

improving the performance of Indonesia's dairy milk supply chain. Further, this research aims to (2018) Proceedings of the formulate the right policies for improving the performance of the chain based on the success factor International Conference on Industrial Engineering and that belongs to cause groups. Design/methodology/approach: The paper analyses 10 success factors for **Operations Management** improving the performance of the Indonesian dairy supply chain with the decision-making trial and evaluation laboratory (DEMATEL) method and analyses the Delphi method to formulate the right policies for improving performance. Findings: There are four important influencing factors that directly

Benchmarking the interactions among performance indicators in



Source details

Journal of Modelling in Management	CiteScore 2021 3 7	(j)
Scopus coverage years: from 2006 to Present	J./	
Publisher: Emerald		
ISSN: 1746-5664 E-ISSN: 1746-5672	SJR 2021	(j
Subject area: (Business, Management and Accounting: Strategy and Management)	0.465	
(Decision Sciences: Management Science and Operations Research) (Decision Sciences: General Decision Sciences)		
Source type: Journal	SNIP 2021 0.802	(j
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CiteScore CiteScore rank & trend Scopus content coverage		
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Editorial

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.



Journal of Modelling in Management Vol. 16 No. 1, 2021 pp. 2-6 © Emerald Publishing Limited 1746-5664 DOI 10.1108/JM2-02-2021-293

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

This paper forms part of special section "System Dynamics Contributions to Modelling in Management", guest edited by Martin Kunc, Federico Barnabe and Juan Pablo Torres.

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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

System dynamics

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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. Definitively, 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.

Martin Kunc

Operational Research and Management Science, University of Warwick, Coventry, UK Federico Barnabe Department of Business and Law, University of Siena, Siena, Italy, and Juan Pablo Torres Department of Business, School of Economics and Business, Universidad de Chile, Santiago, Chile

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ISSN: (International 1746-5664 Standard Serial Online date, start – end: 2006 **~**•

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<u>Adoption of renewable energy technologies (RETs) using a mixed-method approach: A case in the Kenyan</u> <u>conservation sector</u>

Nicholas Morgan Geddes

This paper aims to propose that the socio-technical perspective is under-represented when appraising the adoption potential of renewable energy technologies (RETs) in...



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Urban mobility modeling to reduce traffic congestion in Surabaya: a system dynamics framework

Erma Suryani, Rully Agus Hendrawan, Philip Faster Eka Adipraja, Arif Wibisono, Lily Puspa Dewi

This paper aims to address the urban mobility and traffic congestion problem under environmental dynamics to improve mobility and reduce traffic congestion using system...



<u>Improving the performance of a Malaysian pharmaceutical warehouse supply chain by integrating value stream</u> <u>mapping and discrete event simulation</u>

Ahmed Abideen, Fazeeda Binti Mohamad

Lean implementation is vastly incorporated in core manufacturing processes; however, its applicability in the supply chain and service industry is still in its infancy. To...



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Exploring the best policy scenario plan for the dairy supply chain: a DEMATEL approach

<u>Aries Susanty</u>, <u>Nia Budi Puspitasari</u>, <u>Heru Prastawa</u>, <u>Stellya Veronica Renaldi</u>

This research primarily aims to find and analyse the interaction among success factors for improving the performance of Indonesia's dairy milk supply chain. Further, this...

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Modelling undesirable products in non-parametric performance analysis

Fateme Seihani Parashkouh, Sohrab Kordrostami, Alireza Amirteimoori, Armin Ghane-Kanafi

The purpose of this paper is introducing an alternative model to measure the relative efficiency of observations with undesirable products. Describing the reference set...



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<u>Multivariate portfolio optimization under illiquid market prospects: a review of theoretical algorithms and</u> <u>practical techniques for liquidity risk management</u>

Mazin A.M. Al Janabi

This study aims to examine the theoretical foundations for multivariate portfolio optimization algorithms under illiquid market

conditions. In this study, special emphasis...

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Received 5 August 2019 Revised 21 January 2020 14 April 2020 Accepted 6 May 2020

Exploring the best policy scenario plan for the dairy supply chain: a DEMATEL approach

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Abstract

Purpose – This research primarily aims to find and analyse the interaction among success factors for improving the performance of Indonesia's dairy milk supply chain. Further, this research aims to formulate the right policies for improving the performance of the chain based on the success factor that belongs to cause groups.

Design/methodology/approach – The paper analyses 10 success factors for improving the performance of the Indonesian dairy supply chain with the decision-making trial and evaluation laboratory (DEMATEL) method and analyses the Delphi method to formulate the right policies for improving performance.

Findings – There are four important influencing factors that directly impact the overall system, i.e. the number of dairy cattle import, national milk demand, the total number of dairy farmers and the number of dairy cattle ownership or herd size. Several alternative policies have been designed by several experts according to the influencing factors, i.e. the government assists in the procurement of imported cattle, provides financial assistance to farmers in the form of low-interest financing, improves the partnership system between farmers and dairy cooperatives, provides a reward system for the farmers and increases the level of formality of contract between the farmers and cooperatives.

Research limitations/implications – Interrelationships of each success factor and the most important influencing success factors could not be generally determined because it depends on the point of view of the experts. Future research can apply the success factors proposed by this research to the different dairy milk supply chain. Then, this research used only nine experts for formulating alternative policies. Future research may repeat this method using multiple experts to justify the validity of the research. Moreover, this research only explored 21 success factors of the increase in the performance of the Indonesian dairy supply chain. Future research should consider not only the supply side and number of dairy cattle but also several success factors from the causal relationship diagram in the broader dairy milk supply chain.

Practical implications – This research provides essential insights for policymakers, as they have to understand and evaluate the success factors before formulating several alternative policies.

Social implications – The research has revealed that the right alternative policies can be designed, as the causal factor has been known.

Originality/value – This research contributes to applying a combination of causal relationship diagram of System Dynamic and DEMATEL method as a qualitative and quantitative method in one integrated way through performance dairy supply chain analysis. As a result, this research draws a

Journal of Modelling in Management Vol. 16 No. 1, 2021 pp. 240-266 © Emerald Publishing Limited 1746-5664 DOI 10.1108/IM2.08-2019.0185

The authors of this research express their appreciation to the Rector of Diponegoro University and the Head of Research and Community Services Diponegoro University for giving the authors the "International Scientific Publication" grant, in the budget year 2019.



Adoption of renewable energy technologies (RETs) using a mixed-method approach

A case in the Kenyan conservation sector

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Renewable energy technologies

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Received 31 March 2019 Revised 12 September 2019 6 December 2019 Accepted 6 January 2020

Abstract

Purpose – This paper aims to propose that the socio-technical perspective is under-represented when appraising the adoption potential of renewable energy technologies (RETs) in late-industrialising countries and that this results in under-adoption. It also aims to identify a methodological approach that allows the socio-technical perspective to be integrated into management decision-making, alongside the more typical economic appraisal methodology.

Design/methodology/approach - A case study and novel mixed-methodology approach is used, which applies the diffusion of innovations framework, innovation system (IS) framework and system dynamics modelling (SDM) alongside traditional economic modelling and appraisal techniques. This approach is used to assess the adoption potential of solar photovoltaic (PV) and diesel water pumping systems in the wildlife conservation sector and surrounding rural communities in Kenya. The case study approach tests the merits of the mixed-methodology approach.

Findings - The life-cycle costs of solar PV water pumping systems are lower in nearly all financing and utilisation scenarios; offer additional social, technical and environmental benefits; and the conditions exist for greater adoption. The use of an integrated diffusion of innovations and IS framework generates significant qualitative data that can support management decision-making. The use of SDM techniques aid conceptualisation of the community economic, water and institutional systems into which water pumps may be diffused and provide a starting point for formal SDM simulation. The results suggest that these techniques capture the socio-technical perspective well and, when used alongside traditional project appraisal approaches, produce more complete information with which to support management decision-making.

Originality/value – This mixed-methodology approach could be used by practitioners to increase the diffusion and adoption of RETs in more complex contexts in late-industrialising countries. The emergent theory built through the case-study approach should be tested further to assess the merits of applying these techniques to support RET management decision-making in other contexts and more broadly.

Keywords Innovation, Dynamics, Decision-making, Environmental management, Modelling, Renewable energy, Diffusion of innovations, Renewable energy technologies (RETs), Solar photovoltaic (PV) water pumps, System dynamics modelling (SDM),

Sub-system diagramming (SSD), Causal-loop diagramming (CLD), Financial modelling, Project finance, Climate change mitigation, Climate change adaptation

Paper type Research paper

1. Introduction

Our economic system is showing some potentially fatal flaws. It is eroding the natural systems upon which it relies, creating risks for the future, and increasingly the present. Climate change and habitat and biodiversity loss are major warning lights on the global

Journal of Modelling in Management Vol. 20 No. 1, 2021 pp. 7-36 © Emerald Publishing Limited 1746-5664 DOI 10.1108/IM2-03-2019-0082

This paper forms part of special section "System Dynamics Contributions to Modelling in Management", guest edited by Martin Kunc, Federico Barnabe and Juan Pablo Torres.



JM2 16,1

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Received 11 July 2019 Revised 2 October 2019 26 March 2020 Accepted 8 April 2020

Improving the performance of a Malaysian pharmaceutical warehouse supply chain by integrating value stream mapping and discrete event simulation

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Abstract

Purpose – Lean implementation is vastly incorporated in core manufacturing processes; however, its applicability in the supply chain and service industry is still in its infancy. To acquire performance excellence and thrive in the global competitive market, many firms are adopting newer methodologies. But, there is a stringent need for production simulation systems to analyze supply chains both inbound and outbound. The era of face validation is slowly disappearing. Lean tools and procedures that provide future state assumptions need advanced tools and techniques to measure, quantify, analyze and validate them. The purpose of this study is to enable dynamic quantification and visualization of the future state of a warehouse supply chain value stream map using discrete event simulation (DES) technique.

Design/methodology/approach – This study aimed to apply an integrated approach of the value stream mapping (VSM) and DES in a Malaysian pharmaceutical production warehouse. The main focus is diverted towards reducing the warehouse supply chain lead time by initially constructing a supply chain value stream map (both present state and future state) and integrating its data in a DES modelling and simulation software to dynamically visualize the changes in future state value stream map.

Findings – The DES simulation was able to mimic the future state lead time reductions successfully, which assists in better decision-making. Improvements were seen related to total lead time, process time, value and non-value-added percentage. Warehouse performance metrics such as receiving, put away and storage rates were substantially improved along with pallet processing time, worker and forklift throughput usage percentage. Detailed findings are clearly stated at the end of this paper.

Research limitations/implications – This study is limited to the warehouse environment and further additional process models and functional upgrades in the DES software systems are very much needed to directly visualize and quantify all the possible Lean assumptions such as radio frequency image identification/Andon (Jidoka), 5S, Kanban, Just-In-Time and Heijunka. However, DES has a leading edge in extracting dynamic characteristics out of a static VSM timeline and capture details on discrete events precisely by picturizing facility modification and lead time related to it.

Practical implications – This paper includes all the fundamental pharmaceutical warehouse supply chain processes and the simulations of the future state VSM in a real-life context by successfully reducing supply chain lead time and allowing managers in inculcating near-optimal decision-making, controlling and coordinating warehouse supply chain activities as a whole.

Social implications – This integrated approach of DES and VSM can involve managers and top management to support the adoption of anticipated changes. This study also has the potential to engage practitioners, researchers and decision-makers in the warehouse industry.



Journal of Modelling in Management Vol. 16 No. 1, 2021 pp. 70-102 © Emerald Publishing Limited 1746-5664 DOI 10.1108/JM2-07-2019-0159

The authors sincerely thank the anonymous reviewers for their strong constructive comments and the editor for frequent follow-up. Authors are also grateful to University Malaysia Pahang for funding this research with the grant (RDU160109).