A Simulation Model for COVID-19 Public Health Management

Notes to accompany the slide-set at http://www.rogerclarke.com/EC/CVMP.pdf

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1. Simulation modelling is only occasionally the focus of papers at the Bled eConference.
But is seems like an important contributor to the Conference Theme of
DIGITAL SUPPORT FROM CRISIS TO PROGRESSIVE CHANGE.

2. When I started looking at public health management in the context of COVID, there was already a flurry of publishing in many disciplines.
But IS has been very slow, and very inward-looking. And IT has been generally only a minor contributor to progress. We need to do a lot better.

3. Public health management is concerned with the big picture: the population rather than individuals. It has a focus on disease prevention and to some extent wellness, but its biggest challenges are caused by epidemics. About 20 epidemics in the last 20 years have caused 1,000 deaths or more, mostly influenza. Since 1900, 6 pandemics have caused >1m deaths.

4. In the case of COVID-19, there were multiple, in part conflicting aims.
And the aims needed to be fulfilled despite considerable limitations on government powers, and the need for public credibility and minimisation of economic harm.

5. Data is just raw material. Decision-makers need Information. Data only becomes Information is it serves the need. Each contributor to policy-making has their own mental models. And teams of policy-makers evidence considerable diversity. So there's a need to achieved shared understanding, of one another's models, values, priorities, terminology.

6. This is well-travelled space within the IS discipline, and accumulated knowledge in the DSS arena can be applied.

7. In general terms, we need to investigate the extent to which IS is assisting public health management to apply modelling expertise. And we need to understand how modelling can best support policy-making teams in their decision-making.

8. The discipline of epidemiology applies models to understand the spread of diseases.
Those models have narrow focus, and omit a great many of the factors relevant to public health management decision-makers.

9. A modelling technique is needed that supports the expression of broader models, and has flexibility and adaptability to cope with change.
Discrete-Event Simulation (DES) stands out as an appropriate technique.

10. Moving on from the general research questions, the specific purpose of the research is to apply DES to the COVID context. The scope is not limited to how the disease spreads, but extends to all key factors involved in the effective management of public health.

11. A DES model is a socio-technical artefact of the kind that the design science research technique applies to. Applying Peffers et als.'s method, the project begins with appreciation of the Problem, and continues with expression then articulation of a Solution. It extends along all of Peffer's early phases, but this work has yet to reach the Evaluation phase.

12. There are many factors at work that policy-makers cannot influence, although they may be able to at least measure them.
They have to focus on controllable factors, and work out how best to use the available levers, and how to invent a few more levers.
But they have to do so judiciously, 'bringing politicians and the public along on the journey'.

13. The DES modelling work needs to reflect the style of decision-making that's in use. It must encourage team-members to develop and apply shared understanding of the relevant part of the real world. It must avoid being too simplistic, but it must also avoid being too complex for decision-makers to cope with.

14. The next slide shows the model as it was formulated during the Design and Development Phase.
This simpler overview identifies the higher-order States that each Case could go through, from 'Uninfected' [?!], possibly via 'Infected', possibly via 'Hospitalisation', and onwards (via either recovery or vaccination) to 'Maybe Immune'; but with far too many not surviving.

15. The full model that was postulated had 2 Start-Points, 4 End-Points and 10 Intermediate States, and about 30 Flows.
A supporting document identified the Criteria for determining when Cases undergo Transition to a new State. It also identified the key Attributes for which Data was needed in order to determine Transitions, and to count Stocks in each State.

16. But that was just a Design, in the early stages of the pandemic. How could its usefulness (or inadequacy) be demonstrated?
Relevant, prior Case Studies were difficult to find, and new Field Studies or Action Research very challenging to devise and negotiate. The approach adopted was vicarious / secondary research: Reports from around the world were gathered and filtered.

17. In just a few slides, what were the key things that the world's experiences taught us between April and December of 2020?
This and the next slide focus on the question of what levers public health policy-managers tried. These are the abstract categories of interventions, e.g. work on the spreaders and the hotspots, get everyone to be careful, control travel.

18. This slide explodes one of the abstract categories, Personal Protection, and shows the specific measures that fall within the catgory.
The extent to which these were applied – and the extent to which they appear to have been effective – varied a great deal among jurisdictions.

19. Multiple countries had extremely bad experiences. Some of that was a result of environmental variables, e.g. early attack, high incidence of unhealthy lungs.
The focus of this slide is on the stratregic variables. With 20-20 hindsight, China behaved badly for a brief time (and thereafter very well).
The USA, Brazil and some European countries behaved very badly, in multiple ways, and for extended periods of time.

20. Some behaviours in some jurisdictions had considerable success. Many were lucky, but some of them took advantage of their luck (e.g. if you're an island, it's much easier to close your borders). Infectee control measures proved to be particularly vital. So did closedowns. Infectee control measures and short, sharp closedowns have again come to the fore with the later, even-more-infectious variants of the virus.

21. The previous slides reported on implications for public health policy decision-making, and hence IS practice. Here are key implications for research.
The first is that the model wasn't bad, but it needed work.

22. The 'Tested' State was dropped in favour of Testing as a bunch of Attributes of a Case. Ghost States and Flows were created to accommodate the features that were impossible-to-observe and measure (but possible to estimate). Cause of Death proved to be both challenging and important, so greater discrimination is needed.

23. Provided that the model is customised to the context, it can deliver insights.
But modellers must be flexible, and must tune the model to policy-makers' changing needs, priorities and perceptions. The payback is not from quantitative applications of DES. It's from the development of shared intellectual understanding and insight.