

Research on Safe Multimodal Transport of Dangerous Goods in Taiwan: A SQFD Framework Approach

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Date: February 2026



BIO NOTE



Li Chen Liu

- Li Chen Liu is a master's student in the Department of Transportation Science at the College of Maritime Science and Management, National Taiwan Ocean University (NTOU).
- He is Sheng Teng Huang's student. His recent research focused on safety of Dangerous Goods transport and worked with professors on aviation projects.



Sheng Teng Huang

- Dr. Sheng Teng Huang is an Associate Professor in the Department of Transportation Science at the College of Maritime Science and Management, National Taiwan Ocean University (NTOU).
- Prior to his current position, he worked at Inchcape Shipping Service (ISS) in Singapore (stationed at both the Asia Pacific office in Tanjong Pagar) and the Taipei office.
- He earned his PhD in maritime logistics from Kobe University, Japan, under the supervision of Professor Yoshida Shigeru. His primary research interests encompass the Japanese shipping industry, logistics, and delivery management.
- His recent research focuses on port congestion solution analysis, shipping management, resilient supply chains, and ESG initiatives within the container shipping industry.

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Part 1: Introduction

The Challenge of HazMat Transport

LPHC Nature: Hazardous Materials (HazMat) transport is a "Low-Probability-High-Consequence" activity.

- Multimodal Trend: Increasing reliance on integrated road, rail, and sea transport networks.
- Critical Issue: Risks are amplified at "Transfer Interfaces" (e.g., ports, terminals) rather than during transit alone.

Motivation: Interface Risks & Info Gaps

Lessons from Accidents: Incidents like the Kaohsiung gas explosions and Tianjin Port explosion highlight failures in interface management.

1. Key Pain Points:

Regulatory Gaps:

2. Discrepancies between land and sea regulations.

Disconnection:

Opacity Information of data (e.g., UN numbers, SDS) at transfer nodes.

3. Human Factors:

80% of accidents stem from human error or negligence.

Research Gap & Methodology Selection

Current Limitations: Previous studies often focus on single modes (e.g., just road) and lack a quantitative link to "Safety Culture."

- Why SQFD (Safety Quality Function Deployment)?

Systematically translates "Customer Safety Requirements" → "Risk Factors" → "Management Standards" → "Safety Culture".

- Innovation: This study uniquely contrasts Managerial vs. Technical expert perspectives.

Research Objectives

1. Identify Needs: Determine stakeholder requirements for HazMat safety.
2. Build Model: Construct a three-stage House of Quality (HoQ) framework.
3. Analyze Gaps: Compare cognitive differences between managers and frontline technicians.
4. Propose Strategy: Develop prioritized strategies for safety culture implementation.

Part 2: Literature Review

Part 2: Literature Review

Key Definitions

- Hazardous Materials (HazMat): Substances capable of posing risks to health, safety, and property (e.g., explosives, flammables, toxins).
- Multimodal Transport: Carriage of goods by at least two different modes of transport, where the main risk lies in the interface transfer

International Regulatory Framework

UNRTDG: The "Model Regulations" for global classification.

- IMDG Code: Specifically for maritime safety (Stowage, Segregation, Packaging).
- The Challenge: Harmonizing these standards at the port gate (the land-sea interface).

Theoretical Basis: From QFD to SQFD

Original QFD: Translating "Voice of Customer" into product design.

- **SQFD Evolution:** Adapted by *Bas (2013)* and *Shang et al. (2022)* for safety management.
- **Core Logic:** Requirements → Hazards → Protective Measures → Culture

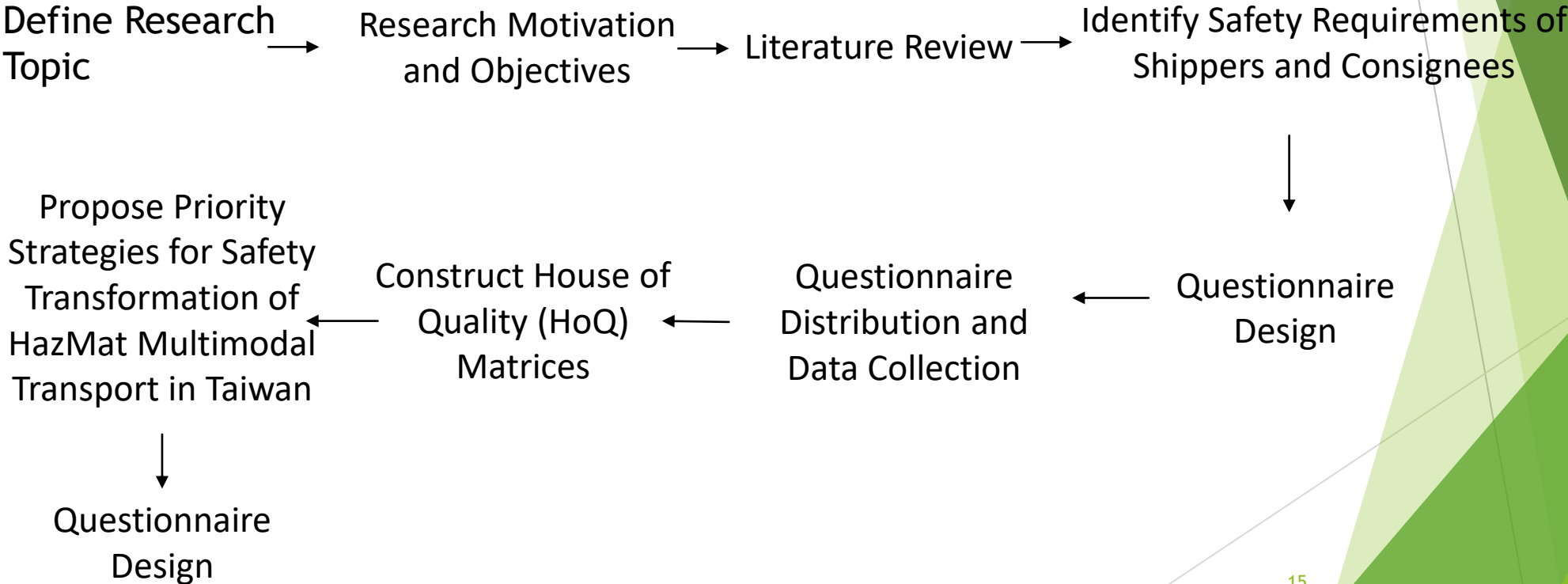
Dimensions of Safety Culture

Adopted 6 dimensions for this study:

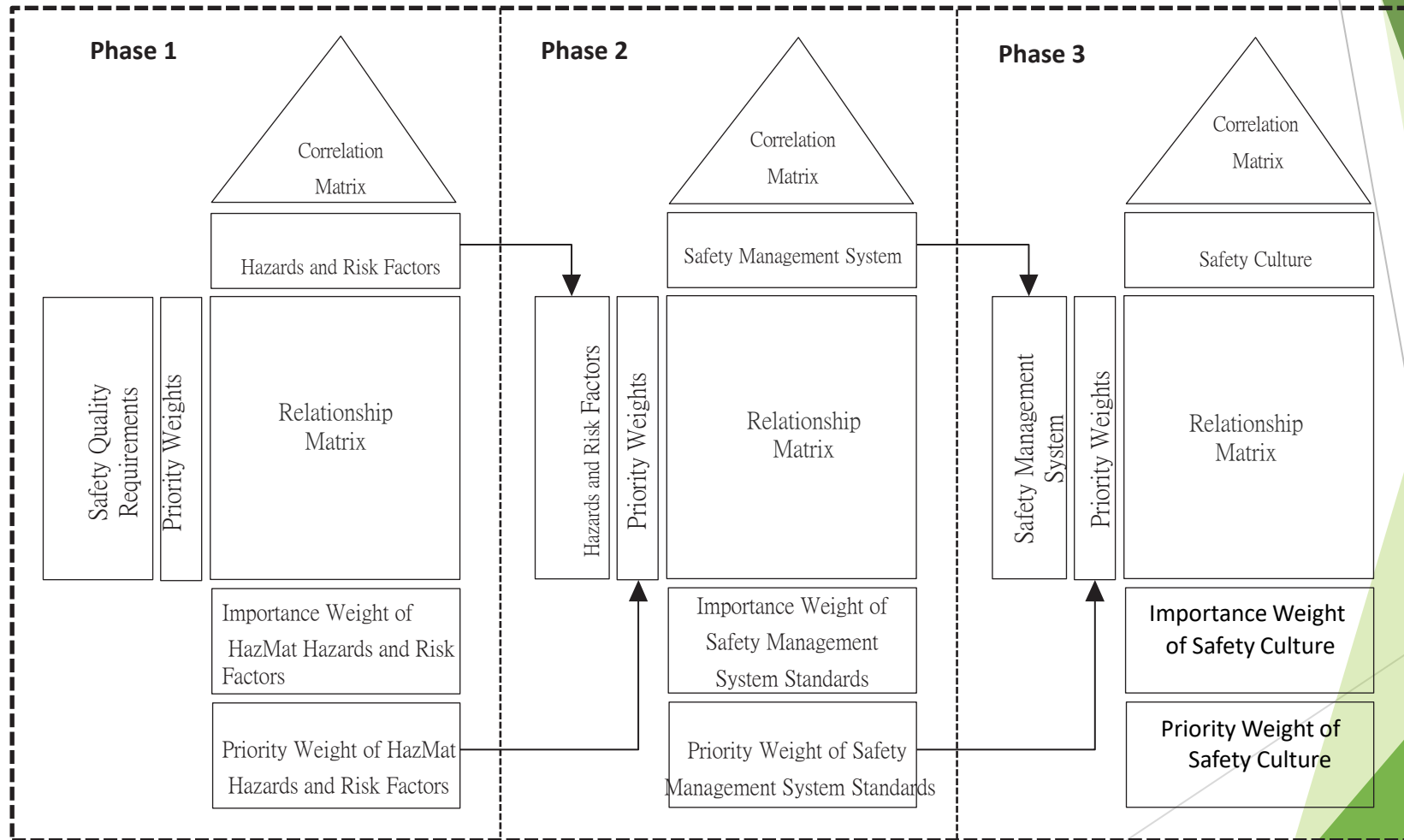
1. Safety Behavior
2. Safety Training
3. Safety Knowledge
4. Safety Management
5. Safety Procedures (SOPs)
6. Technology Application

Part 3: Methodology

Research Framework



The Three-Stage HoQ Framework



Data Collection & Sampling

Phase 1 (IPA Survey):

- Target: HazMat Shippers & Multimodal Operators.
- Valid Samples: 240 (Response rate 66.67%).

Phase 2 (Expert Survey):

- Target: Industry/Academic Experts (Split into Management & Technical groups). Scoring
- Method: 0-1-5-9 Correlation

Data Analysis Methods

IPA (Importance-Performance Analysis): Used to determine the input weights for Stage 1 based on customer gaps.

Matrix Calculation: Calculating the **Relative Weight (Priority Weight)** for each stage to identify critical focus areas.

Part 4: Analysis & Results

Demographic Profile

Profile: Predominantly Male (88%), Young workforce (75% under 30), Junior experience (69% under 5 years).

Implication: Data strongly reflects the voice of the frontline workforce exposed to daily risks.

Aspects	Quantity	Percentage (%)
Questionnaire distributed	360	100
Questionnaire collected	309	85.83
Effective questionnaire	240	66.67
Invalid questionnaire	69	19.17

IPA Results: Identifying the Service Gap

Critical Findings:

High Importance / Low Satisfaction: "Immediacy of Emergency Response" (Imp 4.72 / Sat 2.98).

Secondary Gaps: Personnel Competence , Misdeclaration Inspection

Relative Strength: Packaging Integrity has the highest satisfaction (3.65).

Ranking	Items	Importance		Satisfaction	
		Mean	Standard Deviation	Mean	Standard Deviation
1	Immediacy of Emergency Response and Resource Accessibility	4.72	0.45	2.98	0.88
2	Competence of Drivers and Operators	4.68	0.48	3.35	0.72
3	Inspection Mechanism for Preventing Misdeclaration	4.56	0.52	3.12	0.85
4	Clear Liability Assignment and Communication Channels	4.45	0.55	3.42	0.78
5	Strict Compliance with Stowage and Segregation Rules	4.4	0.58	3.58	0.65
6	Seamless Information Integration at Transfer Interfaces	4.38	0.6	3.52	0.7
7	Confirmation of Packaging and Container Integrity	4.35	0.62	3.65	0.62
8	Risk Avoidance in Transport Route Planning	4.25	0.65	3.15	0.82
9	Security of Cargo Transport Units (CTUs) and Goods	4.18	0.68	3.4	0.75
10	Real-time Cargo and Environmental Monitoring Capability	4.12	0.7	3.25	0.79

HoQ Stage 1 Results (Requirements → Hazards)

Overall Priorities:

1. Management Negligence & Confusion (Weight: 0.129).
2. Source Misdeclaration (Weight: 0.123).

Key Insight: Systemic management failures and opaque information at the source are the root causes of safety gaps.

HoQ1: Customer Requirements vs. Risk Factors Correlation Matrix.

Relative Weight	Weight Importance	Mean of Satisfaction	Priority Ranking	Safety Items & Risks	Operational Errors	Violations	Insufficient Awareness of Hazardous Materials	Oversight Negligence and Managerial Chaos	Information Communication Breakdown	Concealment or Misreporting at the Source	Packaging or Container Defects	Vehicle or Loading Equipment Failure	Improper Stowage and Segregation	External Environmental Interference
0.098	0.099	3.52	5	Seamless Information Integration at Transfer Interfaces	5	1	5	9	9	9	5	1	5	1
0.105	0.101	3.42	4	Clear Liability Assignment and Communication Channels	5	5	5	9	9	9	5	5	5	5
0.064	0.093	3.25	10	Real-time Cargo and Environmental Monitoring Capability	5	5	1	9	5	9	1	9	1	5
0.118	0.103	3.12	3	Inspection Mechanism for Preventing Misdeclaration	5	9	5	9	9	9	9	1	1	9
0.096	0.099	3.58	6	Strict Compliance with Stowage and Segregation Rules	9	9	9	9	5	9	9	1	9	1
0.092	0.098	3.65	7	Confirmation of Packaging and Container Integrity	9	9	9	9	5	9	9	1	9	1
0.125	0.106	3.35	2	Competence of Drivers and Operators	9	9	9	9	5	5	1	5	1	9
0.138	0.107	2.98	1	Immediacy of Emergency Response and Resource Accessibility	5	5	9	9	9	5	5	5	5	9
0.089	0.096	3.15	8	Risk Avoidance in Transport Route Planning	9	9	1	9	9	5	1	9	1	9
0.075	0.095	3.4	9	Security of Cargo Transport Units (CTUs) and Goods	5	5	5	5	9	9	5	9	1	9
				Total	59.5	64	64	80	54	76	53.5	49.5	51.5	66
				Relative Weight	0.096	0.104	0.104	0.129	0.087	0.123	0.087	0.080	0.083	0.107

Stage 1 Comparison: Management vs. Technical

Managerial View: Focuses on "Management Negligence" (0.139) and "Information Disconnection".

Technical View: Focuses on "Source Misdeclaration" and "External Environmental Interference" (0.120).

Insight: Managers blame the system; Technicians fear operational/environmental threats.

HoQ1: Customer Requirements vs. Risk Factors Correlation Matrix.(managerial side)

Relative Weight	Weight Importance	Mean of Satisfaction	Priority Ranking	Safety Items & Risks	Operational Errors	Violations	Insufficient Awareness of Hazardous Materials	Oversight and Negligence and Managerial Chaos	Information Communication Breakdown	Concealment or Misreporting at the Source	Packaging or Container Defects	Vehicle or Loading Equipment Failure	Improper Stowage and Segregation	External Environmental Interference
0.098	0.099	3.52	5	Seamless Information Integration at Transfer Interfaces	5	1	5	9	9	9	5	1	5	1
0.105	0.101	3.42	4	Clear Liability Assignment and Communication Channels	5	5	5	9	9	9	5	5	5	5
0.064	0.093	3.25	10	Real-time Cargo and Environmental Monitoring Capability	5	5	1	9	5	9	1	9	1	5
0.118	0.103	3.12	3	Inspection Mechanism for Preventing Misdeclaration	5	9	5	9	9	9	9	1	1	9
0.096	0.099	3.58	6	Strict Compliance with Stowage and Segregation Rules	9	9	9	9	5	9	9	1	9	1
0.092	0.098	3.65	7	Confirmation of Packaging and Container Integrity	9	9	9	9	5	9	9	1	9	1
0.125	0.106	3.35	2	Competence of Drivers and Operators	9	9	9	9	5	5	1	5	1	9
0.138	0.107	2.98	1	Immediacy of Emergency Response and Resource Accessibility	5	5	9	9	9	5	5	5	5	9
0.089	0.096	3.15	8	Risk Avoidance in Transport Route Planning	9	9	1	9	9	5	1	9	1	9
0.075	0.095	3.4	9	Security of Cargo Transport Units (CTUs) and Goods	5	5	5	5	9	9	5	9	1	9
				Total	66	66	58	86	74	78	50	46	38	58
				Relative Weight	0.106	0.106	0.094	0.139	0.119	0.126	0.081	0.074	0.061	0.094

HoQ1: Customer Requirements vs. Risk Factors Correlation Matrix. (technical side)

Relative Weight	Weight Importance	Mean of Satisfaction	Priority Ranking	Safety Items & Risks	Operational Errors	Violations	Insufficient Awareness of Hazardous Materials	Oversight Negligence and Managerial Chaos	Information Communication Breakdown	Concealment or Misreporting at the Source	Packaging or Container Defects	Vehicle or Loading Equipment Failure	Improper Stowage and Segregation	External Environmental Interference
0.098	0.099	3.52	5	Seamless Information Integration at Transfer Interfaces	5	1	1	5	9	5	0	0	0	5
0.105	0.101	3.42	4	Clear Liability Assignment and Communication Channels	5	9	5	5	1	9	9	9	9	9
0.064	0.093	3.25	10	Real-time Cargo and Environmental Monitoring Capability	1	1	5	9	5	1	5	9	9	9
0.118	0.103	3.12	3	Inspection Mechanism for Preventing Misdeclaration	1	9	9	9	5	9	5	1	9	9
0.096	0.099	3.58	6	Strict Compliance with Stowage and Segregation Rules	9	9	9	9	1	9	9	1	9	9
0.092	0.098	3.65	7	Confirmation of Packaging and Container Integrity	9	9	9	9	5	5	9	5	9	1
0.125	0.106	3.35	2	Competence of Drivers and Operators	9	9	9	5	5	9	1	9	1	5
0.138	0.107	2.98	1	Immediacy of Emergency Response and Resource Accessibility	9	5	9	9	1	9	9	9	9	9
0.089	0.096	3.15	8	Risk Avoidance in Transport Route Planning	0	9	5	5	1	9	1	1	1	9
0.075	0.095	3.4	9	Security of Cargo Transport Units (CTUs) and Goods	5	1	9	9	1	9	9	9	9	9
				Total	53	62	70	74	34	74	57	53	65	74
				Relative Weight	0.086	0.101	0.114	0.120	0.055	0.120	0.093	0.086	0.106	0.120

HoQ Stage 2 Results (Hazards → SMS Standards)

Overall Priorities:

1. Strengthening On-site Supervision (Weight: 0.133).
 2. Cargo Unit Inspection Mechanism (Weight: 0.119).
- Key Insight: Rigorous auditing is deemed more effective than theoretical planning.

Stage 2 Comparison: Prevention vs. Defense

- Managerial View: Prioritizes "Dynamic Route Planning (0.136). Strategy: Avoidance.
- Technical View: Prioritizes "On-site Supervision (0.144) and "Joint Emergency Response ". Strategy: Defense & Response.

HoQ2: Customer Requirements vs. Risk Factors Correlation Matrix

Relative Weight	Priority Ranking	Hazard / Risk Factors	Full-Time Proactive Driver/Operator Monitoring System (DMS)	IoT-based Real-time Sensing Technology for Cargo and Equipment	Integrated Digital Platform for Hazardous Materials Information	Establishment of Standard Operating Procedures (SOPs)	Inspection Mechanism for Cargo Transport Unit (CTU) Loading and Securing	Source Compliance Screening and Blacklisting Mechanism	Dynamic Risk-Oriented Route Planning and Dispatching	Competency-Based Professional Training and Certification for HazMat	Intermodal and Cross-Organizational Joint Emergency Response Mechanism	On-site Supervision and Safety Culture Assessment
0.096	6	Operational Errors	9	3	1	7	9	7	7	9	7	9
0.104	4	Violations	5	1	3	7	9	9	9	9	3	9
0.104	4	Insufficient Awareness of Hazardous Materials	5	7	3	9	9	5	5	9	9	9
0.129	1	Oversight Negligence and Managerial Chaos	7	9	7	9	9	9	7	7	9	9
0.087	7	Information Communication Breakdown	7	9	9	7	2.5	5	9	2.5	4.5	4.5
0.123	2	Concealment or Misreporting at the Source	7	5	7	7	9	9	5	3	9	7
0.087	7	Packaging or Container Defects	3	3	5	5	9	5	5	5	5	7
0.080	9	Vehicle or Loading Equipment Failure	3	5	0.5	1	5	0.5	5	1	3	9
0.083	8	Improper Stowage and Segregation	3	5	5	7	9	1	7	5	9	7
0.107	3	External Environmental Interference	2.5	3	2.5	3	0.5	5	9	0.5	9	9
		Total	51.5	50	43	62	71	55.5	68	29 51	67.5	79.5
		Relative Weight	0.086	0.083	0.072	0.104	0.119	0.093	0.114	0.085	0.113	0.133

HoQ2: Customer Requirements vs. Risk Factors Correlation Matrix.(managerial side)

Relative Weight	Priority Ranking	Hazard / Risk Factors	Full-Time Proactive Driver/Operator Monitoring System (DMS)	IoT-based Real-time Sensing Technology for Cargo and Equipment	Integrated Digital Platform for Hazardous Materials Information	Establishment of Standard Operating Procedures (SOPs)	Inspection Mechanism for Cargo Transport Unit (CTU) Loading and Securing	Source Compliance Screening and Blacklisting Mechanism	Dynamic Risk-Oriented Route Planning and Dispatching	Competency-Based Professional Training and Certification for HazMat	Intermodal and Cross-Organizational Joint Emergency Response Mechanism	On-site Supervision and Safety Culture Assessment
0.096	6	Operational Errors	9	5	1	9	9	5	5	9	5	9
0.104	4	Violations	1	1	1	9	9	9	9	9	1	9
0.104	4	Insufficient Awareness of Hazardous Materials	1	5	5	9	9	1	9	9	9	9
0.129	1	Oversight Negligence and Managerial Chaos	5	9	5	9	9	9	5	9	5	9
0.087	7	Information Communication Breakdown	5	9	9	5	0	1	9	0	0	0
0.123	2	Concealment or Misreporting at the Source	5	5	9	9	9	9	9	5	9	9
0.087	7	Packaging or Container Defects	1	5	9	5	9	5	9	5	5	5
0.080	9	Vehicle or Loading Equipment Failure	1	1	0	1	9	0	9	1	5	9
0.083	8	Improper Stowage and Segregation	5	5	9	9	9	1	5	9	9	5
0.107	3	External Environmental Interference	0	5	0	1	0	1	9	0	9	9
		Total	33	50	48	66	72	41	78	56	57	73
		Relative Weight	0.057	0.087	0.084	0.115	0.125	0.071	0.136	0.098	0.099	0.127

HoQ2: Customer Requirements vs. Risk Factors Correlation Matrix.(technical side)

Relative Weight	Priority Ranking	Hazard / Risk Factors	Full-Time Proactive Driver/Operator Monitoring System (DMS)	IoT-based Real-time Sensing Technology for Cargo and Equipment	Integrated Digital Platform for Hazardous Materials Information	Establishment of Standard Operating Procedures (SOPs)	Inspection Mechanism for Cargo Transport Unit (CTU) Loading and Securing	Source Compliance Screening and Blacklisting Mechanism	Dynamic Risk-Oriented Route Planning and Dispatching	Competency-Based Professional Training and Certification for HazMat	Intermodal and Cross-Organizational Joint Emergency Response Mechanism	On-site Supervision and Safety Culture Assessment
0.096	6	Operational Errors	9	1	1	5	9	9	9	9	9	9
0.104	4	Violations	9	1	5	5	9	9	9	9	5	9
0.104	4	Insufficient Awareness of Hazardous Materials	9	9	1	9	9	9	1	9	9	9
0.129	1	Oversight Negligence and Managerial Chaos	9	9	9	9	9	9	9	5	9	9
0.087	7	Information Communication Breakdown	9	9	9	9	5	9	1	5	9	9
0.123	2	Concealment or Misreporting at the Source	9	5	5	5	9	9	1	1	9	5
0.087	7	Packaging or Container Defects	5	1	1	5	9	5	1	5	5	9
0.080	9	Vehicle or Loading Equipment Failure	5	9	1	1	1	1	1	1	1	9
0.083	8	Improper Stowage and Segregation	1	5	1	5	9	1	9	1	9	9
0.107	3	External Environmental Interference	5	1	5	5	1	9	9	1	9	9
		Total	70	50	38	58	70	70	50	46	74	86
		Relative Weight	0.114	0.083	0.063	0.097	0.117	0.117	0.083	0.077	0.124	0.144

HoQ Stage 3 Results (SMS → Safety Culture)

Overall Priorities:

1. Safety Procedures (Weight: 0.213).
2. Safety Management (Weight: 0.186).

- Conclusion: The foundation of HazMat safety in Taiwan is strict adherence to SOPs, not just training.

Critical Finding: The "Technology Gap"

- Managerial View: Highly values "Technology Application " (0.197).
- Technical View: Gives "Technology" the lowest weight (0.077).
- Implication: Frontline staff believe technology is useless without a foundation of management support and knowledge.

HoQ3: SMS Standards vs. Safety Culture & Measures Matrix

Relative Weight	Priority Ranking	Safety Management System (SMS) Standards	Safety Behavior	Safety Training	Safety Knowledge	Safety Management	Safety Procedures	Technology
0.086	6	Full-Time Proactive Driver/Operator Monitoring System (DMS)	9	3	1	7	9	7
0.083	8	IoT-based Real-time Sensing Technology for Cargo and Equipment	5	1	3	7	9	9
0.072	9	Integrated Digital Platform for Hazardous Materials Information	5	7	3	9	9	5
0.104	4	Establishment of Standard Operating Procedures (SOPs)	7	9	7	9	9	9
0.119	1	Inspection Mechanism for Cargo Transport Unit (CTU) Loading and Securing	7	9	9	7	2.5	5
0.093	5	Source Compliance Screening and Blacklisting Mechanism	7	5	7	7	9	9
0.114	2	Dynamic Risk-Oriented Route Planning and Dispatching	3	3	5	5	9	5
0.085	7	Competency-Based Professional Training and Certification for HazMat	3	5	0.5	1	5	0.5
0.113	3	Intermodal and Cross-Organizational Joint Emergency Response Mechanism	3	5	5	7	9	1
0.133	10	On-site Supervision and Safety Culture Assessment	2.5	3	2.5	3	0.5	5
		Total	51.5	50	43	62	71	55.5
		Relative Weight	0.155	0.150	0.129	0.186	0.213	0.167

HoQ3: SMS Standards vs. Safety Culture & Measures Matrix .(managerial side)

Relative Weight	Priority Ranking	Safety Management System (SMS) Standards	Safety Behavior	Safety Training	Safety Knowledge	Safety Management	Safety Procedures	Technology
0.086	6	Full-Time Proactive Driver/Operator Monitoring System (DMS)	9	1	1	5	9	9
0.083	8	IoT-based Real-time Sensing Technology for Cargo and Equipment	9	1	5	5	9	9
0.072	9	Integrated Digital Platform for Hazardous Materials Information	9	9	1	9	9	9
0.104	4	Establishment of Standard Operating Procedures (SOPs)	9	9	9	9	9	9
0.119	1	Inspection Mechanism for Cargo Transport Unit (CTU) Loading and Securing	9	9	9	9	5	9
0.093	5	Source Compliance Screening and Blacklisting Mechanism	9	5	5	5	9	9
0.114	2	Dynamic Risk-Oriented Route Planning and Dispatching	5	1	1	5	9	5
0.085	7	Competency-Based Professional Training and Certification for HazMat	5	9	1	1	1	1
0.113	3	Intermodal and Cross-Organizational Joint Emergency Response Mechanism	1	5	1	5	9	1
0.133	10	On-site Supervision and Safety Culture Assessment	5	1	5	5	1	9
		Total	70	50	38	58	70	70 ³⁴
		Relative Weight	0.197	0.140	0.107	0.163	0.197	0.197

HoQ3: SMS Standards vs. Safety Culture & Measures Matrix .(technical side)

Relative Weight	Priority Ranking	Safety Management System (SMS) Standards	Safety Behavior	Safety Training	Safety Knowledge	Safety Management	Safety Procedures	Technology
0.086	6	Full-Time Proactive Driver/Operator Monitoring System (DMS)	5	5	5	9	9	9
0.083	8	IoT-based Real-time Sensing Technology for Cargo and Equipment	9	5	5	9	1	9
0.072	9	Integrated Digital Platform for Hazardous Materials Information	5	5	9	5	5	5
0.104	4	Establishment of Standard Operating Procedures (SOPs)	5	5	9	9	9	1
0.119	1	Inspection Mechanism for Cargo Transport Unit (CTU) Loading and Securing	9	9	9	9	9	1
0.093	5	Source Compliance Screening and Blacklisting Mechanism	1	5	9	9	9	1
0.114	2	Dynamic Risk-Oriented Route Planning and Dispatching	5	5	5	9	9	1
0.085	7	Competency-Based Professional Training and Certification for HazMat	9	9	9	9	9	1
0.113	3	Intermodal and Cross-Organizational Joint Emergency Response Mechanism	5	9	9	9	9	1
0.133	10	On-site Supervision and Safety Culture Assessment	9	1	9	9	9	1
		Total	62	58	78	86	78	30
		Relative Weight	0.158	0.148	0.199	0.219	0.199	0.077

Summary of Analysis Path

The Roadmap:

1. Satisfy "Emergency Response" needs...
2. By controlling "Management Negligence" risks...
3. Through "On-site Supervision" standards...
4. To build a "Safety Procedure (SOP)" culture.

Part 5: Conclusions & Recommendations

Conclusions

1. Service Gap: "Emergency Response" is the critical pain point.
2. Root Cause: Information opacity (Misdeclaration) and Management negligence.
3. Solution: Field supervision is prioritized over route planning.
4. Cultural Foundation: SOPs are the core; technology is secondary to procedural compliance.

Practical Implication 1: Prioritize SOPs

Strategy: Before investing heavily in AI/Tech, operators must refine and enforce Standard Operating Procedures (SOPs) at transfer interfaces.

Rationale: The "Technology Gap" shows that frontline staff will not accept digital tools if basic procedures are unclear.

Practical Implication 2: Strengthen Supervision

Strategy: Increase the frequency of physical inspections at port gates and container terminals.

Rationale: This is the most direct countermeasure against "Misdeclaration" and "Negligence".

Practical Implication 3: Digital Info Platform

Strategy: Establish a unified cross-modal digital platform for real-time sharing of SDS and UN Numbers.

Rationale: To solve the "Information Disconnection" risk identified by managers and ensure seamless handover.

Contributions & Limitations

- Contributions: Applied SQFD to Taiwan's multimodal context; quantified the "Managerial-Technical Perception Gap."
- Limitations: Sample skewed towards younger workforce; SQFD is a static assessment.
- Future Work: Integrate with SEM (Structural Equation Modeling) for dynamic validation

Thank you for listening!

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