Tackling Complexity in Aid for Trade: System Dynamics frameworks and models


Kim Warren

OUTLINE

Project background and purpose

Why the Trade “system” is difficult (like others!)

Seeing total Trade = sum of its parts

Generic structure of a trade border (+ working models)

Organising the portfolio of Trade-improvement efforts

Issues, challenges and limitations
Background ...

**A DFID-funded research project on “Complex systems tools”**

Seeking new ways to **analyse** and **understand** the problems and issues DFID works on

... being clear and transparent about the **assumptions** and **limitations** of existing tools

Exploring the potential of **new tools** better suited to dealing with complex, dynamic realities; focusing on **wealth creation**

Examining **implications** for DFID’s current business models

... led by Ben Ramalingam, ODI and author of *Aid on the edge of Chaos*, [http://aidontheedge.info/](http://aidontheedge.info/)

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The 4 *pilot projects* on complex systems tools ...

**System dynamics** of Aid for Trade (Aft) in Nigeria ... for the analysis, design, planning, managing, monitoring and evaluation of Aft initiatives (specifically for smaller-scale export activity of direct benefit to those in poverty

**Network analysis** techniques with the Girl Hub project in N. Nigeria ... to test the method’s relevance for informing stakeholder-based theories of change and strategies for the empowerment of girls

‘**Complexity-informed theory of change**’ for private sector development (PSD) in the Democratic Republic of Congo (subsequently, a **system dynamics** analysis has been performed for PSD in 4 large sectors of the Nepal economy)

**Systems thinking and mapping** of DFID’s End-to-End Programme Management
**Conclusions** from the pilot complex-systems projects...

Legitimise the *trial of new approaches* for understanding the complex problems of Aid.

Establish a *rich picture* of problems *from the start* ... a view of the systems, the network, the behaviours and the dynamics around a given issue.

Recognise the whole ‘aid chain’ and ensure that *ex-ante* design and analysis joins up with *downstream* implementation and evaluation.

*Network with others* – scientists, private sector and the wider public sector where the necessary capabilities are established.

Build on the established ‘plan and control’ model by encouraging ‘*experiment and adapt*’ in addition.

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**Aims of the system dynamics project on AfT** ...

**Support** new DFID Aid-for-Trade program *

- pilot the use of system dynamics with model(s) of DFID trade-related interventions
- ... and for the next 5-year Nigeria programme (*only partially achieved*)

**Start-point** ...

- An existing Monitoring and Evaluation framework is in place
- ... but DFID sees limitations, caused by the system-nature of Trade

**Benefits looked for**

- assess ways forward for the Aid-for-Trade programme
- inform economic appraisal of the programme
- support future programme management

* The style of system dynamics mapping and modelling adopted in this study is highly *evidence-based* and *quantitative*, not to be confused with other styles of system dynamics work, such as *qualitative feedback mapping.*
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*Issues*, challenges and limitations

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The “*logical framework*” for evaluation and monitoring*

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Financial, human and material resources</th>
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<tbody>
<tr>
<td>Activities</td>
<td>Task undertaken to transform inputs into outputs</td>
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<tr>
<td>Outputs</td>
<td>Products/services produced or delivered</td>
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<tr>
<td>Outcomes</td>
<td>Behavioural changes: intended + unintended positive + negative</td>
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<td>Impacts</td>
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The “logical framework” for evaluation and monitoring*

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<tbody>
<tr>
<td>Financial, human and material resources</td>
<td>Task undertaken to transform inputs into outputs</td>
<td>Increased access to infrastructure</td>
<td>Intermediate:</td>
<td>Increased, sustained growth</td>
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<td>More access to trade facilitation</td>
<td>- Reduction in non-tariff barriers</td>
<td>Reduced poverty</td>
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<td>More/better infrastructure (e.g. km of roads)</td>
<td>- Reduction in time to trade</td>
<td>More employment for poor and excluded groups</td>
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<td>More/better trade facilitation services</td>
<td>- Reduction in trade costs</td>
<td>Higher incomes for poor and excluded groups</td>
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<td>Increased access to productive sector</td>
<td>- Improved market access</td>
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<td>More/better productive sector services (e.g. business development)</td>
<td>- Higher capacity to trade (including poor and excluded groups)</td>
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<td>Better/simpler trade-related regulations and procedures</td>
<td>- Eventual:</td>
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<td>More of private sector engaging in trade</td>
<td>- Increased international trade</td>
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<td>More LDCs with trade in development strategies</td>
<td>- Increased intra-regional trade</td>
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<td>More LDCs implementing trade elements of development</td>
<td>- Increased investment</td>
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<td>More trade strategies/policies implemented</td>
<td>- Increased share of world trade</td>
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<td>- Increased value-added exports</td>
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<td>- Greater diversification of exports</td>
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<td>- Increased productivity/competitiveness</td>
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<td>- More suppliers engaging in trade</td>
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The bigger challenge: many projects: many agencies
(Nigeria change projects only, policy studies + institutional support are additional)

**Government**
- Implement systems for “single widow” facility
- Bill to update existing Customs Management Act
- Implement 48-hour clearance policy
- Implement 24/7 operation at the port
- Strengthen NCS manpower to achieve items above
- Reduce agencies at the port from 16 to 6
- Increase professionalism of NCS
- Increase focus on enabling trade v. collecting revenue

**US AID**
- Customs modernisation
- Agricultural growth along Lagos-Kano-Jibiya corridor
- Cut hold time at Lagos ports and Seme Border post
- Implement the ECOWAS Common External Tariff
- Business service provision to exporting enterprises

**European Union**
- Joint Nigeria: Benin border post (Seme-Krake)

**DFID**
- Okerete joint border post trial – bridge, roads, market
- Advice on professionalising Customs (Crown Agents)

**GIZ**
- Increase NCS training capacity
- Joint cross-border controls with neighbour countries
- Training for Ministry of Trade & Investment

**Regional Facilitation initiatives**
- Transport facilitation (joint crossings, corridors, single windows, border procedures …)
- Trade facilitation initiatives (various)
- Abidjan-Lagos Trade and Transport facilitation project
- Authorised economic operator program
- ECOWAS Regional Transit System
- Borderless Initiative

How to understand the interactions and consequences of all these? How to coordinate for best overall impact?

Difficulties with the current framework

- **Inputs**: Financial, human and material resources
- **Activities**: Task undertaken to transform inputs into outputs
- **Outputs**: Products/services produced or delivered
- **Outcomes**: Behavioural changes: intended + unintended positive + negative
- **Impacts**: Long-term, widespread improvement in society

*Cause-effect* relationships are unclear

... due to the *system-nature* of export trading

Outcomes reflect how the system responds to the Outputs arising from Inputs + Activities

- **Build roads**
- **Access to border**

  - **The Trade system**: [starting to trade is easier]
  - **Outcomes**: more people trade
  - **Impacts**: less poverty
Feedback within the trade system and from Outcomes

The Trade system

For example:

- people trade
- delays at borders
- visible trade opportunities
- people start trading and others stop

4 reasons why designing and managing a system is hard!

Examples

Consequences
4 reasons why *designing* and *managing* a system is *hard*!

<table>
<thead>
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<th><strong>Examples</strong></th>
<th><strong>Consequences</strong></th>
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</table>
| **Accumulation**: Critical factors build up or deplete over long periods | Building road capacity  
  Training border staff  
  Encouraging people to engage in trade | Long delays from action to impact  
  Things get worse before they get better |
| **Interdependence**: Change depends on more than one factor | Road access and port capacity are both needed for people to start trading | Interventions may have no apparent impact ... providing roads may make no difference if port delays increase |
| **Feedback**: Interdependence causes changes that either accelerate or brake their own progress | Successful growth of people trading encourages others to start ... but border capacity stifles growth | Desirable and undesirable changes can run away with themselves  
  The system can “resist” efforts to improve its performance |
| **Thresholds**: The system is unresponsive to change over a wide range, then switches to a new mode | Traders are not interested in potential profit of $X-3X, but respond en-masse at $4X. | Apparent failure of interventions, while moving to the tipping point |

System dynamics deals explicitly with *all* these mechanisms  
(agent-based and discrete-event methods too, suited to certain types of challenge)

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*Generic* structure of a *trade border* (+ working models)

Organising the *portfolio* of Trade-improvement efforts

*Issues*, challenges and limitations
The start-point: time-charts of system performance

There is a history
... the situation could get worse
... and will take time to fix

These are our overall aims, but trade occurs through each individual border crossing and port.

Disaggregating the trade system

Total trade = sum of all trade through each mode
... and total trade through each mode = sum of trade through all crossings
2 levels of understanding ...

1 ... for policy and interventions across *all borders and ports*
2 ... for specific factors at *each* border or port.

We need to understand all *enablers* and *disablers* at *each* crossing. Example: a single, small land border

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Trade through a land-border: desired *Outcomes*

A desired *Outcome*

A *Resource* causing the Outcome

A *Resource* causing the Outcome

Another factor causing the Outcome

The behaviour of *Resources* (“accumulating stocks”)

A “*resource*” or “*stock*”

A “*flow-rate*” – how fast the stock is increasing or being lost

“If we know A (traders) we can work out B (trade volume)"

“*Flow-rates*” drive the *resources* ... and therefore how performance changes over time ... so *flow-rates* are the items we need to *control*
Accumulation (and depletion) continue over time

1. New people must start trading faster...

To grow the number of people engaged in trade faster...

...and/or 2. People must cease trading more slowly.

(If both flows change slowly, little progress is made).

Growing trade participation

If this is to grow...

...then this must grow...

...so this must be higher

This is the critical item – another desired outcome (and is the net of gains minus losses)

...so why do people make this choice?

...and why do people make this choice?
What causes traders to start or stop?

I start trading if I see others make money.

I stop trading if I can’t cross the border.

Border delays happen if more people want to cross than can be handled.

I trade less if tariffs and corruption take my money, or delays cut my income.

Interdependence on other existing resources

More roads enable more traders to reach the crossing.

More permitted products make opportunities for more traders.

More permitted products enable more traders to reach the crossing.
Interdependence causes feedback

"Reinforcing" feedback drives self-sustaining growth ... more people trading → more start trading ... (or decline)

"Balancing" feedback stifles growth ... more people trading → more delays → people stop trading

Supply-side resources grow capacity

↑ capacity needs more physical and human resources

↑ capacity also needs more intangible resources
Supply-side resources grow capacity

A generic theory of how export trading actually works

Action options to grow the system and Outcomes
Part of a working model on attracting traders ...

The working model is at www.sdl.re/DFIDtradeM1 (latest-version browser required)

Implications for **Planning, Monitoring and Evaluation**

**Inputs**
- Financial, human and material resources

**Activities**
- Task undertaken to transform inputs into outputs

**Outputs**
- Products/services produced or delivered

**Outcomes**
- Behavioural changes: intended + unintended positive + negative

**Impacts**
- Long-term, widespread improvement in society – impossible to ascribe to any project or programme.
Implications for Planning, Monitoring and Evaluation

Getting the data: simple survey

Access
- How far have you come?
- How much by road?
- How long did it take?
- When did you last make the trip? tells us the number of 1st-time traders and frequency
- How many check-points stopped you?
  - for how long at each?
- How much did you have to pay at each? estimate of bribes
- What products do you have?
- Any banned products you could have brought?

Capacity
- How long has it taken to cross the border?
- How many documents do you need?
  - and did you have them all?
- How many different officials have you seen?
- How many hours are left for you to sell your goods?

Profitability
- What duty have you had to pay?
- What other payments have you had to make?
  - for what reason? estimate of bribes
- What did your goods cost you (money or labour)?
- How much do you expect to sell them for? gives likely profit
- How much money do you need to make for the trip to be worthwhile?

Is anything changing ...
- When will you likely make another trip?
- Same products or different?
- What would make it easier + quicker to get to the border?
- What would make it quicker to cross the border?
- What would improve the profit you can make on each trip?
Monitoring and evaluation examples from a working model

How to use dynamic mapping/modeling? ... 3 options:

1. **Manual model only**
   ’sketch’ estimated scale and time-path of Inputs, Outputs and Outcomes implicitly estimating the interdependencies
   plot actual results against Plan manually each period
   adjust projects and spend+effort in light of progress

2. **Manual model, in software**
   enter numerical estimates for Inputs, Outputs and Outcomes
   include simple calculations to save effort
   enter actual results to compare with Plan
   adjust projects and spend+effort in light of progress

3. **Functioning software model**
   enter numerical estimates for Inputs, Outputs and Outcomes
   ... and compute expected relationships
   enter actual results to compare with Plan
   adjust the model to evaluate changes to projects and spend+effort
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**The same system** for all border types, and all crossings
Requirements for the trade system to work

Resources enabling traders and trading...
“Negative” resources disabling traders and trading ...

Build the enablers and cut the disablers ...
Successful trade development creates potential traders

Mapping World Bank indicators onto the system

1. Effectiveness of clearing system
2. Roads and infrastructure
4. Quality of logistics services

Access

Capacity

Profitability

These are high-level aggregate indicators (understandably)
Each reflects specific resources in our framework (+ve and -ve)
Some items missing (banned products, duties, standards …)
### Initiatives’ impact, by *mode*, by *location* (illustrative)

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<th>Enablers</th>
<th>All land borders</th>
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<th>Crossing 2</th>
<th>Crossing 3</th>
<th>Crossing ... N</th>
<th>All ports</th>
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<th>All airports</th>
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</table>

**Create a crossing or port at specific locations**

**Train staff for all locations**
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### Disablers

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### Some initiatives have *broad impact*

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<td>XX</td>
<td>XX XX XX XX</td>
<td>XX XX XX XX</td>
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<td>XX XX XX XX XX</td>
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</tbody>
</table>

### Disablers

<table>
<thead>
<tr>
<th>Disablers</th>
<th>All land borders</th>
<th>Crossing 1</th>
<th>Crossing 2</th>
<th>Crossing 3</th>
<th>Crossing ... N</th>
<th>All ports</th>
<th>Port 1</th>
<th>Port 2</th>
<th>Port 3</th>
<th>Port ... N</th>
<th>All airports</th>
<th>Airport 1</th>
<th>Airport ... N</th>
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</thead>
<tbody>
<tr>
<td>Cut banned products</td>
<td></td>
<td>XX XX XX</td>
<td>XX XX XX</td>
<td>XX XX XX</td>
<td>XX XX XX XX XX</td>
<td>XX XX XX</td>
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<td>XX</td>
<td>XX XX XX XX</td>
<td>XX XX XX XX</td>
<td>XX</td>
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<tr>
<td>Cut check-points</td>
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<td>XX XX XX</td>
<td>XX XX XX</td>
<td>XX XX XX XX XX</td>
<td>XX XX XX</td>
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<td>XX XX XX XX</td>
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<td>XX</td>
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<tr>
<td>Reduce agencies</td>
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<td>XX XX XX XX XX</td>
</tr>
</tbody>
</table>
**Some initiatives have *differential local impact***

<table>
<thead>
<tr>
<th>Enablers</th>
<th>All land borders</th>
<th>Crossing 1</th>
<th>Crossing 2</th>
<th>Crossing 3</th>
<th>Crossing ...</th>
<th>All ports</th>
<th>Port 1</th>
<th>Port 2</th>
<th>Port 3</th>
<th>Port ...</th>
<th>All airports</th>
<th>Airport 1</th>
<th>Airport ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add crossings/ports</td>
<td>x</td>
<td>x</td>
<td>✔</td>
<td>✔</td>
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<td></td>
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</tr>
<tr>
<td>Build roads</td>
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<td>✔</td>
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<td></td>
</tr>
<tr>
<td>Train staff</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td></td>
</tr>
<tr>
<td>Create markets</td>
<td>x</td>
<td>✔</td>
<td>✔</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Grow access to finance</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
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</tr>
</tbody>
</table>

Some initiatives have different local impacts

**Some project are *local*, and need *multiple initiatives***

<table>
<thead>
<tr>
<th>Enablers</th>
<th>All land borders</th>
<th>Crossing 1</th>
<th>Crossing 2</th>
<th>Crossing 3</th>
<th>Crossing ...</th>
<th>All ports</th>
<th>Port 1</th>
<th>Port 2</th>
<th>Port 3</th>
<th>Port ...</th>
<th>All airports</th>
<th>Airport 1</th>
<th>Airport ...</th>
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</thead>
<tbody>
<tr>
<td>Add crossings/ports</td>
<td>x</td>
<td>x</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Build roads</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td></td>
</tr>
<tr>
<td>Train staff</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Create markets</td>
<td>x</td>
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<tr>
<td>Grow access to finance</td>
<td>✔</td>
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</tr>
</tbody>
</table>

Some projects are location-specific (e.g. Okarete)
## Check-list of Enablers and Disablers

<table>
<thead>
<tr>
<th>ENABLERS</th>
<th>DISABLERS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Access</strong></td>
<td></td>
</tr>
<tr>
<td>Roads</td>
<td>Banned product</td>
</tr>
<tr>
<td>Border posts</td>
<td>Internal check-points</td>
</tr>
<tr>
<td>Ports</td>
<td></td>
</tr>
<tr>
<td>Educate potential traders</td>
<td></td>
</tr>
<tr>
<td>Product standards</td>
<td></td>
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<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td></td>
</tr>
<tr>
<td>Staff: each Agency</td>
<td>Number of agencies</td>
</tr>
<tr>
<td>Skills</td>
<td></td>
</tr>
<tr>
<td>Procedures</td>
<td>Number of documents</td>
</tr>
<tr>
<td>Buildings</td>
<td></td>
</tr>
<tr>
<td>Equipment + Systems</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td><strong>Profitability</strong></td>
<td></td>
</tr>
<tr>
<td>Markets</td>
<td>Corrupt officials</td>
</tr>
<tr>
<td>Customers</td>
<td>Duties</td>
</tr>
<tr>
<td>Financial services</td>
<td>...</td>
</tr>
</tbody>
</table>

### Additional items to consider:
- waterways, seaports, rail infrastructure
- truck operators
- reliable power supplies
- education and skills of traders
- legislation
- regional integration (ECOWAS etc.)
- risk based controls
- automation
- Free-trade zones
- “Authorised Economic Operator”

---

## Current and prospective projects: DFID + other agencies

What actual and prospective project or intervention, by which agency, is aimed at which factors?

<table>
<thead>
<tr>
<th>ENABLERS</th>
<th>Projects + interventions</th>
<th>DISABLERS</th>
<th>Projects + interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Access</strong></td>
<td></td>
<td></td>
<td>Access</td>
</tr>
<tr>
<td>Roads</td>
<td></td>
<td></td>
<td>Product bans</td>
</tr>
<tr>
<td>Border posts + ports</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td></td>
<td></td>
<td>Capacity</td>
</tr>
<tr>
<td>Staff &amp; skills</td>
<td></td>
<td></td>
<td>Number of agencies</td>
</tr>
<tr>
<td>Buildings + equipment</td>
<td></td>
<td></td>
<td>Number of documents</td>
</tr>
<tr>
<td><strong>Profitability</strong></td>
<td></td>
<td></td>
<td>Profitability</td>
</tr>
<tr>
<td>Markets &amp; customers</td>
<td></td>
<td></td>
<td>Corrupt officials</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Duties</td>
</tr>
</tbody>
</table>
OUTLINE

Project background and purpose

Why the Trade “system” is difficult (like others!)

Seeing total Trade = sum of its parts

Generic structure of a trade border (+ working models)

Organising the portfolio of Trade-improvement efforts

Issues, challenges and limitations + next steps

Issues, challenges, and limitations

How to specify relationships in the models:
most are arithmetical
involve experienced parties
check performance against reality

Identifying tipping points
many arise when 2 trajectories cross (e.g. rising demand approaches a capacity limit)
behavioural tipping points from research and other cases, especially where crises occur

Binding constraints
models show particular constraints at any point in time –
removing one constraint releases performance until the next is reached (implements “Theory of Constraints”)
Issues, challenges, and limitations

External factors:
trading behaviour also reflects market conditions, enterprise-development and producer-trader relationships – using the model for guidance must recognise these limitations

Where to stop (model boundaries)?
... at the point where enough confidence has been gained (recognising the additional factors above)

Team-based model development
this is a pilot project, to illustrate the opportunity, though knowledgeable parties are being consulted
any real project must be done with those involved, including diverse expertise

Issues, challenges, and limitations

Lack of data:
start with well-informed estimates
use experience from people familiar with other cases
design simple data-collection and adjust the model as we learn

Aim = to improve the system (not just avoid mistakes)
use simple models to identify immediate constraints
simulate promising projects and the programme
model impact of initiatives affecting more than 1 transport mode
adjust initiatives and the models as progress provides more data

Gaining partner adoption of the approach
involve partners in developing the models
... and in selecting/designing projects
... and use the data from tests
Critical ... building shared understanding

Engaging games
Joint planning
Training
Just do it!

Learn the value of the approach

Questions?

What is the best trade value you can build, when you can only focus on limited initiatives

See www.simudyne.com/nigeria

Comments to kim@strategydynamics.com