



MODELLING AND SIMULATION IN BUSINESS, ECONOMICS AND MANAGEMENT

Ernesto LEÓN-CASTRO¹, Jose M. MERIGÓ^{2,3*}, Ezequiel AVILÉS-OCHOA⁴,
Anna M. GIL-LAFUENTE⁵, Enrique HERRERA-VIDEIRA⁶

¹*Faculty of Economics and Business Administration, Universidad Católica de la Santísima Concepción,
Av. Alonso de Ribera 2850, 4070129 Concepción, Chile*

²*Department of Management Control and Information Systems, School of Economics and Business,
University of Chile, Av. Diagonal Paraguay 257, 8330015 Santiago, Chile*

³*School of Information, Systems & Modelling, Faculty of Engineering and Information Technology,
University of Technology Sydney, 81 Broadway, Ultimo 2007, NSW, Australia*

⁴*Autonomous University of Occidente, Blvd. Lola Beltrán s/n esq. Circuito Vial,
Culiacán 80200, México*

⁵*Department of Business Administration, University of Barcelona,
Av. Diagonal 690, 08034 Barcelona, Spain*

⁶*Department of Computer Science and Artificial Intelligence, University of Granada,
Av. Periodista Daniel Saucedo s/n, Granada, Spain*

The special issue of Technological and Economic Development of Economy entitled “Modelling and Simulation in Business, Economics and Management” presents extended versions of papers presented at the International Conference on Modelling and Simulation in Engineering, Economics and Management (MS’18 Mazatlán). The edition of the conference was hosted by the University of Occidente, Mexico. More than 100 authors and 50 papers concerning different topics of modelling and simulation in a wide range of areas were presented.

The aim of the special issue is to present high quality papers in the area of modelling and simulation in business, economics and management. The main reason is that enterprises usually need to deal with complex and uncertain environments. In order to maximize as much as possible their management. After the reviewing process, five papers have been selected for publication in this special issue that is divided in two sections that are explained as follows.

*Corresponding author. E-mail: jmerigo@fen.uchile.cl

1. Modelling and simulation in an uncertain world

In modern world, decision-making has become a key part for enterprises in order to maintain their competitiveness (Cabrerizo, Herrera-Viedma, & Pedrycz, 2013; Capuano, Chiclana, Fujita, Herrera-Viedma, & Loia, 2018). In this sense, there is a wide range of methods for doing that process (Engemann, Filev, & Yager, 1996; Gil-Aluja, 1999, Merigó, 2010). Since the appearance of uncertainty theories connected to the idea of fuzzy sets (Zadeh, 1965), these methodologies have evolved in order to include uncertainty in each step of the decision making process. The objective is to include the expectations, knowledge, aptitude and other qualitative elements to the results and in that sense generate better course of actions (Carrasco, Blasco, García-Madariaga, Pedreño-Santos, & Herrera-Viedma, 2018; Kacprzyk, Yager, & Merigó, 2019).

In today's competitive and unpredictable business world, modelling and simulation has been used as a tool to support decision making in different areas such as manufacturing, services, healthcare, public services and many more, being an essential element of daily process in enterprises (Jahangirian, Eldabi, Naseer, Stergioulas, & Young, 2010; Azab & AlGeddawy, 2012). Since the Monte Carlo method invented in 1947, many other simulation methods have emerged in order to determine the outcome of an experiment or event differentiating mainly between dynamic and static modelling (Mourtzis, Doukas, & Bernidaki, 2014; Perez et al., 2018).

One of the main problems with modelling and simulation is that it losses its effectiveness when decision alternatives become too many or the problem to be analysed has an important degree of uncertainty or misleading information (Azab & AlGeddawy, 2012). In order to overcome these limitations the use of different fuzzy techniques and aggregation of information operators have become an important part in modelling and simulation (Blanco-Mesa, Merigó, & Gil-Lafuente, 2017; Cabrerizo et al., 2017; Cid-López, Hornos, Carrasco-González, & Herrera-Viedma, 2018).

2. Applications in business, economics and management

The use of different fuzzy techniques combined with traditional modelling and simulation methods in business, economics and finance have become an interesting research field including the analysis of the exchange rate (León-Castro, Avilés-Ochoa, Merigó, & Gil-Lafuente 2018), stock markets (Cheng, Wei, Liu, & Chen, 2013), enterprise risk management (Olson & Wu, 2010; Blanco-Mesa, León-Castro, & Merigó, 2018), supply chains (Campuzano, Mula, & Peidro, 2010; Sandhu, Helo, & Kristianto, 2013), new market expansions (Merigó, Palacios-Marqués, & Soto-Acosta, 2017), governmental decisions (Dyson & Chang, 2005; Qi & Chang, 2011), investment decisions (Ustundag, Kılınc, & Cevikcan, 2010), logistics (Banomyong & Sopadang, 2010), supplier evaluation (Datta, Samantra, Mahapatra, Banerjee, & Bandyopadhyay, 2012) and personal selection (Sari, Oktay, & Tevfik, 2010).

These new ideas help us to understand better the future situations that have different degrees of uncertainty and because of that, the traditional modelling and simulation techniques are not as useful as they should be. This is why the idea of generating new formulations, methods and processes that can provide new approaches and ways to solve different business problems are necessary to help companies increase profit and maintain their life in the market.

3. About the papers in this special issue

The first paper presented by Ernesto Leon-Castro, Luis F. Espinoza-Audelo, Ezequiel Aviles-Ochoa, Jose M. Merigo and Janusz Kacprzyk, introduced a new operator to calculate volatility using the ordered weighted average (OWA) operator. The aim is to improve aggregation information according to the decision maker knowledge, expectations and attitude. This approach is implemented in an exchange rate problem with EUR/MXN and EUR/USD for 2016.

The next paper, written by Fabio Blanco-Mesa, Xiomara Patiño-Hernandez, Julieth Rivera-Rubiano and Maribel Martinez-Montaño, presents an analysis in enterprise risk identification (ERI) and their relationship with corporate risk goals. This approach is done by the use of aggregation operators based on the adequacy coefficient and OWA operators. An application in large companies of Colombia using this new operator is also presented.

In the third paper, Hugo Baier-Fuentes, Paolo Saona, Laura Muro and Pablo San Martin present an analysis about how board gender diversity influences managerial opportunistic behavior. By the information obtained from indexed non-financial companies from Europe for the period 2006–2016 and the use of several panel data techniques the authors conclude that having a balanced board provides benefits to the company.

The fourth paper by Victor Alfaro-Garcia, Jose M. Merigo, Leobardo Plata-Perez, Gerardo Alfaro-Calderon and Anna M. Gil-Lafuente, presents a new extension of the OWA operator using logarithmic operators. The main purpose of this operator is to aid in decision making when a set of regions with different properties must be considered. An application in the United Nations World States information for global regions is presented.

Finally, Nelson Rangel-Valdez, Eduardo Fernandez, Laura Cruz-Reyes, Claudia G. Gomez-Santillan, Gilberto Rivera-Zarate and Julia P. Sanchez Solis present an evolutionary-based indirect parameter elicitation method that uses preference information embedded in assignment examples. This approach offers an analysis of their impact in a priori incorporation. By an extensive computed experiment over random test sets, the authors determine that the method estimated properly the model parameters values.

Acknowledgements

We would like to thank the Association for the Advancement of Modelling & Simulation (AMSE), specially the General Secretary Dr. Christian Berger-Vachon, for his help that has been essential for the realization of the congress. We would also like to acknowledge all the reviewers and editors for their support in the evaluation of the papers submitted to this special issue.

References

- Azab, A., & AlGeddawy, T. (2012). Simulation methods for changeable manufacturing. *Procedia CIRP*, 3, 179-184. <https://doi.org/10.1016/j.procir.2012.07.032>
- Banomyong, R., & Sopadang, A. (2010). Using Monte Carlo simulation to refine emergency logistics response models: a case study. *International Journal of Physical Distribution & Logistics Management*, 40(8/9), 709-721. <https://doi.org/10.1108/09600031011079346>
- Blanco-Mesa, F., León-Castro, E., & Merigó, J. M. (2018). Bonferroni induced heavy operators in ERM decision-making: A case on large companies in Colombia. *Applied Soft Computing*, 72, 371-391. <https://doi.org/10.1016/j.asoc.2018.08.001>
- Blanco-Mesa, F., Merigó, J. M., & Gil-Lafuente, A. M. (2017). Fuzzy decision making: a bibliometric-based review. *Journal of Intelligent & Fuzzy Systems*, 32(3), 2033-2050. <https://doi.org/10.3233/JIFS-161640>
- Cabrerizo, F. J., Al-Hmouz, R., Morfeq, A., Balamash, A. S., Martínez, M. A., & Herrera-Viedma, E. (2017). Soft consensus measures in group decision making using unbalanced fuzzy linguistic information. *Soft Computing*, 21(11), 3037-3050. <https://doi.org/10.1007/s00500-015-1989-6>
- Cabrerizo, F. J., Herrera-Viedma, E., & Pedrycz, W. (2013). A method based on PSO and granular computing of linguistic information to solve group decision making problems defined in heterogeneous contexts. *European Journal of Operational Research*, 230(3), 624-633. <https://doi.org/10.1016/j.ejor.2013.04.046>
- Campuzano, F., Mula, J., & Peidro, D. (2010). Fuzzy estimations and system dynamics for improving supply chains. *Fuzzy Sets and Systems*, 161(11), 1530-1542. <https://doi.org/10.1016/j.fss.2009.12.002>
- Capuano, N., Chiclana, F., Fujita, H., Herrera-Viedma, E., & Loia, V. (2018). Fuzzy group decision making with incomplete information guided by social influence. *IEEE Transactions on Fuzzy Systems*, 26(3), 1704-1718. <https://doi.org/10.1109/TFUZZ.2017.2744605>
- Carrasco, R. A., Blasco, M. F., García-Madariaga, J., Pedreño-Santos, A., & Herrera-Viedma, E. (2018). A model to obtain a SERVPERF scale evaluation of the CRM customer complaints: An application to the 4G telecommunications sector. *Technological and Economic Development of Economy*, 24(4), 1606-1629. <https://doi.org/10.3846/tede.2018.5080>
- Cid-López, A., Hornos, M. J., Carrasco-González, R. A., & Herrera-Viedma, E. (2018). Prioritization of the launch of ICT products and services through linguistic multi-criteria decision-making. *Technological and Economic Development of Economy*, 24(3), 1231-1257. <https://doi.org/10.3846/tede.2018.1423>
- Cheng, C. H., Wei, L. Y., Liu, J. W., & Chen, T. L. (2013). OWA-based ANFIS model for TAIEX forecasting. *Economic Modelling*, 30, 442-448. <https://doi.org/10.1016/j.econmod.2012.09.047>
- Datta, S., Samantra, C., Mahapatra, S. S., Banerjee, S., & Bandyopadhyay, A. (2012). Green supplier evaluation and selection using VIKOR method embedded in fuzzy expert system with interval-valued fuzzy numbers. *International Journal of Procurement Management*, 5(5), 647-678. <https://doi.org/10.1504/IJPM.2012.048880>
- Dyson, B., & Chang, N. B. (2005). Forecasting municipal solid waste generation in a fast-growing urban region with system dynamics modeling. *Waste Management*, 25(7), 669-679. <https://doi.org/10.1016/j.wasman.2004.10.005>
- Engemann, K. J., Filev, D. P., & Yager, R. R. (1996). Modelling decision making using immediate probabilities. *International Journal of General Systems*, 24(3), 281-294. <https://doi.org/10.1080/03081079608945123>
- Gil-Aluja, J. (1999). *Elements for a theory of decision in uncertainty* (Vol. 32). Springer Science & Business Media. <https://doi.org/10.1007/978-1-4757-3011-1>

- Jahangirian, M., Eldabi, T., Naseer, A., Stergioulas, L. K., & Young, T. (2010). Simulation in manufacturing and business: A review. *European Journal of Operational Research*, 203(1), 1-13.
<https://doi.org/10.1016/j.ejor.2009.06.004>
- Kacprzyk, J., Yager, R. R., & Merigó, J. M. (2019). Towards human centric aggregation via the ordered weighted aggregation operators and linguistic data summaries: A new perspective on Zadeh's inspirations. *IEEE Computational Intelligence Magazine*, 14(1), 16-30.
<https://doi.org/10.1109/MCI.2018.2881641>
- León-Castro, E., Avilés-Ochoa, E., Merigó, J. M., & Gil-Lafuente, A. M. (2018). Heavy moving averages and their application in econometric forecasting. *Cybernetics and Systems*, 49(1), 26-43.
<https://doi.org/10.1080/01969722.2017.1412883>
- Merigó, J. M. (2010). Fuzzy decision making with immediate probabilities. *Computers & Industrial Engineering*, 58(4), 651-657. <https://doi.org/10.1016/j.cie.2010.01.007>
- Merigó, J. M., Palacios-Marqués, D., & Soto-Acosta, P. (2017). Distance measures, weighted averages, OWA operators and Bonferroni means. *Applied Soft Computing*, 50, 356-366.
<https://doi.org/10.1016/j.asoc.2016.11.024>
- Mourtzis, D., Doukas, M., & Bernidaki, D. (2014). Simulation in manufacturing: Review and challenges. *Procedia CIRP*, 25, 213-229. <https://doi.org/10.1016/j.procir.2014.10.032>
- Olson, D. L., & Wu, D. D. (2010). *Enterprise risk management models*. New York: Springer.
<https://doi.org/10.1007/978-3-642-11474-8>
- Perez, I. J., Cabrerizo, F. J., Alonso, S., Dong, Y. C., Chiclana, F., & Herrera-Viedma, E. (2018). On dynamic consensus processes in group decision making problems. *Information Sciences*, 459, 20-35.
<https://doi.org/10.1016/j.ins.2018.05.017>
- Qi, C., & Chang, N. B. (2011). System dynamics modeling for municipal water demand estimation in an urban region under uncertain economic impacts. *Journal of Environmental Management*, 92(6), 1628-1641. <https://doi.org/10.1016/j.jenvman.2011.01.020>
- Sandhu, M. A., Helo, P., & Kristianto, Y. (2013). Steel supply chain management by simulation modelling. *Benchmarking: an International Journal*, 20(1), 45-61. <https://doi.org/10.1108/14635771311299489>
- Sari, K., Oktay, F., & Tefvik, A. T. (2010). A simulation model for managing outsourcing decisions. *International Journal of Management and Enterprise Development*, 9(2), 132-146.
<https://doi.org/10.1504/IJMED.2010.036118>
- Ustundag, A., Kılınç, M. S., & Cevikcan, E. (2010). Fuzzy rule-based system for the economic analysis of RFID investments. *Expert Systems with Applications*, 37(7), 5300-5306.
<https://doi.org/10.1016/j.eswa.2010.01.009>
- Zadeh, L. (1965). Fuzzy sets. *Information and Control*, 8(3), 338-353.
[https://doi.org/10.1016/S0019-9958\(65\)90241-X](https://doi.org/10.1016/S0019-9958(65)90241-X)