Dimensions of Lifeline Dependencies

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Lifeline Dependencies

Interdependencies will make disaster recovery much more difficult. The earthquake will damage all systems at the same time.

To restore water service, you need electricity

To restore electric service, you need to reopen roads

To reopen roads, you need to restore fuel supplies

Refinery

Fuel Storage Container
Dimensions of Dependencies

• Internal and External
• Time
• Space
• Source

(These dimensions may not be independent)

Source: NIST CRPG 2015
Internal and External Dependencies

• Internal Dependency (examples)
  • Physical Infrastructure System
  • Equipment and Repair Supplies
  • Operations Center (and more)
  • Employees

• External Dependency (examples)
  • Transportation
  • Power
  • Communication (and more)
  • Contractors
  • Personnel from other regions
  • Financial

(It is also good to consider who may depend on your system)
Space Dimension
Source Dimension

Additional Examples
- Wholesale Water Supplier
- Wholesale Power supplier

Time Dimension

- Recovery Phases
  - Short-Term, Intermediate, and Long-Term
- Dependencies may change from one phase to another

Source: National Disaster Recovery Framework
2010 Chile Earthquake - Concepcion

Short Term:

• Multimodal Transportation
  – Airport: minor nonstructural damage
  – Navy ship + helicopters (1st week) due to port damage
  – Roads to/around the city restored within 1st week

• Power
  – Transmission level (500 KV, 220 KV) within 24 hours
  – sub-transmission level (66KV, 110KV, 154 KV) within 72 hours

• Telecommunication (co-location, power outage, equipment damage)
  – Landline
  – Wireless (only 4 up to 8 hrs battery)
  – Critical central offices with generators
  – Lack of fuel and difficult access to generators

• Refineries Shutdown for inspection
  – Aconcagua refinery
  – Bio-Bio refinery
    • Damaged refractory of heater
    • crude oil feeder pipeline damage
  – Power outage
2010 Chile Earthquake - Concepcion

Intermediate Term:

- **Multimodal Transportation**
  - Airport: Significant operation increase for relief (& commercial flights after 10 days)

- **Power**
  - Distribution restored within 2 weeks
  - Staff augmentation (from other regions/country)

- **Telecommunication**
  - Landline restored first (in 7-8 days)
  - Wireless (followed power restored)

- **Refineries**
  - Restart Aconcagua refinery in 7 days

- **Water**
  - Water pipes broke
  - Stabilized pump station
  - Water containers at distribution points

- **Wastewater**
  - Secondary Clarifier & CCB damaged
  - Protect public health by discharging to river

Source: ASCE TCLEE 2013
Approximate Fraction of Customers with Service

Days after the Earthquake

Source: ASCE TCLEE 2013
2010 Chile Earthquake - Concepcion

Long Term:

• Multimodal Transportation
  – Bridges
  – Ports

• Power
  – 154 KV River Crossing Transmission Towers (3)
  – Replace long lead equipment

• Refinery
  – Bio-Bio refinery restarted in 4 months

• Water
  – Pump station
  – Intake structure
  – Clarifiers
  – Broken pipes

• Wastewater System
  – Secondary Clarifier & CCB
  – Broken Pipes

Source: ASCE TCLEE 2013
Remarks

• Improve Data Collection to Better Capture Dependencies

• Regional Planning to Develop Solutions

• Develop Business Continuity Plan

• Help FEMA Restart Lifeline Guideline Development
Thank You