



UNIVERSITY  
OF WOLLONGONG  
AUSTRALIA

University of Wollongong  
Research Online

---

Faculty of Engineering and Information Sciences -  
Papers: Part A

Faculty of Engineering and Information Sciences

---

2017

# Editorial: Modelling and simulation in health care systems

Nagesh Shukla

*University of Wollongong, nshukla@uow.edu.au*

Pascal Perez

*University of Wollongong, pascal@uow.edu.au*

Manoj K. Tiwari

*Indian Institute of Technology*

Darek Ceglarek

*University of Warwick*

Joana M. Dias

*Universidade de Coimbra*

---

## Publication Details

Shukla, N., Perez, P., Tiwari, M. K., Ceglarek, D. & Dias, J. M. (2017). Editorial: Modelling and simulation in health care systems. *International Journal of Systems Science: Operations & Logistics*, 4 (1), 1-3.

Research Online is the open access institutional repository for the University of Wollongong. For further information contact the UOW Library: [research-pubs@uow.edu.au](mailto:research-pubs@uow.edu.au)

---

# Editorial: Modelling and simulation in health care systems

## **Abstract**

Increasingly, changes in population demography, technological and medical advancements, and others, have affected the paradigm of health and social care systems worldwide. These changes have direct effect on organisation and working of health care systems whether they are hospitals, general practitioners or long-term care. An efficient and effective health care system is crucial for high quality of the life in the society. In recent times, major challenges faced by health care systems are accurate diagnosis, operational issues (such as bottlenecks, low throughput, low resource utilisation), hospital redesign, workforce planning and scheduling, streamlining of patient flow, performance management, disease monitoring, and health care technology assessment. Over the last 10 years, operations research and management science scholars have implemented their innovative techniques and knowledge to improve health care systems. However, it still has many untouched and unresolved issues, requiring attention. Along with this, there are many techniques that have been successfully implemented and tested in other sectors that can be employed in this area for major improvements.

## **Keywords**

care, health, systems, simulation, editorial, modelling

## **Disciplines**

Engineering | Science and Technology Studies

## **Publication Details**

Shukla, N., Perez, P., Tiwari, M. K., Ceglarek, D. & Dias, J. M. (2017). Editorial: Modelling and simulation in health care systems. *International Journal of Systems Science: Operations & Logistics*, 4 (1), 1-3.

# Modelling and Simulation in Healthcare Systems

Nagesh Shukla<sup>1</sup>, Manoj Kumar Tiwari<sup>2</sup>, Pascal Perez<sup>1</sup>, Darek Ceglarek<sup>3</sup>, Joana Matos Dias<sup>4</sup>

<sup>1</sup> SMART Infrastructure Facility, University of Wollongong, Wollongong 2522, Australia

<sup>2</sup> Department of Industrial and Systems Engineering, Indian Institute of Technology, Kharagpur, India

<sup>3</sup> WMG, University of Warwick, Coventry, CV4 7AL, UK

<sup>4</sup> Faculdade de Economia, Universidade de Coimbra, Coimbra 3004-512, Portugal

Increasingly, changes in population demography, technological and medical advancements, and others, have affected the paradigm of health and social care system worldwide. These changes have direct effect on organization and working of healthcare systems whether they are hospitals, general practitioners or long-term care. An efficient and effective health care system is crucial for high quality of the life in society. In recent times, major challenges faced by health care system are accurate diagnosis, operational issues (such as bottlenecks, low throughput, low resource utilization), hospital redesign, workforce planning and scheduling, streamlining of patient flow, performance management, disease monitoring, and health care technology assessment. In last ten years, operations research and management science (OR/MS) scholars are attracted to implement their innovative technology and knowledge to improve health care systems. However, it has many untouched and unresolved issues that are still to be attended. Along with this, there are many techniques that are successfully implemented and tested in other sectors that need to be established in this area.

This special issue focuses on fast-growing and promising area of mathematical modelling and simulation that have drawn great deal of attention from researchers over past decade. These methods have been used in variety of areas such as supply chain management (Singh et al 2015; Shukla & Kiridena 2016), manufacturing (Mannar et al 2006; Shukla et al 2008, 2013b; Tyagi et al 2012, 2015, 2016), logistics (Shukla et al 2013a), transportation science (Barthelemy and Toint, 2013) and others. However, their use in healthcare systems are still far and few in between. For example, Sangi et al (2015) provided a data mining based approach to model and predict diabetes complications. Shukla et al (2014a,b; 2015b) proposed systematic and integrated simulation model development for hospital workflow improvements. Shukla et al (2015a) modelled the efficient and effective placement of radiotherapy units in a region. Hoang et al. (2016) comprehensively reviewed the literature on various modelling and simulation approaches adopted for economic evaluations of health interventions for drug and alcohol problems. There are still many sectors in health care systems where modelling and simulation can prove to be effective in solving planning problems.

This special issue helps to bridge the gap between different communities such as health care managers, clinicians, management consultants on one hand and simulation experts, operations research and management science scholars, computer scientists on the other. The

papers published in this special issue focus on modelling and simulating certain aspect of healthcare sector. Following text introduces these papers.

Malekpoor et al (2016) proposed an intelligent TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) case-based reasoning approach for radiotherapy dose planning problem. The method can help oncologists to determine optimal combination of dose for a particular patient. The method is validated on the real datasets from a UK hospital.

Smith et al (2016) developed an approach to better manage hospital medication supply chains, in particular, hospital inventories. Two simulation models – centralised and stockless, were developed to simulate hospital supply chains. The results of the study suggests the adoption of strategy based on classifications to aid strategic supply chain decisions related to inventory management.

Dasaklis et al (2016) proposed an integrated model for rapid response management including logistics planning and infectious disease transmissions. The paper considers a large-scale deliberate smallpox attack. They investigated the change in various assumptions in response, logistical constraints and material flow for better managing regional mass vaccination campaign. A numerical example is used to illustrate the application of the proposed methodology.

Swami et al (2016) have studied the differences between discrete wavelet transform, wavelet packet transform and dual-tree complex wavelet transform for detection of epileptiform patterns. Several set of features from the data were extracted from the dataset for neural network classifier. The performance of the classifier is illustrated and compared. The result indicate that the classifier quickly and reliably diagnose epilepsy.

Auping et al (2016) studied the intervention-capacity deployment in Liberia in the light of Ebola virus outbreak. They have used the disease transmission model with an extension to model dynamical intervention capacities. The model is used to test effectiveness of various approaches in extending intervention capacities across different plausible scenarios.

Shukla et al (2016) proposed an integrated discrete event simulation model which takes into account detailed process flow based on role activity diagrams (RAD) for quick and reliable simulation model development. RADs are useful in modelling complex healthcare service delivery processes. The methodology is applied to improve real case study from a large UK hospital.

We are happy to edit this special issue and believe that it brings together multi-disciplinary researchers to improve healthcare systems. This special issue on Modelling and Simulation in Healthcare Systems is the compilation of some of the innovative research studies conducted in different domains by utilizing advance analytics and optimisation tools from decision sciences to address the problems in manufacturing processes, inventory management, weather prediction, and supply chain. The guest editors would also like to thank Professor Peter Fleming (editor-in-chief) and Professor Ioannis Konstantaras (co-editor) of International Journal of Systems Science: Operations & Logistics for their invitation for this issue. Special

thanks are herewith extended as well to all contributors and anonymous referees for their valuable time and efforts in the review process.

## References

- Barthelemy J, Toint PL, 2013, Synthetic population generation without a sample, *Transportation Science* 47 (2), 266-279.
- Mannar, K, Ceglarek, D, Niu, F, Abifaraj, B, 2006, Fault region localization: product and process improvement based on field performance and manufacturing measurements, *IEEE transactions on automation science and engineering* 3 (4), 423.
- Sangi, M., Win, K., Shirvani, F., Namazi-Rad, M. & Shukla, N. 2015, 'Applying a novel combination of techniques to develop a predictive model for diabetes complications', *PLoS One*, vol. 10, no. 4, pp. 1-22.
- Shukla N, Choudhary AK, Prakash PKS, Fernandes KJ, Tiwari MK, (2013a) Algorithm portfolios for logistics optimization considering stochastic demands and mobility allowance, *International Journal of Production Economics* 141 (1), 146-166.
- Shukla, N., Ceglarek, D. & Tiwari, M. K. 2013b, 'Key characteristics-based sensor distribution in multi-station assembly processes', *Journal of Intelligent Manufacturing*, vol. 26, no. 1, pp. 43-58.
- Shukla, N., Keast, J. & Ceglarek, D. 2014a, 'Improved workflow modelling using role activity diagram-based modelling with application to a radiology service case study', *Computer Methods and Programs in Biomedicine*, vol. 116, no. 3, pp. 274-298.
- Shukla, N., Keast, J. & Ceglarek, D. 2014b, 'Modelling variations in hospital service delivery based on real time locating information', *Applied Mathematical Modelling: simulation and computation for engineering and environmental systems*, vol. 38, no. 3, pp. 878-893.
- Shukla, N., Kiridena, S. 2016, 'A Fuzzy Rough Sets-based Multi-agent Analytics Framework for Dynamic Supply Chain Configuration', *International Journal of Production Research*, DOI: 10.1080/00207543.2016.1151567.
- Shukla, N., Lahiri, S. & Ceglarek, D. 2015b, 'Pathway variation analysis (PVA): modelling and simulations', *Operations Research for Health Care*, vol. 6, pp. 61-77
- Shukla, N., Tiwari, M. K. & Shankar, R. 2008, 'Optimal sensor distribution for multi-station assembly process using chaos-embedded fast-simulated annealing', *International Journal of Production Research*, vol. 47, no. 1, pp. 187-211.
- Shukla, N., Wickramasuriya, R., Miller, A. Alexis. & Perez, P. 2015a, 'An approach to plan and evaluate the location of radiotherapy services and its application in the New South Wales, Australia', *Computer Methods and Programs in Biomedicine*, vol. 122, no. 2, pp. 245-56.
- Singh, A., Mishra, N., Ali, S., Shukla, N. & Shankar, R. 2015, 'Cloud computing technology: reducing carbon footprint in beef supply chain', *International Journal of Production Economics*, vol. 164, pp. 462-471.
- Tyagi, S, Choudhary, A, Cai, X, Yang, K, 2015, Value stream mapping to reduce the lead-time of a product development process, *International Journal of Production Economics* 160, 202-212
- Tyagi, S, Yang, K, Tyagi, A, Verma, A, 2012, A fuzzy goal programming approach for optimal product family design of mobile phones and multiple-platform architecture, *IEEE Systems, Man, and Cybernetics, Part C: Applications and Reviews*, 42, 6, 1519-1530.
- Tyagi, S., Shukla, N., Kulkarni S., 2016, 'Optimal design of fixture layout in a multi-station assembly using highly optimized tolerance inspired heuristic', *Applied Mathematical Modelling*, DOI:10.1016/j.apm.2015.12.030

Hoang, V.P., Shanahan, M., Shukla, N., Perez, P., Farrell, M., & Ritter, A., (2016). A systematic review of modelling approaches in economic evaluations of health interventions for drug and alcohol problems. BMC Health Services Research, 16, 1–14. doi:10.1186/s12913-016-1368-8

**Special Issue Papers:**

<b>Paper ID</b>	<b>Authors</b>	<b>Paper Title</b>
TSYB-2015-0374	Thomas K. Dasaklis, Nikolaos Rachaniotis & Costas Pappis	Emergency supply chain management for controlling a smallpox outbreak: the case for regional mass vaccination
TSYB-2015-0391	Piyush Swami, Tapan K. Gandhi, Bijaya K. Panigrahi, Manvir Bhatia, Jayasree Santhosh & Sneha Anand	A Comparative Account of Modelling Seizure Detection System using Wavelet Techniques
TSYB-2015-0412	Kathryn N. Smith, Anita R. Vila-Parrish, Julie S. Ivy & Steven R. Abel	A Simulation Approach for Evaluating Medication Supply Chain Structures
TSYB-2015-0414	Willem L. Auping, Erik Pruyt & Jan H. Kwakkel	Simulating Endogenous Dynamics of Intervention-Capacity Deployment: The Ebola Outbreak in Liberia
TSYB-2015-0296	Nagesh Shukla, John E. Keast, Darek Ceglarek	Role activity diagram-based discrete event simulation model for healthcare service delivery processes
TSYB-1135354	Hanif Malekpoor, Nishikant Mishra, Shubham Sumalya & Sushma Kumari	An efficient approach to radiotherapy dose planning problem: a TOPSIS case-based reasoning approach