continuous improvement at AEROM"
TECHB	Consistency, discipline, respect, punctuality	"The strategies determined by the directive are followed"	"Generate continuous improvement in our products and services"	"They are important, we are looking for employees who work under pressure"	"jokes on new employees on their first day of work"	"We do what our clients ask us with the technical specifications they need"
ITM	Cooperation, efficiency, teamwork, commitment	"The strategies are action guides for which we compose this enterprise""	"Create a competitive enterprise in a highly complex industry"	"Engineers are committed to ITM"	"The company organizes a meeting to commemorate the day of the dead and employees dress up"	"We want to be a world-class company, we have to innovate"

In the second stage of the fieldwork, the SMEs most likely to promote a Culture of innovation are analyzed through the following indexes:

5.1. Innovation culture index (ici)

The index is made up of questions from a to z (Appendix B). The results are shown in Figure 1.

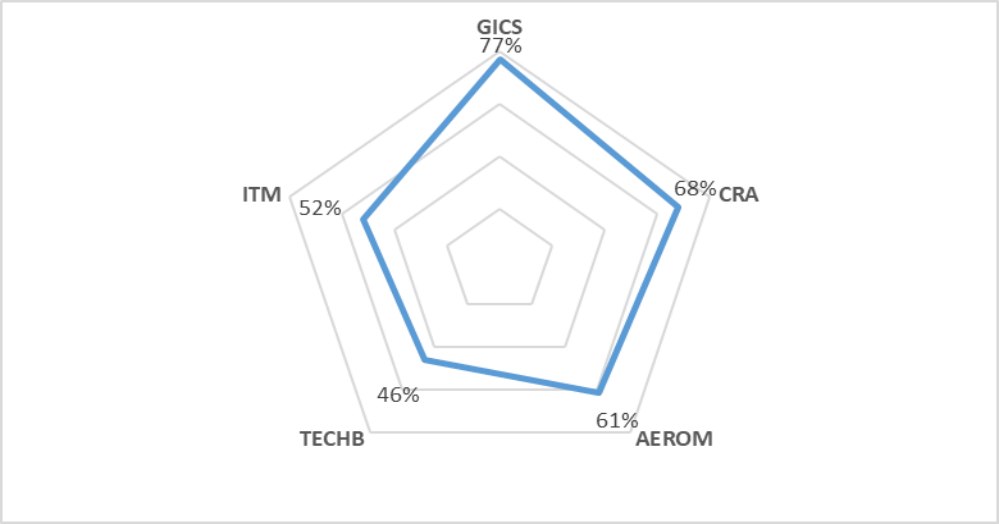

Figure 1. Innovation culture index results

The index (cij) shows the promotion of SMEs towards an innovation culture. Through this index, a better positioning of the GICS company is observed with 84% of the total, CRA has 68%, AEROM with 61% in third and fourth place, and ITM with 57% respectively, finally and in agreement to the survey, TECHB is found with 46%.

5.2. Innovation activities index (iai)

The index is made up of questions from a to m (Appendix B). The results are shown in Figure 2.

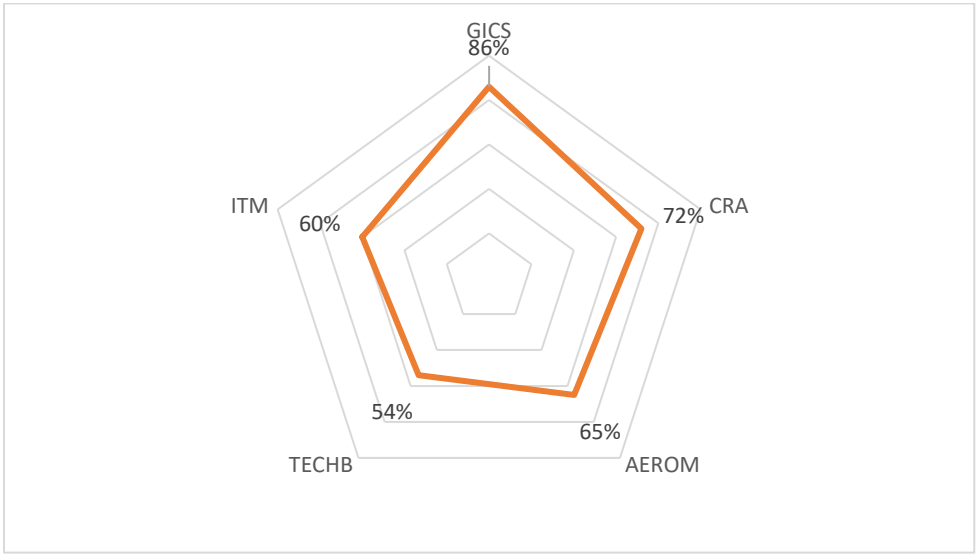

Figure 2. Innovation activities index results

5.3. Organizational innovation index (oii)

The index is made up of questions from n to z (Appendix B). The results are shown in Figure 3.

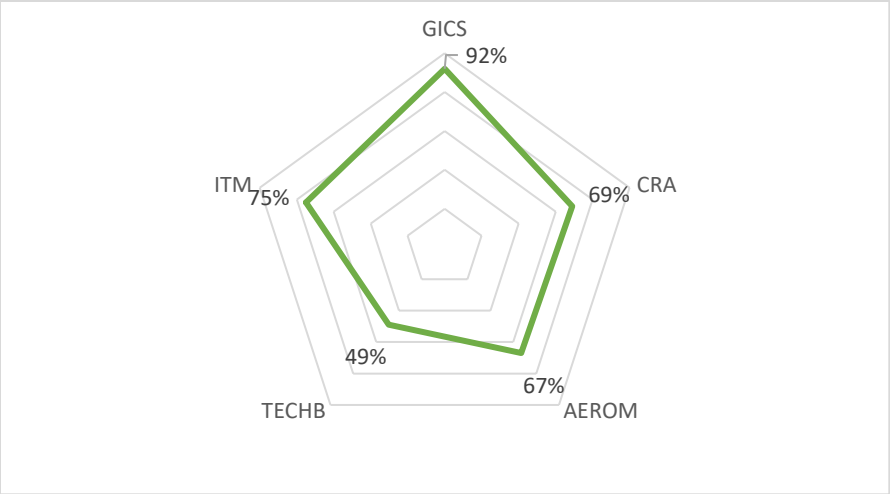

Figure 3. Organizational innovation index results

The indicator analyzes the degree of cohesion that exists in SMEs to generate changes in the organization focused on innovation. The SME with the highest index is GICS with 92%, followed by ITM with 75% and CRA with 69%, for this indicator AEROM presents 67%, and finally the company TECHB with 49%.
The case studies show that SMEs dedicated to AI with the highest scores in the indexes are undoubtedly better able to foster innovation processes and develop technological capabilities. In a highly complex industry, the generation of radical and incremental innovations is required.

Some of the main characteristics of the SMEs with the highest scores in the analyzes, such as the GICS and CRA are:

- They are enterprises with the objectives aligned to a common project.
- Creativity is constantly promoted and rewarded, failure is not sanctioned because it is recognized as part of the learning process.
- Knowledge is shared, and employees are trained to improve their skills

6. Conclusions

The case studies show that SMEs dedicated to AI with the highest scores in the indexes are able to foster innovation processes and develop technological capabilities. In a highly complex industry, the generation of radical and incremental innovations is required. A culture of innovation in SMEs reconciles and integrates the attitudes and behaviors of reative people to respond to the demands of the aerospace industry. The key is to implement this type of culture by the management and encourage employee participation. The results show that organizational culture has a positive influence on innovation activities, which is consistent whit previous research (Tang et al., 2020; Lijauco et al., 2020; Dabić et al., 2019; Sánchez-Báez et al., 2019). The research has some limitations, first, the analysis focused only on SMEs dedicated AI. Medium and large companies were not taken for the study. Secondly, the study was applied in SMEs only in the state of Queretaro, there are other states that are developing innovation capabilities in Mexico. The third limitation, the sample size is relatively small to apply other types of analysis (for example, statistical analysis or quantitative models).

Future research emerges from this study, it is feasible to apply the study in medium-sized, large enterprises and leading companies in the AI worldwide that are located in Mexico (for example, Bombardier, Safran, Airbus, Aernnova). Another line of research focuses on studying the relationship between OC and innovation from other quantitative and qualitative methodological perspectives.

Acknowledgements

This work was financially supported by the Instituto Politécnico Nacional, México. The authors would like to thank this institution for their support and commitments to this research project. May thanks also to the referees for their valuable comments and suggestions to improve this research.

References

Asheim, B.T., Lawton Smith, H. and Oughton, C., "Regional innovation systems: theory, empirics and policy". Regional Studies, 45(7), 875-891, 2011. https://doi.org/10.1080/00343404.2011.596701

Connolly, E., Norman, D. & West, T., "Small business finance roundtable". Canberra, Australia: Reserve Bank of Australia, 2012.

Dabić, M., Lažnjak, J., Smallbone, D. & Švarc, J., "Intellectual capital, organisational climate, innovation culture, and SME performance: Evidence from Croatia". Journal of Small Business and Enterprise development, 26 (4), 522-544, 2018. https://doi.org/10.1108/JSBED-04-2018-0117.

Davis, H. & Scase, R., Managing Creativity: The Dynamics of Work and Organization, Open University Press, Buckingham, 2020.

Deal, T. & Kennedy, A., Culturas corporativas: ritos y rituales de la vida organizacional. México, Fondo Educativo Interamericano,1985.Ellet, W., The case study handbook: How to read, discuss, and write persuasively about cases. Boston: Harvard Business School Press, 2007.

Ehrhart, M.G., Schneider, B., & Macey, W.H., Organizational Climate and Culture. New York, Routledge.

Federación Mexicana de la Industria Aeroespacial (FEMIA), Pro-Aéreo 2012 - 2020. Programa Estrategico fr la Industria Aeroespacial, 2016. Recuperado de: http://femia.com.mx/themes/femia/ppt/proaereo_esp.pdf

Secretaría de Desarrollo Sustentable de Querétaro (SEDESU), Available: http://www.queretaro.gob.mx/sedesu, August 28, 2017.

Garcia Echevarria, S. & Pumpin, C., Dinamica empresarial: una nueva cultura para el éxito de la empresa. Madrid, Ediciones Díaz de Santos, 1988.

Herriott, R.E. & Firestone, W.A., Multisite Qualitative Research: Optimizing Description and Generalizability. Education Researcher, 12, 14-19, 1983.

Leal Millan, A., Conocer la cultura de las organizaciones. Una base para la estrategia y el cambio. Actualidad Editorial, Madrid, 1991.

Lijauco, F., Gajendran, T., Brewer, G. & Rasoolimanesh, M., "Impact of innovation culture on innovation propensity in small to medium enterprises in construction". Journal of Construction Engineering and Management, 146 (9), 2020. https://doi.org/10.1061/(asce)co.1943-7862.0001753

Lee, J., Shiue, Y. & Chen, C., "Examining the impacts of organizational culture and top management support of knowledge sharing on the success of software process improvement". Computers in Human Behavior, 54 (1), 462-474, 2016. https://doi.org/10.1016/j.chb.2015.08.030

Leonard-Barton, A dual methodology for cases studies, en G. Huber & A. Van de Ven (eds.), Longitudinal Field Research Methods, pp. 38-64, California, Sage Publications, 1991.

Lundvall, B. A., "National Innovation Systems-Analytical Concept and Development Tool". Industry and Innovation, 14 (1), 95-119, 2007. https://doi.org/10.1080/13662710601130863

Malerba, F., "Sectoral systems of innovation and production". Research Policy, 31 (2), 247-264, 2002. https://doi.org/10.1016/S0048-7333(01)00139-1

Miron, E., et al., "Do personal characteristics and cultural values that promote innovation, quality, and efficiency compete or complement each other?". Journal of Organizational Behavior, 25 (22), pp. 175-199, 2004. https://doi.org/10.1002/job.237

Nazarian, A., Atkinson, P. & Foroudi, P., "Influence of national culture and balanced organizational culture on the hotel industry's performance". International Journal of Hospitality Management, 63 (1), 22–32, 2017. https://doi.org/10.1016/j.ijhm.2017.01.003

Nelson, R. (ed.), National Systems of Innovation: A Comparative Analysis, Oxford: Oxford University Press, 1993.

OECD, Oslo manual: Guidelines for collecting and interpreting innovation data (4th. ed.). Luxembourg, 2018.

Ouchi, W., La teoría Z. Cómo pueden las empresas hacer frente al desafío Japonés. Barcelona: Orbis, 1982.

Prencipe, A., "Breadth and depth of technological capabilities in CoPS: the case of the aircraft engine control system". Research Policy, 29(7-8), 895-911, 2000. https://doi.org/10.1016/S0048-7333(00)00111-6

Sackmann, S.A., Culture and Performance. The Handbook of Organizational Culture and Climate, (segunda edición). Londres: Sage, 2011.

Sánchez-Báez, E. & Fernández-Serrano, I., "Organizational culture and innovation in small businesses in Paraguay". Regional Science Policy & Practice, 12 (233), 1-15, 2019. https://doi.org/10.1111/rsp3.12203

Schein, E.H., Organizational Culture and Leadership (4th ed.). San Francisco: Jossey-Bass, 2010.

Schumpeter, J., Capitalismo, socialismo y democracia. Tomo 1, Biblioteca de Economía, Folio, España, 1976.

SEDESU, Secretaría de Desarrollo Sustentable de Querétaro. Recuperado de http://www.queretaro.gob.mx/sedesu, Agosto 10, 2018

Tracey, S., & Allen, T., Culture and global change. Ed. Routlegge, London 1999.

Tang, G., Park, K., Agarwal, A. & Liu, F., "Impact of innovation culture, organization size and technological capability on the performance of SMEs: The case of China". Sustainability, 12 (4), 1-14, 2020. https://doi.org/10.3390/su12041355

Yin, R., Case study research and applications: design and methods. 6th ed. Los Angeles: SAGE, 2018.

Biographies

Alonso Rojas Rodríguez: is a PhD holder in Law (C.), lecturer, and researcher at Escuela Superior de Comercio y Administración (ESCA-STO), Instituto Politécnico Nacional (IPN)-Mexico. He has published journal and conference papers on research areas: law management, governance, competitivity, juridical science. He is Chief Officer at Escuela Superior de Comercio y Administración (ESCA-STO), Instituto Politécnico Nacional (IPN)-Mexico. He is member of the IEOM Society International.

Dulce María Monroy-Becerril is a PhD holder in Public Management, lecturer, and researcher at Escuela Superior de Comercio y Administración (ESCA-STO), Instituto Politécnico Nacional (IPN)-Mexico. She has published journal and conference papers on research areas: waste management, governance, competitivity and sustainability. She is a Head Manager of Postgraduate studies and Research Section at at Escuela Superior de Comercio y Administración (ESCA-STO), Instituto Politécnico Nacional (IPN)-Mexico.

Christian Muñoz-Sanchez is a PhD holder in Management Sciences. He is a specialist in innovation theory, sustainability transitions, sustainability development, technological capabilities, and innovation systems. He is professor of the Instituto Politécnico Nacional (IPN), Escuela Superior de Comercio y Administración (ESCA-STO) in Mexico City. He is member of the Mexican National Researchers System (SNI-CONACYT). He is member of the IEOM Society International.

Jorge Alejandro Silva Rodríguez de San Miguel is a PhD holder in Management Sciences. He is professor of the Instituto Politécnico Nacional (IPN), Escuela Superior de Comercio y Administración (ESCA-STO) in Mexico City. He has published journal and conference papers on innovation, sustainability, and and green technologies is member of the Mexican National Researchers System (SNI-CONACYT) He is member of the IEOM Society International.

Eugene Hakizimana is a PhD holder in Economic Sciences, lecturer, and researcher at Escuela Superior de Comercio y Administración (ESCA-STO), Instituto Politécnico Nacional (IPN)-Mexico, research areas: complex systems, institutions, competitivity and sustainability. Member of National System of Researchers.