Human-Aware Work Systems

Vision, Phased Roadmap, and MVP (Safety Twin Lite)

Compiled from the current canvas • October 09, 2025

This document consolidates the research-backed venture vision, MVP definition, adoption drivers, barriers & mitigations, multi-year roadmap, and compliance guardrails.

Venture Vision: Human-Aware Work Systems

A roadmap toward intelligent, empathetic, and safe workplaces.

> **Research standard:** All factual statements below include source attributions (organization + year). Live links are provided in chat.

0. Market Rationale & Problem Definition

The Core Problem

Construction and field-work industries remain high-risk and data■fragmented.

- **Global burden:** Nearly **3 million workers die each year** due to work■related accidents and diseases (International Labour Organization, 2023).
- **U.S. construction risk:** In **2023, U.S. construction recorded 1,075 fatalities**; falls alone accounted for **421 deaths** (Bureau of Labor Statistics release & OSHA Stand■Down page, 2024).
- **Economic drag:** The **total cost of work injuries in 2023 was $176.5B**; **cost per medically■consulted injury averaged $43,000** (National Safety Council Injury Facts, 2025).
- **Operational reality:** Mid■sized contractors juggle multiple siloed portals (IoT sensors, wearables, equipment telematics) and largely **react** to lagging indicators instead of anticipating hazards (National Safety Council Work to Zero, 2024; Cagno et al., Safety Science 2024).

The Unmet Need

Managers consistently ask for predictive, unified visibility: a single, trustworthy view that merges workers, equipment, and environment to flag risks before incidents (Xu et al., Safety Science 2023; Jahangir/Schultz/Kamari, ITcon 2024).

Why Now

- **Mature enablers:** Commodity sensors, open APIs, and applied ML enable **near■real■time anomaly detection** (NSC Work to Zero, 2024).
- **Compliance & cost pressure:** Executives report safety programs **return \~$3 per $1 invested** (Liberty Mutual/ASSP ROI survey; Huang et al., 2009), while insurers and states increasingly **reward proactive safety programs** with credits or discounts (The Hartford Loss Control IoT Lab; Travelers program announcements; state workers' comp credits summaries, 2024–2025).
- **Adoption intent is real but fragile:** Predictors of adoption include **perceived usefulness, ease of use, pilotability, and compatibility**; blockers include privacy and training burden (Nnaji et al., 2019; Chong et al., 2023).

> **Strategic soundbite:** "Sites are data■rich but insight■poor. Safety Twin Lite turns fragmented feeds into **predictive safety intelligence** managers can act on."

1. Phase 0 (0–6 months): Safety Twin Lite — Tangible MVP Build

Objective: Ship a solo■built, API■powered real■time safety map that demonstrates predictive value with simulated or open feeds and validates user demand.

Primary users: Site Safety Managers (primary), Project/Operations Managers (secondary), with Insurance/Compliance stakeholders as influencers.

Non■negotiable outcomes (aligned to research)

- **Leading indicators over lagging** (Xu 2023): continuous **proximity, heat stress, and geofence** risk scoring.
- **Low friction, high pilotability** (Nnaji 2019): setup in minutes, demo mode without hardware; clear “explain this alert” to build trust.
- **Compatibility** (Nnaji 2019): ingest JSON/MQTT from common sources; simple exports for reporting.
- **Privacy by design** (Chong 2023): team■level or role■level views; opt■in if individual signals exist.

MVP feature set

- **Live Map Dashboard:** workers, equipment, zones, and **risk heatmap** (WBGT■lite heat stress; TTC/proximity; geofence breaches).
- **Alert Feed + Acknowledgment:** severity, timestamp, location; **“Why flagged?”** explainer.
- **Incident Playback:** time■scrubbed replay for after■action learning.
- **KPI Cards:** time■in■hazard, near■miss frequency, alert MTTA/MTTR; exportable snapshots for compliance & insurer discussions.
- **Data Simulation Layer:** scenario generator (crane swing, forklift crossing, midday heat spike) to support **pilotability** before hardware.

Tech approach (solo■friendly)

- **Frontend:** Streamlit/Dash (fast) or React + Leaflet/Mapbox.
- **Backend:** Python FastAPI for ingest + rules; WebSocket for live updates.
- **Risk Engine:** proximity/TTC, WBGT■lite, point■in■polygon geofences; optional LLM **alert summaries** for manager briefings.

Validation plan & success criteria

- **Users:** 3–5 safety managers; 1 operations leader.
- **Tasks:** 20■minute guided demo → interpret heatmap, triage alerts, export KPIs.
- **Metrics:** ≥70% report improved situational awareness; ≥30% perceived time saved vs. manual logs; ≥1 pilot LOI.

- **Evidence capture:** qualitative quotes + before/after workflows to support ROI narrative (ASSP/Liberty ROI framing; NSC cost context).

2. Product Role & Positioning (Who/Why/What)

- **Mission:** Real■time, predictive safety intelligence for mid■market construction and industrial sites.
- **Job■to■be■done (manager):** “Give me one living map that shows where today’s risks are and how to reduce them quickly.”
- **Differentiation:** Lightweight setup; leading■indicator focus; privacy■respecting views; exportable evidence for insurers and audits (The Hartford; state credits).

One■liner: *“A lightweight safety twin that predicts danger before it happens.”*

3. Research■Backed Adoption Drivers → Feature Mapping

ver (evidence)	Product response
sefulness / ROI** (Liberty Mutual/ASSP; NSC costs)	KPI cards quantify avoided exposure; incident playback supports audit and insure
& pilotability** (Nnaji 2019)	No■hardware demo mode; setup wizard; opinionated defaults.
y** (Nnaji 2019)	Open JSON/MQTT ingest; CSV/PDF export; simple web UI.
icators** (Xu 2023)	Proximity/TTC, WBGT■lite, geofence leading metrics out■of■the■box.
acy** (Chong 2023)	Role■level aggregation; opt■in toggles; **“why”** explanations.
entives** (The Hartford; Travelers; state comp credits)	Reports tuned to insurer/loss■control conversations; template letters for credit ap

4. Barriers & Mitigations (Designing for Reality)

Barrier (evidence)	Mitigation in V1
Worker privacy / acceptance (Chong 2023)	Start with location & environment; avoid biometrics; anonymize by role/team.
Training burden (Nnaji 2019)	15■min onboarding; inline help; demo data included.
Integration fatigue (ITcon 2024)	Begin stand■alone; add connectors only after value proven; publish a simple ingest schema.
Budget uncertainty (Work to Zero 2024)	Month■to■month pilot pricing; clear ROI worksheet using NSC cost figures.

5. Roadmap Snapshot (Multi■Year)

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0–6 mo  : Safety Twin Lite (demo + pilots) → LOIs & insurer conversations
6–18 mo : Safety Twin Foundation (live feeds, multi■site)
18–30 mo: Bio■Aware Workforce Analytics — Privacy■First & Outcomes■Driven
30–42 mo: Context■Aware HR Copilot (no emotion recognition)
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3+ years: Unified Human■Aware Work Intelligence Suite
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Phase 2 (18–30 months): Bio■Aware Workforce Analytics — Privacy■First & Outcomes■Driven

Focus (modified): Team■level, opt■in well■being and exposure analytics that predict operational risk (fatigue, heat exposure) using standardized, low■intrusion signals.

Design principles (research■aligned):

- **Team■level aggregation only**; no individual dashboards.
- **Minimize raw biometrics**: ingest → compute metrics → discard raw streams.
- **Standardized protocols** for signals like HRV (time■of■day, posture, duration).
- **Outcome framing**: link signals to **leading indicators** and operational outcomes (near■miss trend, time■in■heat■risk zone), not medical ROI.

Milestones:

- Analytics MVP with **privacy controls** and protocol guidance.
- 1–2 cross■sector pilots (shift■work or outdoor operations).
- Templates for consent + disclosure (US & EU variants).

Output: Credible, privacy■respecting team analytics that help managers anticipate risk without surveillance.

Phase 3 (30–42 months): Context■Aware HR Copilot (No Emotion Recognition)

Focus (pivot): An assistive HR copilot that accelerates onboarding, training, and policy answers using role/context data — without inferring emotions. EU■compliant by design (no workplace emotion recognition).

Core capabilities:

- **Onboarding accelerator**: adaptive checklists, learning paths, policy Q&A.;
- **Manager assist**: draft 30/60/90■day plans, schedule check■ins, summarize feedback.
- **Knowledge retrieval**: HRIS/LMS■aware answers with citations to source docs.
- **Measurement**: cycle■time KPIs (time■to■proficiency, ticket resolution), quality metrics (completion accuracy).

Milestones:

- Copilot prototype integrated with sample HRIS/LMS data.
- Pilot with HR consulting partner; validate **cycle■time reduction** targets.

- Compliance modes: **EU (no emotion inference)**; **US (optional text sentiment at aggregate level with consent)**.

Output: A trusted, productivity■focused assistant that improves HR outcomes without intrusive affect analytics.

Compliance & Ethics Guardrails (applies across phases)

- **EU AI Act Article 5(1)(f)**: No **emotion recognition** in workplaces/education; platform ships with a hard **EU■compliance mode** (feature■level enforcement).
- **Biometrics & consent**: US BIPA awareness (Illinois amendments in 2024 lowered per■scan damages but preserved consent obligations); provide **consent, retention, and deletion** templates.
- **Privacy by design**: Default to team■level aggregation, data minimization, and clear **“Why this alert?”** explainability.