Impact of Safety Climate on Lone and Remote Workers

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*generating knowledge to help people live safer and more secure lives*

**Mission:**
To advance scientific, business-relevant knowledge in workplace and highway safety, and work disability

Conducting non-proprietary research – findings are published in the peer-reviewed scientific literature
Catastrophic STS Failures - Lessons

- Weak management of manning levels, workload, shiftwork, often due to downsizing
- Inadequate training
- Lack of communication
- Poor safety culture, morale
- Human-system interface deficiencies
  - Over/under-reliance on automation
  - Information overload
- Inadequate knowledge about system state in relation to safety boundaries
  - Safety Management Systems, metrics, oversight
- Inadequate internal systems model
Research Objectives

- Understand the existence/formation of safety climate in **lone and remote workers**, and its impact on safety behaviors and outcomes

- Develop valid and reliable safety climate scales for
  - Trucking industry
  - Utility/electric industry

- Test the validity of the generic SC scale for lone/remote workers
Unique Strengths

• Industry-specific content
  – focusing on competing demands (context-dependent)
  specific to industry sector, but including generic scale items

• Multi-level approach
  – Surveyed employees’ perceptions of safety priorities of
  immediate supervisors (Group level) as well as top
  managers (Company level)

• Surveyed employees and supervisors

• Large sample sizes across multiple companies

• Collected both subjective and objective safety data

• Confirmed reliability and validity
  – Scale psychometric development was highly rigorous
Reliability and Validity

- Content Validity (Expert Panel)
- Exploratory Factor Analysis
- Cronbach’s Alpha Reliability (coefficient of internal consistency)
- Confirmatory Factor Analysis
  - Fit Indices Confirm Structure
- Criteria Related Validity
  - Subjective Behavior Ratings
  - Objective Individual/Group Safety Scores
  - DOT Company Level Safety Scores (trucking)
SC in the Trucking Industry

Data collected:

- **Subjective**: SC and self-reported behaviors
- **Objective**: accident/injury data (6 mo and 3 yrs post survey)

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<thead>
<tr>
<th>Company</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td># Respondents</td>
<td>558</td>
<td>248</td>
<td>2,030</td>
<td>461</td>
<td>290</td>
<td>4,003</td>
<td>235</td>
<td>270</td>
</tr>
<tr>
<td>Response Rate</td>
<td>55%</td>
<td>73%</td>
<td>34%</td>
<td>37%</td>
<td>58%</td>
<td>51%</td>
<td>40%</td>
<td>N/A</td>
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- 8 Large trucking firms in the US
- 9,095 respondents (8095 employees, 1,000 supervisors)
- Final SC survey includes 40 items (20 Group-level, 20 Company-level Safety Climate)
Injury Rate versus Safety Climate Score for Participating Carriers

\[ R^2 = 0.5905 \]
SC in the Utility Industry

Data collected:
- **Subjective:** SC, self-reported behaviors, self-reported accident/injuries
- **Objective:** Group-level accident/injury data

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<tr>
<th>Company</th>
<th>A</th>
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<tbody>
<tr>
<td># Respondents</td>
<td>1,560</td>
<td>869</td>
</tr>
<tr>
<td>Response Rate</td>
<td>46%</td>
<td>74%</td>
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- Two large electric utility firms
- 2,421 respondents
- 48 item survey (19 Group-level, 29 Company-level)
SC and Safety Behavior for Utility Workers
Key Findings

- **Generic scales** and **industry-specific scales** are reliable and valid instruments for measuring SC in lone workers (true for both trucking and utility workers).

- Both generic and industry-specific scales predicted driving safety behavior (self-reported) and road injury outcomes (accident data).

- The industry-specific safety climate scale demonstrated stronger predictive value than the generic scale (data only available for trucking).
Scale Attributes

- Measurement equivalence for the 12-point *generic scale* confirmed strong external validity across 3 industries, 11 companies (including third industry with remote workers)
- The trucking *industry-specific safety climate scale* items and measurement constructs have consistent meaning across different trucking companies
Employee vs. Supervisors’ Perceptions
(Trucking and Utility Industries)

• For both company- and group-level safety climate, employee and supervisor perceptions of safety climate were significantly different
  – supervisors consistently reported higher levels of safety climate

• Only employee perceptions of safety climate significantly predicted safety behavior (directly) and injury outcomes (indirectly)
  – supervisor perceptions had no predictive value
Leaders Create Culture

Testing the role of contextual factors of lone work known from the management science literature

Leader-Member Exchange (LMX) and Work Ownership both promote safety climate
Interaction Between Group and Organization Safety Climate

• The highest levels of safety behavior occur when both Company-level SC and Group-level SC are high

• If either Group-level or Company-level SC is high, the overall impact on Safety Behavior for lone workers is good

• Supervisors with high commitment to safety are critical, especially for companies with low Company-level SC
Safety Climate Affects Work Quality

- Company-level and Group-level safety climate perceptions directly influence **job satisfaction**, **employee engagement**, and objective **turnover rate** (3 years after survey).
Towards Evidence-Based Interventions

• Safety climate is a valid thermometer across diverse settings and applications

• While predictive of outcomes, and able to discriminate good from bad organizations, SC is not diagnostic

• Intervention requires systematic evaluation to identify system weak points

• For complex systems, other indicators (surveillance, probes, tests, etc.) may be required to guard against “drift into failure”
  – Complex sociotechnical systems are dynamic and non-linear and may require continuous adaptation
Safety as an Emergent Property

Sociotechnical System Perspective

- Human System Integration
- Social-organizational context (safety Culture)
- Broader work and demographic milieu
The Future

- Exploring the intersection between safety climate, resilience engineering and management science
- Developing interventions based on SC screening followed by comprehensive analysis guided by sociotechnical systems theory
References


