Beyond Metric-Centric Adaptation:
Redefining Occupational Heatwave Governance through Living Lab Co-creation

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News Case

Death of a Cart Pusher in 33° C Heat

In June 2023, a 29-year-old worker died of heatstroke while managing shopping carts at a Costco parking lot in South Korea, having walked 43,000 steps the previous day. Despite an ambient temperature of 33° C, the parking structure acted as a lethal heat trap, where stagnant engine emissions and asphalt radiant heat created a micro-climate that far exceeded regulatory safety thresholds. Although the worker repeatedly signaled his distress, stating, "My chest feels heavy" and "I can't breathe," the standardized monitoring system failed to recognize these physiological signals as a crisis. The subsequent autopsy confirmed the cause of death as pulmonary embolism driven by excessive dehydration, revealing a fatal gap between macro-scale metrics and the lived, biological reality of the worker.

1. Research Background

Why Is Perceived Heat Risk Overlooked?

Just as other fields utilize perceived realities to complement objective metrics, climate adaptation for outdoor labor must integrate Perceived Risk to fill the gaps in existing technical thresholds.

Field	Standard Metric	Perception	Purpose
Economics	Growth Rate (GDP)	Consumer Sentiment	Household Realities
Meteorology	Air Temperature	Apparent Temperature	Reflects Body Feels
Heat Risk	Technical Thresholds	{ }	{ }

Outdoor workers' perceived risks and embodied symptoms reveal what metrics miss.

2. Research Questions

From this gap, the study asks:

RQ 1. The Blind Spots of Metric-Centric Governance
How do standardized technical metrics fail to capture the localized environmental stressors and "lived realities" of outdoor workers?

RQ 2. Perceived Risk as Empirical Evidence
Can workers' "perceived risk" serve as a high-fidelity diagnostic signal to identify and fill the structural gaps in existing monitoring systems?

RQ 3. Redefining Governance through Co-creation
How can Living Lab co-creation integrate these lived insights to complement and refine current occupational heatwave governance?

3. Methodology: Field-Based Living Lab Approach

Outdoor workers face long working hours, shift work, strict safety regulations, and precarious employment, making sustained participation in Living Lab co-creation difficult. As reported in European case studies, such constraints require alternative methods, including observation, in-depth interviews, and partnerships with labor unions or professional associations. Given these limitations, this study adopted a field-based Living Lab approach, **in which researchers visited worksites to listen to workers' voices and seek solutions.** Data were collected from 36 outdoor workers from 2 industries in Incheon Metropolitan City during the 2025 heatwave season.

Category	Participants	Date	Number
Port	**Port Workers A spot**	Aug 26	20
	Port Workers B spot	Sep 02	10
Manufacturing	**Chemical Manufacturing Workers**	Aug 11, 21	6
Total	2 Industries-3 Workplaces		**36**

4. Theory and Framework

Epistemic Injustice (Fricker, 2007)
- Explains how workers' embodied experiences of heat stress can be reduced to subjective complaints in institutional risk assessment
- Shows why workers' experiential knowledge is often not recognized as legitimate risk knowledge

Situated Knowledges (Haraway, 1988)
- Argues that knowledge is produced from specific positions and contexts
- Frames workers' perceptions as situated knowledge generated within workplace micro-climates

Post-Normal Science (Funtowicz & Ravetz, 1993)
- Provides a methodological basis for including affected actors under conditions of uncertainty and high stakes
- Supports the inclusion of workers as part of an "extended peer community" beyond technical experts

5. Analysis: Worker Perception

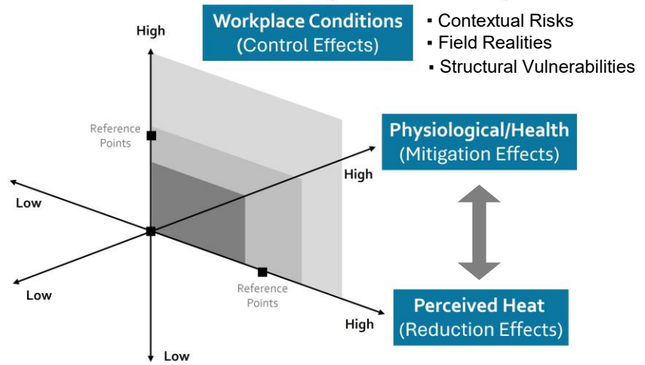
The contextual risks highlighted in this study are exacerbated by environmental constraints. **Radiant heat** from steel surfaces exceeding 45°C, as experienced by port workers, and **internal heat accumulation** in chemical manufacturing processes represent "field realities" that standard meteorological observations, such as 33°C air temperature, fail to capture. In chemical manufacturing environments, openings may be restricted for safety reasons related to hazardous material management, creating structural vulnerabilities that limit cooling and ventilation and intensify thermal stress.

▲ **Port:** Direct sunlight + steel-plate radiation → Surface heat load
Mobile shade/Cold bottled water

▲ **Chemical:** Internal heat + limited ventilation → Heat stagnation and amplification

Risk Formation	▪ Heat risk emerges when bodily symptoms intersect with workplace conditions. ▪ Workers detect danger through embodied signals such as sweating, dehydration, dizziness, and fatigue.
Port Sites	▪ Direct sunlight, asphalt and steel radiant heat, vessel schedules, and loading routes intensify heat exposure. ▪ Mobile shade and wearable cooling devices are limited by wind, discomfort, and safety risks. ▪ Highly heat-exposed tasks are often assigned to daily workers, revealing unequal protection.
Chemical Sites	▪ Chemical reactions, high-temperature processes, humidity, and large equipment amplify heat. ▪ Limited cooling and ventilation appear as symptoms such as dehydration and reduced urination.

Figure 1. Solution-Derivation Framework for occupational Heat Adaptation



6. Conclusion and Discussion

- Worker perception data reveal heat risks missed by standard metrics.
- Living Lab reframes workers **as epistemic agents** in occupational heat adaptation.
- **A complementary governance model** is needed to connect lived experience, technical monitoring, and site-specific solution design.
- Beyond physical location, outdoor workers must be redefined as **'climate-vulnerable workers'** whose lived heat distress transcends standard metrics (cf. ILO, 2024)
- **Worker Perception Data→Information→Knowledge→Scientific/Policy Evidence**

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