What is System Dynamics?

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Aims of this introduction

• System dynamics methodology
  • Tool for modelling healthcare systems

• Explain system dynamics with a simple model of planned inpatient activity
  • ... model hospital waiting lists, change in behaviour
What is system dynamics?

• Grew out of Industrial Dynamics 1950s - 1970s
  • based on systems theory ideas
  • Originator was Jay Forrester

• Key features
  • Model structure
  • Causal connections
  • Delays

• System structure determines behaviour
• Feedback and control
Stock

Variable

Number of people in beds in a ward

Remains the same unless something changes
Flow

Adding to stock “per month” (per time unit)

Hypothesis: 5 new arrivals each month
Structure: Constant recruitment
Behaviour: Straight line growth
Building the waiting list structure: stocks & flows

arrival rate → Number of patients occupying beds → departure rate

Flow out
Building the waiting list structure: stocks & flows

Stock:

Flow in from ... waiting list
Building the waiting list structure: stocks & flows

referral rate → Number of people waiting → arrival rate → Number of patients occupying beds → departure rate
Number of patients leaving depends on the number occupying beds.
Balancing Feedback Loop

Hypothesis: Patients leaving depends on number of occupants

Structure: Balancing loop

Behaviour: Slowing growth
The rate of arrival to occupy a bed depends upon the number of people waiting.
Balancing Feedback Loop

Hypothesis → Structure → Behaviour

Accounting for the capacity of the system

Bed occupancy

referral rate → Number of people waiting → arrival rate → Number of patients occupying beds → departure rate

average duration in hospital
Balancing Feedback Loop
Hypothesis → Structure → Behaviour

referral rate

Number of people waiting

arrival rate

Bed occupancy

Number of patients occupying beds

departure rate

average duration in hospital
Balancing Feedback Loop

Hypothesis → Structure → Behaviour

- Referral rate
- Number of people waiting
- Arrival rate
- Bed occupancy
- Number of patients occupying beds
- Departure rate
- Average duration in hospital
Balancing Feedback Loop

Hypothesis → Structure → Behaviour

- Referral rate > departure rate
- Inflow > outflow
- Exponential growth of waiting list

Diagram:

- Number of people waiting
- Number of patients occupying beds
- Bed occupancy
- Capacity
- Arrival rate
- Departure rate
- Average duration in hospital
Balancing Feedback Loop

Hypothesis → Structure → Behaviour

- Number of hospital beds
- Bed occupancy
- Number of people waiting
- Arrival rate
- Number of patients occupying beds
- Departure rate
- Referral rate
- Average duration in hospital
Balancing Feedback Loop

Hypothesis → Structure → Behaviour

Number of hospital beds

Capacity

Bed occupancy

Number of people waiting

Referral rate

Arrival rate

Number of patients occupying beds

Departure rate

Average duration in hospital
Changing capacity

Number of hospital beds

change in number of beds

Bed occupancy

Number of people waiting

referral rate

arrival rate

Number of patients occupying beds

departure rate

average duration in hospital
Resources


http://systemdynamics.org.uk

UK conference

THEME: System dynamics for developing strategy in the real world
VENUE: The Shard, London
DATE: Thursday 14th April – Friday 15th April