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The balance between efficiency, resilience and sustainability of infrastructure for development

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The United Nations context

SUSTAINABLE DEVELOPMENT GOAL 9

Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation



SUSTAINABLE DEVELOPMENT GOAL 11

Make cities and human settlements inclusive, safe, resilient and sustainable



Sendai Framework for Disaster Risk Reduction

2015 - 2030

UNITED NATIONS
PARIS CLIMATE
AGREEMENT
SIGNING CEREMONY
— 22 APRIL 2016 —

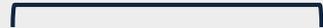




A framework for understanding resilience

1. Context

e.g. social group,
region, institution



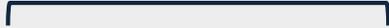
System or
process



Resilience of what?

2. Disturbance

e.g. natural hazard,
conflict, insecurity, flood
shortage, high fuel prices



Resilience to what?

3. Capacity to deal with disturbance



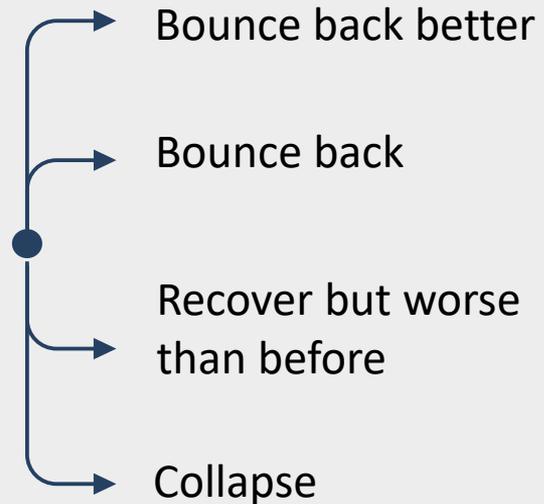
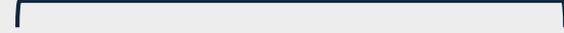
Exposure

Sensitivity

Adaptive
Capacity

4. Reaction to disturbance

e.g. survive, cope, recover, learn,
transform



Source: Based on DFID-UK (2016).



Infrastructure resilience

- **DHS-US:** “The **ability to resist, absorb, recover from, or successfully adapt** to adversity or a **change** in conditions”.
- **NIAC-US:** “The ability to **reduce the magnitude and/or duration of disruptive events**”.

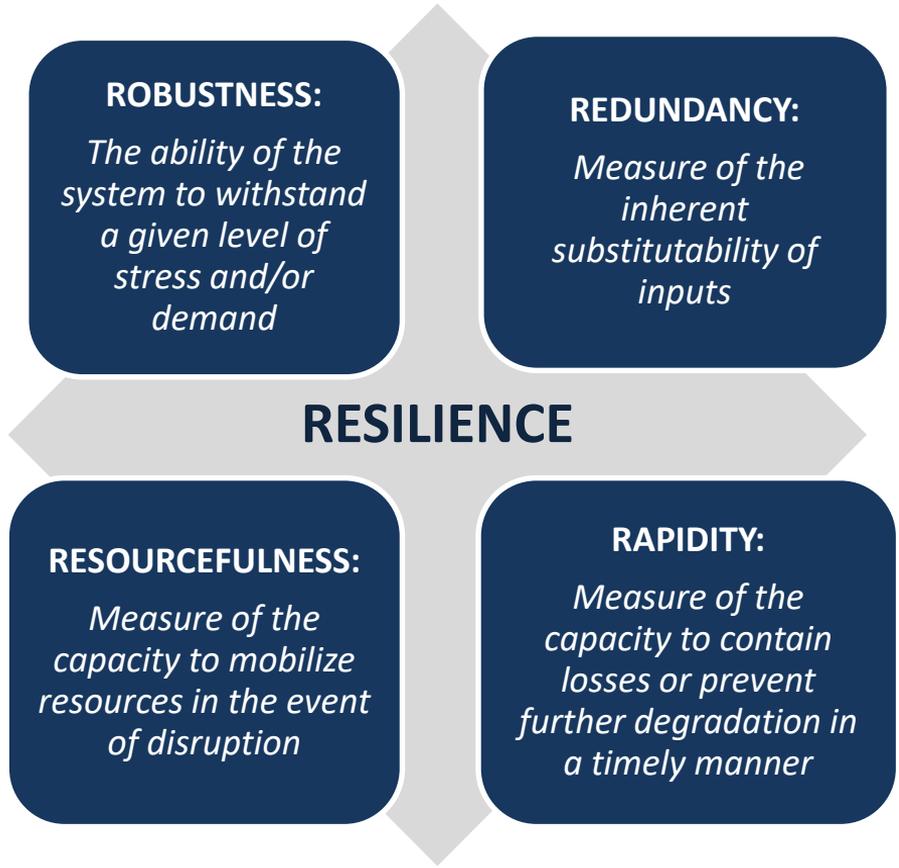
KEY ASPECTS:

1) The resilience of infrastructure itself

2) How infrastructure affects resilience



The components of infrastructure resilience



Source: Based on Bruneau et al. (2003)

Source: Moor et al. (2015)



Resilience properties and dimensions

DIMENSION / QUALITY	TECHNICAL	ORGANIZATIONAL	SOCIAL	ECONOMIC
ROBUSTNESS	Building codes and construction procedures for new and retrofitted structures	Emergency operations planning	Social vulnerability and degree of community preparedness	Extent of regional economic diversification
REDUNDANCY	Capacity for technical substitutions and “workarounds”	Alternate sites for managing disaster operations	Availability of housing options for disaster victims	Ability to substitute and conserve needed inputs
RESOURCEFULNESS	Availability of equipment and materials for restoration and repair	Capacity to improvise, innovate, and expand operations	Capacity to address human needs	Business and industry capacity to improvise
RAPIDITY	System downtime, restoration time	Time between impact and early recovery	Time to restore lifeline services	Time to regain capacity, lost revenue

Source: O’Rourke (2007).



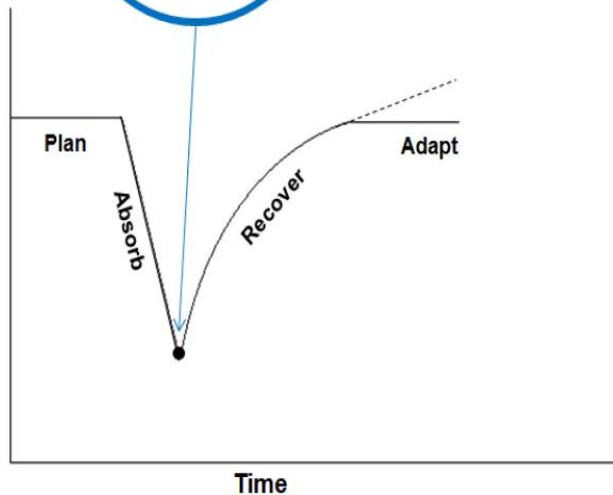
A visual representation of resilience



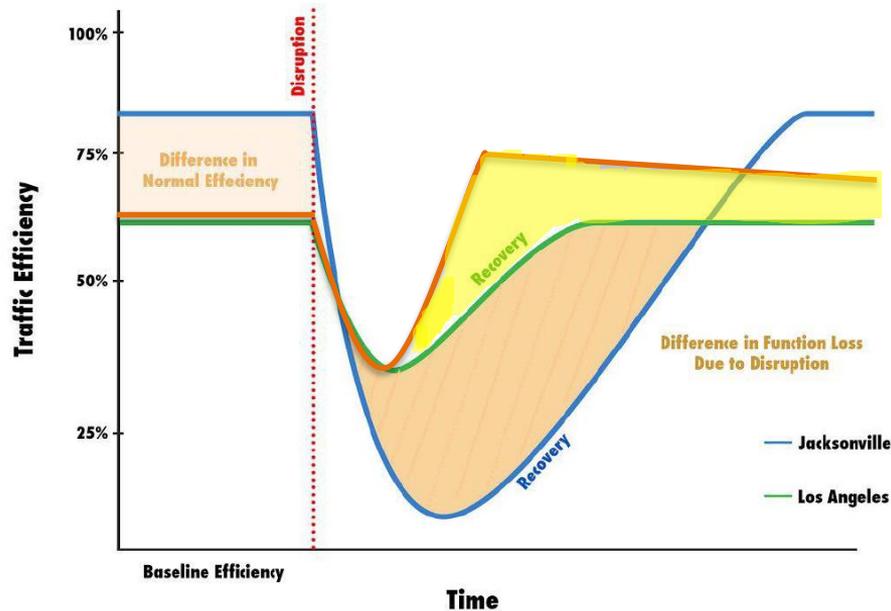
Risk
Analysis

System
Resilience

Critical
Functionality

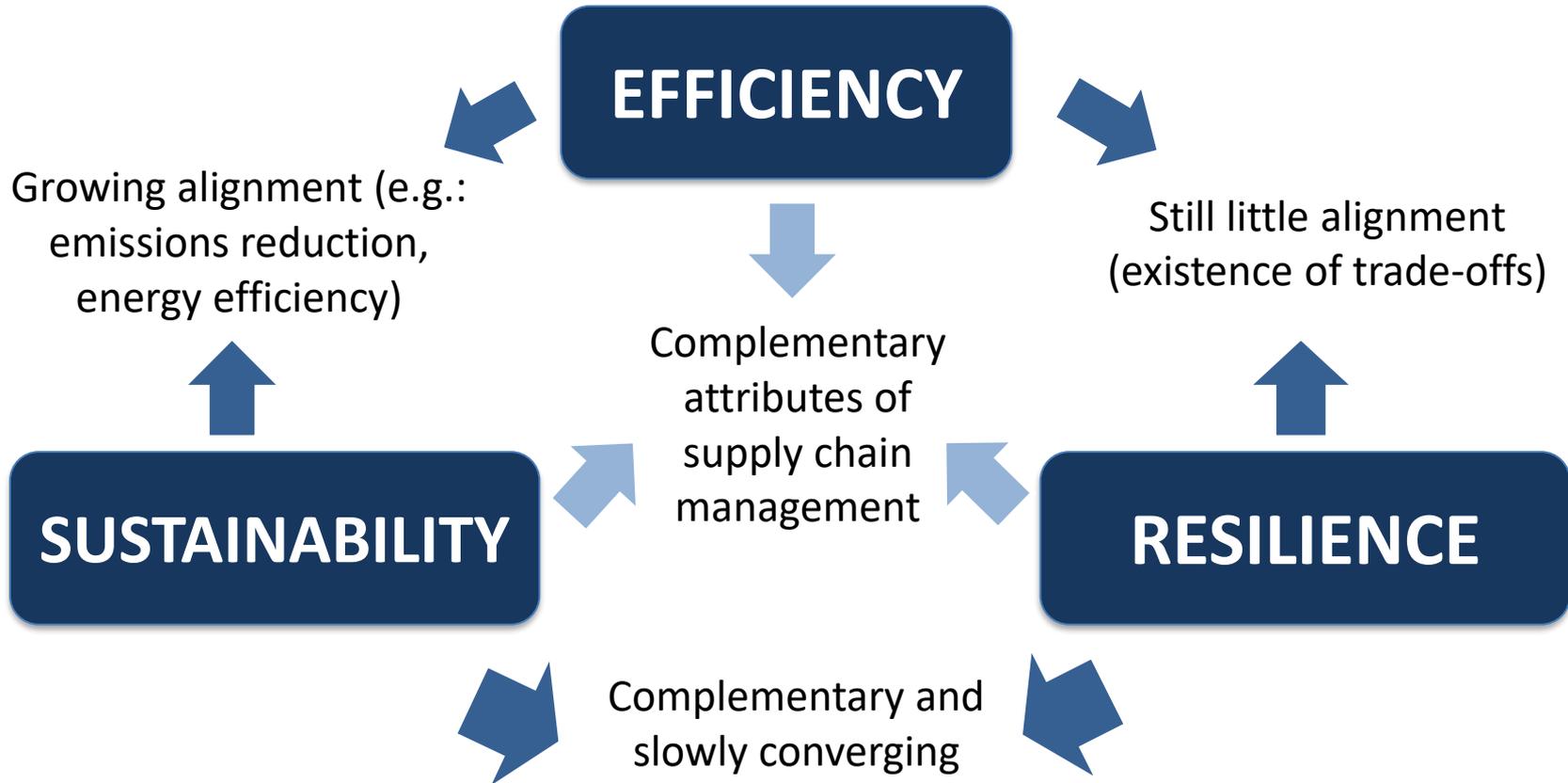


Comparative Performance of Traffic Networks With No Disruption Vs. Traffic Networks After Disruption





Finding a balance for multi-modal supply chains



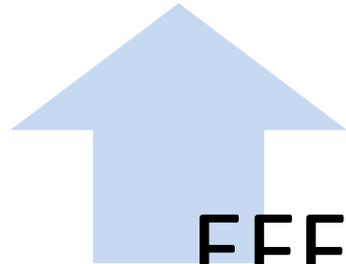


The relationship between efficiency and resilience

Inventory
reduction

Capacity utilization
improvement

Outsourcing



EFFICIENCY



RESILIENCE



The relationship between efficiency and resilience

Possible trade-off
between efficiency
and resilience

“... care must be taken to balance the cost reduction drive to those of the flexible resilient organization, since it is generally possible to get lower costs with restrictions, organizations will end up paying more for the desired flexibility and resiliency”.
(Banomyong, 2018)

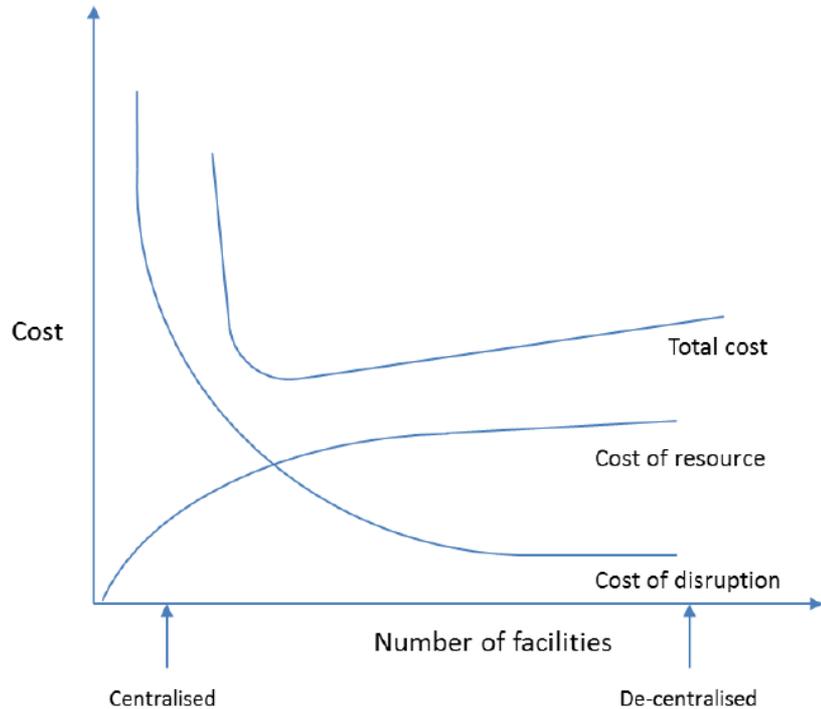
BUT...

Costs of disruption (non-resilience) are hardly ever taken into account



Example: Supply chain re-engineering

Resilience x Supply Chain Centralization



“... If supply chains can be designed, wherever possible, to avoid the reliance on a single facility or source of supply then resilience will be enhanced. In a sense there is a trade-off between the cost savings resulting from consolidation and centralization and the resulting risk implications.”

(Christopher, 2018)



Infrastructure resilience in Latin America: a regional perspective

INVESTMENT, OPERATION AND MAINTENANCE

- Infrastructure gap
- Poor conservation (roads!)

PUBLIC POLICY

- Modal Split > Externalities (e.g. congestion and emissions)
- Security and safety

INDUSTRIAL ORGANIZATION

- Concentration / Competition

REGIONAL INTEGRATION

- Lack of regional coordination and integration



Infrastructure resilience: important remarks (i)

Integrated approach to infrastructure and logistics

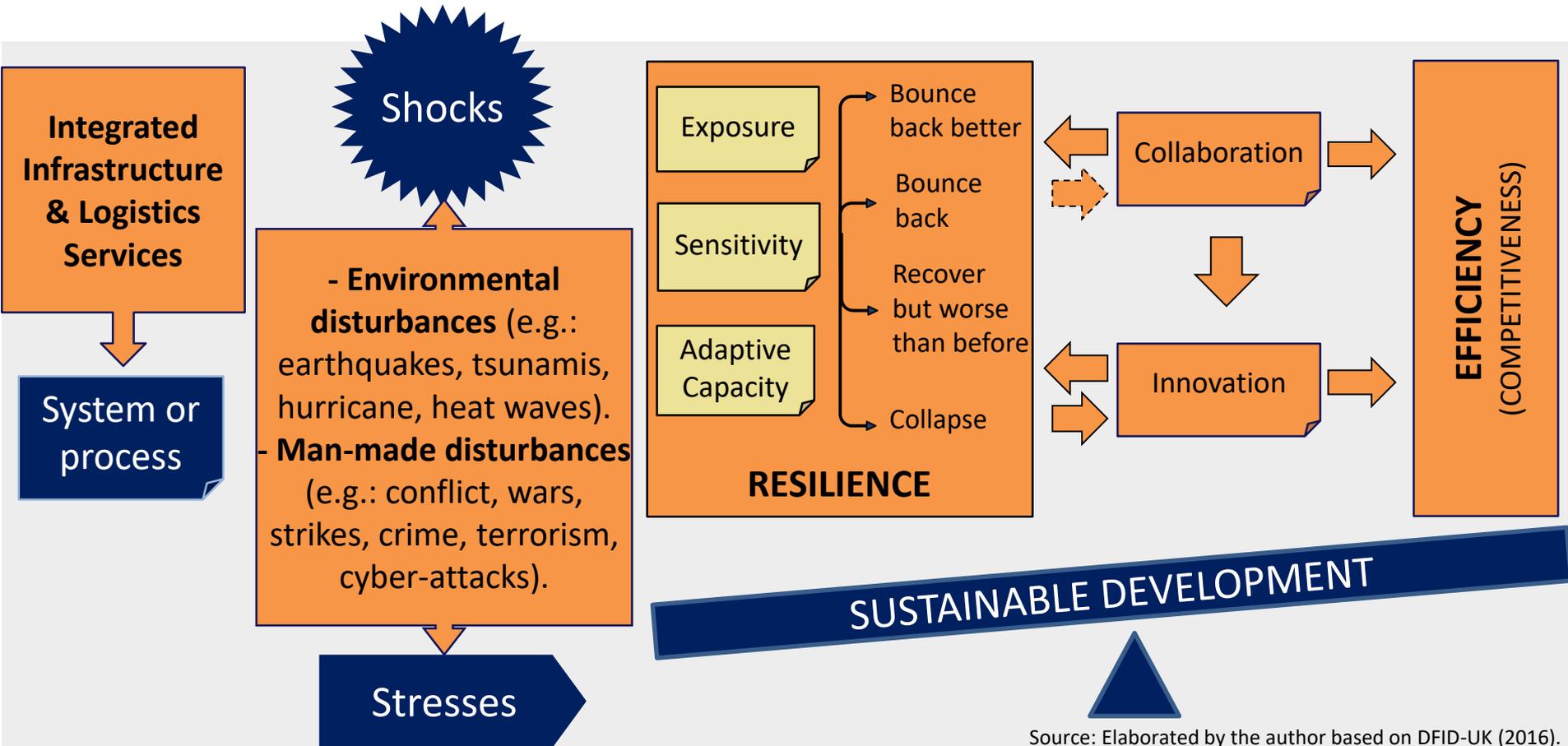
- The assessment of resilience should not separate infrastructure from services. In turn, both elements should be assessed in an integrated way.

Sustainability-based approach

- Resilience of infrastructure should be assessed not only in relation to climate change impacts, but to a range of disturbances linked to natural and/or man-made events and processes.
- A sustainability-based approach, which accounts for economic, social and environmental elements, is needed.
- Sustainability implies cooperation and competitiveness in the long-run.



An expanded framework for understanding infrastructure resilience





Infrastructure resilience: important remarks (ii)

The balance between resilience, efficiency and sustainability

- Trade-off?
- Costs of non-resilience.
- The infrastructure gap.
- The infrastructure gaps and the opportunities.
- Increased resilience.



Thank you!

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