Systems Analysis and Modelling to Support Implementation of the SDGs

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Contents

1. The Sustainable Development Goals (SDGs)
2. Systems approaches to support implementation
3. Case study 1: Cross-impact and network analysis to support prioritisation
4. Case study 2: Integrated system dynamics modelling to support scenario analysis and policy evaluation
5. Final words
1. Sustainable Development Goals (SDGs)

- 17 Goals
- 169 targets
- 232 indicators

- Address economic, social, environmental issues
- Apply to developing and developed countries
- Commenced in 2016 with 2030 timeframe
- Evidence-based framework for policy making
Many challenges for implementation...

- SDGs are very comprehensive in scope – need to prioritise
- SDGs are integrated with very complex feedbacks and dynamics – significant change from narrow, linear approach to development
- SDG targets have complex trade-offs and synergies between targets

We currently have a weak conceptual understanding of these interlinkages - limits our ability to respond coherently

We need approaches and tools to enable analysis of interlinkages and trade-offs and support decision making and systemic action on the SDGs
2. Systems analysis approaches to support SDG implementation

- A range of different systems analysis approaches are recommended by experts to support SDG implementation (range from qualitative to quantitative approaches)...

- **Systems mapping**
  - Problem scoping
  - Identification of all linkages

- **Cross impact analysis**
  - Preliminary identification of critical linkages for specific conditions
  - Policy leverage points

- **Modelling and scenario analysis**
  - Detailed investigation of critical linkages for range of conditions
  - Policy leverage points
2. Systems analysis approaches to support SDG implementation

- Key research question – how and when they can support decision-making on the SDGs (e.g. prioritising targets, policy evaluation etc.)?
3. Case study 1: cross-impact and network analysis to support SDG target prioritisation (UN-ESCWA, Arab region)
Assessment undertaken for the United Nations

**Aim:** to support initial stages of implementation of the SDGs – i.e. prioritisation and target setting

- Comprised six sequential steps
- Used a multi-criteria analysis framework to support prioritisation
- Three criteria using different types of assessment to identify ‘high priority’ targets

1. **SCOPE (SCREENING)**
   - Initial screening of priorities for the region

2. **BASELINE ASSESSMENT**
   - Baseline assessment of indicators, trends and benchmarking
   - “Level of Urgency”

3. **MAPPING & ALIGNMENT**
   - Assess alignment of the SDGs with existing strategies and plans
   - “Policy Gaps”

4. **ASSESS INTERLINKAGES**
   - Assess interlinkages between targets and identify high leverage targets
   - “Systemic Impact”

5. **PRIORITISE & EVALUATE**
   - Multi-criteria assessment to identify higher priority targets and indicators; evaluate target values

6. **ADAPT & PLAN**
   - Adapt global targets to regional and national circumstances; propose target values; develop implementation framework
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‘Systemic impact’ criteria

Aim: to identify ‘high leverage’ targets with a strong multiplier effect

i.e. where action to achieve a target leads to positive flow-on effects to many other targets

Applied two types of semi-quantitative systems analysis:
1. Cross-impact matrix analysis
2. Network analysis
Cross-impact matrix analysis

- Applied a **seven-point scale developed** by ISCU (2017) to explore interactions and causal relationships between SDG targets (scores from +3 to -3)

- Scores for interactions were based on several recent studies and compiled into a cross-impact matrix

<table>
<thead>
<tr>
<th>Interaction Score</th>
<th>Name</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>+3</td>
<td>Indivisible</td>
<td>Inextricably linked to the achievement of another target</td>
</tr>
<tr>
<td>+2</td>
<td>Reinforcing</td>
<td>Aids the achievement of another target</td>
</tr>
<tr>
<td>+1</td>
<td>Enabling</td>
<td>Creates conditions that further another target</td>
</tr>
<tr>
<td>0</td>
<td>Consistent</td>
<td>No significant positive or negative interactions</td>
</tr>
<tr>
<td>-1</td>
<td>Constraining</td>
<td>Limits options on another target</td>
</tr>
<tr>
<td>-2</td>
<td>Counteracting</td>
<td>Clashes with another target</td>
</tr>
<tr>
<td>-3</td>
<td>Cancelling</td>
<td>Makes it impossible to reach another target</td>
</tr>
</tbody>
</table>

![Cross-impact matrix](image)
Results - Cross-matrix impact analysis

- Cumulative scores were calculated for each target – green shading highlights synergies, red shading trade-offs

- High leverage targets identified: have a large number of positive connections (synergies) with other targets; strong multiplier effect
Network analysis

- A more **visual systems analysis** approach
- Used the same data on interactions from the cross-matrix analysis – reformatted into an ‘**adjacency matrix**’ - used by network analysis software.
- Applied **3 different metrics** that are ‘built-in’ to the network analysis software (‘Kumu’): outdegree; closeness centrality; weighted centrality
  - Calculate a **score and ranking** for each target in the network based on the number of outgoing connections or distance to other targets
  - Produce **network charts** that highlight the most ‘interconnected’ targets (larger dot and darker colour) – i.e. ‘high leverage’ targets
Summary - Systems analysis of interlinkages between targets

- High degree of consistency between the different approaches
- When the methods are combined, 11 targets consistently scored very highly across all methods...
- These could be considered ‘high leverage’ targets, based on the analysis
  - e.g. 7.2 and 7.3 (renewable energy and energy efficiency)
- Simple approach – not too resource intensive; useful for prioritisation, but limited for evaluation of policies and interventions
4. Case study 2: system dynamics modelling for scenario analysis and policy evaluation – energy sector
(Millennium Institute, Africa)
Objective: to model the installation of solar PV capacity out to 2030 and 2050, and provide advice on policy options and impacts on energy security, GDP and GHG emissions.

Developed an integrated macro-economic system dynamics model in Vensim (11 modules/sectors; simplified version of the Threshold 21 model):

- **Economic modules**: firms, households, government, finance
- **Social modules**: population, education, health
- **Environment modules**: energy, land, transport + solar PV module

Model included a range of key development indicators and variables – population, GDP, employment, life expectancy, income, expenditure etc.

Calibrated on real annual data over 25 year period (1990-2015)

Connections and feedbacks across all modules - dynamic
Solar PV Module

Stock – installed solar PV capacity (kW)

Flows – installation (inflow) and depreciation (outflow)

Rate of installation flow:
- determined by the demand for electricity from solar PV, compared with existing solar PV capacity
- demand is market-driven by the price of solar PV electricity compared to the price of current fossil fuel electricity (oil)
Cost of electricity from solar PV is falling rapidly, and expected to reach parity with fossil fuel electricity around 2027 (if not before). This will drive investment in installed Solar PV capacity - projected to rise rapidly from 2028 to 2045 and then plateau due to thresholds...
Baseline versus Solar Subsidy Scenario

By introducing a subsidy, price parity with oil moves forward to 2018... 10 years earlier

Drives early investment in solar PV capacity
Impacts on energy security, GDP, GHG...

Slight increase in GDP over the long term (as a result of cheaper electricity)

Significant reduction in oil consumption – extends lifetime of reserves (greater energy security)

Significant reduction in GHG emissions over the long-term
Modelling outcomes

By developing and applying quantitative simulations, we could assess:

- **Key feedback loops and leverage points**
- **A range of policy scenarios and options** (BAU, subsidy, tax, subsidy + tax)
- **the ‘best’ combination of policy interventions** based on several criteria – GDP, energy security, GHG emissions
- **Impacts on a broad range of other variables** and indicators (income, productivity, life expectancy, education etc.)

Simulation much more valuable for policy evaluation – but very resource and time intensive

Before detailed modelling, need to set clear priorities to reduce scope for analysis

Best to combine multiple approaches & tools
5. Final words

- There are many systems analysis approaches that range from qualitative, to semi-quantitative, to quantitative.
- Each can support national decision-making on the SDGs (or any policy challenge).
- Need to select an approach that is suitable for the problem and questions you want answered.
- Start with more qualitative and less data-intensive approaches, and move toward more detailed (and expensive/time consuming) modelling as you refine the scope and research questions.
Thank you!

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