UNIVERSITY OF CAMBRIDGE

Resilience in Digitally Mediated Critical Urban Systems

Viviana Bastidas Melo
Assistant Research Professor
Centre for Smart Infrastructure and Construction (CSIC)
University of Cambridge
vab44@cam.ac.uk

The Ove Arup Foundation ai@cam AISI AI SECURITY INSTITUTE

Overview

- **Resilience** and critical infrastructures
- **Digital technologies** for resilient urban systems
- **Critical Urban Systems** in the age of AI

The Concept of Infrastructure Resilience

"A mechanism for understanding how infrastructure systems can **survive uncertain extreme events** outside traditional design boundaries, **achieve** a **safe-to-fail** state and **recover functionality**."

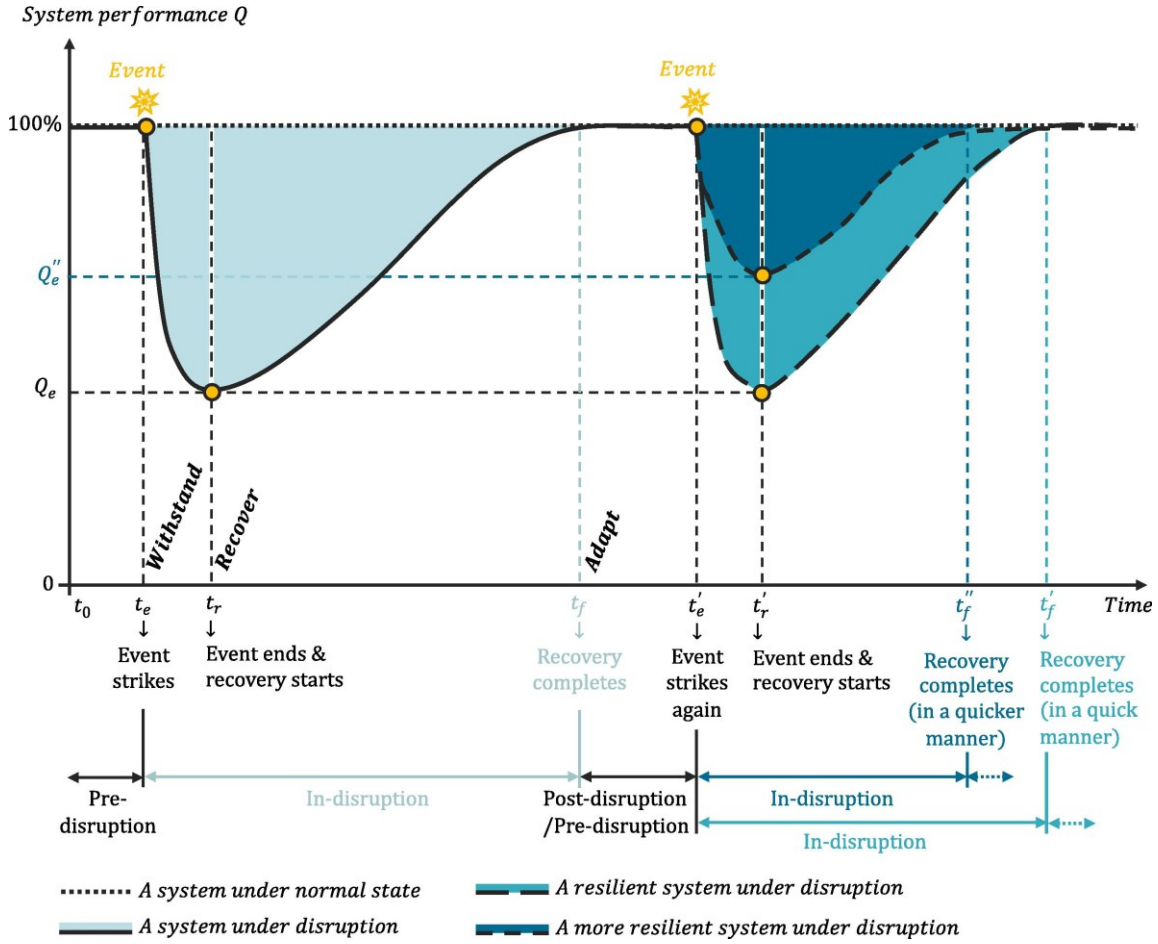

Fig 1. Conceptualisation of Infrastructure resilience [1]

[1] Bi, W., MacAskill, K. and Schooling, J., 2023. Old wine in new bottles? Understanding infrastructure resilience: Foundations, assessment, and limitations. Transportation Research Part D: Transport and Environment, 120, p.103793.

Resilience and its Multidimensionality

Why understanding its multidimensionality matter for critical systems in practice

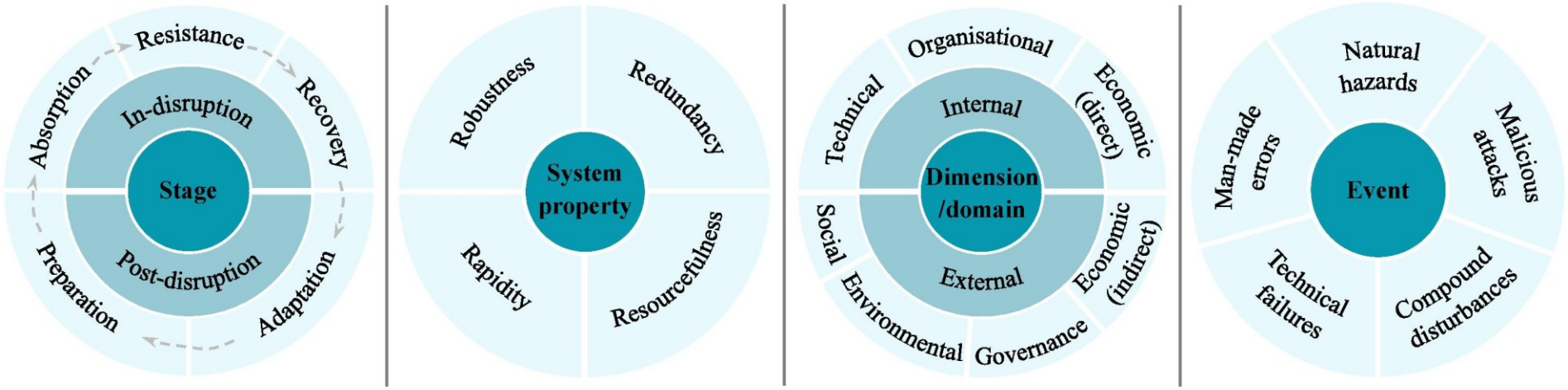

Fig 1. The multidimensionality of infrastructure resilience [1]

[1] Bi, W., MacAskill, K. and Schooling, J., 2023. Old wine in new bottles? Understanding infrastructure resilience: Foundations, assessment, and limitations. Transportation Research Part D: Transport and Environment, 120, p.103793.

Resilience in Urban Socio-technical Systems

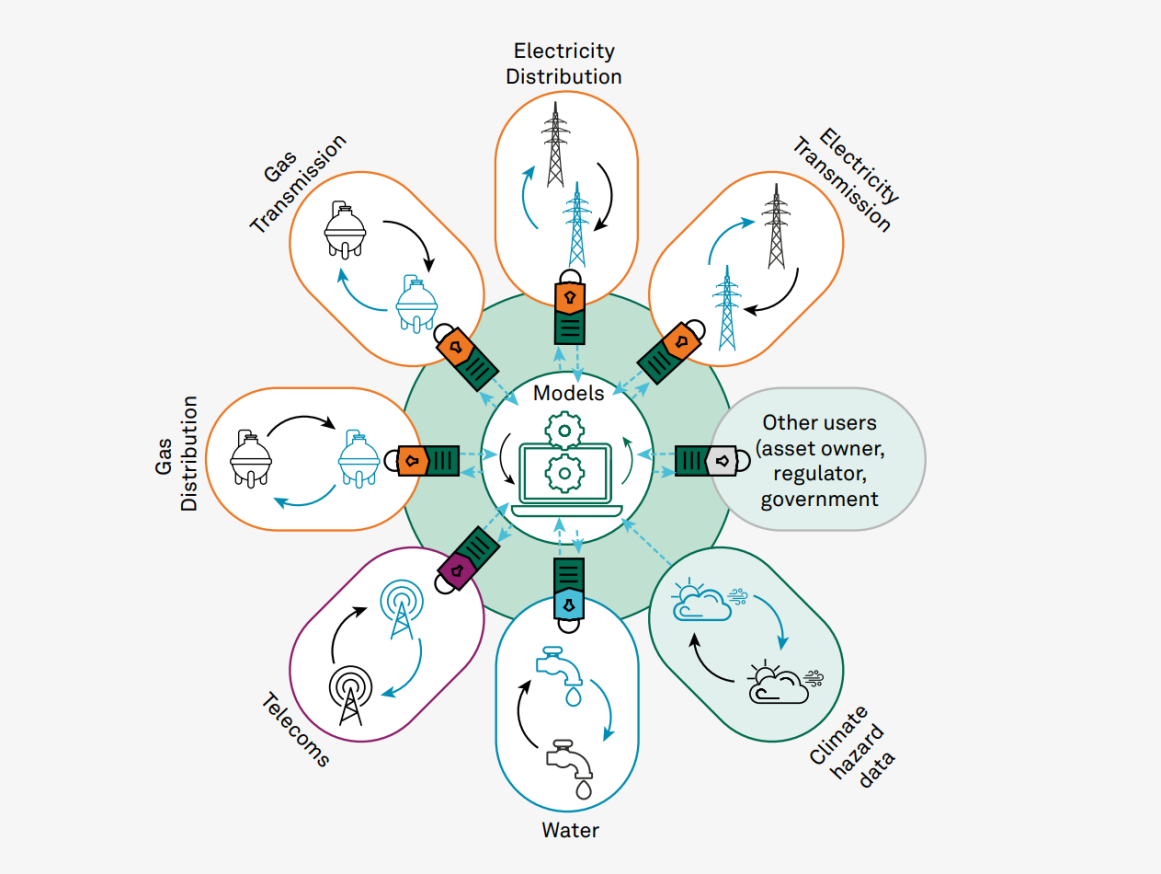

Fig 2. The UK's Climate Resilience Demonstrator (CReDO)
https://cp.catapult.org.uk/case-study/unlocking-climate-resilience-through-connected-digital-twins/

Unlocking climate resilience through connected **digital twin systems**:

- Fragmented oversight
- Cascading risks
- Gaps in resilience
  - → Secure
  - → Scalable
  - → Cross-sector data collaboration

Resilience in Urban Socio-technical Systems

Fig 3. Residents transfer money using the M-Pesa banking service at a store in Nairobi, Kenya [2]

Digital technologies to promote **community resilience** [2]:

- **Kenya**: mobile money for building **economic resilience** among communities.
- **Latin America**: early warning systems for **natural disaster** response.
- **Mexico**: digital systems to monitor **water quality and access**.
- **Africa's rural areas:** mobile phones and the internet are helping to bridge the **digital divide**.

[2] Mehan, A., 2023. The role of digital technologies in building resilient communities. *Bhumi, The Planning Research Journal*, *10* (1).

The Systems Engineering Approach in Times of Large Language Models

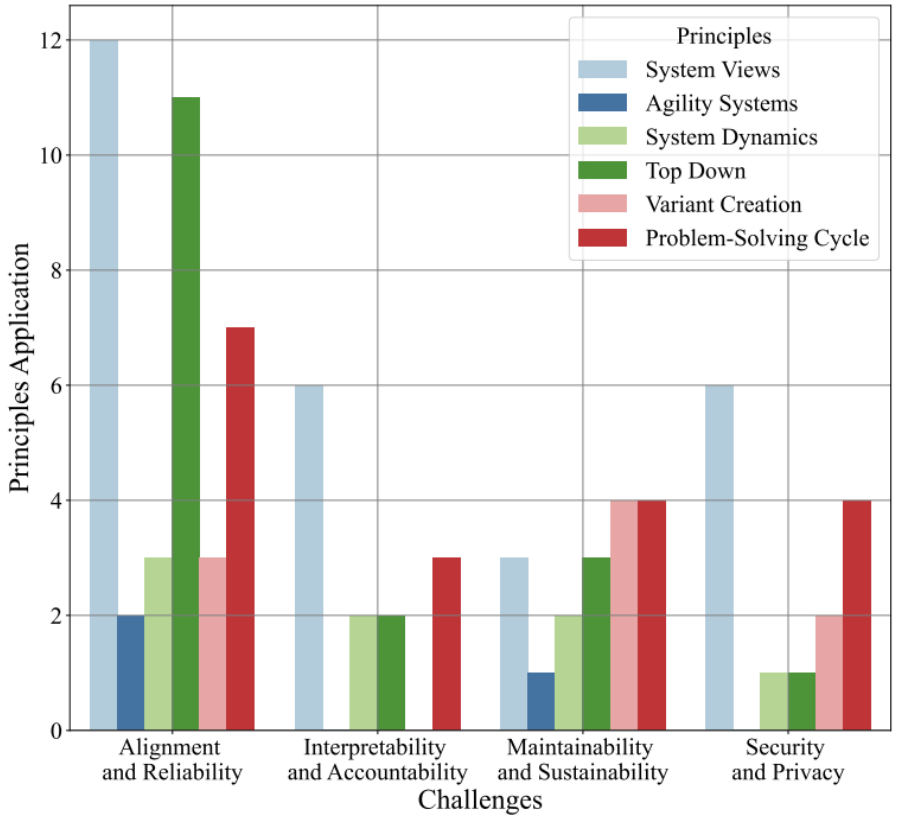

Fig 4. Systems engineering principles to address the identified LLM challenges [3]

LLMs inject new threats into critical socio-technical systems

⇩

Agile culture lowers the bar for what counts as safety-critical

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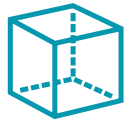
"**The Systems Engineering approach** is better equipped to facilitate **the adoption of LLMs** by prioritising the problems and their context before any other aspects" [3].

[3] Cabrera, C., **Bastidas, V.**, Schooling, J. and Lawrence, N.D., 2024. The systems engineering approach in times of large language models. Proceedings of the 58th HICSS.

Summary



Resilience needs to be seen as a **multidimensional concept.**

Digital twins are challenged by **secure**, **scalable**, **cross-sector** collaboration.

Governed, context-sensitive digital systems are a precondition for resilience that communities need and firms can trust.

The **systems engineering** approach can facilitate **the adoption of AI** in critical **socio-technical** systems.

Thank you!

vab44@cam.ac.uk