

Title: System Dynamics in Ireland; Past, Present and Future Research and Education Opportunities

Author: Sinéad M. Madden

Keywords: Computational Modelling, Mathematical Modelling, System Dynamics Modelling, Hybrid Simulation Modelling, Complexity Science, Ireland

Extended Abstract

System Dynamics (SD) modelling is a valuable tool for understanding complex systems and informing decision-making. This review aims to provide a comprehensive overview of the research conducted on SD modelling in Ireland, exploring its applications across various domains. It examines the educational landscape for SD training and discusses the importance of continuous education and research in advancing the field. The review explores the diverse applications of SD modelling in healthcare, urban and environmental studies, energy, economics, operations research, marketing, and government policy. It emphasises the interdisciplinary collaboration, continuous education, and research necessary for advancing the field and building capacity for SD modelling in Ireland. The review also discusses the need for global collaboration, the potential impact of technology on education, the relevance of educational institutions, and the importance of addressing challenges in higher education.

The review identified 48 relevant pieces of literature related to SD modelling in Ireland. The most popular research areas were healthcare, environment, and methodology. Furthermore, a search on Google using specific keywords yielded two appropriate results related to SD modelling used by the Government of Ireland. These findings highlight the growing interest and relevance of SD modelling in Ireland and its recognition by government entities.

SD modelling has been extensively applied in various domains in Ireland. In the healthcare domain, it has been used for policy analysis, addressing acute bed blockage problems, healthcare worker flu vaccination strategies, and conducting economic impact assessments. In urban and environmental studies, SD modelling contributes to understanding climate change mitigation scenarios, urban regeneration, renewable energy diffusion, and sustainable forestry. The energy sector benefits from SD modelling by examining power system variability, wave energy converter development, and innovative integrated HVAC systems in buildings. SD modelling also finds applications in economics, operations research, marketing, and government policy domains, enabling better decision-making and addressing complex problems.

The review examines the inclusion of SD modules in undergraduate and postgraduate degree programs in institutions such as National University of Ireland Galway, Maynooth University, Technological University of the Shannon, Athlone Campus, University College Cork, and National College Ireland. SD modules are offered within relevant disciplines such as computer science, electronic engineering, engineering, mathematical modelling and machine learning, and modelling simulation. However, there is a need for clearer pathways for students and academics interested in studying SD modelling techniques. While master's level courses in

mathematical modelling are available, there is currently no explicit program dedicated to terminal System Dynamics modelling degrees.

The review emphasises the importance of continuous education and training in SD modelling to build future capacity. It calls for collaboration between practitioners and educators, the development of a skilled workforce, and curriculum design aligned with contemporary needs. It highlights the need for research into emerging trends such as the integration of big data, machine learning, and artificial intelligence methods into SD modelling. Building the necessary skills and capabilities in Ireland requires educational initiatives and training programs to meet the demands of the field.

While the review does not explicitly discuss the competitive advantage of Irish universities in SD programs, it acknowledges the contributions made by various institutions in Ireland to SD research and education. Future research could explore the specific factors contributing to Ireland's success, such as interdisciplinary collaboration, funding opportunities, industry partnerships, or government support.