Brunel University London

Simulation modelling: building resilience and readiness for emergencies

Professor Simon Taylor

Policy Context: Since the COVID-19 pandemic, the government has placed renewed emphasis on resilience and readiness for emergencies. This includes preparing models to forecast possible future scenarios, particularly in health policy.

Research: Simulation models can factor in the likely behaviour of groups to make more accurate predictions. It's easier to build understanding and trust in these models than in AI.

Advice: Invest in simulation models for your priority risks, which can be rapidly tailored to assess a real-world crisis when it occurs. Build robust assurance and trust of these models in advance.

Key research findings

Brunel academics have developed a suite of simulation tools for short- and long-term pandemic management, which have been received positively by health agencies across Europe. FACS simulates pandemics at a household level across all regions of the UK. CHARM uses this information to help hospital decision makers plan for bed management. CALM uses health evidence to predict lifelong care needs resulting from long COVID. This work shows that:

- **Mathematical models used by decision makers in the COVID-19 pandemic were too high-level to capture the behaviour of groups of individuals, which is a key factor in the spread of pandemics.** The models did not include transmission factors such as household mixing, key worker movements or school opening. This limited decision makers' understanding of the likely progression of the pandemic and impacts of different policy options.
- **Simulation modelling techniques can factor in the likely behaviour of groups to make more accurate predictions.** These involve working with key stakeholders to create conceptual models of interaction and then using computational techniques to simulate different "what-if" scenarios.
- **Simulation modelling methods involve stakeholders from the beginning, so it is easier to build understanding and trust in these models than it is in Artificial Intelligence (AI).** Expert involvement is particularly useful when there is little data available – their opinion can be incorporated into the model through qualitative data representation.

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Policy advice

- **Prioritise risks and invest in rapidly tailorable models.** It is expensive and time consuming to build valuable simulation models. Policy-makers should prioritise the risks that are of highest concern, and invest in models which assess these risks and the effectiveness of responses to them. If these models are easily tailorable, they can be rapidly adapted to assess the specific nature of a real-world crisis when it happens. For example, Brunel's suite of pandemic management tools can be adapted to different geographies, types of pandemics or specific hospital ward systems.
- **Build robust assurance and trust.** Build trust by opening up the model and explaining the inputs, assumptions and calculations that create the outputs. This also allows stakeholders to contribute to the assumptions used in the model, as well as to assure other aspects of the model.
- **Develop a language that allows end users to understand how simulations work and engage with their developers.** Simulation modellers who have experience of working with end users could collaborate with government to build this language and then design or run training.
- **Invest in skills and capacity.** Assess the gap between the available skills and infrastructure for modelling in government and what will be required now and in the future. Consider how the gap might be remedied by expertise drawn from outside government, or developed within government. It will usually be cheaper to build flexible internal capacity than to hire consultants. Universities like Brunel could provide assistance and training for this.
- **Combine simulation modelling and AI to gain the strengths of each approach.** AI approaches can give you a better understanding of the past. Simulation models are better for understanding the future because, unlike AI, their predictions can be verified and validated. The UK has very strong AI and simulation modelling communities, but they tend to be very separate. Opportunities for the two to work together could significantly advance the UK's predictive capabilities – this is something that other countries are not doing at the moment.

Work with me

Simon J E Taylor is a Professor of Computer Science at Brunel University London, specialising in modelling, simulation, and digital infrastructures. He has made many research contributions in the field of healthcare, as well as manufacturing and international development.

Contact Professor Taylor at simon.taylor@brunel.ac.uk if you would like to learn more about his research, invite him to speak at your event, or collaborate with him to improve your use of simulation modelling.