Editorial for special issue “system dynamics contributions to modelling in management”

The call for papers for a special issue aimed to present contributions of system dynamics (SD) Modelling to the broad area of management. SD (Forrester, 1961; Forrester, 1968; Sterman, 2000) has been available for 60 years, and it has become more prominent in modelling issues related with management in the last 20 years. SD research occurs in multiple management fields such as supply chain management, strategic planning, project management, health-care planning and marketing (Kunc *et al.*, 2018a; Kunc *et al.*, 2018b; Torres, 2019). The guest editors of this issue welcomed papers from all management areas, especially managerial decision-making; marketing, performance management, operations and strategy. Another interesting aspect of SD is the possibility of creating qualitative (soft) or quantitative (hard) models (Kunc, 2017a; Kunc 2017b). Qualitative models are usually used to facilitate discussions with stakeholders and agree on the feedback loops to describe a dynamically complex system (Hwang and Kunc, 2015). Several SD scholars have also explored qualitative models through group model building in which a group of business practitioners is deeply involved in the process of model construction (Vennix, 1999). Group model building projects can support large client groups in business model formulation to conceptualise messy problems (Richardson and Andersen, 1995). For example, Giorgino *et al.* (2020) explore the role of qualitative SD to evaluate the information presented in corporate accounting reports. They construct a resource map, which is an integration between SD and the resource-based view, to visualise the key resources and their connections responsible for the performance of the organisation.

Quantitative models are used to perform an empirical test of a hypothesis about the structure responsible for the performance over time observed in selected variables or test alternatives in terms of strategies, policies or organisational design (Torres *et al.*, 2017). For example, Kazakov and Kunc (2016) constructed dynamic strategic configurations using SD based on anticipation of their future possible states within the competitive environment. They develop a strategic decision-making framework where firm's performance depends on its strategy-making process based on anticipation and its managerial capabilities that enable the anticipatory process. They developed an in-depth exploratory study with a group of senior managers in a pharmaceutical firm to uncover diverse anticipatory capabilities. One of the fundamental assumption in quantitative SD is that structural complexity of SD models could be used as a basis for formal analysis of dynamic complexity (Oliva, 2004). Hence, equations, algorithmic rules, all model parameters and initial values for model representations should be sufficient to allow an independent party to implement and simulate the model, which depicts a behaviour close to real data (Rahmandad and Sterman, 2012). Structural and dynamic (simulation) analyses in SD offer diverse opportunities to use it in different areas related to management problems with less data than other modelling methods while actively engaging with decision makers.

The papers in this special issue (in alphabetical order)

Barnabè and DavidSEN (2019) used SD models to analyse decision-making heuristics. They collected data by through feedback questionnaires and reports drawn up by 86 participants, as well as notes collected through direct observation of one of the authors, to infer

information about participants' decisions. The findings revealed participants are not fully rational decision makers confirming previous literature on the emergence of suboptimal strategies in supply chain management, e.g. phantom ordering and hoarding strategies.

Bivona *et al.* (2019) showed how the changing interrelationships between fleet management, human resources and outsourcer capacity areas are likely to counterbalance managerial policies, thereby generating a performance decay. The authors learned these lessons through a case study with a waste collection company where they made an effective contribution to support decision makers to overcoming their myopic decisions.

Geddes (2020) proposed a methodological approach that allows the socio-technical perspective to be integrated into management decision-making, alongside the more typical economic appraisal methodology, to support the adoption of renewable energy technologies. The socio-technical perspective integrated innovation systems theories together with SD and traditional economic modelling. The perspective was tested in a case study in the Kenyan conservation sector.

Gu and Kunc (2019) explored the applicability and strengths of a three-paradigm hybrid simulation (HS) approach to developing and analysing strategies. In this paper, the authors integrated SD with two other simulation methods (discrete-event and agent-based simulation) to model a full firm covering multiple levels of detail, e.g. supply chain and customer behaviour. The model was later used to test diverse strategies arising from scenario planning. This is an area where SD has made critical contributions (Kunc, 2018)

Oesterreich and Teuteberg (2019) integrated SD with visualization of financial implications (VoFI) to generate a dynamic approach to evaluate investments in information technology and information systems. This is a novel extension of VoFI offering a useful capital budgeting method in finance and accounting. They used case study research to test and validate the model. A critical contribution is enabling the visualisation of interdependencies among the variables in the VoFI financial plan improving decision-making.

Oleghe (2019) developed a hybrid model (SD and discrete-event model) to support a stepwise capacity expansion programme without undermining company's financial performance or affecting the performance of its value chain. The model represented the supply chain of a large vertically integrated aquaculture company and investigated the long-term impact on the company's working capital management of the different modes of financing and rate of expanding capacity.

Poornikoo and Qureshi (2019) used SD as the central modelling method for hybrid simulation. Further, the authors used MATLAB for undertaking fuzzy logic modelling and constructing a fuzzy inference system that is later on incorporated into the SD model for interaction with the main supply chain structure. Despite the increased complexity of the calculations and structure of the fuzzy model, the bullwhip effect has been considerably decreased resulting in an improved supply chain performance.

Strohhecker and Größler (2019) investigated the effects of extended production disruptions because of process quality breakdowns on operational and financial performance, especially inventory management. The investigation evaluated inventory policies over the market cycle of a highly profitable product, e.g. a patented pharmaceutical, under different degrees of availability of a substitute product. They identified the existence of non-linear relationships between product characteristics and safety stock that makes managing stock a dynamically complex problem.

Sundarakani *et al.* (2019) applied SD to the study of the growth of 3PL industry in Singapore. They developed a population growth model incorporating the predator-prey interaction to account for growth through M&A among 3PLs, and their interaction are modelled through modified Lotka-Volterra method. The two-species system model

consisting of small and medium logistics service providers (SMLSPs as the prey) and the lead logistics providers (LLPs as the predator) are gauged according to the firm size. The findings indicate that Singapore's logistics industry looks very optimistic for SMLSPs for another six years from 2018, whereas the LLP population will achieve a peak at about 12 years from 2018.

Suryani *et al.* (2019) developed a SD model comprising three sections: land, productivity and production models, to improve the productivity of corn production. Several scenarios have been developed by modifying the model's structures and parameters to find improvements on productivity and production in East Java (Indonesia). The model showed the factors affecting productivity include soil nutrition, planting patterns, corn quality, irrigation, technology, climate, disease and pest attacks. Corn production after land expansion and intensification depends on the harvested area and productivity.

Suryani *et al.* (2020) presented a SD study to reduce traffic congestion in an Indonesian city. They calibrated the model using data from the Transportation Department. Their work included scenarios to improve urban mobility and reduce traffic congestion demonstrating a reduction in traffic between 58% and 69%. Some of their scenarios included an implementation of a modern urban public transport system with a switch from car into the system.

Conclusion and future research

The papers in this special issue show the flexibility of SD to tackle diverse set of problems in the management field with strong emphasis on supporting strategic decisions and policymaking. Clearly, the field has reached a level of maturity where scholars can use SD methods to address multiple research questions with an interdisciplinary approach. This special issue also shows the broad geographical coverage of scholars in the field with studies coming from multiple countries. Definitely, we expect increasing use of SD alone or mixed with other methods in more works with strong change of becoming a core method to address any management problem. However, there are weaknesses that scholars need to consider in future work. Firstly, how to communicate, many times, complex models in an efficient and not overwhelming manner. Overcoming this weakness is critical for academic papers due to the limited space to explain complex models. Secondly, how to demonstrate the validity of models. Although there are methods to validate models in the literature (Barlas, 1996; Groesser and Schwaninger, 2012; Oliva, 2004; Rahmandad and Sterman, 2012; Morecroft, 2015), there is not a clear dominant set of methods that are widely accepted because of its accuracy and simplicity. Thirdly, there are still challenges on the use of SD in interdisciplinary approaches such as hybrid modelling and the balance between qualitative SD and quantitative SD with other approaches. Fourthly, the integration of qualitative SD with quantitative SD as complementary and not alternative approaches. Finally, how to communicate the results of the experimentation with model in a way that is beyond time series and support more insightful information for scholars and practitioners (Dhawan *et al.*, 2011). The editors of this special issue are very pleased with the resulting papers and grateful to the *Journal of Modelling in Management* for allowing us to bring examples of research using SD.

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- Barnabè, F. and Davidsen, P.I. (2019), "Exploring the potentials of behavioral system dynamics: insights from the field", *Journal of Modelling in Management*, Vol. 15 No. 1.

- Bivona, E., Ceresia, F. and Tumminello, G. (2019), "Overcoming managers' myopic decisions in a waste collection company: Lessons from a system dynamics-based research", *Journal of Modelling in Management*, Vol. 14 No. 4.
- Geddes, N.M. (2020), "Adoption of renewable energy technologies (RETs) using a mixed-method approach: a case in the Kenyan conservation sector", *Journal of Modelling in Management*, Vol. ahead-of-print No. ahead-of-print.
- Gu, Y. and Kunc, M. (2019), "Using hybrid modelling to simulate and analyse strategies", *Journal of Modelling in Management*, Vol. 15 No. 2.
- Oesterreich, T.D. and Teuteberg, F. (2019), "Integrating system dynamics and VoFI for the dynamic visualization of financial implications arising from IT and is investments", *Journal of Modelling in Management*, Vol. 15 No. 1.
- Oleghe, O. (2019), "System dynamics analysis of supply chain financial management during capacity expansion", *Journal of Modelling in Management*, Vol. 15 No. 2.
- Poornikoo, M. and Qureshi, M. (2019), "System dynamics modeling with fuzzy logic application to mitigate the bullwhip effect in supply chains", *Journal of Modelling in Management*, Vol. 14 No. 3, pp. 610-627.
- Strohhecker, J. and Größler, A. (2019), "Threshold behavior of optimal safety stock coverage in the presence of extended production disruptions", *Journal of Modelling in Management*, Vol. 15 No. 2.
- Sundarakani, B., Lai, Y., Goh, M. and de Souza, R. (2019), "Studying the sustainability of third party logistics growth using system dynamics", *Journal of Modelling in Management*, Vol. 14 No. 4, pp. 872-895.
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- Suryani, E., Hendrawan, R.A., Adipraja, P.F.E., Wibisono, A. and Dewi, L.P. (2020), "Urban mobility modeling to reduce traffic congestion in Surabaya: a system dynamics framework", *Journal of Modelling in Management*, Vol. ahead-of-print No. ahead-of-print.

Further reading

- Dwivedi, A. and Madaan, J. (2020), "A hybrid approach for modeling the key performance indicators of information facilitated product recovery system", *Journal of Modelling in Management*, Vol. 15 No. 3.