



HAL
open science

Using participatory systems approaches to improve healthcare delivery

Guillaume Lamé, Antuela Tako, Maaïke Kleinsmann

► **To cite this version:**

Guillaume Lamé, Antuela Tako, Maaïke Kleinsmann. Using participatory systems approaches to improve healthcare delivery. *Health Systems*, 2023, 12 (4), pp.357-361. 10.1080/20476965.2023.2285555 . hal-04392946

HAL Id: hal-04392946

<https://hal.science/hal-04392946>

Submitted on 15 Jan 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Using Participatory Systems Approaches to Improve Healthcare Delivery

Guillaume Lamé ^a, Antuela Tako ^b, Maaïke Kleinsmann ^c

^a Paris-Saclay University, CentraleSupélec, Laboratoire de Génie Industriel

^b Loughborough Business School, Loughborough University

^c Delft University of Technology

The planning of Health Systems needs to be understood holistically, looking at the interconnectedness between providers and processes, and the expectations and values of all stakeholders. Yet, in the context of ageing population and increasingly high prevalence of chronic diseases, the provision of healthcare services remains often very fragmented, while at the same time, more and more patients present multiple comorbidities that require coordination between specialties and providers. Tackling these issues is a fundamental social and political challenge that regularly generates public debate.

In this context, there is a need to develop and use tools, concepts, and principles that can help make sense of complex and fragmented healthcare structures. Healthcare problems need to be viewed holistically and as an integrated system with multiple interacting components (Braithwaite, 2018). To achieve this, we need to bridge across ecosystems, areas, communities, disciplines, and specialties by engaging with a variety of stakeholders to explore and analyse the issues faced and to identify feasible and desirable solutions. The effective management of healthcare problems impacts on patient care and deserves attention. It requires clinical evidence and ways of capturing the views of multiple stakeholders with different points of view, values, and priorities. The integration of diverse perspectives also requires the use of methods that facilitate dialogue and debate between care providers, care commissioners, healthcare professionals, patients, and carers. This integrative view on healthcare systems allows for the design of collectively agreed (models of) healthcare delivery services.

The past two decades have seen calls for better uptake of complexity science (e.g., Braithwaite, 2018; Greenhalgh and Papoutsis, 2018), better integration of human factors (NHS England National Quality Board, 2013), and calls for systems orientation by national and international bodies (e.g., Clarkson et al., 2017; De Savigny and Adam, 2009). In parallel, systems approaches in healthcare delivery science have flourished in different disciplines, including human factors/ergonomics (Carayon et al., 2014; Hignett, Carayon, Buckle, & Catchpole, 2013), design (Huynh-Dagher, Lamé, Duong, & Jankovic, 2022; Pannunzio, Kleinsmann, & Snelders, 2019) and operational research (including Soft OR) (Kotiadis and Mingers, 2006; Kotiadis and Tako, 2018; Kotiadis et al., 2013; Lamé, Jouini, & Stal-Le Cardinal, 2020; Pitt, Monks, Crowe, & Vasilakis, 2016). Yet, all these disciplines have also noted the specificities of healthcare compared to other sectors (Morales Ornelas, Kleinsmann, & Kortuem, 2023; Tako and Robinson, 2014; Waterson and Catchpole, 2016). It is now time to think about how we can best integrate these disciplines, in a true systems spirit (Lamé, Crowe, Komashie, & Royston, 2023). In response to these emerging needs the *Health Systems Journal's* new focus areas in facilitated modelling, problem structuring, Soft OR and systems thinking, are well suited to fit within the wider health systems research agenda

The present special issue was first discussed during collaborative transdisciplinary meetings (Ciccone et al., 2020; Komashie et al., 2019). Noting that there is much more bringing us together than setting us apart, and that our approaches are complementary in tackling the ‘hypercomplexity’ of healthcare (Klein and Young, 2015). This special issue presents articles from different disciplines, which have in common the core principles of being systems-informed, interdisciplinary and participative. By systems-informed, we mean that they are mindful of boundaries, interdependencies, and embeddedness into broader systems, and aware of multiple coexisting perspectives on a situation. By interdisciplinary, we mean that these methods help bridge across groups and communities, whether they are academic or professional. By participative, we mean that these approaches use systems models as a basis for dialogue and engagement with stakeholders, and often rely on facilitated conversations to enable a shared framing and tackling of issues in healthcare planning and delivery (Kotiadis and Tako, 2018; Tako and Kotiadis, 2015).

This special issue attracted 25 submissions, of which nine articles were accepted. The articles included represent different disciplines, human factors, design, engineering, operational research, and behavioural operational research. These studies illustrate the variety of healthcare system design approaches and cover a broad range of application areas. The SI has been structured into 3 sections: health system improvement and quality of care, education and training in healthcare and information and data systems in health services. Next, the articles included in each section are briefly introduced.

The first five articles deal with health systems improvement. In the first article of this issue, titled: “Towards a better understanding of mental health care delivery systems: From stories to system components” Komashie, Rae, & Clarkson (2023) illustrates and focuses on how an interactive and participatory method using storytelling can be used to understand the key components of health delivery systems from different stakeholders’ perspective. The authors apply this method to a mental health delivery service focusing on the stories of two system stakeholders, service users and staff (clinical staff and managers). Qualitative data collected in interviews and focus groups are coded to identify key system components, People, Goals, Conditions, Interventions, Processes, Resources, Staff/Carers, Data/Information, Family/Friends and Environment. Narratives have been highlighted as a key form of evidence to inform health systems improvement (Oluoch et al., 2023). This method combines the distinctive strength of narratives with the value of systems modelling efforts.

Next, the article “Participatory Design Research for the Development of Real-time Simulation Models in Healthcare” by Harper and Mustafee (2023) provides an example of cross-fertilisation between systems disciplines that combines a design research framework, the Design Research Methodology (Blessing and Chakrabarti, 2009), with a facilitated modelling and simulation approach adapted from the PartiSim framework (Tako and Kotiadis 2015; Kotiadis and Tako 2018). The result is a staged participative modelling approach that enables staff and patients to input into the model. The authors illustrate this approach through a case study of developing a real-time simulation of an emergency department. This study highlights the potential of design research as a participative methodology inside which OR modelling can be embedded, in complement to previous studies that combined OR modelling with e.g. Soft Systems Methodology (Holm, Dahl, & Barra, 2013; Tako and Kotiadis, 2015).

In the article titled: “The bio-psycho-socio-technical model: A systems-based framework for human-centred health improvement”, Card (2023) extends the biopsychosocial model, a classic layered model of how nested, multilevel interactions affect individual health. The author combines this model with sociotechnical theory, and more specifically builds on the Systems Engineering Initiative for Patient Safety (SEIPS) framework, a key framework for human factors engineering in healthcare to develop a new and extended model that offers a broader and systemic approach to improving

healthcare systems. This model suggests that to improve health systems one needs to act based on biological, psychological, social, and technological factors, and adapting through feedback loops.

The next article “Balancing the Satisfaction of Stakeholders in Home Health Care Coordination: A Novel OptaPlanner CSP Model”, Zhang, Pingaud, Fontanili, Lamine, Martinez, Bortolaso and Derras (2023) consider the integration of human behaviour and preferences *in* models (Kunc, Harper, & Katsikopoulos, 2018). They consider the problem of home health care routing and scheduling, using constraint-satisfaction programming, which also includes constraints that represent stakeholders’ satisfaction criteria. With staff shortages and turnover increasingly pressing issues in health services, accounting for stakeholders’ preferences is important.

With the aim to achieving a better integration of human factors in health services improvement, the article “The Better Work, Better Care Framework: 7 Strategies for Sustainable Healthcare System Process Improvement”, by Neumann and Purdy (2023) proposes the ‘Better Work, Better Care’ framework. This framework consists of seven human factors/ergonomics tenets targeted at health services’ current woes, which adopts the view that better working conditions can lead to achieving better quality of care. The seven tenets include among others the integration of work environment quality into goalsetting and key performance indicators and the use of a human-centred design thinking approach. As healthcare increasingly recognises that little can be achieved without engaged staff and meaningful healthcare work (Sikka, Morath, & Leape, 2015), frameworks that help integrate this concern are welcome.

The two next articles are concerned with education and training in healthcare. In the article titled “Applying a participatory systems and value approach in a transdisciplinary exercise: on assessing the impact of training and education initiatives”, Akinluyi, Greenough, Ison, & Clarkson (2023) apply the System Impact Model to assess the impact of education and training programs on a wide range of stakeholders in health services. System Impact Models consists of a causal map that connects the influencing factors with target outcomes, as seen from different stakeholders’ perspectives, reminding us of both system dynamics and causal loop diagramming (Forrester, 1961; Sterman, 2009), and Peter Checkland’s key systemic insight on how different worldviews coexist in any situation (Checkland, 1981). The authors report how the System Impact Model was used to understand and assess the impact of the training and education offered by the Education Academy of King’s Health Partners (KHP), an Academic Health Science Centre made up of three NHS Foundation Trusts and a University, to a wide range of students and healthcare professionals, administrative and support staff.

The next article by Schoepen, Vansteenkiste, De Gerssem, & Detand (2023) titled: “Systems thinking and designerly tools for medical device design in engineering curricula”, assesses medical device development curricula and use of systems design tools by Belgian industrial design engineering students. A key insight is that students use participatory techniques and systems tools in early phases of medical device development, but often fail to translate the insights into requirements, and pay insufficient attention to regulatory and clinical testing imperatives. This type of studies is important for improving education of industrial engineering curricula as we prepare the next generation of health designers.

Finally, the next two articles focus on information and data systems in health services. In their article “Automating data collection in Electronic Health Record Systems: A Social Determinant of Health (SDOH) viewpoint”, Berg, Doktorchik, Quan, & Saini (2023) discusses the importance of taking into account social determinants of population health in researching health information systems. An individual’s health is influenced by a number of factors such as culture, gender, affluence, upbringing that can help explain outcomes and adapt clinical management of health conditions. The authors

suggest that to improve the equity of future health information systems, it is necessary to include the voices of a variety of stakeholders, including end-users, care-providers, researchers, technicians, and administrators. The article offers recommendations for research directions aimed at improving the participative nature of data collection and analysis of SDOH in healthcare data systems.

Last but not least, in the article “From digital health to Learning Health Systems: four approaches to using data for digital health design”, Pannunzio, Kleinsmann, Snelders and Raijmakers (2023) build on existing distinctions in design studies (Gorb and Dumas, 1987) and on recent evolutions in data-enabled design (Noortman et al., 2022) to define Silent, Overt, Data-Enabled and Convergent approaches to the use of data for digital health design. Depending on how data is collected, managed and fed-back into design and care processes, projects can fall into one of the four categories. This typology is timely, as health data is increasingly prevalent with the pervasive deployment of connected devices and the increasing integration of health information systems. More importantly, the exploitation of these data is considered a key lever to develop Predictive, Preventive, Personalised and Participative (or ‘P4’) medicine (Patou, Ciccone, Thorpe, & Maier, 2020).

The collection of studies included in this special issue provide evidence that an appreciation for diverse worldviews, objectives and expectations, a participative ethos, and a model-informed exploration of experiences and processes can drive improvement in healthcare delivery, education of healthcare industrial designers and health information systems. Our aim through this special issue has been to initiate conversations between the different systems disciplines, which can lead to new insights. By combining methods from different streams and tackling issues we had not addressed before, the articles extend both the scope and the toolkit available to health researchers and practitioners in their quest for improving health systems. We hope these conversations continue beyond this special issue and pave the way for more interdisciplinary collaborations. Participative systems approaches are not the easiest path when intervening in health organizations (Groeneveld, Dekkers, Boon, & D’Olivo, 2018; Perry, Catchpole, Rivera, Henrickson Parker, & Gosbee, 2021). Yet, reading the contributions in this special issue reinforces our conviction that participatory systems approaches can make a unique contribution to unify and improve our fragmented systems—or reimagine them altogether—and help us achieve improved population health, enhanced patient experience, reduced costs, and improved work life for those who deliver care (Bodenheimer and Sinsky, 2014).

Acknowledgements

We thank Prof. Kathy Kotiadis for her support and assistance in preparing and managing this special issue, the anonymous reviewers who contributed to the assessment of the manuscripts and the authors for the submissions and their engagement with the peer review process. We also thank all participants to Healthcare Systems Design Research workshops in Cambridge, the Technical University of Denmark, TU Delft and Paris-Saclay University between 2019 and 2023 for the rich discussions that led to this endeavour.

Funding

This work received no funding.

References

- Akinluyi, E. A., Greenough, A., Ison, K., & Clarkson, P. J. (2023). Applying a participatory systems and value approach in a transdisciplinary exercise: on assessing the impact of training and education initiatives. *Health Systems*, 12(4)doi:10.1080/20476965.2023.2230632 Retrieved from <https://doi.org/10.1080/20476965.2023.2230632>
- Berg, K., Doktorchik, C., Quan, H., & Saini, V. (2023). Automating data collection methods in electronic health record systems: a Social Determinant of Health (SDOH) viewpoint. *Health Systems*, 12(4)doi:10.1080/20476965.2022.2075796 Retrieved from <https://doi.org/10.1080/20476965.2022.2075796>
- Blessing, L. T. M., & Chakrabarti, A. (2009). *DRM, a Design Research Methodology* London: Springer London.
- Bodenheimer, T., & Sinsky, C. (2014). From Triple to Quadruple Aim: Care of the Patient Requires Care of the Provider. *The Annals of Family Medicine*, 12(6), pp. 573-576. doi:10.1370/afm.1713 Retrieved from <https://www.annfam.org/content/annalsfm/12/6/573.full.pdf>
- Braithwaite, J. (2018). Changing how we think about healthcare improvement. *BMJ*, 361, p k2014. doi:10.1136/bmj.k2014 Retrieved from <https://www.bmj.com/content/bmj/361/bmj.k2014.full.pdf>
- Carayon, P., Wetterneck, T. B., Rivera-Rodriguez, A. J., Hundt, A. S., Hoonakker, P., Holden, R., & Gurses, A. P. (2014). Human factors systems approach to healthcare quality and patient safety. *Applied Ergonomics*, 45(1), pp. 14-25. doi:10.1016/j.apergo.2013.04.023
- Card, A. J. (2023). The biopsychosociotechnical model: a systems-based framework for human-centered health improvement. *Health Systems*, 12(4)doi:10.1080/20476965.2022.2029584 Retrieved from <https://doi.org/10.1080/20476965.2022.2029584>
- Checkland, P. (1981). *Systems thinking, systems practice* Chichester: Wiley.
- Ciccone, N., Patou, F., Komashie, A., Lame, G., Clarkson, P. J., & Maier, A. M. (2020) *Healthcare systems design: a sandbox of current research themes presented at an international meeting*. Paper presented at the Proceedings of the Design Society: DESIGN Conference, Cavtat (Croatia). <https://www.cambridge.org/core/article/healthcare-systems-design-a-sandbox-of-current-research-themes-presented-at-an-international-meeting/94460BD3F99FC3C3C48A6617B140C60D>
- Clarkson, P. J., Bogle, D., Dean, J., Tooley, M., Trewby, J., Vaughan, L., . . . Shelton, P. (2017). *Engineering Better Care*. London: R. A. o. Engineering. <http://www.raeng.org.uk/publications/reports/engineering-better-care>
- De Savigny, D., & Adam, T. (2009). *Systems thinking for health systems strengthening* Geneva: Alliance for Health Policy and Systems Research.
- Forrester, J. W. (1961). *Industrial dynamics* Cambridge, Massachusetts: M.I.T. Press.
- Gorb, P., & Dumas, A. (1987). Silent design. *Design Studies*, 8(3), pp. 150-156. doi:10.1016/0142-694X(87)90037-8 Retrieved from <http://www.sciencedirect.com/science/article/pii/0142694X87900378>
- Greenhalgh, T., & Papoutsis, C. (2018). Studying complexity in health services research: desperately seeking an overdue paradigm shift. *BMC Medicine*, 16(1), p 95. doi:10.1186/s12916-018-1089-4 Retrieved from <https://doi.org/10.1186/s12916-018-1089-4>
- Groeneveld, B., Dekkers, T., Boon, B., & D'Olivo, P. (2018). Challenges for design researchers in healthcare. *Design for Health*, 2(2), pp. 305-326. doi:10.1080/24735132.2018.1541699 Retrieved from <https://doi.org/10.1080/24735132.2018.1541699>
- Harper, A., & Mustafee, N. (2023). Participatory design research for the development of real-time simulation models in healthcare. *Health Systems*, 12(4)doi:10.1080/20476965.2023.2175730 Retrieved from <https://doi.org/10.1080/20476965.2023.2175730>
- Hignett, S., Carayon, P., Buckle, P., & Catchpole, K. (2013). State of science: human factors and ergonomics in healthcare. *Ergonomics*, 56(10), pp. 1491-1503.

- doi:10.1080/00140139.2013.822932 Retrieved from <https://doi.org/10.1080/00140139.2013.822932>
- Holm, L. B., Dahl, F. A., & Barra, M. (2013). Towards a multimethodology in health care - synergies between Soft Systems Methodology and Discrete Event Simulation. *Health Systems*, 2(1), pp. 11-23. doi:10.1057/hs.2012.21
- Huynh-Dagher, S., Lamé, G., Duong, T.-A., & Jankovic, M. (2022). Design research in healthcare: a systematic literature review of key design journals. *Journal of Engineering Design*, 33(8-9), pp. 522-544. doi:10.1080/09544828.2022.2123702 Retrieved from <https://doi.org/10.1080/09544828.2022.2123702>
- Klein, J. H., & Young, T. (2015). Health care: a case of hypercomplexity? *Health Systems*, 4(2), pp. 104-110. doi:10.1057/hs.2014.21
- Komashie, A., Lamé, G., Patou, F., Ciccone, N., Maier, A., & Clarkson, P. J. (2019) *Exploring healthcare systems design research and practice: outcomes of an international meeting*. Paper presented at the ICED19 - The 22nd International Conference on Engineering Design, Delft.
- Komashie, A., Rae, S., & Clarkson, P. J. (2023). Towards a better understanding of mental health care delivery systems: From stories to system components. *Health Systems*, 12(4)doi:10.1080/20476965.2023.2229391 Retrieved from <https://doi.org/10.1080/20476965.2023.2229391>
- Kotiadis, K., & Mingers, J. (2006). Combining PSMs with hard OR methods: the philosophical and practical challenges. *Journal of the Operational Research Society*, 57(7), pp. 856-867. doi:10.1057/palgrave.jors.2602147
- Kotiadis, K., & Tako, A. A. (2018). Facilitated post-model coding in discrete event simulation (DES): A case study in healthcare. *European Journal of Operational Research*, 266(3), pp. 1120-1133. doi:<https://doi.org/10.1016/j.ejor.2017.10.047> Retrieved from <https://www.sciencedirect.com/science/article/pii/S0377221717309608>
- Kotiadis, K., Tako, A. A., Rouwette, E. A. J. A., Vasilakis, C., Brennan, J., Gandhi, P., . . . Webb, P. (2013). Using a model of the performance measures in Soft Systems Methodology (SSM) to take action: a case study in health care. *Journal of the Operational Research Society*, 64(1), pp. 125-137. doi:10.1057/jors.2012.21 Retrieved from <https://doi.org/10.1057/jors.2012.21>
- Kunc, M., Harper, P., & Katsikopoulos, K. (2018). A review of implementation of behavioural aspects in the application of OR in healthcare. *Journal of the Operational Research Society*, pp. 1-18. doi:10.1080/01605682.2018.1489355 Retrieved from <https://doi.org/10.1080/01605682.2018.1489355>
- Lamé, G., Crowe, S., Komashie, A., & Royston, G. (2023). Joining forces: the value of design partnering with operational research to improve healthcare delivery. *Design Science*, 9, p e4. doi:10.1017/dsj.2023.2 Retrieved from <https://www.cambridge.org/core/article/joining-forces-the-value-of-design-partnering-with-operational-research-to-improve-healthcare-delivery/5944A7459864226D1DE21022F2884EBB>
- Lamé, G., Jouini, O., & Stal-Le Cardinal, J. (2020). Combining Soft Systems Methodology, ethnographic observation, and discrete-event simulation: A case study in cancer care. *Journal of the Operational Research Society*, 71(10), pp. 1545-1562. doi:10.1080/01605682.2019.1610339 Retrieved from <https://doi.org/10.1080/01605682.2019.1610339>
- Morales Ornelas, H. C., Kleinsmann, M., & Kortuem, G. (2023). EXPLORING HEALTH AND DESIGN EVIDENCE PRACTICES IN EHEALTH SYSTEMS' DEVELOPMENT. *Proceedings of the Design Society*, 3, pp. 1795-1804. doi:10.1017/pds.2023.180 Retrieved from <https://www.cambridge.org/core/article/exploring-health-and-design-evidence-practices-in-ehealth-systems-development/834E63B52A982B6FA7E2E13CF37139F0>
- Neumann, W. P., & Purdy, N. (2023). The better work, better care framework: 7 strategies for sustainable healthcare system process improvement. *Health Systems*, 12(4)doi:10.1080/20476965.2023.2198580 Retrieved from <https://doi.org/10.1080/20476965.2023.2198580>

- NHS England National Quality Board. (2013). *Human factors in healthcare: A concordat from the National Quality Board*. Available at: <https://www.england.nhs.uk/wp-content/uploads/2013/11/nqb-hum-fact-concord.pdf>. London
- Noortman, R., Lovei, P., Funk, M., Deckers, E., Wensveen, S., & Eggen, B. (2022). Breaking up data-enabled design: expanding and scaling up for the clinical context. *AI EDAM*, 36, p e19. doi:10.1017/S0890060421000433 Retrieved from <https://www.cambridge.org/core/article/breaking-up-dataenabled-design-expanding-and-scaling-up-for-the-clinical-context/F90F97F5357D31FF7A15A27DF5921A24>
- Oluoch, D., Molyneux, S., Boga, M., Maluni, J., Murila, F., Jones, C., . . . Hinton, L. (2023). Not just surveys and indicators: narratives capture what really matters for health system strengthening. *The Lancet Global Health*, 11(9), pp. e1459-e1463. doi:10.1016/S2214-109X(23)00281-4 Retrieved from [https://doi.org/10.1016/S2214-109X\(23\)00281-4](https://doi.org/10.1016/S2214-109X(23)00281-4)
- Pannunzio, V., Kleinsmann, M., & Snelders, D. (2019). Three Approaches to Design Engineering in the Health Domain: A Systemic Perspective. *Proceedings of the Design Society: International Conference on Engineering Design*, 1(1), pp. 1005-1014. doi:10.1017/dsi.2019.106 Retrieved from <https://www.cambridge.org/core/article/three-approaches-to-design-engineering-in-the-health-domain-a-systemic-perspective/OFD2FE65A76452A4D77D0B6C9CB80834>
- Patou, F., Ciccone, N., Thorpe, J., & Maier, A. (2020). Designing P4 healthcare interventions for managing cognitive decline and dementia: where are we at? *Journal of Engineering Design*, pp. 1-20. doi:10.1080/09544828.2020.1763272 Retrieved from <https://doi.org/10.1080/09544828.2020.1763272>
- Perry, S. J., Catchpole, K., Rivera, A. J., Henrickson Parker, S., & Gosbee, J. (2021). 'Strangers in a strange land': Understanding professional challenges for human factors/ergonomics and healthcare. *Applied Ergonomics*, 94, p 103040. doi:10.1016/j.apergo.2019.103040 Retrieved from <https://www.sciencedirect.com/science/article/pii/S0003687019302467>
- Pitt, M., Monks, T., Crowe, S., & Vasilakis, C. (2016). Systems modelling and simulation in health service design, delivery and decision making. *BMJ Quality & Safety*, 25(1), pp. 38-45. doi:10.1136/bmjqs-2015-004430
- Schoepen, M., Vansteenkiste, E., De Gerssem, W., & Detand, J. (2023). Systems thinking and designerly tools for medical device design in engineering curricula. *Health Systems*, 12(4)doi:10.1080/20476965.2022.2072778 Retrieved from <https://doi.org/10.1080/20476965.2022.2072778>
- Sikka, R., Morath, J. M., & Leape, L. (2015). The Quadruple Aim: care, health, cost and meaning in work. *BMJ Quality & Safety*, 24(10), pp. 608-610. doi:10.1136/bmjqs-2015-004160 Retrieved from <https://qualitysafety.bmj.com/content/qhc/24/10/608.full.pdf>
- Sterman, J. D. (2009). *Business dynamics: systems thinking and modeling for a complex world* Boston: Irwin/McGraw-Hill.
- Tako, A. A., & Kotiadis, K. (2015). PartiSim: A multi-methodology framework to support facilitated simulation modelling in healthcare. *European Journal of Operational Research*, 244(2), pp. 555-564. doi:10.1016/j.ejor.2015.01.046
- Tako, A. A., & Robinson, S. (2014). Is simulation in health different? *Journal of the Operational Research Society*, 66(4), pp. 602-614. doi:10.1057/jors.2014.25
- Waterson, P., & Catchpole, K. (2016). Human factors in healthcare: welcome progress, but still scratching the surface. *BMJ Quality & Safety*, 25(7), pp. 480-484. doi:10.1136/bmjqs-2015-005074 Retrieved from <http://qualitysafety.bmj.com/content/qhc/25/7/480.full.pdf>
- Zhang, L., Pingaud, H., Fontanili, F., Lamine, E., Martinez, C., Bortolaso, C., & Derras, M. (2023). Balancing the satisfaction of stakeholders in home health care coordination: a novel OptaPlanner CSP model. *Health Systems*, 12(4)doi:10.1080/20476965.2023.2179947 Retrieved from <https://doi.org/10.1080/20476965.2023.2179947>