Dynamics of a performance management system: performance information to performance knowledge

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OUTLINE

- Introduction
  - Kaplan and Norton’s balanced scorecard
- The NHS performance policy and issues
- Performance framework evaluation
  - Mental model
  - Definition of a dynamical system model
    // steps and details
  - Simulation of a model system
    // method, results and analysis
  - Evaluation and knowledge
- Summary
- Q&A
Introduction

- Systems: physical and logical
- Operators needs information and knowledge about the system to complete required tasks

- Information and prescriptions
  - Indicators $\rightarrow$ Information-base
  - Information about the instrument, e.g. organisation
  - Prescription $\leftarrow$ information + knowledge based upon Organisation, Environment and various dynamics

- Performance dashboard of a car, an aeroplane and the NHS: comparative?
Patient Focus (PF)

6 months Inpatient Waits (P1)
Total Inpatient Waits – percentage of Plan (P2)
13 weeks Outpatients Waits (P3)
Cancelled Operations non-readmission (K5)
Breast Cancer Treatment (P7)
Delayed Transfer of Care (P8)

Clinical Focus (CF)

Clinical Negligence (C1)
Emergency Readmission – overall (C4)
Emergency Readmission for Children (C5)
Emergency Readmission for Fractured Hip (C6)
Emergency Readmission for Stroke (C7)

Capacity and Capability Focus (CC)

Data Quality (CC1)
Staff Satisfaction Survey (CC2)
Junior Doctors’ Hours (CC3)
Sickness Absence Rate (CC4)
Information Governance (CC5)
Balanced Scorecard (BSC)

The scheme/theme that made BSC popular

- Dimensions
- Inter-relationships
- Strategy – at hub


Balanced Scorecard (BSC) & Strategy

The NHS performance policy and issues

- **Overview**
  - Performance management system (performance measurement system)
  - Star ratings (policy), a key feature of the NHS Plan (2000)
  - Performance ratings (tool)
  - Tool → Policy → System (and its objectives)

- **Policy and aim**
  - Targets related to the performance indicators
  - Improve all performance aspects

- **Issues**
  - Criticism about the Star Rating (performance measurement framework)
  - Recurring concerns, e.g. increase in Emergency Readmissions
Performance framework evaluation

- Formative evaluation of the framework based on performance information
  - What framework can achieve?
  - What performance an average participant local trust hospital can plan for?
  - Improving the framework based on the performance data and observations (primary objective)

- Four components of the methodology
  >> Mental model
  >> Dynamic Interaction model
  >> Simulation model
  >> Evaluation
Mental model:

- Balanced scorecard based framework
  - ‘Patient’, ‘clinical’, and organisational ‘capability and capacity’ dimensions
Definition of a dynamical system

- Approach: quantitative structural analysis
  - Use of model structure based on time-lag assumption and structural equation modelling
    - Model structure

- Data
- Process
  - Heuristic (based on significant estimate criterion)
- Outcome
### Performance Ratings: Balanced Scorecard based performance indicators

**Patient Focus (PF)**
- 6 months Inpatient Waits (P1)
- Total Inpatient Waits – percentage of Plan (P2)
- 13 weeks Outpatients Waits (P3)
- Cancelled Operations non-readmission (K5)
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**Capacity and Capability Focus (CC)**
- Data Quality (CC1)
- Staff Satisfaction Survey (CC2)
- Junior Doctors’ Hours (CC3)
- Sickness Absence Rate (CC4)
- Information Governance (CC5)

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<thead>
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<td>Breast cancer treatment within a month</td>
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<td>Cancelled operations</td>
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<td>Day case booking</td>
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<td>Delayed transfers of care</td>
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<td>Nine month heart operation waits</td>
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<tr>
<td>Outpatient A&amp;E survey - better information, more choice</td>
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<td>Outpatient A&amp;E survey - building relationships</td>
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<td>Outpatient A&amp;E survey - clean, comfortable, friendly place to be</td>
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<td>Paediatric outpatient did not attend rates</td>
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<td>Patient complaints procedure</td>
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<td>Privacy &amp; dignity</td>
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<td>Six month inpatient waits</td>
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<td>Thirteen week outpatient waits</td>
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<td>Total inpatient waits</td>
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<td>Waiting times for Rapid Access Chest Pain Clinic</td>
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<td>Deaths within 30 days of a heart bypass operation*</td>
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<td>Staff opinion survey</td>
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* variables related to special practices or high proportion of missing information
Graphical input, supported by AMOS as well as other leading SEM packages

Set of structural equations

Model Fitting with AMOS

AMOS output

Start

MI output threshold set to 2. Critical Value set to Default*. Tolerance value set to 0.01.

Select the all possible parameter to be estimated for model fitting (Full Model Estimation)

Graphical input, supported by AMOS as well as other leading SEM packages

Potential parameter(s) repeatedly found nonsignificant with earlier iterations?

NO

Potential parameter with MI>2

YES

Include potentially significant parameter with the highest MI

NO

Potential parameter with MI<2 consecutively resulted in P-value more than Critical Value?

NO

Is Tolerance value zero?

NO

Potentially significant parameter(s) present which are not invalid?

NO

Tolerance value set to zero

YES

P-values of all the parameters less than Critical Value + Tolerance?

NO

End

YES

Include all the potentially significant parameters with MI>2

NO

Remove the non-significant parameter(s)

Potential parameter(s) repeatedly found nonsignificant with earlier iterations?

NO

Is Tolerance value zero?

YES

Tolerance value set to zero

NO

Model Investigation with A-Step-Forward and A-Lot-Backward

Stepwise Selection - FULL model Start

Model Investigation with A-Step-Forward and A-Lot-Backward

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YES

P-values of all the parameters less than Critical Value + Tolerance?

NO

End

YES

Include all the potentially significant parameters with MI>2

NO

Remove the non-significant parameter(s)
Path diagram
Map of interrelations

- Emergency Readmission
- Data Quality
- 6 mths Inpatient waits
- Delayed Transfer of Care
- Junior Doctor's Hrs
- Emergency Readmission for Children
- B5 / R12
- B3
- R5
- R2
- R9
- R1
- Information Governance
- Breast cancer treatment within a month
- B1
- Data Quality
- B8
- R11
- Total Inpatient waits - % of plan
- Sickness absence rate
- Cancelled Operations
- R4
- Emergency Readmission for Stroke
- R10
- R7
- Staff Satisfaction Survey
- R6
- R3
- R12 / B5
- B4
- B2

R = Reinforcement loop
B = Balancing loop

Clinical Negligence
Scenario A

Clinical Negligence

Breast cancer treatment within a month

13 wks Outpatient Waits

Delayed Transfer of Care

Junior Doctor's Hrs

Emergency Readmission for Children

Emergency Readmission for Stroke

Emergency Readmission for Fractured hip

6 mths Inpatient Waits

Total Inpatient waits - % of plan

Sickness absence rate

Cancelled Operations

Data Quality

Information Governance

Reinforcement loop

Balancing loop

Dormant loop
Scenario C

Emergency Readmission

13 wks Outpatient Waits

Emergency Readmission for Children

6 mths Inpatient waits

Total Inpatient waits - % of plan

Breast cancer treatment within a month

Delayed Transfer of Care

Information Governance

Junior Doctor's Hrs

Emergency Readmission for Stroke

Emergency Readmission for Fractured hip

Staff Satisfaction Survey

Sickness absence rate

Cancelled Operations

Clinical Negligence

Data Quality

Reinforcement loop

Balancing loop

Dormant loop
Scenario B
### Synthesis of the scenarios A, B and C

<table>
<thead>
<tr>
<th>Performance Variables (affected by the feedback loops)</th>
<th>Improvement in Emergency Readmission</th>
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<tbody>
<tr>
<td></td>
<td>Scenario A</td>
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<tr>
<td>Patient Focus</td>
<td></td>
</tr>
<tr>
<td>6mths Inpatient waits</td>
<td>0</td>
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<tr>
<td>Total Inpatient waits-%of Plan</td>
<td>0</td>
</tr>
<tr>
<td>13wks Outpatient waits</td>
<td>1</td>
</tr>
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</tr>
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<td>Junior Doctors' Hrs</td>
<td>1</td>
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<tr>
<td>Sickness absence rate</td>
<td>0</td>
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</tbody>
</table>

- **not compromised**
- **compromised**
Simulation of a model system

- Cellular automata based model simulations

Cellular automata based model simulations

Jumper settings determining effective rule-table

Performance indicator

Labels

Initial State

Rule-set producing new generations at each time unit

Generations with time-stamp

Repeating pattern comprised of one generation
Model simulation and results

- 2-state, 13 indicators, 360 rule-tables, ~3 million cellular automata
- Computations
  - Job-split parallel computations
  - 18 PCs and ~30hrs each
- Outcomes
  - Patterns
- Distributions
Scenarios

<table>
<thead>
<tr>
<th>Pattern_01</th>
<th>Pattern_02</th>
<th>Pattern_03</th>
<th>Pattern_04</th>
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<tr>
<td>Pattern_05</td>
<td>Pattern_06</td>
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<td>Pattern_13</td>
<td>Pattern_14</td>
<td>Pattern_15</td>
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</table>
Assess scenarios (quantitative)

- Measures of characteristics

\[
\frac{1}{r} \left( \sum_{i=1}^{r} \sum_{j=1}^{p} w_j G_{ij} \right)
\]

\[
\frac{1}{r} \left( \sum_{i=1}^{r} \sum_{j=1}^{p} w_j R_{ij} \right)
\]
Assess scenarios (qualitative)

- Signature for each of 15 scenarios
- Scenario comparisons
>> Evaluation and knowledge

- The model system suggest no scenario with improvements for all the performance indicators.
- Performance knowledge-base for system behaviours; accounts interactions and dynamics based on various interactions.
- Performance management strategies
  - Scenario planning for local units
    - Positioning
    - Shifting scenarios
    - Proactive policy participation
Specifications and limitations

- **SEM used for structural analysis**
  - Influences mapped based on linear relationships

- **Cellular automata based simulations**
  - Parallel calculations (job-split): 18 PCs approximately 30hrs each for ~3million evolutions calculated
  - Limited information utilised from the path diagram
  - Binary cells
    - Cellular automata with k-state; rule-tables

- **Dynamic or random graphs**
  - Static but statistically significant graph based simulation
  - Dynamic graphs can incorporate non-linear dynamics but practically limited due to data availability for most of the high-level frameworks
Summary

- Statistical technique provided basis for deriving knowledge based on performance information
  - Knowledge-base for prescriptions based on the performance information are what makes information relevant for decision-making

- Simulation based knowledge about the model system can be useful for formative evaluation.


I am coming over to attend your queries...
- Where is the problem?
I saw the angel in the marble and carved until I set him free.

Thanks to you, Michelangelo
A view on the NHS Plan

- A change programme (planned) to achieve reform
- If we look on implementations to-date from organisational change perspective, then
  - Star Ratings and (observed) and others (follow-up programmes etc) are implementation tools, and
  - Role for change programme, monitoring and communications
- Performance measurement system and the NHS Plan
  - Performance Ratings and Annual Health Check as strategic choices
- Formative evaluation?
  - Reduced complexity with simple structure
  - Performance Ratings and Balanced Scorecard based performance indicators
\textbf{Association rules for rule-table 335}

<table>
<thead>
<tr>
<th>Pattern 06</th>
<th>Pattern 06 or 10</th>
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</thead>
<tbody>
<tr>
<td>(K5 = 0) \land (P2 = 0) \land (C6 = 0) \land (CC1 = 0) \land (C7 = 1) \Rightarrow \text{Pattern 06}</td>
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where $0$ = degrading (black) and $1$ = improving (grey).
Stepwise Selection - FULL model Start

Model Investigation with A-Step-Forward and A-Lot-Backward

Start

- MI output threshold set to 2. Critical Value set to Default*. Tolerance value set to 0.01.
- Select the all possible parameter to be estimated for model fitting (Full Model Estimation)
- Graphical input, supported by AMOS as well as other leading SEM packages
- Set of structural equations
- Model Fitting with AMOS
- AMOS output

Include potentially significant parameter with the highest MI

Potential parameter(s) repeatedly found nonsignificant with earlier iterations?

- NO
- YES

Potential parameter with MI<2 consecutively resulted in P-value more than Critical Value?

- NO
- YES

Is Tolerance value zero?

- NO
- YES

Potentially significant parameter(s) present which are not invalid?

- NO
- YES

P-values of all the parameters less than Critical Value + Tolerance?

- NO
- YES

Tolerance value set to zero

End

* Default value can be 0.10, 0.05, or 0.01.
Evolution – a basis for evaluation

- Evolution of a modelled non-physical systems
- Future of American Society: a case of two questions (issues)
  - $3 \times 3 = 9$ possibilities
    - Only 5 considered
    - 4 not congruent with structural relationship of the system
- Complexity
  - If issues measured and modelled as continuous or interval measure
    - Enumerated cone of plausibility: $N \times N$ or $R \times R$
  - More than two issues!

Source: Kleiner, 1996
Evolution – a basis for evaluation and planning

- Evolution of a modelled non-physical systems
- Future of American Society: a case of two questions (issues)
- 3x3=9 possibilities
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Source: Kleiner, 1996
### Performance indicators

- **Performance Ratings and Balanced Scorecard based performance indicators**

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<td>Emergency Readmission for Stroke (C7)</td>
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*Note: EFMJ indicates that the performance rating is not sufficiently high to be considered a strength in the Balanced Scorecard.*