

Translating Locally-led Resilience into Action  
in the Age of Complex Risk and Digital Transformation  
복합위험과 디지털 전환시대, 지역주도 복원력의 실행

The 5<sup>th</sup>



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송도컨벤시아 그랜드볼룸 A  
Songdo Convensia, Grand Ballroom A

SESSION 4 · INSTITUTIONALIZING AI-DRIVEN LOCALIZED DISASTER SAFETY  
MANAGEMENT SYSTEMS

## The Watchkeeper's Playbook

What Aviation Safety Science Teaches a City About Institutionalizing AI

An aviation-safety practitioner reads Busan through HFACS, SMS and High-Reliability theory

**Seunghwan Kim** · In-house Aviation Safety Specialist

Airside Operations Department, Gimhae International Airport, Korea Airports Corporation (KAC) ·  
Dong-A University

[army181@airport.co.kr](mailto:army181@airport.co.kr)

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AI IS THE INSTRUMENT. THE INSTITUTION IS THE RESILIENCE.

THE MESSENGER IS THE METHOD

## Aviation already answered this question — 40 years ago

Why an airport responder has something specific to say about city AI governance



**Aviation is the most deeply institutionalized safety culture on earth.**

Under ICAO Annex 19 and Doc 9859, every operator runs a Safety Management System: mandatory reporting, quantified risk, root-cause discipline, non-punitive 'just culture'.



**The city's question is aviation's solved problem.**

“How does a system make safety survive people, budgets and elections?” — aviation has answered it for four decades. AI is only the newest instrument to institutionalize.



**My vantage point is the border itself.** Gimhae airport sits inside Busan — I stand where the most institutionalized safety domain physically meets the city. This talk carries the method across that border.

Aviation is not the subject — it is the **reference model** for institutionalizing city AI.

### THE THESIS

**AI does not create resilience.**

**Institutions do — and aviation already knows how to build them.**

*I will read one city — Busan — through aviation's safety science, and propose what a city should build next.*

## THE DIAGNOSTIC LENS

# Three aviation instruments, one city test

How I read any disaster system — the method I bring from the flight line and the doctorate



### HFACS

#### Read failure upward.

James Reason's 'Swiss cheese' — don't stop at the unsafe act. Climb the four levels: act → preconditions → supervision → organizational influence. Blame ends where institutions begin.



### RCA + SMS

#### Convert findings into duties.

ICAO's discipline: every non-conformity triggers root-cause analysis and a corrective action; risk is scored on a 5×5 matrix; mitigation is owned, not hoped for.



### HRO + Q-method

#### Measure the human system.

High-reliability theory: preoccupation with failure, deference to expertise. Q-methodology: my doctoral tool for mapping how responders actually perceive safety.

AI GOVERNANCE CHAIN

SENSE local data

→ INTERPRET AI model

→ DECIDE human authority

→ ACT field response

→ LEARN institution

## WHY THIS CITY IS THE TEST

# Busan's risk profile — a coastal metropolis under pressure

The hazards that recur here, and the AI the city is already deploying against them — verified public sources, 2026

**BUSAN — A LOCALIZED AI SAFETY TESTBED** adaptation to local hazard, terrain, decision authority

## WHAT RECURS HERE



### Underground & urban flooding

Choryang underpass, 2020 — three lives lost; the reason the register exists.



### Coastal hazards

Wave overtopping, storm surge and rip currents along the city's beaches.



### Steep-slope landslides

Hillside districts across a mountainous port city.



### Sinkholes (social disaster)

Ageing sewer mains beneath heavy urban traffic.

## THE CITY'S RESPONSE

# 6 hazard types

Three nationally designated casualty risks, extended by three of Busan's own — a register the city owns, not merely observes.

## AI ALREADY IN SERVICE

Safety ON · sewer-inspection AI robot · rip-current AI — sensing, already operational.

## THE FISCAL LANDSCAPE

General account ₩14.4 tn — welfare 47.0%; public order & safety ₩594.7 bn (4.1%). This is not the whole resilience budget; resilience is dispersed across multiple budgets and bureaux.

The question is not how much a city spends on safety, but whether AI-enabled disaster management can be **institutionalized across fragmented budgetary and administrative boundaries.**

# Choryang, re-read upward

The same evidence, seen through HFACS — a demonstration, not a description

## A CITY TRAGEDY, CLIMBED LEVEL BY LEVEL

- 1** **Unsafe act** — An underpass entered as water rose (2020) — three lives lost.  
↑
- 2** **Preconditions** — No automatic barrier, no real-time water signal at the point of decision.  
↑
- 3** **Supervision** — No standing rule on when, and by whom, a closure is ordered.  
↑
- 4** **Organizational** — Hazard data and closure authority dispersed across separate offices.

## WHAT THE LENS REVEALS

Busan's own response already climbs the ladder:

**the 5 cm auto-closure rule, the C-grade slope sensors, and 'Safety ON' answer levels 2–4 — precondition, supervision, organization.**

*The city acted institutionally. The lens simply names why it works.*

DO NOT STOP AT THE ACCIDENT. CLIMB TO THE INSTITUTION THAT LET THE RISK PROPAGATE.

## Four real projects, scored like an audit

Verified public evidence — read as functions of a safety-management system

### Safety ON

**LIVE · MAY 2026**

One operating picture; AI flags, humans decide.

**READ AS:** *SMS control function*

### No WET City

**2025–2029**

Physics+AI flood model on the city's own data.

**READ AS:** *RCA: prediction → action*

### Sewer AI robot

**₩125 M**

Crawler + AI reads 6 defect classes, Aug–Dec 2026.

**READ AS:** *Proactive hazard ID*

### Rip-current AI

**10 BEACHES**

AI on a 15-year index; lifeguards on the sand.

**READ AS:** *Detection + procedure*

**The reframe:** *each project is not a headline — it is a function in a safety-management system the city is assembling without naming it.*

## WHAT THE LENS EXPOSES

### Four gaps every city shares — and aviation closed long ago

The move from clever projects to a true safety-management system



#### No non-punitive reporting.

Aviation's 'just culture' turns every near-miss into data. Cities still wait for the disaster to learn.



#### No structured cause investigation.

Aviation mandates RCA on every finding. Cities analyze the headline event, rarely the latent organizational cause.



#### The human system is unmeasured.

Aviation studies crew performance relentlessly. No city routinely measures how its responders perceive risk.



#### Safety stops at the border.

The airport, the port, the city drill apart. Compound urban risk demands interoperable, cross-boundary response.

**FIFTH GAP · AI ACCOUNTABILITY** Who validates the model? Who can override it? Who owns false positives, missed alerts and model drift?

## WHAT I PROPOSE TO LEAD · 1–2

### From projects to a city Safety Management System

Author-led proposals · grounded in aviation practice and disaster-management scholarship

#### A municipal disaster Safety Management System, set in a city ordinance.

1

Give the four pillars of the aviation SMS — policy, risk management, assurance, promotion — a legal home in city law, so 'Safety ON' and its successors become a standing duty, not a project.

**Aviation origin:** *ICAO Annex 19 · Aviation Safety Act, Arts. 56 & 58 (SSP/SMS mandate)*

#### A 'Just Culture' non-punitive reporting channel for staff and citizens.

2

Adopt aviation's confidential, non-punitive hazard reporting so a jammed drain or a cracked slope becomes data weeks before it becomes a disaster — feeding directly into 'Safety ON'.

**Aviation origin:** *ICAO 'just culture'; the aviation voluntary-reporting model*

## WHAT I PROPOSE TO LEAD · 3–4

### Investigate upward; measure the human system

Where my doctoral method enters the architecture directly

#### A City-HFACS cause-investigation unit — 'investigate upward.'

3

After any serious near-miss, a standing unit climbs Reason's four levels to the organizational root and issues an owned corrective action — the discipline aviation applies to every finding, brought to city hall.

**Aviation origin:** *HFACS (Reason's model) · ICAO Doc 9756 · RCA + corrective-action loop*

#### A Q-methodology diagnosis of responder safety perception — my doctoral method.

4

Before we train, we must know how responders actually see risk. I propose using Q-methodology — the core method of my doctoral research — to map responder safety perception across agencies, then design High-Reliability training to the gaps it reveals.

**Aviation origin:** *High-Reliability Organization theory · Q-methodology (author's doctoral research)*

**AI RECOMMENDS. AUTHORIZED HUMANS DECIDE. INSTITUTIONS REMAIN ACCOUNTABLE.**

## WHAT I PROPOSE TO LEAD · 5

### **Jump the wall — interoperable response across the border**

The proposal only a person standing on the border could make



#### **5 · A cross-boundary interoperability drill: airport ARFF × city fire × port.**

Gimhae's aircraft rescue-and-firefighting service runs to ICAO standards a few kilometres from the city's own responders. I propose a standing joint exercise so that in a compound disaster, the most institutionalized safety unit in the region and the city fight as one — not as strangers meeting at the fence.

## WHY THESE FIVE COHERE

### **Reporting**

near-misses become  
data

### **Investigation**

findings become root  
causes

### **Measurement**

perception becomes  
training

### **Legal home**

functions become  
duties

### **Border**

institutions become  
interoperable

**DISASTERS CROSS INSTITUTIONAL BORDERS. SAFETY SYSTEMS MUST CROSS THEM FIRST.**

## FROM BUSAN TO OTHER CITIES

### What is transferable — and what must remain local?

A localized disaster-AI system should standardize the institution, not the hazard.

#### TRANSFERABLE — THE INSTITUTION

- Governance architecture (the SMS four pillars)
- Safety-assurance cycle
- Non-punitive near-miss reporting
- The human-override principle
- Root-cause investigation discipline
- Interoperability protocols

#### MUST REMAIN LOCAL — THE INTELLIGENCE

- Hazard thresholds
- Terrain and infrastructure data
- Citizen-vulnerability profiles
- Response resources
- Legal authority to act
- Local risk tolerance

**STANDARDIZE THE MANAGEMENT SYSTEM. LOCALIZE THE INTELLIGENCE.**

## CLOSING

### The watchkeeper's answer

From experimenting with AI to institutionalizing it

- 1**      **AI is an instrument; the institution is the aircraft.**  
*Aviation never asked its instruments to fly the plane. A city must not ask AI to govern — only to inform the human who does.*
  
- 2**      **A city can borrow aviation's forty years.**  
*SMS, just culture, HFACS, high-reliability practice — the institutional grammar of safety already exists.  
Busan is closer to it than it knows.*
  
- 3**      **The messenger is the method.**  
*I did not come to list a city's projects. I came to carry a discipline across a border — and to help build what is still missing.*

#### THREE THINGS TO CARRY HOME

**AI does not create resilience. Institutions do.**

**Standardize the management system. Localize the intelligence.**

**AI may inform the decision. It must never own the accountability.**

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***AI does not create resilience. Institutions do — and aviation already knows how to build them. “A watchkeeper, never the captain.”***

# REFERENCES & SOURCES

## Every figure verified against a primary source

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*Currency: UN operational rate of exchange, Mar 2026 (US\$1 = ₩1,488.937).*

*Where no single official figure existed, values were cross-checked across independent outlets.*

*All statistics reflect public reporting as of August 2026.*

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# Thank you

**The Watchkeeper's Playbook — Aviation Safety Science for City Disaster Governance**

**Seunghwan Kim** · In-house Aviation Safety Specialist, Airside Operations Department, Gimhae International Airport, Korea Airports Corporation (KAC) · Dong-A University

[army181@airport.co.kr](mailto:army181@airport.co.kr)

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Method sources: ICAO Annex 19 · Doc 9859 · Doc 9756 · HFACS (Reason) · HRO theory · Q-methodology.  
City evidence triangulated against official public sources, Aug 2026.

