Monitoring Business Resilience After Earthquakes: EERI Pilot Programs in CA and OK

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Committee membership

Diverse group of perspectives and experience:

- **Ibrahim Almufti**, Arup
- **Cynthia Kroll**, Association of Bay Area Governments
- **Mike Mieler**, Arup
- **Anne Wein**, USGS
- **Yu Xiao**, Portland State University
- **Heidi Tremayne**, EERI

Later joined the committee:

- **Alex Greer**, Oklahoma State University
- **Ezra Jampole**, Exponent
- **Nicole Paul**, Arup
- **Tristan Wu**, Oklahoma State University

With help from **Omar Plata**, intern at EERI, for further work
Outline

- Background
- Development process
- Survey overview
- Napa pilot program
- Cushing pilot program
- Next steps
A Shift in Paradigm...

Building and Infrastructure Centric  →  Resilience based

What is “resilience?”
What is “resilience?”

“The term "resilience" refers to the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.”

Its communities, through mitigation and pre-disaster preparation, develop the adaptive capacity to maintain important community functions and recover quickly when major disasters occur.
To measure resilience

- Resilience is a system concept
- We should observe performances of multiple systems and their interdependencies
  - Natural environment
  - Built environment
  - Social, political, and economic systems

- We should take a long-run approach
Objectives

Develop a consistent set of survey questions to:

- Monitor business recovery issues in near real time
- Answer important longer term research questions
- Facilitate comparisons across different earthquakes
Development process

- Assemble interdisciplinary team
- Review existing survey tools and identify research needs
- Develop draft set of survey questions
- Revise survey tool using feedback from technical review
- Conduct pilot study in Napa and Cushing to further refine survey
- Develop survey instruments for future use
# Survey organization

- Comprises two different modules:

<table>
<thead>
<tr>
<th>Audience</th>
<th>Building damage survey</th>
<th>Business impacts survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timeline</td>
<td>Once, soon after earthquake</td>
<td>Several times after earthquake</td>
</tr>
</tbody>
</table>

### Relevant data

<table>
<thead>
<tr>
<th>Building damage survey</th>
<th>Business impacts survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent and severity of damage</td>
<td>Business baseline conditions</td>
</tr>
<tr>
<td>Building placard</td>
<td>Physical damage</td>
</tr>
<tr>
<td>Utility disruption</td>
<td>Building downtime</td>
</tr>
<tr>
<td></td>
<td>Business recovery</td>
</tr>
<tr>
<td></td>
<td>Funding and finance</td>
</tr>
<tr>
<td></td>
<td>Resilience</td>
</tr>
</tbody>
</table>
Timelines of Survey Implementations

- Earthquake Occurs
- Business Survey (Initial Survey)
- Intermediate Business Survey(s)
- Final Business Survey

Building damage survey
Deployment in Napa

Earthquake occurs
(24 August 2014)

- ~ 3 months: EERI invites three members of Resilience Panel to form Working Group
- ~ 9 months: Draft survey sent to reviewers
- ~ 24 months: Business impacts survey piloted in Napa
Pilot study in Napa

- Significant effort to survey diverse cross-section of businesses (cold calls, newspaper editorial, Twitter, Mayor’s office)
- Yielded 20 complete survey responses (takes 20 min to 60 min to complete)
- Limited dataset due to:
  - Survey launch 2 years after earthquake
  - Not many significantly impacted businesses
- Building damage survey was not performed – information taken from available sources such as ATC, SEAOC, EERI
Pilot Study in Cushing, OK

M5.0 earthquake in Cushing, Oklahoma, on November 7, 2016
EERI Reconnaissance November 14-16, 2016
Sampling

- Unit of Analysis: Individual Business
- Sampling Frame: Business List from ReferenceUSA
- Sampling Strategy: Random Sample

Full list of over 400 Businesses

Random Sample of 150 Businesses
Day 1 Morning: Entire team met with City Manager

Day 1 Afternoon: Recon in smaller teams

Day 2: Business survey + building damage assessment with adjusted sample

Day 3 Morning: Wrap up work
Departed from Cushing after lunch
Team Composition

Engineers + Social Scientists
Team Composition

- Pair up one Engineering with one Social Scientist

Damage Assessment

Business interview
Technologies

- Google Map

Quick-Tap Surveys

Building Damage Survey (FIN...)

1. Please record time in using 4 digits and 24 hour format (e.g. 0230 for 2:30AM and 1425 for 2:25PM)

2. Please record building PIN number if known

3. Please enter your initials.

4. What is your expertise in building design, construction or inspection?

Business Info Survey -- Cushi...

14. Damage extent reported by owner for: Building damage

15. Damage extent reported by owner for: Inventory damage

16. Damage extent reported by owner for: Equipment/machiner damage

17. Damage extent reported by owner for: Other damage (please specify type in next question)
### Results

Table 3. Building damage assessment conducted by the EERI Reconnaissance Team for downtown Cushing, OK, categorized by severity of damage (source: EERI Reconnaissance Team survey).

<table>
<thead>
<tr>
<th>Building Damage</th>
<th>Numbers of Building</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No damage</td>
<td>6</td>
<td>11.5</td>
</tr>
<tr>
<td>Minor damage</td>
<td>31</td>
<td>59.6</td>
</tr>
<tr>
<td>Moderate damage</td>
<td>9</td>
<td>17.3</td>
</tr>
<tr>
<td>Severe damage</td>
<td>6</td>
<td>11.5</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Figure 26. Self-reported severity of damage to various components of necessary for business operation by businesses in the downtown area of Cushing, Oklahoma (source: EERI Reconnaissance Team survey).
Results (cont.)

Figure 27. Lifeline loss as reported by business owners in the downtown area of Cushing, Oklahoma (source: EERI Reconnaissance Team survey).
Results (cont.)

Damage to Business Buildings

Business Operational Status
Follow-up surveys

- Oklahoma State University
- Follow-up business surveys in May 2017
- 150 flyers distributed, 3 completed responses after 3 weeks
Lessons learned

- Systematic data collection allows for long-run observation of recovery
- Informed reconnaissance can increase efficiency
  - Maps of businesses and damaged properties help team navigate and find the appropriate places to go
- The strategy of pairing up an engineer with a social scientist worked well
- Lack of responses in the follow-up survey due to low severity of the earthquake
Next Steps

- Polish building damage survey and business surveys
- Choose the survey platform
- Streamline the reconnaissance procedure
  - IRB
  - Sampling strategy
  - Survey strategy
  - Team formation
Questions? Comments?